© Academy of Management Journal
2008, Vol. 51, No. 5, 1014–1029.

INTERNATIONAL JOINT VENTURES AND THE VALUE OF GROWTH OPTIONS

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According to real options theory, international joint ventures (IJVs) offer valuable growth options, yet there has been no direct evidence of whether, and under what conditions, firms actually capture such value. We argue that an IJV's ownership structure, product-market focus, and geographic location are important contingencies affecting the value of embedded growth options. Our evidence confirms that IJVs do enhance firms' growth option values, but only under certain circumstances. Specifically, minority IJVs and diversifying IJVs contribute to growth option value, but other IJVs do not. The findings also challenge recent claims about the growth option value of investments in emerging economies.

Real options theory has attracted increasing attention in the strategy and management fields (e.g., Adner & Levinthal, 2004; McGrath, Ferrier, & Mendelow, 2004), and has been applied to a number of corporate investment contexts such as joint ventures (JVs). A central proposition of real options theory is that JVs confer valuable options to expand—or growth options—under conditions of uncertainty (Kogut, 1991). Studies to date have accumulated indirect empirical evidence affirming this perspective on JVs. For example, it has been shown that resolution of external uncertainty can lead firms to terminate JVs and alliances by acquisition in order to capitalize on the growth options (Folta & Miller, 2002; Kogut, 1991), and that firms' initial decisions to undertake JVs rather than alternative governance forms also conform to the real options logic (Folta, 1998).

However, despite their importance to advancing real options theory, existing studies have not yet provided direct evidence of whether firms actually capture growth option value from their investments in JVs. This may be because the theory is still at its early stages of development in general, but it also likely reflects important empirical challenges associated with testing the firm outcomes of investments in real options (Trigeorgis, 1996). In addition, although researchers have used formal models to analyze some of the conditions under which firms stand to gain the most from investing in JVs as options to expand (Chi, 2000), they have not developed or empirically tested contingency perspectives on the use of JVs to obtain valuable growth options.

In this article, we aim to extend the real options theory of JVs by accomplishing two objectives. First, we bridge the gap between theory and evidence by directly testing the theory's central proposition that JVs confer valuable growth options. To do so, we derive empirical estimates of firms' growth option values by integrating some of the foundational research on corporate valuation with more recent research on value-based management. Our approach can be used in a variety of settings to examine the unique benefits real options theory claims for firms; namely, that real options investments help firms enhance upside opportunities while limiting downside risk (McGrath, 1997; McGrath et al., 2004). Prior strategy research has examined the downside risk implications of real options (Reuer & Leiblein, 2000), and our study complements this research by also addressing the

In developing this research, we have benefited from helpful discussions with Jay Barney, Rich Bettis, and Michael Leiblein. We appreciate research funding from the School of Management at the State University of New York at Buffalo, the Wahlen Case Development and Research Fund at the UNC Kenan-Flagler Business School, the OSU and UNC Centers for International Business Education and Research, and the National Science Foundation (CAREER Grant SES 0552089). All views expressed are ours and do not necessarily represent those of the funding organizations.

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upside opportunities part of real options theory's argument. In view of real options theory's current stage of development, we believe that rigorous empirical tests that provide direct evidence on the firm outcomes associated with real options can serve as an important step toward better establishing the theory's usefulness and boundaries in strategy and management.

Given that the growth options embedded in JVs are likely to be valuable under conditions of uncertainty, our study focuses on different types of international joint ventures (IJVs), since IJVs tend to involve high levels of uncertainty (Barkema, Shenkar, Vermeulen, & Bell, 1997; Inkpen & Beamish, 1997; Lyles & Salk, 1996; Reuer & Tong, 2005). As one illustration, firms often use IJVs to enter emerging markets to target growth opportunities, but there has been very little research on real options and IJVs in emerging economies (Hoskisson, Eden, Lau, & Wright, 2000; Peng, 2000, 2003). We develop the theoretical argument that IJVs in emerging economies in particular provide valuable growth options, and our study compares the growth option value implications of IJVs located in emerging economies with those of IJVs located in developed economies.

Our second, and related, objective is to develop a contingency view of growth options in IJVs by examining how some key IJV characteristics can differentially affect firms' growth option values rather than invoking real options arguments in a universalistic fashion or assuming they apply to all such ventures. More specifically, we use real options theory to bring together three core IJV attributes that have been examined in prior studies using different theoretical lenses and have generated inconclusive findings; namely, IJVs' ownership structure, product-market focus, and geographic location. For instance, studies on the performance effects of IJV ownership and control have yielded mixed results (e.g., Beamish, 1985; Mjoen & Tallman, 1997), and we focus on the influence of IJVs' ownership structure on growth option values. Regarding product-market focus, although some researchers have found that both diversifying and nondiversifying JVs are valuable (e.g., Chan, Kensinger, Keown, & Martin, 1997), others have shown that diversifying JVs generate more shareholder wealth (e.g., Balakrishnan & Koza, 1993; Reuer & Koza, 2000). Finally, on geographic location, some studies have shown that IJVs in emerging economies increase firm value (e.g., Chen, Hu, & Shieh, 1991), but others have indicated that IJVs in emerging economies often fail and may destroy value (e.g., Beamish, 1985; Prahalad & Lieberthal, 2003).

These studies have been conducted in different fields and have largely developed separately from one another. However, researchers have increasingly noted the need to integrate the effects of ownership, product-market diversification, and geographic location when conducting international strategy research (e.g., Barkema et al., 1997; Dunning, 1995; Hitt, Hoskisson, & Kim, 1997; Tallman & Li, 1996). Currently, no unifying framework captures the underlying relationships among these distinct attributes of IJVs. In the present study, we suggest that real options theory can provide such a framework, because these attributes can be linked to the value of embedded growth options (Chi & McGuire, 1996; Hurry, Miller, & Bowman, 1992; Kim & Kogut, 1996; Vassolo, Anand, & Folta, 2004).

THEORETICAL BACKGROUND

Real Options Theory and Growth Option Value

Real options theory traces its intellectual roots to Myers's (1977) initial insight of viewing a firm's discretionary future investment opportunities as growth options, or "call options on real assets," in that the firm has the discretion to decide in the future whether or not it wants to exercise the option to undertake these investments. Myers's (1977) seminal idea has provided a useful perspective for understanding the theory of corporate valuation and allows one to estimate a firm's growth option value. Specifically, his work extended the valuation theory formalized by Miller and Modigliani (1961) and partitioned the value of a firm (V) into the value of assets in place (V_{AIP}) and the value of growth options (V_{GO}):

$$V = V_{AIP} + V_{GO}. \quad (1)$$

Kester (1984) provided the first set of empirical estimates of growth option value, defined as the proportion of a firm's market value that is attributable to growth options. He measured the firm's value of growth options (V_{GO}) as the difference between its market value (V) and the capitalized value of its current earnings stream, which represents the value of the firm without growth options; that is, the value of assets in place (V_{AIP}). He then calculated a firm's growth option value (GOV) as the value of growth options (V_{GO}), stated as a percentage of the market value (V):

$$\textit{Growth option value} = V_{GO}/V = (V - V_{AIP})/V$$
$$= (V - \textit{current earnings/discount rate})/V. \quad (2)$$

Kester found that many firms have growth option values over 50 percent and as high as around 90 percent. A similar estimation approach can be

found in other related work (e.g., Alessandri, Lander, & Bettis, 2002; Brealey & Myers, 2000; Strebel, 1983; Tong & Reuer, 2006).

Researchers have noted that many corporate investments create valuable future growth opportunities and contribute to growth option value. Myers (1977), for instance, suggested that valuable growth options may originate from investments in research, advertising, JVs, and so forth (see also Myers, 1984). Kester (1984) found that firms in industries with a high-technology component, such as electronics, computers, and chemicals, tend to have greater growth option values than those in food processing or tire manufacturing. Kogut and colleagues suggested that JVs, technology and knowledge platforms, and investments in emerging markets create valuable growth options (Kim & Kogut, 1996; Kogut, 1991; Kogut & Kulatilaka, 1994).

Real Options Theory and Joint Ventures

Myers's (1977) idea also provides a guide for managers making decisions under uncertainty (Bowman & Hurry, 1993; Kogut & Kulatilaka, 2001; McGrath, 1997), such as those regarding investments in R&D (Mitchell & Hamilton, 1988), JVs (Kogut, 1991), emerging markets (Kogut & Kulatilaka, 1994), and entrepreneurial initiatives (McGrath, 1999). Of specific interest to us is the application of real options theory to JVs. Kogut (1991) provided the first set of theoretical arguments and empirical evidence that firms invest in JVs to obtain growth options and sequentially expand into new and uncertain markets. JVs provide valuable growth options because, by entering into JVs, a firm is able to limit its downside losses to an initial, limited commitment, as well as to position itself to expand—but only if future circumstances turn out favorably. Specifically, in Kogut's model the firm undertakes expansion by exercising the option of acquiring equity from a partner when a positive demand shock materializes. Modeling JVs as akin to call options stands in contrast to previous research using organizational learning (Lane & Lubatkin, 1998) and transaction cost theory (Pisano, 1989) that highlights ex post knowledge appropriability hazards and other potential losses. This treatment of JVs also differs from that in prior research that portrayed JV termination as collaborative failure.

Using formal models, Chi and colleagues analyzed the gains from obtaining real options through JVs (Chi, 2000; Chi & McGuire, 1996). Their work has examined the circumstances under which the option to acquire or sell out a JV provides positive economic value for partners, under various assumptions such as divergence in firms' ex post valuations of the JV, ex ante asymmetry in their anticipation of the possibility of such ex post divergence, and the presence or absence of agreements to purchase equity from a partner at a prespecified price (see also Reuer & Tong, 2005).

HYPOTHESES

International Joint Ventures

It is useful to start with the general observation that firms investing in JVs, whether domestic or international, face various sources of uncertainty, which can positively affect the growth option value embedded in JVs. These uncertainties can stem from factor and product-market conditions, the evolution of technology trajectories, and so on, and they are likely to magnify in an international setting wherein partners come from different cultural backgrounds and bring together different social and business norms (Kedia & Bhagat, 1988). For example, trust may be lower between partners that are socially dissimilar or culturally distant (Barkema, Bell, & Pennings, 1996; Barkema & Vermeulen, 1997). Foreign investors in particular need to learn new "rules of the game" in host countries to overcome the "liability of foreignness" (Zaheer & Mosakowski, 1997). In addition, IJVs also experience some unique sources of uncertainty owing to heterogeneous external environments across national borders (Sundaram & Black, 1992). For example, input prices reflect changes in exchange rates as well as macroeconomic factors. Foreign investors may also be exposed to significant political uncertainty, especially in emerging economies where a large number of IJVs have been established (Delios & Henisz, 2000; Lyles & Salk, 1996; Peng, 2000, 2003; Steensma & Lyles, 2000).

IJVs have long been viewed as an attractive foreign market entry vehicle because their structural attributes help firms reduce risk (Reuer & Leiblein, 2000). By engaging in IJVs rather than outright acquisitions, for instance, firms can spread risk over multiple capital providers, and such benefits have long been documented as an important motive for IJV formation in capital- and research-intensive industries (e.g., Contractor & Lorange, 1988). By entering into IJVs, multinational corporations (MNCs) can also rely upon local partners' resources to manage risk, including their local knowledge, relationships with local government, and so forth (e.g., Gomes-Casseres, 1996; Inkpen & Beamish, 1997).

Early models of firms' sequential investment process captured many of these dynamics (e.g., Johan-

son & Vahlne, 1977), and the real options view of IJVs builds upon this work through increased formalization. For instance, in contrast to these early models, real options theory parameterizes various sources of uncertainty and identifies key value drivers underlying corporate investments with embedded options. The real options view also makes other unique contributions relative to this early stream of research in international business. For example, by highlighting the asymmetry between a firm having the right, but not the obligation, to expand after making an initial, limited investment, real options theory portrays the firm as exploiting sources of uncertainty rather than avoiding uncertainty (Kogut, 1991: 32).

In sum, at the core of real options theory is the insight that IJVs are attractive not only because they enable reduction of downside risk, but also because they enable firms to access upside opportunities by expanding sequentially as new information on key sources of uncertainty becomes available. Changes in product-market demand, input prices, exchange rates, and so forth can elevate the value of such ventures in such a way that a firm expands and exercises its growth options. However, the firm is not compelled to expand if situations are not favorable. For these reasons, IJVs are often viewed as attractive stepping stones toward more extensive investments in a host country (Kogut, 1991; Kogut & Kulatilaka, 1994), and firms with a portfolio of such investments have discretion over which ventures to develop further to seize emerging opportunities (Bowman & Hurry, 1993). Thus:

Hypothesis 1. The greater a firm's number of IJVs, the greater its growth option value.

As mentioned earlier, we expect IJVs in general to confer valuable growth options, but we would also like to further isolate some of the specific sources of option value in order to provide a contingency view of growth options in IJVs. Toward this end, we follow prior authors and classify IJVs into different types (e.g., Barkema et al., 1997), and our classification is based upon three important IJV attributes: ownership structure, product-market focus, and geographic location. Although these IJV attributes have been studied extensively, prior researchers have tended to treat them separately, despite recent calls to consider them in a more integrative way (e.g., Barkema et al., 1997; Dunning, 1995; Hitt et al., 1997; Tallman & Li, 1996). As we suggest below, real options theory can offer a useful way to consider these attributes together.

The Ownership Structure of IJVs

Kogut's (1991) model suggests that the growth option value embedded in a JV is inversely related to a firm's ownership position, everything else being constant. This relationship is manifested in the way the firm captures value: A firm makes an initial investment in a JV and then monitors market and other cues over time to determine if the venture's value is such that expansion via the acquisition of additional equity from the partner is warranted. Thus, by holding less equity, the firm is able to put less capital at risk up front, as well as capture greater value if conditions prove to be favorable ex post. This argument is consistent with Hurry and colleagues' (1992) hypothesis and finding that Japanese venture capitalists follow more of an option strategy than their U.S. counterparts, by making smaller individual investments yet a larger number of investments and thus capturing a wider range of future opportunities.

Formally stated, if V_c is the value the call holder places on an entire venture, α_{c0} is the call holder's initial equity (where $0 < \alpha_{c0} < 1$), and P is the price at which the subsequent equity purchase occurs, then the firm will gain $([1 - \alpha_{c0}]V_c - P)$ by acquiring the JV, and will hold the option open otherwise (i.e., if $[1 - \alpha_{c0}]V_c < P$). A lower level of initial equity α_{c0} therefore contributes to a higher growth option value, everything else being constant. A lower ownership level therefore reduces the firm's downside risk in the collaboration, though still allowing it to potentially benefit from the venture's upside opportunities. By contrast, higher initial ownership stakes in IJVs involve greater initial commitments, and the terminal value of the call option is lower, everything else being constant. Thus, according to Kogut (1991), minority IJVs—in which a firm holds an equity stake of less than 50 percent—may represent a better means of capturing growth option value than IJVs involving greater ownership (see also Chi & McGuire, 1996). Dunning (1995) also argued that minority IJVs are especially well suited for exploring opportunities and knowledge in uncharted territories. Therefore, we propose:

Hypothesis 2. The number of a firm's minority IJVs has a greater impact than the number of its nonminority IJVs on the firm's growth option value.

The Product-Market Focus of IJVs

The growth option value a firm derives from IJVs may reflect not only the IJVs' ownership structure, but also the ventures' product-market focus, as this

affects the uncertainty facing the firm in the cross-border collaboration. We predict that noncore IJVs—namely, IJVs outside of the firm's primary business—will have a greater positive impact on the firm's growth option value than core IJVs in the firm's primary business, for several reasons. First, prior studies on real options and alliances have shown that growth options become more salient in new and exploratory activities (Folta, 1998; Hurry et al., 1992; Vassolo et al., 2004). Using an implementation perspective on real options, recent conceptual advances also suggest that a firm is more likely to manage diversifying businesses such as noncore JVs according to a real options approach, given that such businesses are more distinct from the firm's primary business, making option exercise decisions organizationally easier to structure (Adner & Levinthal, 2004). Second, prior authors have found that JVs are more often used for diversifying into new businesses (e.g., Balakrishnan & Koza, 1993; Hagedoorn, 1993; Reuer & Koza, 2000; Stopford & Wells, 1972), and that such ventures are attractive because they can help the firm overcome "local search" and reach out for new and more distant capabilities (e.g., Ireland, Hitt, & Vaidyanath, 2002; Rosenkopf & Almeida, 2003). Analysis based on real options theory indicates that new capabilities especially confer option value because of the heightened uncertainty surrounding their uses in exploratory environments (Kogut & Kulatilaka, 2001).

Third, the literature on diversifying JVs can be related to the broader literature on diversification that incorporates an emerging real options perspective. For instance, Kim and Kogut (1996) applied real options analysis to diversification and found that diversification helps build "knowledge platforms," permitting a firm to leverage a wider array of distant market opportunities. Raynor (2000) suggested that diversification can be viewed as providing valuable growth options because of future synergistic opportunities and found that these options can lead to a diversification premium. Matsusaka (2001) developed a model framing the formation of uncertain new ventures as offering real options to the firm searching for growth opportunities in new industries. In addition, using JVs in particular for diversification has an added advantage in that they provide organizational flexibility with which to address the uncertainty due to operating in new business environments (Dyer, Kale, & Singh, 2004). Unlike acquisitions that involve a terminal sale (Bergh & Lawless, 1998), diversifying JVs allow a firm to experiment with new capabilities, limit its exposure to uncertainty via shared ownership, and exploit future opportunities by exercising the growth options (Kogut, 1991). Thus, we propose:

Hypothesis 3. The number of a firm's noncore IJVs has a greater impact than the number of its core IJVs on the firm's growth option value.

The Geographic Location of IJVs

In addition to product-market focus, the uncertainty surrounding an IJV, and hence its growth option value, may also reflect the venture's geographic focus. Our investigation of the location effects of IJVs follows a recent strand of international strategy research by focusing on the differences between developed and emerging economies (e.g., Hitt, Ahlstrom, Dacin, Levitas, & Svobodina, 2004; Hitt, Dacin, Levitas, Arregle, & Borza, 2000; Hoskisson et al., 2000; Wright, Filatotchev, Hoskisson, & Peng, 2005). Emerging economies can be defined along dimensions such as growth rate or market size, but scholars have argued that the most important criterion differentiating the two groups of countries is the development of market-supporting institutions (Khanna & Palepu, 1997). These are formal institutions embodied in rules and regulations that facilitate the efficient functioning of markets and reduce the risk of failures in product, labor, and capital markets (Peng, 2003). In developed economies, these institutions are well developed, and firms can rely upon them to a good extent. In emerging economies, by contrast, although certain market-supporting institutions have been established, overall many institutional voids wait to be filled. The underdevelopment of these institutions in an emerging economy presents many sources of uncertainty to firms operating there, concerning areas such as supply and demand conditions, property rights, and sudden changes in government policies (Delios & Henisz, 2000; Hoskisson et al., 2000; Peng, 2000, 2003; Wright et al., 2005). According to real options theory, the higher levels of uncertainty in emerging economies should elevate the growth option value of IJVs in such locations in particular.

Although firms operating in emerging economies need to deal with considerable uncertainty, they may also stand to benefit from growth opportunities that are either untapped or will only materialize in the future with the further development of market-supporting institutions (Hoskisson et al., 2000; Peng, 2000, 2003; Prahalad & Lieberthal, 2003). Firms may also derive valuable growth options in other international market contexts, but recent research suggests that growth options considerations are particularly salient in emerging economies. These options may

explain why MNCs routinely undertake seemingly negative net present value investments in new and uncertain foreign markets (Chen et al., 1991; Pantzalis, 2002). Hence, we propose:

Hypothesis 4. The number of a firm's IJVs in emerging economies has a greater impact than the number of its IJVs in developed economies on the firm's growth option value.

DATA AND METHODS

Sample and Data

One challenge for this research was to derive an estimate of firms' growth option values. We drew the data used to calculate this measure from the Stern Stewart Performance 1000, developed by Stern Stewart & Co., a financial consultancy that specializes in the measurement of shareholder wealth. The data set includes Stern Stewart's annual rankings of the 1,000 largest U.S. publicly traded companies, based on their market value added (MVA). Besides MVA, the data set also provides Stern Stewart's estimates of other value-based measures, such as economic value added (EVA), capital invested (CI), and the weighted average cost of capital (WACC), which we combined to derive an estimate of firms' growth option values (demonstrated below). Measures such as EVA and MVA in the Stern Stewart data set have also recently been used in strategy research (e.g., Hawawini, Subramanian, & Verdin, 2003). We also obtained firms' accounting data from Compustat and firms' JV information from the Securities Data Company (SDC) database, and then merged the data from these two sources with the Stern Stewart data.

We imposed several sampling criteria on the merged data set. First, we restricted the sampling frame to the period 1989–2000 (inclusive), because the SDC database started to record JV announcements in 1985 and we sought to have a five-year rolling window, over which to calculate a firm's number of JV investments. Second, we only focused on manufacturing firms (i.e., SICs 2000–3999), which reduced the sample size to 420 from the initial 1,000. Conglomerates (e.g., General Electric), or those firms assigned an SIC of 9997 rather than a primary industry, were not included in these 420 firms. Using a manufacturing sample facilitated comparisons with previous findings and addressed differences in IJV investment activities and accounting practices across industry sectors. After accounting for missing data, these screening procedures yielded an unbalanced panel data set comprising 293 firms and a total of 2,698 firm-year observations in 19 two-digit SIC industries. For this data set, we deflated all financial figures to the base year 1989 to account for inflation, using gross domestic product deflators provided by the U.S. Bureau of Economic Analysis.

Variables and Measurement

Growth option value. The dependent variable, *growth option value*, is the portion of a firm's value attributable to growth options. Specifically, we used the Stern Stewart data to calculate a firm's growth option value according to the following equation:

$$\text{Growth option value} = V_{GO}/V = (V - CI - PV \text{ of } EVA)/V, \quad (3)$$

where the present value of the economic value added is calculated by treating the firm's current EVA as a perpetuity discounted by the firm's weighted average cost of capital. All the other terms on the right side of the equation, as well as the estimate of the firm's WACC, are available from the Stern Stewart data set. The Appendix provides a brief explanation of these terms and how they are used in the derivation, and more detailed discussions can be found elsewhere (e.g., Stewart, 1991; Young & O'Byrne, 2001).

Our approach to calculating growth option value bears a number of similarities to that in Kester (1984) (i.e., Equation 2), but our estimation represents several improvements owing to our use of the Stern Stewart data set. First, this data set provides firm-specific discount rates (i.e., WACC) that helped us avoid applying some arbitrary discount rate across firms. Second, the data set's value-based measures, such as EVA, account for firms' full capital costs and are better proxies for economic profit than earnings, which only incorporate the cost of debt capital. Third, these measures also make adjustments to account for accounting policies that may distort the true level of firms' invested capital or operating performance. Other major improvements include adjustments to goodwill, provisions, and operating leases (see Stewart, 1991).[1]

We found that the average firm in our sample had

[1] We also calculated alternative measures of growth option value, following Kester (1984). These included a measure based on Compustat's earnings data and Stern Stewart's estimates of firm-specific discount rates (i.e., WACC), and three other measures that used discount rates of 15, 20, and 25 percent, respectively, to discount Stern Stewart's value-based measure EVA. We found that these measures all had high correlations with our measure (i.e., $r > .86$, $p < .001$) and that the results were qualitatively similar when they were used in the regressions.

a growth option value of 43 percent, and in line with Kester, there were large interindustry differences (see also Tong & Reuer, 2006). Firms in industries with relatively heavy technology components tend to have a larger growth option value, such as electrical equipment (SIC 36; 54%), measuring, analyzing, and controlling instruments (SIC 38; 50%), chemical and allied products (SIC 28; 48%), and industrial and commercial machinery (SIC 35; 45%). On the other hand, firms in industries with fewer technology components, such as stone, clay, glass, and concrete (SIC 32; 12%), furniture and fixtures (SIC 25; 20%), and textile mill products (SIC 22; 22%), tend to derive much less value from growth options.

Explanatory variables. Our theoretical variables were the numbers of various types of equity JV investments, and we operationalized them using the same approach as Barkema and colleagues (1997), which is consistent with earlier research (e.g., Berg & Friedman, 1981; Duncan, 1982). Specifically, we used the SDC database to track a firm's JVs and counted the number of domestic and international JVs that the firm had during a five-year rolling window, in order to construct a firm-level measure to test Hypothesis 1. The selection of the five-year window represents a compromise, in that longer time windows might count JVs that may have either terminated or be of less relevance to the firms' future growth initiatives, whereas very short time intervals may fail to capture important investments.

To test Hypotheses 2–4, we needed to develop more disaggregated measures of IJVs based on ownership structure, product-market focus, and geographic location. We therefore classified each IJV as (1) either a minority (i.e., less than 50%) or a nonminority IJV (i.e., 50% and above); (2) either a core or a noncore IJV, depending on whether or not it operated in the firm's primary business at the four-digit SIC level; and (3) as located either in an emerging/developing economy or in a developed economy, as defined by the United Nations (based on the World Bank's *World Development Indicators 2004*). Developed economies were 24 high-income Organisation for Economic Cooperation and Development members, all of which were represented in our sample. All the other countries were considered emerging/developing economies. We then counted the numbers of minority and nonminority IJVs, core and noncore IJVs, and IJVs located in emerging and developed economies, respectively, and entered them in the regressions.

Control variables. First, we controlled for firm size, since larger firms tend to have larger IJV portfolios and may have more resources available for investments in growth opportunities. We measured firm size as a firm's total sales normalized by the industry average. Second, we controlled for capital structure because corporate debt policy can affect firms' investment decisions, and it also relates to growth option value (Myers, 1977). We calculated financial leverage as the ratio of a firm's long-term debt to its total capital. Third, we controlled for organizational slack, given its role in releasing resources for discretionary investment (Nohria & Gulati, 1996). We focused on a firm's absorbed slack and measured organizational slack as the ratio of a firm's selling, general, and administrative expenses to its total sales (Singh, 1986). Fourth, we controlled for firms' investments in R&D, since R&D investment can be viewed as conferring real options because of the sequential and discretionary nature of these projects (Mitchell & Hamilton, 1988). Because the effects of R&D investment can persist over time, prior studies have suggested that measures of R&D investment include both current-year R&D expenditures and accumulated investments in R&D. We followed a number of prior studies (e.g., Hall, 1993) and applied a 15 percent depreciation rate to a firm's R&D expenditures, going back four years before scaling the sum by its current-year total sales. Fifth, we controlled for industry growth options, defined as the mean growth option value for all other firms in the focal firm's industry. Incorporating this time-varying, firm-specific variable controlled for industry-level heterogeneity. Sixth, we controlled for the number of domestic JVs (see also Barkema et al., 1997). Finally, we controlled for firm fixed effects and year fixed effects to account for unobserved firm heterogeneity and effects of economy-wide factors.

Analytical Approach

Several theoretical and practical considerations drove our decision to use panel data models to estimate the influence of various types of IJVs on a firm's growth option value. Theoretically, one should use panel data models rather than ordinary least squares if specification tests suggest rejection of the null hypothesis of equal individual effects (i.e., firm effects), and this can be done through *F*-tests (Hsiao, 2003). The null hypothesis of equal firm effects was rejected via *F*-statistics, as reported below in the results section, indicating that the use of panel data models was appropriate. Practically, panel data models offer a number of advantages over purely cross-sectional models, such as controlling for individual heterogeneity, reducing multicollinearity problems as well as omitted variable bias, and contributing to enhanced estimation effi-

TABLE 1
Descriptive Statistics and Correlation Matrix[a]

Variable	Mean	s.d.	1	2	3	4	5	6	7
1. Growth option value	0.43	0.29							
2. Firm size	0.03	0.06	−.19						
3. Financial leverage	0.18	0.15	−.25	.06					
4. Organizational slack	0.25	0.14	.38	−.14	−.22				
5. R&D stock	0.17	0.21	.38	−.18	−.26	.64			
6. Industry growth option value	0.47	0.19	.35	−.24	−.10	.29	.24		
7. Domestic joint ventures	1.36	2.74	−.03	.18	−.04	−.16	−.01	−.01	
8. International joint ventures	2.64	6.92	−.04	.24	−.01	−.20	−.07	−.01	.76

[a] $n = 2{,}698$. All correlations with absolute values greater than .04 are significant at $p < .05$.

ciency (Greene, 2003; Hsiao, 2003). Given that panel data can be modeled by treating the individual effects either as fixed or as random, we conducted a Hausman-Wu test to determine the appropriate analytical approach. The test statistic indicated that the null hypothesis of no correlation between the individual effects and regressors could be rejected; therefore, we chose a fixed-effects model. By including firm-specific intercepts in the regression, a fixed-effects model further captures unobserved (firm) heterogeneity that may not be captured by the control variables (Hall, 1993). However, a fixed-effects model cannot estimate time-invariant effects such as industry fixed effects (Hsiao, 2003).[2]

Regarding the tests of the individual hypotheses developed above, we tested Hypothesis 1 by considering the coefficient estimate of the IJVs variable obtained from fixed-effects panel data regression analysis. Hypotheses 2–4 are different from Hypothesis 1 in that they are stated in comparative terms, and the two subcategories of IJVs in each of these hypotheses are mutually exclusive and collectively exhaustive. The two subcategories of IJVs therefore add up to the total number of IJVs that each firm has, and Hypotheses 2–4 are all nested under Hypothesis 1. Thus, we tested Hypotheses 2–4 by performing hierarchical *F*-tests (Neter, Kutner, Nachtsheim, & Wasserman, 1996) as well as by considering the coefficient estimates of the two subcategories of IJV variables in each of the three hypotheses.

[2] We sought to compare some of the characteristics of firms over years to address possible sample selection bias due to the use of an unbalanced panel data set. We noted a slight increase in firm size and a relatively flat trend of profitability, both of which are consistent with the data patterns reported in McGahan and Porter (1997) for the Compustat universe. These findings suggested that sample selection was not an issue (Greene, 2003). Our sensitivity analyses also revealed that the results were unchanged when we followed prior work by including dummy variables to capture firms' entry into or exit from the sample, and when we examined the balanced subsample that only consisted of firms appearing throughout the whole 12-year period (i.e., 142 firms with 1,704 firm-year observations).

RESULTS

Table 1 reports means, standard deviations, and correlations. For our sample of firms, the average number of IJVs formed is 2.64, and of these, 28 percent were minority IJVs, 56 percent were diversifying IJVs, and 63 percent were IJVs in emerging economies. We investigated potential multicollinearity problems in several ways. We found that the maximum variance inflation factor value obtained for the models was 3.3, which is below the rule-of-thumb threshold value of 10 indicative of multicollinearity problems (Neter et al., 1996). In addition, the maximum condition index is 10.3, substantially below the usual accepted cutoff value of 30 (Belsley, Kuh, & Welsch, 1980). We also examined the proportion of the variation of the coefficient estimates accounted for by each variable, and we found that the variable with the highest condition index did not contribute strongly to the variation of two or more variables (Belsley et al., 1980). Therefore, as suggested by Hsiao (2003), multicollinearity does not appear to be a concern for our panel data set.

Table 2 reports regression results for different types of JVs and the control variables. Model 1 is the baseline model including all of the control variables. Model 2 adds to model 1 the number of JVs in which a firm had invested. Both models are highly significant ($p < .001$), and a hierarchical *F*-test comparing the two models suggests that adding the JVs variable to model 2 significantly increases its explanatory power ($F = 5.11$, $p < .05$). In model 2, the coefficient estimate for the JVs variable is pos-

TABLE 2
Results of Fixed-Effects Regression Analyses[a]

Independent Variables	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Intercept	0.11	(0.07)	0.09	(0.07)	0.08	(0.07)	0.08	(0.07)	0.09	(0.07)	0.08	(0.07)
Firm size	0.64	(0.47)	0.66	(0.45)	0.66	(0.45)	0.65	(0.45)	0.66	(0.45)	0.65	(0.44)
Financial leverage	−0.17**	(0.06)	−0.16**	(0.06)	−0.16**	(0.06)	−0.17**	(0.06)	0.17**	(0.07)	−0.17**	(0.06)
Organizational slack	0.28	(0.23)	0.28	(0.22)	0.28	(0.22)	0.29	(0.22)	0.27	(0.22)	0.29	(0.22)
R&D stock	0.47***	(0.11)	0.47***	(0.11)	0.47***	(0.11)	0.47***	(0.11)	0.47***	(0.10)	0.47***	(0.11)
Industry growth option value	0.35***	(0.06)	0.35***	(0.06)	0.35***	(0.06)	0.35***	(0.06)	0.35***	(0.06)	0.34***	(0.06)
Year fixed effects[b]	4.10***		4.26***		4.26***		4.22***		4.25***		4.26***	
Firm fixed effects[b]	4.90***		5.00***		5.00***		4.86***		5.02***		4.99***	
Joint ventures ($\times 10^{-2}$)			0.53**	(0.17)								
Domestic JVs ($\times 10^{-2}$)					0.70	(0.55)	0.62	(0.55)	0.61	(0.57)	0.57	(0.56)
International JVs ($\times 10^{-2}$)					0.48**	(0.19)						
Minority IJVs ($\times 10^{-2}$)							1.58**	(0.56)				
Nonminority IJVs ($\times 10^{-2}$)							0.02	(0.43)				
Core IJVs ($\times 10^{-2}$)									−0.09	(0.32)		
Noncore IJVs ($\times 10^{-2}$)									0.89**	(0.27)		
IJVs in developed economies ($\times 10^{-2}$)											1.30*	(0.53)
IJVs in emerging economies ($\times 10^{-2}$)											0.19	(0.23)
Adjusted R^2	.485		.489		.489		.490		.490		.490	
Model F	24.70***		24.68***		23.29***		22.39***		22.34***		22.33***	
Hierarchical F			5.11*				5.49*		4.99*		4.44*	

[a] n = 2,698. Huber-White-Sandwich robust standard errors appear in parentheses.
[b] F-statistics for the null hypothesis of equal year or firm effects.
* $p < .05$
** $p < .01$
*** $p < .001$

itive and significant ($p < .01$), indicating that a firm's investments in JVs in general enhance growth option value.[3] Models 3–6 empirically test Hypotheses 1–4. Specifically, model 3 tests Hypothesis 1 and reports the impact of a firm's IJVs on its growth option value. Models 4–6 test Hypotheses 2–4 by examining the contingent effects of IJVs' ownership structure, product-market focus, and geographic location, respectively. All four models are highly significant ($p < .001$). The table provides hierarchical F-statistics for models 4–6; model 3 is the reduced model.

Hypothesis 1 predicted that a firm's growth option value is positively related to the number of its IJVs. In model 3, the coefficient estimate for the IJVs variable is positive and significant ($p < .01$), supporting Hypothesis 1. Hypothesis 2 posited that minority IJVs contribute to growth option value more strongly than nonminority IJVs. An initial comparison of the coefficients of the two variables in model 4 shows that minority IJVs have a positive and significant impact on growth option value ($p < .01$), and nonminority IJVs do not. We statistically compared the coefficients by conducting a hierarchical F-test, and the result revealed that the difference between the effects of the two types of IJVs on growth option value is statistically significant ($F = 5.49$, $p < .05$). These results support Hypothesis 2. Hypothesis 3 predicted that diversifying IJVs matter more importantly to growth option value than nondiversifying IJVs. In model 5, the coefficient of diversifying IJVs is positive and significant ($p < .01$), and the parameter estimate for nondiversifying IJVs is negative and nonsignificant. The result of the F-test confirmed the statistical significance of

[3] We conducted two tests to address the concern for possible endogeneity of firms' JV investments. First, we separated firms that invested in JVs from those that did not, allowing the implementation of a Heckman model to test whether the results might be subject to any endogeneity bias. We found that the JVs variable had a positive and significant effect and the inverse Mills ratio term was not significant. Second, we estimated the models using the instrumental variables approach described in Greene (2003). We created both a "just-identified" case by using firm size as an instrumental variable to predict JVs, and an "overidentified" case, in which a lagged endogenous variable was added as another instrument. The JVs variable remained positive and significant in both cases. These results are available upon request.

TABLE 3
Results for IJVs in Developed versus Emerging Economies[a]

Independent Variables	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Intercept	0.08	(0.07)	0.08	(0.07)	0.08	(0.07)	0.08	(0.07)	0.09	(0.07)	0.08	(0.07)
Firm size	0.69	(0.43)	0.64	(0.42)	0.62	(0.44)	0.61	(0.41)	0.66	(0.42)	0.64	(0.42)
Financial leverage	−0.17**	(0.06)	−0.17**	(0.06)	−0.17**	(0.06)	−0.18**	(0.06)	−0.17**	(0.06)	−0.17**	(0.06)
Organizational slack	0.30	(0.22)	0.29	(0.22)	0.29	(0.22)	0.30	(0.22)	0.30	(0.22)	0.29	(0.22)
R&D stock	0.47***	(0.11)	0.47***	(0.11)	0.47***	(0.11)	0.47***	(0.11)	0.47***	(0.11)	0.47***	(0.11)
Industry growth option value	0.34***	(0.06)	0.35***	(0.06)	0.34***	(0.06)	0.35***	(0.06)	0.34***	(0.06)	0.34***	(0.06)
Year fixed effects[b]	4.23***		4.21***		4.19***		4.35***		4.32***		4.20***	
Firm fixed effects[b]	4.98***		5.01***		4.88***		5.04***		4.89***		5.05***	
Domestic JVs ($\times 10^{-2}$)	0.53	(0.57)	0.56	(0.58)	0.60	(0.56)	0.56	(0.57)	0.55	(0.57)	0.57	(0.57)
IJVs in developed economies ($\times 10^{-2}$)					1.25	(0.54)	1.24*	(0.50)				
Minority IJVs in developed economies ($\times 10^{-2}$)	3.25***	(0.88)							3.19***	(0.86)		
Nonminority IJVs in developed economies ($\times 10^{-2}$)	0.41	(0.73)							0.36	(0.74)		
Core IJVs in developed economies ($\times 10^{-2}$)			0.79	(1.03)							0.82	(1.09)
Noncore IJVs in developed economies ($\times 10^{-2}$)			1.78***	(0.48)							1.67**	(0.51)
IJVs in emerging economies ($\times 10^{-2}$)	0.16	(0.22)	0.19	(0.21)								
Minority IJVs in emerging economies ($\times 10^{-2}$)					1.43*	(0.70)			1.39†	(0.74)		
Nonminority IJVs in emerging economies ($\times 10^{-2}$)					0.06	(0.36)			0.02	(0.35)		
Core IJVs in emerging economies ($\times 10^{-2}$)							−0.45	(0.46)			−0.36	(0.47)
Noncore IJVs in emerging economies ($\times 10^{-2}$)							0.70*	(0.33)			0.68*	(0.34)
Adjusted R^2	.491		.490		.490		.490		.491		.490	
Model F	21.63***		21.21***		21.35***		21.47***		20.72***		20.43***	
Hierarchical F	7.11**		1.12		2.92†		3.87†		4.82**		2.09	

[a] n = 2,698. Huber-White-Sandwich robust standard errors appear in parentheses.
[b] F-statistics for the null hypothesis of equal year or firm effects.
† $p < .10$
* $p < .05$
** $p < .01$
*** $p < .001$

this difference ($F = 4.99$, $p < .05$); thus, there is support for Hypothesis 3. Finally, Hypothesis 4 suggested that IJVs in emerging economies are more strongly related to growth option value than IJVs in developed economies. However, results in model 6 show that growth option value is positively and significantly associated with IJVs in developed economies ($p < .05$), but not with IJVs in emerging economies. The F-statistic also confirmed the significant difference between the estimates ($F = 4.44$, $p < .05$); hence, Hypothesis 4 is not supported.[4]

Given the lack of support for Hypothesis 4, we sought to investigate further the differential effects of more disaggregated measures of IJVs in developed economies and emerging economies; Table 3 reports the results. Models 1 and 2 disaggregate IJVs in developed economies, models 3 and 4 disaggregate IJVs in emerging economies, and models 5 and 6 disaggregate IJVs in developed economies and in emerging economies simultaneously. These models thus present finer-grained results on the combined effects of IJV ownership structure, product-market focus, and geographic location. All of the models are significant at the .001 level. Hierarchical F-statistics are provided for each of the models, with model 6 in Table 2 as the reduced model.

In models 1 and 2 of Table 3, it is shown that minority and diversifying IJVs in developed economies are positively and significantly related to growth option value ($p < .001$), but only model 1 indicates a significant difference between minority and nonminority ventures ($F = 7.11$, $p < .01$). Models 3 and 4 indicate that among IJVs in emerging economies, those with a minority position and a diversifying focus contribute significantly to grow option value ($p < .05$), and separate F-tests provide

[4] Our results were robust to the use of two- and three-digit SIC levels to define core versus noncore IJVs, and to the use of alternative definitions adopted by Hoskisson et al. (2000) and the *Economist* to define emerging economies versus developed economies. We also separated minority IJVs into those in which a focal firm owned less than 25 percent versus those in which ownership was above 25 percent but less than 50 percent, and we found that the effects of minority IJVs did not vary across the two ownership ranges. In addition, we separated nonminority IJVs into 50/50 and majority ventures and found no significant results.

modest support for the difference in the effects of ownership structure, as well as the difference in the effects of product-market focus ($F = 2.92$, and 3.87, respectively; $p < .10$). Finally, in models 5 and 6, the above results continue to hold, though only in model 5 do significant differences across the four types of IJVs exist ($F = 4.82$, $p < .01$). These finer-grained results suggest that what matters most to growth option value are the ownership structure and product-market focus of IJVs rather than geographic location. Minority IJVs and diversifying IJVs contribute to a firm's growth option value, whether they are located in emerging or in developed economies.

The results for the control variables are worth noting. Our analysis reveals no significant effect of firm size or organizational slack. The negative and significant coefficient of financial leverage is consistent with Myers's (1977) model of growth options and corporate financing policy, which maintains that corporate borrowing is inversely related to growth option value. The effect of industry growth option value is positive and highly significant, indicating the relevance of industry effects. The multivariate results for R&D stock present strong evidence that R&D investment can provide growth options that are valuable to a firm. Firm fixed effects are jointly significant. This finding is in line with previous research documenting the large heterogeneity of growth option value across firms (Kester, 1984). Finally, year fixed effects are also jointly significant, indicating that economy-wide factors may influence growth option value.

DISCUSSION

Contributions

Three sets of contributions emerge from our study. First, we provide the first direct empirical test of real options theory's central proposition that JVs provide firms valuable growth options, and we do so by introducing a measure indicating the growth option value firms capture. Studies like ours can offer important contributions to the development of real options theory not only because they help bridge the gap between theory and empirical evidence (e.g., McGrath & Nerkar, 2004), but also because they can also help move this research beyond its current decision-theoretic focus (e.g., Folta, 1998; Kogut, 1991) to begin to attend to the firm outcomes associated with real options. The challenge in testing such firm outcomes boils down to developing appropriate empirical measures that can capture the unique benefits the theory claims; namely, that real options help firms enhance upside opportunities while curtailing downside risk (McGrath, 1997; McGrath et al., 2004). Whereas prior strategy research has examined the downside risk part (Reuer & Leiblein, 2000), our study is unique in that we also address the upside opportunities part of real options theory's argument.

Second, this article also makes a broader theoretical contribution to real options theory and its applications in the JV context. Our research adopts a contingency perspective on real options theory's predictions; in other current writing, by contrast, JVs generally are viewed as real options, so the option concept is construed in rather universalistic terms. In our theory, we highlight several important conditions shaping the uncertainty facing IJVs and firms' abilities to manage uncertainty, and we add to the real options theory of JVs by demonstrating the value of investigating some of the JV structural attributes in a more microanalytic fashion. This approach is broadly consistent with recent calls to use real options theory in more bounded ways (e.g., Adner & Levinthal, 2004; Janney & Dess, 2004).

Finally, through the use of real options theory in the IJV context, our research also contributes to the IJV literature by uniting three important IJV attributes: ownership structure, product-market focus, and geographic location. Applying this framework to focus on the growth option value implications of IJVs provides evidence that can help make sense of some of the inconclusive results on these attributes documented in prior literature. First, regarding ownership structure, the characteristic argument in one stream of research emphasizes the advantages of having a majority position in IJVs (e.g., Mjoen & Tallman, 1997; Vanhonacker, 1997), yet another stream's argument is that majority IJVs do not tend to outperform minority IJVs (e.g., Erramilli, 1996; Steensma & Lyles, 2000). Our study helps reconcile these arguments by suggesting that minority IJVs are investments that may afford firms more valuable opportunities for future growth. Second, our finding on diversifying IJVs might provide one explanation for the contradictory results in prior studies. Balakrishnan and Koza (1993), for instance, found that the stock market rewards diversifying JVs over nondiversifying ones, and Koh and Venkatraman (1991) found the opposite. Although these studies examined the total valuation effects of investing in JVs, our methodology and dependent variable separated the firm value effects of IJVs on the basis of whether the ventures contributed more or less to a firm's value of growth options than to assets in place, and our evidence demonstrates that diversifying IJVs particularly enhance the former.

Third, our finding that firms do not generally

derive growth option value from their IJVs in emerging economies in certain ways challenges recent arguments that growth options provide an important rationale for firms' investments in these locations (e.g., Chen et al., 1991; Pantzalis, 2002; Wright et al., 2005). Our findings may reflect the high failure rate of JVs in general, (e.g., Li, 1995; Park & Russo, 1996; Park & Ungson, 1997) and in emerging economies in particular (e.g., Beamish, 1985; Prahalad & Lieberthal, 2003), yet other more specific explanations are also plausible. Although IJVs based in emerging economies can provide growth options in theory, in practice their ongoing operation may entail nontrivial transaction costs that make it difficult to capture the value of the growth options latent in these ventures (Khanna & Palepu, 1997; Lyles & Salk, 1996; Peng, 2000, 2003; Reuer & Tong, 2005; Steensma & Lyles, 2000). These costs and the need for ongoing investments in these IJVs also imply that firms' downside losses may not be limited to their initial capital outlays during venture formation (Reuer & Leiblein, 2000). Furthermore, the recent rush of many foreign investors into emerging economies (Guillén, 2002; Wright et al., 2005) may actually reduce the value of these growth options by bidding up their initial and exercise prices via increases in the cost for inputs such as labor and raw materials, as well as by limiting the price that firms can charge for their products as a result of increased market competition.

Managerial Implications

Our study has several implications for managers considering investments in IJVs. First, the findings indicate that firms investing in IJVs can obtain valuable growth options; however, not all types of IJVs are equal in enhancing firms' growth option value. The evidence therefore reveals that managers evaluating IJV investment decisions need to pay particular attention to the design and structuring of IJVs. Our theory and results can help managers seeking growth options in IJVs to identify the conditions under which such investments are most likely to offer valuable growth options. For instance, a firm is more likely to obtain valuable growth options through IJV investments when it takes a minority stake and when the venture represents product-market diversification. However, if the firm's goal is to exploit existing resources rather than develop follow-on opportunities, investments in the firm's primary business and greater ownership positions may be advised. Our evidence also casts doubt on the received wisdom that emerging economies generally confer valuable growth options to investing firms. In these markets as well as in others, managers must recognize that the ownership structure and product-market focus of IJVs are critical. In emerging economies in particular, the growth option value that firms attain may hinge upon their abilities to manage challenges such as obtaining market and competitor information in order to make appropriate option purchase and exercise decisions. Recent liberalization of investment policies in some emerging economies allows managers greater freedom in exercising options in such markets by acquiring additional equity, but this does not necessarily mean that foreign investors should take on more equity at the outset, if they are following an options-based approach. Managers may clearly invest in IJVs for reasons other than their latent options, but our findings underscore the more general point that the type of value a firm seeks to obtain has an important bearing on IJV design, as well as on the type of IJVs in which the firm should invest in the first place.

Limitations and Future Research Directions

This study has several limitations that future research can address. First, the use of the Stern Stewart data set helped us obtain a relatively accurate estimate of growth option value. Although this is a contribution of the article, it might limit the generalizability of the findings. For instance, firms included in this data set are publicly listed, relatively large, and among the most important in the U.S. economy; extensions of this research could investigate whether the findings also hold for other types of firms, such as smaller and newly listed ones.

Second, opportunities also exist to extend our empirical approach to other international investments contexts where real options theory is applicable. For example, future studies might focus on other types of foreign direct investment activities (e.g., cross-border acquisitions, "greenfield" investments) and address alternative ways of categorizing countries and locations along dimensions such as cultures and institutions (e.g., bank-centered versus family-centered economies). Finally, our focus on JVs concerns firms' external corporate development activities, but a wide range of internal investment activities can similarly provide valuable growth options, such as investments in technology development projects and investments in new product lines. This suggests that the application of the theory and our approach should not be limited to international and corporate strategy; it could also be usefully extended to business and technology strategy. On a more general level, more research is needed to investigate the firm outcomes associated

with real options (Tong & Reuer, 2006). Such work could help move existing research on real options beyond its current decision-theoretic focus and help better identify some of the boundaries of the theory as it is applied in strategy.

Conclusion

A significant amount of research has applied real options theory to the JV domain in which JVs are viewed as growth options, yet this article is the first to directly test whether firms actually capture growth option value from their JV investments. We also extend the real options theory of JVs by developing a contingency framework that links three important IJV attributes. We contribute a finer-grained understanding of the value of growth options embedded in IJVs; namely, that IJVs do enhance firms' growth option values, yet such value enhancement only occurs in certain well-defined situations. As a result, universalistic statements on the growth option value of investing in JVs, or in emerging economies, should be embraced with caution.

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APPENDIX

Calculation of Growth Option Value

The value of a firm can be expressed as the sum of the book value of capital employed and a residual component beyond capital employed. The former captures the total capital that creditors and shareholders have entrusted to the firm over the years in the form of loans, paid-in capital, retained earnings, etc. In Stern Stewart's language this is called capital invested (*CI*), and the residual component is labeled market value added (*MVA*):

$$V = CI + MVA. \quad \text{(A1)}$$

MVA is the aggregate net present value of all of the firm's investment activities and opportunities, which is equivalent to the present value (*PV*) of all of the firm's expected economic value added (*EVA*) (Stewart, 1991; Young & O'Byrne, 2001):

$$MVA = PV \text{ of expected } EVA. \quad \text{(A2)}$$

EVA is a performance metric trademarked by Stern Stewart, yet it essentially measures what is called "residual income" in accounting, or "economic profit," a concept usually ascribed to Marshall (1890). Unlike traditional accounting profitability measures (e.g., earnings) that only include the cost of debt capital, residual income measures profit net of all capital charges that also include the cost of equity capital. Thus, residual income can be expressed as follows:

$$RI = NOPAT - (CI \times WACC), \quad \text{(A3)}$$

where *RI* is residual income, *NOPAT* is a firm's net operating profits after tax, and *WACC* is its weighted average cost of capital. To calculate its estimate of residual income, *EVA*, Stern Stewart adjusts the *NOPAT* and *CI* components on the right side of the equation to account for accounting anomalies or distortions, as discussed previously (Stewart, 1991).

The final step in calculating growth option value using Stern Stewart's value-based performance metrics lies in decomposing the value of expected *EVA* (Equation A2). This value in any given year consists of a component that is an equivalent to that year's *EVA*, assuming a no-growth policy (i.e., *current-level EVA*), as well as a residual component (i.e., *EVA growth*) that could be either positive or negative, depending on the firm's investments in future growth opportunities. A firm has negative future growth opportunities when it is believed to be unable to sustain its current level of performance or makes value-destroying investments. This identity is expressed as follows:

$$PV \text{ of expected } EVA = PV \text{ of current-level } EVA + PV \text{ of } EVA \text{ growth}. \quad \text{(A4)}$$

When we combine Equations A1, A2, and A4, we can recalculate the firm's value (*V*) as follows:

$$V = CI + PV \text{ of current-level } EVA + PV \text{ of } EVA \text{ growth}, \quad \text{(A5)}$$

where the sum of the first two terms (i.e., *CI* and *PV of current-level EVA*) makes up the value of assets in place (i.e., V_{AIP}), and *PV of EVA growth* measures the value of growth options (i.e., V_{GO}).

To calculate *growth option value*, we solve Equation A5 for *PV of EVA growth* (i.e., V_{GO}), and scale it by firm value (*V*):

$$\text{Growth option value} = (V - CI - PV \text{ of current-level } EVA)/V. \quad \text{(A6)}$$

We calculated the *PV of current-level EVA* by treating a firm's current *EVA* as a perpetuity discounted by the firm's *WACC*. All the other terms appearing on the right side of the equation, as well as the estimate of *WACC*, are available from the Stern Stewart data set.

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