What Makes and What Does Not Make a Real Option?

A Study of International Joint Ventures

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Abstract

Recently, questions have emerged about the boundaries of real options logic when the firm that made an option-like investment can subsequently affect the parameters of the decision. This paper advances this debate theoretically, with an empirical application to joint ventures. Uncertainty is widely held to be a principal motivation for using joint ventures to expand internationally, as well as to be a predictor of investments in real options. We distinguish between two forms of uncertainty, uncertainty which resolves endogenously and uncertainty which resolves exogenously, and theorize that only exogenous uncertainty will have an impact as predicted by real options theory. Using a sample of 6,472 Sino-foreign joint ventures established between 1979 and 1996, we show that investors’ choices of equity shares are indeed consistent with real options predictions when uncertainty resolves exogenously, but not when uncertainty resolves endogenously. We discuss implications for real options research and joint venture research.
INTRODUCTION

The concept of real options has aroused considerable enthusiasm in recent years among scholars and practitioners of strategic investments, i.e. those investments that may encompass multiple stages subject to intervening events. Investments such as R&D projects, taking out patents, subcontracting, founding new businesses, and entering into joint ventures (JVs) have been classified as real options (e.g. Kester 1981, Reuer and Leiblein 2000, Van Mieghem 1999). The widespread use of real option logic, combined with the fact that a gap between theoretical and empirical works continues to exist (Reuer 2002), leaves open questions about the conditions under which real options logic is indeed applicable. At the same time, it is important to examine what variables are indeed suitable predictors within a real options framework, for both theoretical and empirical reasons.

Theoretically, Adner and Levinthal (2004a, 2004b) called for further attention to the boundaries for the application of real option theory to strategic decision-making. They argued that the assumptions underlying the real option model are violated if variables such as the end-date of the underlying project are discretionary: “Because much attention in the management literature is focused on the ways in which the firm can affect outcomes and variances[...], it is important to examine what happens to the applicability of options logic as we move away from a world of wait and see to a world of “act and see,” in which uncertainty resolution is endogenous to firm activity” (Adner and Levinthal 2004a: 76). This question is especially relevant when applying real options logic to the study of JVs, because JVs represent both investments with strategic implications, and a choice of a governance mode that itself may encourage strategic behavior among partners.

Empirically, while some studies of JVs have found support for predictions derived from real options theory, others have not. Indeed, two prominent studies, by Folta (1998) and Reuer and Leiblein (2000), found deviations from real options predictions with respect to the formation and consequences of JVs respectively.

We aim to contribute to the literature by examining, theoretically and empirically, to what extent the real option logic accurately describes decisions to initiate international joint ventures (IJVs). Whereas
Adner and Levinthal (2004a, 2004b) focus on the duration of the investment, we focus on uncertainty, which is a key reason for using JVs to enter international markets (Kogut 1991) and to make real option investments in general. Specifically, we examine whether various forms of uncertainty predict JV formation in the way that real options logic suggests, depending on whether the uncertainty can be resolved endogenously.

**BACKGROUND**

**Real Options**

Simultaneously with the increasing popularity of financial options in the 1970s, it was realized that an analogy exists between organizational resources investments and financial options (Myers 1977). Bowman and Hurry (1993) argued that the option lens can be very useful to study the strategies of organizations, since the capabilities and assets of an organization can be seen as a bundle of options for future strategic choices. These options are called “real options” and can be seen as contingent investment commitments in an asset or capability, rather than in a financial contract, which secure decision-making rights in the future (Trigeorgis 1993).

Numerous insights and techniques from financial option pricing have spilled over to the valuation of organizational resources investments. Prominently, they imply that the traditional Net Present Value (NPV) approach to value investment does not fully capture the value of management’s flexibility to adapt to unexpected market developments (Trigeorgis 1995). Such flexibility can increase the investment’s upside potential while limiting its downside losses relative to management’s initial expectations under passive management (Trigeorgis 1995). This does not mean that the traditional NPV approach to valuing investments should be put aside, but instead that it should be expanded to take into account both a passive NPV component and a dynamic option value component (Pindyck 1988). The value of the real option component of an investment is a function of the same parameters that determine the value of a financial option (Seth and Kim 2000).
However, not every investment or decision is an investment in real options. The two different value components can be captured in a different way because they require a different size of investment. On the one hand, the passive NPV component requires a large investment in order to capture as much cash flow as possible. On the other hand, the dynamic option component can be captured with a smaller investment. We will go into this in more detail in the next section when we look at JVs.

In order to qualify as a real option, an investment must meet three additional conditions, besides securing decision rights in the future (McGrath and Boisot 2002): (1) the investment must be small, relative to the investment required to capture control over the underlying asset, (2) the initial investment may not prevent the organization from abandoning the investment and (3) there must exist a possibility that more information at some future point will improve the outcome of the investment relative to making the full investment outright at an earlier point.

Joint ventures and the option to acquire

The first to apply real option theory to IJVs was Kogut (1991). He argued that firms can capture the upside potential of a JV by buying out the partner in a later stage when favorable information becomes available. At the same time the investment in a JV limits the downside risk to the initial investment in the JV. This option to acquire can be explicit, but this is not a necessity. Even when there is no ex ante contractual specification of which party holds the acquisition right and of the strike price, it remains possible for both parties to negotiate the acquisition of the other party’s share at a price that is agreed upon. Hence, JVs have at least an embedded implicit call option to acquire a partner’s stake, and correspondingly a put option for the other party to sell its stake (Chi and Seth 2001).

Following Kogut (1991), several other scholars have looked at JVs from a real options perspective (e.g. Chi and McGuire 1996, Chi and Seth 2001, Reuer 2000, Reuer 2002, Reuer and Koza 2000, Reuer and Leiblein 2000). One of the key findings is that the options embedded in JVs will have an impact on the distribution of the equity stakes. On the one hand, if the investor tries to capture the static NPV part (s)he will take an as large as possible share, to fully capture the future cash flows. In the
extreme, this will lead to an acquisition instead of a JV (Seth and Kim 2000). On the other hand, an investor who aims to capture the dynamic real options part will invest in a smaller share of the JV because this way the investor limits the downside risk while leaving open the opportunity to capture the upside potential of the JV (see Chi and McGuire 1996, Reuer 2002). Thus a JV contains an implicit or explicit call to acquire the other party’s stake, and we can expect the firm investing in the call option to be the party taking the smaller share in a JV.

Real option theory and uncertainty

One of the most prominent concepts in real option theory is uncertainty.¹ Two broad streams of research (Reuer 2002) address JV formation (among other outcomes) using the logic of real options. These two streams provide different but complementary insight into the role of uncertainty:

In the first stream, researchers use formal models to study the theoretical benefits and cost of investing in different kinds of strategic real options and to assess how flexibility can contribute to value contribution. Many of these models focus on one or at most two different sources of uncertainty each. For instance, Bell (1995) and Huchzermeier and Cohen (1996) focused on exchange rate uncertainty. Bollen (1999) looked at demand uncertainty. Chi and McGuire (1996) and Chi (2000) examined how uncertainty about the market and about a collaborative partner can add to the value of collaborative ventures. Additionally, some scholars have emphasized that real option reasoning applies to uncertainty that is exogenous, i.e. outside the control of the firm (e.g. Kulatilaka 1995). Indeed, Miller and Folta (2002) argued that such exogenous uncertainty increases the value of a call option, unlike uncertainty that is under the control of the firm (e.g., responding to rivals’ threat of pre-emption).

In the second stream, researchers examine empirically whether the formation and outcome of JVs are consistent with real options theory. Kogut (1991) found evidence of JVs being used as options to

¹ The concept of uncertainty used in option theory is actually one of risk in the sense of Knight (1921), in that options pricing models assume that it is possible to specify the probability distribution of future asset values. We follow the extant use of terminology in referring to this as “uncertainty”.
make subsequent acquisitions in the presence of market uncertainty. Folta and Miller (2002) looked at the
timing of exercising options and found evidence of the influence of uncertainty, operationalized as the
variability in stock-market subfield indices, on the timing of partner buyouts in equity partnerships in the
biotechnology industry. Reuer (2002) found that the likelihood that a firm will have an explicit option to
acquire equity in an IJV increases as property rights uncertainty, cultural uncertainty and diversification-
related uncertainty increase. However, other studies found results inconsistent with real options
predictions. Reuer and Leiblein (2000) found that firms that enter into multiple JVs do not thereby reduce
their downside risk; in fact, for two of three measures of downside risk, IJVs were associated with
increased risk. Folta (1998) found that multiple forms of uncertainty were associated with the taking of
real option positions in the form of minority investments (rather than acquisitions). However, only
exogenous technological uncertainty encouraged the formation of JVs as call options.

In summary, multiple sources and concepts of uncertainty have been advanced in real options
research; however, very few studies have contrasted the effects of two or more sources of uncertainty.
Furthermore, differences in concepts of uncertainty may explain some of the inconsistencies found in the
empirical literature with respect to JVs. To address this, we seek to contrast multiple sources of
uncertainty. In this respect, the gaps between theoretical and empirical literatures suggest that a critical
distinction is whether or not uncertainty is exogenous to the firm’s influence.

**HYPOTHESES**

The decision to invest in the call option to acquire will depend on the value of the call option.
This value will increase as uncertainty surrounding the value of the underlying asset increases. As the
distribution of the possible values of the underlying asset at maturity widens, it becomes more probable
that the option will be in-the-money at maturity, making the exercise of the call profitable. Conversely,
the downside if the option is out-of-the-money does not increase – it is just the initial cost of the option.
Once a firm acquires a real option on a future opportunity, it can strike the option and take the full
opportunity if the uncertainty resolves favorably over time, or just let the opportunity pass at no further cost if the uncertainty resolves unfavorably.

Carrying over this insight from financial options to real options is what makes real option theory particularly appealing: It deals with one of firms’ most important challenges by linking current strategic decisions with uncertainty about future outcomes. However, the carry-over is problematic if the conditions for the resolution of the uncertainty depart from the theory (Adner and Levinthal 2004a). In this respect, two forms of uncertainty can be distinguished: exogenous uncertainty and endogenous uncertainty (Roberts and Weitzman 1981, Folta 1998).

Exogenous uncertainty is uncertainty of which the resolution is unaffected by the actions of the firm (Chi and Seth 2001, Roberts and Weitzman 1981). For example, uncertainty about currency exchange rates is exogenous since these rates are determined in atomistic markets (Campa 1994). By contrast, endogenous uncertainty is resolved (at least in part) by the actions of the firm itself over time. More specifically, the degree and the pace of resolution of endogenous uncertainty depend on the effort of the firm to obtain more information (Chi and Seth 2001, Roberts and Weitzman 1981). For instance, a firm may not know a priori how hierarchically structured organizations in a given foreign location may be, but that uncertainty can be resolved by making a systematic effort to learn about the country (Hofstede 2001).

We argue that while real options theory should apply in the case of exogenous uncertainty resolution, it need not when uncertainty resolution is endogenous. The case of exogenous uncertainty corresponds to the case of financial options, where it is assumed that uncertainty is resolved independently of the investor’s behavior. If this property carries over to investments that are non-financial in nature, the real option logic should hold (Adner and Levinthal 2004a). Furthermore, Dixit and Pindyck (1994) argue that exogenous uncertainty increases the value of waiting for new information and makes committing resources less attractive because investing will not influence how uncertainty is resolved. Hence, options pricing models should be applicable.

Conversely, when uncertainty resolves endogenously, two different but related arguments can be made whereby real option logic will not hold anymore. Firstly, in case of financial options, investors are
assumed to be price-takers (Black and Scholes 1973, Jarrow and Turnbull 2000). This is reflected in the use of the Brownian (random) motion to model the price of the underlying asset. However, when investors can influence the resolution of uncertainty through their own actions, they are not pure price-takers anymore; instead, they can affect the value of the underlying asset. This violates a fundamental assumption of (financial) option pricing models (e.g. Black and Scholes 1973, Merton 1973). The resulting arbitrage opportunities mean that existing models will fail to price options accurately (Jarrow and Turnbull 2000).

Secondly, uncertainty that can be resolved endogenously influences the investment decision differently than uncertainty that resolves exogenously. Endogenous uncertainty can be resolved by undertaking efforts to learn, i.e. by making a form of investment (Dixit and Pindyck 1994). In such a situation, which is common in R&D projects for instance, the issue becomes one of figuring out the cost to resolve uncertainty rather than of uncertainty about the payoffs of the project proper. According to Dixit and Pindyck (1994), only investing will reveal the relevant information. Therefore, there exists an incentive to invest and commit resources rather than wait. Hence, real option logic will not apply in case of endogenous uncertainty. As Dixit and Pindyck (1994) noted, this does not exclude that investments surrounded by endogenous uncertainty occur sequentially, thereby superficially resembling real option investments when in fact their resolution depends on a different mechanism (the NPV component).

For these reasons, we expect that while real options predictions will accurately describe firms’ responses to exogenous uncertainty, they will not accurately describe their responses to endogenous uncertainty. To explicate this difference further, we derive five hypotheses, of which three deal with sources of uncertainty that resolve exogenously and two with sources of uncertainty that resolve endogenously.

**Exogenously resolved uncertainty**

*Economic Uncertainty:* An important host country factor that has an impact on the value of an investment is economic uncertainty. This refers to the uncertainty about the macroeconomic situation in a
host country and encompasses all the unknowns about the level of economic activity and prices (Oxelheim and Wihlborg 1987). More economic uncertainty results in higher variability in the foreign investor’s cash flows and in the value of the investment. As a result, the value of a call option will increase as economic uncertainty increases.

Key macroeconomic variables such as inflation, prices and aggregate demand are determined in a complex system consisting of markets and sovereign governments (Oxelheim and Wihlborg 1991). Thus, for individual firms it is extremely difficult, if not outright impossible in larger economies, to influence the macroeconomic conditions of the host country. Therefore, economic uncertainty will be resolved exogenously. Accordingly, we expect real option logic to hold:

**Hypothesis 1:** Ceteris paribus, a foreign partner entering into a joint venture in an environment with higher economic uncertainty will have a higher propensity to make a call option investment. Therefore, the foreign partner will take a smaller share in the joint venture.

**Local Institutional Uncertainty:** The institutional environment includes political institutions, regulations and adjudication, and other government institutions (Henisz and Delios 2001). These institutions can cause uncertainty for investors in several ways. In an underdeveloped local legal and judicial system, laws will tend to be unclear, inadequate, and their enforcement unreliable. Investors may for instance be uncertain about current and future tax obligations, labor laws and the neutrality of courts in case of disputes. Generally, an unstable local political system with unpredictable and highly variable policies greatly increases uncertainty for business owners (Henisz and Delios 2001).

Such uncertainty is bound to affect foreign investors, including JVs (e.g. Shan 1991). Furthermore, institutional uncertainty resolves exogenously, especially in larger and more complex national systems, because a firm is unlikely to be able to affect the multiple layers of government and institutions that make such policies (e.g. Chi and Seth 2001, Henisz and Delios 2001). Accordingly, we hypothesize:
Hypothesis 2: Ceteris paribus, a foreign partner entering into a joint venture located in an area within a country with higher institutional uncertainty will have a higher propensity to make a call option investment. Therefore, the foreign partner will take a smaller share in the joint venture.

Exchange Rate Uncertainty: Expanding abroad usually also means that a firm has to deal with a currency other than their home country’s currency. Changes in the exchange rate will in turn influence the value of the foreign investment. This form of uncertainty is an inherent factor in international business, regardless of whether the exchange rate is fixed (and thus subject to unpredictable adjustment) or flexible (Katz 1972, Miller 1992).

It has been well established that individual firms are price-takers on the foreign exchange markets. Foreign exchange markets are too large in volume and too liquid for individual non-financial companies to influence exchange rates (e.g. Eiteman, Stonehill and Moffett 1998). Hence, exchange rate uncertainty is resolved exogenously. Accordingly, we hypothesize:

Hypothesis 3: Ceteris paribus, a foreign partner entering into a joint venture in an environment with higher exchange rate uncertainty will have a higher propensity to make a call option investment. Therefore, the foreign partner will take a smaller share in the joint venture.

Endogenously resolved uncertainty

Cultural Uncertainty: When an organization expands abroad it will be confronted with an environment that is culturally different from that in its home country. The success of the foreign venture will depend on the cooperation and communication with local parties who tend to have different values, beliefs, and customs (Hofstede 2001). Lack of knowledge of the local culture can have serious negative effects on the investment (Barkema, Bell and Pennings 1996). The more distance between the culture of the foreign investor and the culture of the host country, the more uncertainty there will be in this respect. The foreign partner will be unsure of how well it can learn the skills, such as communicating with
employees and customers, that are necessary to succeed in its new environment. The more distant the cultures, the less certain it becomes that the essential skills and knowledge can be effectively acquired. That is because organizations are limited in the amount of newness they can absorb (Cohen and Levinthal 1990). Thus, uncertainty also exists about the rate at which the foreign partner will learn about the new environment. Furthermore, as cultural distance increases, it becomes more uncertain how both parties to a JV will interact with each other. With increased cultural distance the partners face increased communication problems, are more likely to have different goals, are more likely to have a more negative attitude towards each other, and experience more stress (Weber, Shenkar and Raveh 1996). Uncertainty about the JV’s performance increases accordingly.

While such cultural differences indeed represent a severe source of uncertainty for the firm initiating expansion abroad, it can be resolved by the actions of the firm itself. With local experience, a foreign investor can much better assess cultural predilections in the host country. It can then assess better how its own personnel and organization should interface with local parties, and adjust its behavior to conform with local culture as relevant (Black, Mendenhall and Oddou 1991). Furthermore, the firm can decide how to invest in learning about local culture and values (Black and Mendenhall 1990). Similarly, training the JV partner can reduce cultural uncertainty. Thus, unlike the exogenous uncertainty described in our first three hypotheses, cultural uncertainty can be resolved endogenously. This entails a departure from the assumptions underlying real option logic. Therefore, we do not expect cultural uncertainty to determine the value of a call option. Hence, we hypothesize:

Hypothesis 4: Ceteris paribus, a foreign partner originating from a more culturally distant country entering into a joint venture will not have a higher propensity to make a call option investment. Therefore, the foreign partner will not take a smaller share in the joint venture.

Uncertainty about corporate capabilities: In case of JVs an important source of uncertainty pertains to corporate capabilities (Chi and Seth 2001). Firstly, there is uncertainty about the stand-alone
capabilities of the other party, due to information asymmetry. Secondly, there is uncertainty about the potential benefits of combining the assets contributed by each partner. This uncertainty is especially important when it comes to intangible assets and knowledge-based activities (Seth and Kim 2001, Martin and Salomon 2003).

Such uncertainty about capabilities is most prevalent in R&D collaborations. Firstly, R&D projects generally require substantial amount of specific know-how and proprietary information (Chan, Kensinger, Keown and Martin 1997). Furthermore, in JVs that encompass R&D, this specific know-how and information must be shared in order to enable joint discovery and search for new solutions. This entails higher uncertainty than in JVs that limit themselves to the use of existing know-how (Pisano 1989). Therefore, we expect uncertainty about capabilities to be higher in R&D JVs.

However, over time the foreign partner will become better able to assess the R&D effort and the contributions of the JV partner (Chi and Seth 2001). Initial information asymmetry about the stand-alone capabilities of the partner will be reduced (Balakrishnan and Koza 1993). Moreover, learning will also reduce the uncertainty about the benefits of combining assets (Seth and Kim 2001). Furthermore, the pace and extent to which uncertainty is resolved will depend on how much and fast the foreign investor learns and how much resources it allocates to the R&D process (e.g. Cohen and Levinthal 1990). Hence, this kind of uncertainty resolution is endogenous to the foreign partner’s actions (Chi 2000, Chi and Seth 2001, Dixit and Pindyck 1994). Therefore, we do not expect real option logic to hold. Accordingly, we predict:

Hypothesis 5: Ceteris paribus, a foreign partner entering into an R&D joint venture will not have a higher propensity to make a call option investment. Therefore, the foreign partner will not take a smaller share in the joint venture.

METHODS

Sample
We collected data on equity JVs (EJV) formed in China between 1979 and 1996 and involving a foreign partner. The main source of data is the Almanac of Foreign Economic Relations and Trade of China, which is published by the Chinese Ministry of Foreign Trade and Economic Cooperation (MOFTEC). The data for the period between 1979 and 1996, contained 8,077 Sino-foreign EJVs. However, the number of observations was reduced to 6,472, originating from forty-one countries, once we excluded tri-partite JVs for which each party’s equity investment could not be broken down, and countries for which Hofstede’s (2001) cultural scores were not available. The data have been shown to be reliable and consistent with FDI data from independent non-Chinese sources and parts of the data have been used in several published studies (e.g. Hu and Chen 1993, Pan 1996, Chadee and Qiu 2001, Chadee, Qiu and Rose 2003).

China and our JV data are particularly suited to test our hypotheses, for several reasons. Firstly, China was the world’s second largest recipient of FDI after the U.S. as of 1994 – indeed it surpassed the U.S. in 2003 (World Investment Report, 2003). This provides a large number of observations originating from a wide range of countries. Secondly, China is a complex environment for foreign investors, where each of the sources of uncertainty described in our hypotheses is substantial (Boisot and Child 1999). Thirdly, almost all foreign investment in China during the study period was through EJVs. China’s government actively sought to promote EJVs while preventing other modes of investment. This makes the data all the more complete. Finally, we can say with confidence that the foreign parties in Sino-foreign JVs will only hold a call option, and no put option. That is because China’s legislation and the

2 MOFTEC is formerly known as the Ministry of Foreign Economic Relations and Trade (MOFERT) and currently known as the Ministry of Commerce of the People’s Republic of China (MOFCOM).

3 Deng Xiaoping’s reforms were summed up in the “Four Modernizations” of agriculture, industry, science and technology and the military. The focus was on technology transfer from the West. The C.C.P.’s initial view was that this could best be achieved by setting up joint ventures with foreign partners. Therefore, all alternative investment modes were prohibited except for a few exceptions (Almanac of Foreign Economic Relations and Trade of China, various years).
policy of the ruling Chinese Communist Party (C.C.P.) hampered foreigners from exiting by selling their equity to their venture partner. Consequently, the Chinese JV partner, which is often de facto the Chinese government, did not hold a call option but a put option. Finally, the secondary market for JVs stakes among foreign investors in China was highly regulated, and almost non-existent in practice.

**Dependent variable**

*Foreign Share*: Our dependent variable is the percentage of foreign ownership in Sino-foreign EJVs. As discussed earlier, a foreign investor who wants to capture the static NPV part will be more likely to take a large share while an investor who makes a call option investment will take a smaller share (Chi and McGuire 1996, Reuer 2002). Under Chinese law the percentage of foreign ownership can range from 25% to 99.9%.

**Independent variables**

*Economic Uncertainty (H1)*: The degree of economic uncertainty is measured using the *Euromoney* country risk index. This index measures the economic uncertainty of a country at a particular time on a scale from 0 to 100 based on factors such as the economic performance and credit rating of a country. Because the *Euromoney* index is only available from 1982 onwards, we have extrapolated the index back to 1979. Excluding the observations from 1979 to 1981 does not materially change our results.

*Local Institutional Uncertainty (H2)*: The Chinese government has established a number of special areas over time to attract foreign investment. These areas are characterized by a lower level of uncertainty for foreign investors as a result of a higher degree of liberalization and a more developed institutional framework. Two types of such special areas can be distinguished: the *Special Economic Zones (SEZ)* and *Open Coastal Cities*. Five Special Economic Zones\(^4\) were declared in 1980 and a

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\(^4\) Shenzhen, Zhuhai and Shantou in Guangdong Province and Xiamen in Fujian Province, and the entire province of Hainan.
number of coastal cities\(^5\) were opened in 1984. We include a dummy variable which equals zero if the JV was located in either one of the SEZ or open coastal cities, indicating lower uncertainty, and one when the JV is located in any other region.

**Exchange Rate Uncertainty (H3):** In a fixed exchange rate regime such as China’s, exchange rate uncertainty does not come from continuous daily market changes in the exchange rate but from discrete changes made by the government. However, a black market or so-called parallel exchange rate market has developed in many countries with a fixed exchange rate regime (e.g. Reinhart and Rogoff 2002). On this parallel market the exchange rate changes continuously subject to market forces. Therefore, there will often be a difference between the fixed official exchange rate and the floating parallel market rate. These differences are an indication of the level of exchange rate uncertainty for foreign investors. On the one hand, the official rate will correspond to the real (economic) exchange rate when the fixed official exchange rate equals the floating parallel market rate. Thus, it will be extremely unlikely that a discrete change of the official exchange rate will take place. On the other hand, there will be more exchange rate uncertainty when the gap between the fixed official exchange rate and the floating parallel market rate is bigger. This bigger difference indicates more strain on the official exchange rate. Uncertainty increases because it is unclear how much the official rate will change and when it will change. Accordingly, following Reinhart and Rogoff (2002), we measure exchange rate uncertainty as the absolute value of the parallel market premium (or discount):

\[
\text{Parallel Market Premium} = \left| \frac{\text{Average Annual Official Rate} - \text{Average Annual Parallel Rate}}{\text{Average Annual Official Rate}} \right|
\]

Thus, a higher parallel market premium (or discount) indicates more exchange rate uncertainty.

**Cultural Uncertainty (H4):** We measure Cultural uncertainty by using Kogut and Singh’s (1988) cultural distance index. This oft-used index is based on the difference between each country and a focal

\[^5\] Dalian, Qinhuangdao, Tianjin, Yantai, Qingdao, Lianyungang, Nantong, Shanghai, Ningbo, Wenzhou, Fuzhou, Guangzhou, Zhanjiang and Beihai.
country (here, the investor’s home country vs. China) along each of Hofstede’s (2001) four initial cultural dimensions. A higher score on Kogut and Singh’s (1988) cultural distance index implies a higher level of cultural uncertainty.

**R&D Uncertainty (H5):** Based on the textual description of the activities of the JVs, we identified those projects that were engaged in any substantive research and development activities. We construct a dummy variable where the R&D JVs are coded as one, and therefore more exposed to uncertainty about corporate capabilities.

**Control variables.** We control for a number of additional factors that may influence the ownership structure of a JV. Firstly, we control for the *duration* of the JV, using the logarithm of the ex ante specified contractual duration of the JV. Foreign investors entering in an equity JV in China are required to determine the duration of the project ex ante (Shan 1991, Beamish 1993). The duration of an option determines its value insofar as longer time horizons provide more opportunities for the option to become in-the-money (Jarrow and Turnbull 2000). Secondly, we control for the *total size* of the EJV using the logarithm of the dollar amount invested by both partners. We also control for the experience of the foreign investor in China, measured as the logarithm of the number of years since the foreign investor formed its first JV in China. Furthermore, we create period fixed-effects for the different five-year plans of the Chinese Communist Party. These capture general differences in the business environment across periods. Finally, we control for *industry* differences. There is evidence of inter-industry differences in the patterns of ownership of foreign subsidiaries (Kobrin 1987). Furthermore, the C.C.P. preferred to keep control over strategically and symbolically important industries, which might also influence the ownership distribution in certain industries. Therefore, we classified all JVs by two-digit SIC code based

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6 The five-year plans (partially) covered by our data are: the fifth plan (1976-1980), the sixth plan (1981-1985), the five-year plan (1986-1990) and the eight plan (1991-1996). The period effects are lagged by one year because these plans were usually announced at the end of the year. Thus, fixed effects represent the periods 1979-1981, 1982-1986 and so on.
on the description of their activities and business scope. Subsequently, we created industry fixed-effects for every two-digit SIC code.

**Estimation**

We have to consider two important characteristics of our data when choosing the appropriate method to test our hypotheses. Firstly, our dependent variable is censored because the Chinese government only allows foreign ownership to range from a minimum of 25% to a maximum of 99.9%. Foreign investors might actually prefer an ownership share outside this range but end up taking a share somewhere between 25% and 99.9%, choosing the value closest to their true preference. Indeed, a substantial number of observations have either boundary value. Not controlling for the censored dependent variable is likely to lead to biased results (Greene 2003). Secondly, our data is hierarchically structured, with units at two different but nested levels. The lower level consists of the individual JVs, which we label with the subscript $i$. The higher level, which we will label with subscript $j$, represents the different countries of origin of the foreign investors. Failing to take into account the multilevel structure of the data would possibly result in underestimated standard errors (Hox 1995).

Taking these issues into account, we use a multilevel Tobit model to test our hypotheses. More specifically, we use a random-intercept multilevel Tobit model with double-censoring. The general formulation of such a model, given in terms of an index function, is (Hox 1995, Greene 2003):

$$y_{ij}^* = \beta_{oj} + \beta_k X_{ij} + e_{ij} + u_{oj},$$

$$y_{ij} = y_{ij}^* \quad \text{if} \quad 25 < y_{ij}^* < 99.9$$

$$y_{ij} = 0 \quad \text{otherwise}$$

**Testing Null Hypotheses**

Testing the hypothesis that two variables have no effect on each other is one of the most common statistical procedures in the behavioral and social sciences. However, in doing so most attention has gone to the possibility of rejecting the null hypothesis when in fact it is correct, i.e. making a Type I error. Less
attention has gone to possibility of failing to reject the null hypothesis when it is in fact false, i.e. making a Type II error (Murphy and Myors 2004). Therefore, accepting a null hypothesis has often mistakenly been seen as inappropriate (Cohen 1992).

In fact, following proper procedure, the null hypothesis can be accepted when an expected true relationship between two variables is found to be negligible. Such a relationship is shown to be negligible when a statistical test is performed with a sample size that is sufficiently large for the risk of a Type II error to be equal or smaller than the commonly accepted standards for a Type I error risk (i.e. $\alpha = 0.05$; $\alpha = 0.01$) (Cohen 1977, Cohen 1990). In such cases the null hypothesis can be safely accepted with the same level of confidence that is generally accepted to reject the null hypothesis. This technique is called statistical power analysis, where the statistical power of a test is defined as the probability that the null hypothesis will be rejected when doing so is in fact incorrect (Murphy and Myors 2004). Although power analysis is not frequently used in management science, it is commonly used in other disciplines such as psychology. Furthermore, a few researchers have initiated the use of this technique to study corporate strategies (e.g. Lane, Cannella and Lubatkin 1998).

There are four variables of importance in statistical power analysis: the sample size (N), the significance criterion ($\alpha$), the effect size (ES) and statistical power (1-\(\beta\)) (Cohen 1992). Effect size is the most difficult to specify, while the others are relatively straightforward. Three different methods have been proposed to estimate the effect size (Murphy and Myors 2004). Firstly, the effect size can be estimated using inductive methods. This is appropriate when there are sufficient relevant data, derived for instance from meta-analyses. However, such data are not available in our case. Secondly, a deductive method might be used. We do not deem this method appropriate in this study because it presumes that there is a wealth of previous models to draw on. Thirdly, widely accepted conventions for defining small, medium and large effects can be used. These conventions are frequently used (Murphy and Myors 2004). We follow this practice. More specifically, we use Cohen’s (1992) approximations for small, medium and
large effect sizes. It is recommended to use small or small-to-medium effect sizes (Cohen 1977, Cohen 1992, Murphy and Myors 2004). We use a small and therefore particularly conservative effect size.

Our power analysis follows a similar but stricter and more conservative procedure than Lane, Cannella and Lubatkin (1998), who also test null hypotheses using a Tobit model. To be more precise, we also use Cohen’s (1977: 440) multiple regression power table to determine the minimum sample size required to test a null hypothesis. The suggested minimum sample size is 4,373, given that the effect size is conservatively assumed to be extremely small ($R^2 = 0.015$), no more than 50 independent variables are used (including fixed effects not reported in our tables of results), and the desired power of the test is 0.99 (i.e. $\beta = \alpha = 0.01$). This minimum sample size is well below our sample of 6,472 observations. Thus, when we find a non-significant relationship of interest, we can say with a very small risk ($p < 0.01$) of making a Type II error that the effect is trivial ($R^2 < 0.015$) and that the null hypothesis can be accepted.

RESULTS

Descriptive statistics and pairwise correlation can be found in Table 1. The negative correlations between economic uncertainty, local institutional uncertainty and exchange rate uncertainty, respectively and the foreign share in the JV are consistent with our hypotheses 1, 2 and 3. Conversely, the correlations between the two sources of uncertainty that resolves endogenously, i.e. cultural and R&D uncertainty, and

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7 No power table specifically designed for Tobit models exists. Therefore, following Lane, Cannella and Lubatkin (1998), we use Cohen’s (1977) multiple regression power Table.

8 The formula to determine the minimum sample size required is (Cohen, 1977): \[ N = \frac{L(1-R^2)}{R^2} \] with L being the effect size index as set based on $\alpha$, $\beta$ and the number of independent variables.

9 Cohen (1992) classifies effects of $R^2=0.02$ as small, of $R^2=0.15$ as medium and effect of $R^2=0.35$ as large. Thus the effect size we use is slightly smaller than what Cohen (1992) classifies as conservatively small and ten times smaller than what he classifies as medium.
the foreign share in the JV are positive. Additionally, the correlations do not suggest that collinearity might be a problem.

The multilevel Tobit results are reported in Table 2. Model 1 represents a baseline model including all control variables except for the industry fixed-effects while Model 2 includes the industry fixed effects. In Model 3 the sources of uncertainty which resolve exogenously are added. Model 4 only includes the two endogenous forms of uncertainty. Finally, Model 5 includes all sources of uncertainty simultaneously. The model likelihood chi-squares show that every model is significant (p<.001) relative to an intercept-only model.

The results for the control variables reported in Model 1 and Model 2 show that duration is highly significant (p<.001) and positively related to foreign share. Thus, foreign investors will take a larger share in a JV when the contractually duration of the JVs is longer. Inclusion of industry effects does not substantially change the interpretation of the model.

**Exogenously resolved uncertainty**

The results of Model 3, which includes all sources of exogenously resolved uncertainty, are consistent with our hypotheses and with real option logic. We find a negative and significant relationship (p<.05) between foreign share and economic uncertainty, which is consistent with hypothesis 1. As economic uncertainty increases the value of the real option embedded in the JV will increase and the
foreign investor will opt to capture that value by taking a smaller share in the JV. Similarly, we find a negative and significant relationship (p<.05) between foreign share and local institutional uncertainty, supporting hypothesis 2. Hence, foreign investors will capture option value by taking a smaller share when option value is levered by higher levels of local institutional uncertainty. Finally, we find that foreign investors will take a smaller share when exchange rate uncertainty increases. Thus, hypothesis 3 is strongly supported (p<.001). When we add to Model 3 the effects for endogenously resolved uncertainty, as in Model 5, we find almost identical results, and hypotheses 1, 2 and 3 remain supported.

Thus, our findings are consistent with our first three hypotheses. The results for the exogenously resolved sources of uncertainty are, as expected, in line with real options logic.

**Endogenously resolved uncertainty**

Model 4 adds the effects of endogenously resolved uncertainty. The results are consistent with hypotheses 4 and 5. Contrary to what would be expected if real option logic were applied, but consistent with hypothesis 4, we find no relationship between foreign share and cultural uncertainty (probability of Type II error < .01). Similarly, consistent with hypothesis 5, we find no relationship between foreign share and R&D uncertainty (probability of Type II error < .01). The inclusion of additional variables in Model 5 does not change the results.

Thus, the results support hypotheses 4 and 5. As expected, real option predictions do not hold when uncertainty can be resolved endogenously, and thereby departs from the assumptions underlying option logic.

**DISCUSSION**

The results advance our understanding of the boundary conditions for real option theory. In real option theory, one of the main predictions is that higher levels of uncertainty will increase the value of options, which will in turn increase the likelihood of the occurrence of a real option investment. In JVs this will result in a smaller ownership share for the call option holder. However, we also argued that this logic need not hold when uncertainty resolves endogenously rather than exogenously. When uncertainty
resolves exogenously, we indeed find a negative relationship between economic uncertainty (Hypothesis 1), local institutional uncertainty (Hypothesis 2), and exchange rate uncertainty (Hypothesis 3) respectively and the foreign share in a JV. These results confirm the power of real option logic when it comes to exogenous uncertainty. We also examined the relationship between cultural uncertainty (Hypothesis 4) and R&D uncertainty (Hypothesis 5) respectively and the foreign share in a JV. Using an appropriate technique to test null hypotheses, we found no support for the statistical relationship that would follow from a real option model. Thus, as we argued, real options logic is applicable when uncertainty resolves exogenously, but not when it resolves endogenously.

This study has implications for both scholars and practitioners. Firstly, our framework makes it possible to identify under what conditions an investment can truly be expected to represent a real option. A wide range of investments have been classified as real option investments, and previous empirical results have shown inconsistent support for real option theory. We argue that this may be because real options logic might inadequately characterize investments which are subject to endogenously resolving uncertainty, such as some investments in joint R&D. However, our research also confirms that real options theory has strong predictive power in the presence of exogenous uncertainty. While we did not examine the performance implications of JV stakes, the results are consistent with arguments whereby real options can be an effective means of dealing with uncertainty when undertaking strategic investments – provided the uncertainty is exogenous. Secondly, as appealing as using real options metaphorically may be, this should only be done while keeping carefully in mind what sources of uncertainty the option is meant to hedge, and whether the uncertainty resolves endogenously. Thirdly, researchers and practitioners should be aware of the boundaries of the theory when they use it to examine potential investments. Using real options logic to value projects when it is not suitable is likely to lead to suboptimal decision making. Adner and Levinthal (2004a, 2004b) argued that practitioners might be able to make use of real options logic when uncertainty resolves endogenously, but only if they compensate for endogeneity by putting control systems into place and by changing the design of the organization. However, this is likely to come
at a trade-off, as uncertainty might resolve slower or not at all as a result of such mechanisms, and the organizational costs may outstrip the option value thus obtained.

The implications for joint venture research are substantive too. Our results confirm that a real options perspective can be useful in modeling JV formation, but add an important caveat that this is only true when uncertainty resolves exogenously. Furthermore, while much has been written about conditions under which JVs are more or less appropriate (i.e. why JVs exist), our model describes determinants of the optimal level of ownership for a foreign investor. This is especially relevant in dealing with highly (exogenously) uncertain markets, which is a basic reason to consider JVs in the first place.

**Limitations and Suggestions for Further Research**

This study, as any other study, is not without its limitations and several suggestions for further research can be made. We study the applicability of real options theory in one particular country. While China has become a favorite destination of foreign investment, future studies could verify our results in other national settings. Secondly, we only look at one particular type of real option investment, namely the JV. However, all our theoretical arguments hold for other types of real option investments. Thus, it would be interesting to look at other types of real option investments such as R&D projects, taking out patents, or founding new businesses. Thirdly, we look at five different sources of uncertainty. Future research could examine additional sources of uncertainty to further evaluate where real option logic holds. Finally, we use a dichotomous classification to distinguish between endogenously and exogenously resolving uncertainty. However, some sources of uncertainty may be more endogenous than others. Therefore, a more continuous classification of how uncertainty resolves could lead to additional insights.

Notwithstanding these limitations, our study shows that the use of real options can be made more powerful, both academically and in practice, by paying extra attention to the sources and resolution of the uncertainty that the options are meant to exploit. In the context of IJVs, we show that real options predictions are ineffective when uncertainty resolves endogenously, but all the more powerful when the firm faces exogenous uncertainty. Given the prevalence of uncertainty in international operations, and of IJVs as a mode of entry, further research in this area is all the more justified.
REFERENCES


TABLE 1: Descriptive Statistics and Correlations

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All models include industry fixed effects. Standard errors are in parentheses.
All two tailed tests: † p < 0.10  * p < 0.05  ** p < 0.01  *** p<0.001