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Elmar Lukas

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Sequential International Joint-Ventures and the Option to Choose

Elmar Lukas [a,*]

[a] *Department of Economics, University of Paderborn*

Abstract The purpose of this study is to formalize the optimal choice of market entry strategy for an individual multinational enterprise (MNE) from a dynamic perspective. It is argued that incorporating a suitable treatment of irreversibility, uncertainty and flexibility related to a MNEs investment decision gives further insights to the expansion, dissolvement, and optimal timing of international joint ventures (IJVs). In most cases, the initial entry strategy serves as a platform allowing the firm to make subsequent investments to exploit host-country advan tages and capabilities. We allow for this by taking a three-step expansion strategy explicitly into account. The evolutionary process of the value of the foreign direct investment can be interpreted as a compound complex chooser option. The results suggest that uncertainty, size of equity share and future investment/divestment opportunities play an important role when it comes to transit from export to the first phase of the foreign direct investment commitment. The paper underscores the importance of modeling the dynamics of market entry and helps to refine the application of real options in the alliance context by providing a closed-form solution in continuous time to value the overall strategic flexibility.

Keywords Foreign direct investment, multinational enterprise, sequential invest ments, entry mode, international joint venture, real options.

***JEL*-classification numbers**: D43, F23, L13, P31.

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* Corresponding author: Elmar Lukas, Warburger Str. 100, D-33098 Paderborn, Germany, Tel.: +49 5251 60 2961; fax: +49 5251 60 3731. Email: ELukas@notes.uni-paderborn.de

1 Introduction

The decision on how to enter a foreign market has become crucial to an internationalizing firm (see e.g. McCarthy and Puffer 1997). Besides all other market entry modes and a perceived decline in 2001, worldwide foreign direct investment (FDI) continues to grow stressing the importance of equity based entry strategies. In this context, uncertainty puts a premium on flexibility which results in the fact, that multinational enterprises (MNEs) often prefer the formation of collaborate ventures, e.g. equity ventures or strategic alliances when entering a foreign market for the first time. This is due to several reasons. The early stage of an international joint venture (IJV) provides important information, e.g. about true market demand, certain governmental or cultural behavior. Such information is important because it could not have been obtained through investigation before the venture was initiated making export strategies a clear initial favorite. On the other hand, an IJV provides an opportunity to buy more fully into a successful venture later on, an opportunity which is not available to those who have not taken any equity stake. As a consequence it avoids the more modest set-up costs of wholly owned subsidiaries (WOS).

A joint venture (JV) is an agreement of two or more legally independent companies, which pool their capabilities and resources together to a shared business. The joint venture becomes an international joint venture if at least one foreign partner is involved. The joint aspect is that ownership and risk are shared, whereas the venture term implies separate legal and/or economic personality of the created enterprise.[1] The economic rational of an international joint venture is thus, that it allows both of the partners to acquire some of the benefits of internalising the knowledge flow which is in addition economically justified if some complementary resources exist (e.g. Buckley and Casson 1996, Contractor and Lorange 1988, Chi and McGuire 1996).

So far, models of the multinational enterprise have been too static and thus fail to take proper account of uncertainty that is created by the volatility in the international business environment. Consequently, flexibility was identified as the hallmark of modeling the multinational firm (Buckley and Casson 1998b p.21). In particular, there exists a lack of in-depth research in the MNE literature, and in the international business literature respectively, with respect to the following questions. First, what triggers the switching of modes and second under which circumstances does the firm expand or dissolve international joint ventures from a dynamic viewpoint? A third question arises from the search for an optimal degree of foreign ownership since MNEs have frequently to decide to own 100%, majority or minority shares of newly created foreign entities.

The rest of the paper is organized as followed. Section two will provide a review of recent literature, following the presentation of the model in the subsequent section three. After this, the main results are presented in the fourth section. A synopsis of major comparative-static results is provided in section five. Finally, section six summarizes the main findings and provide suggestions for further research.

2 Review of the Literature

Most studies in the field of IJV driven research is empirical in nature (e.g. Dimelis and Louri 2002, Henisz 2000, Culpan and Kostelac 1993, Geringer and Herbert 1991, Gatignon and Anderson 1988 or Gomes-Casseras 1987). Less effort, however, has been made in scrutinizing the properties of IJV through rigorous theoretical modeling. Buckley and Casson (1996) present a discrete choice model that explains the formation of IJVs in terms of key explanatory factors suggested by internalization theory, e.g. cultural distance, economies of scope and protection of independence. In addition, the authors discuss the strategic interactions between IJVs and merger on the one hand, and IJVs and licensing on the other hand. Although static in nature the model accounts for volatility as a proxy for pace for innovation and rate of interest. Thus, they argue that IJVs are present in situations where market size and volatility are both either high or low. In a qualitative manner, Buckley and Casson (1998a) focused explicitly on determinants influencing the choice between alternative forms of foreign direct investment. They stress the importance of certain additional costs that trigger the choice of preferring IJV with respect to other forms like e.g. greenfield or acquisition. In particular, the authors identify learning costs, adaptation costs and trust-building costs, i.e. those for technology transfer, marketing expertise and intermediate output flow, as important once-and-for-all set up cost for IJVs. However, all attempts do not account for the fact, that a firms commitment to invest into a new market is associated with sunk costs which cannot be recovered once the project is initiated. Furthermore, foreign direct investment decisions are to a large portion investment decisions under uncertainty and are only but the first commitment of subsequent expansion. Thus, with respect to the initial switching decision, i.e. whether to abandon export or not, one has additionally to consider the impetus of subsequent expansion. Another criticism stems from that fact, that these models only consider the unidirectional case. Thus, they lack explanation of divestment or strategic reorientation (see e.g. Buckley and Tse 1996 and Buckley and Casson 1998a, Kogut and Zander 1993).

In the last decade, researchers have highlighted the importance of a more dynamic perspective in foreign direct investment (FDI) theory. Real options theory has recently generated significant interest in the international business field. In brief, real option theory suggests to view real investments as options buying the firm the rights such as to make investments later, the right to defer or alter scale or to initiate subsequent investments.[2] Besides others, Buckley and Casson (1998b) have drawn the attention on this by arguing that the existing models do value FDI decisions only with respect to its immediate effects rather than in terms of possible new investment opportunities. In other words, in most cases initial foreign production serves as a platform in the expansion abroad, e.g. MNEs R&D units, indicating that the initial investments carry a high option value due to possible new investment opportunities (Kogut and Chang 1996, Howells and Wood 1993, Chang and Rosenzweig 2001, Lukas and Gilroy 2005). It is clear that this fact is most obvious for international joint ventures and it is Kogut (1991) who puts this thought further. Possible project interdependencies within the IJV allow for strategic flexibility calling for a interpretation of IJVs as platform investments. Thus, although unprofitable from a stand-alone perspective, the value of a joint-venture can be much higher due to the flexibility to acquire later stakes of the venture in the future. Consequently, the termination of a IJV does not indicate its failure but the exploitation of its flexibility. Lately, his idea has become a building block for empirical research (see e.g. Reuer and Leiblein 2000 or Reuer and Tong 2005). Based on a two-stage binomial model, Chi and McGuire (1996) model a situation in which the MNE has the option to acquire or sell out the partner's stake in an equity JV.[3] They depict that both options create economic value for the partners of the JV, especially if the partners foresee different valuation expectations of the venture ex post. In addition, the presence of transactions costs can lead to a certain amount of ex ante asymmetry which results in the motivation to trade in the right to the option. By treating two sources of uncertainty explicitly in their model, the authors were also able to show how the options serve in diminishing the risk of misappropriation and thus alleviating the difficulty of JV contracting under information asymmetry. Besides the theoretical analysis, the authors also present a number of testable hypotheses related to their work. In a more advanced model setting, Pennings and Sleuwaegen (2000) design an option model where both the timing of market entry and the entry mode are determined simultaneously. The switch from export whether to a WOS, a joint venture or to licensing is dependent on uncertainty of payoffs, cost structure, competitive stance of incumbents, tax differences and the degree of cooperation between the joint venture partners. In particular, the timing of JV is related to transfer prices, amount of equity share, market structure, and to the degree of governmental regulation.

Over and beyond the attempts of the current literatures, the goal of this paper is twofold: To model a market entry situation of foreign direct investment under uncertainty in a continuous time setting given the observed fact of an evolutionary expansion sequence via an IJV. Thus, the rest of the paper is structured as followed. First, we will present the model: a three-phase market entry situation where each phase is connected to some sort of sunk cost and the flexibility to decide whether to initiate the phase or not. The first phase represents the initial phase of an international joint venture, e.g. the establishment of a physical presence by either holding minority, majority or an equal stake of the collaborative venture. This phase serves as a platform, i.e. an important prerequisite to further expand an MNEs presence in the new market. After a second phase of joint collaboration, the third phase is linked to two options. The first is to expand the foreign commitment by acquiring the remaining shares and transform the market entry into a merger. The counterpart option is to dissolve the venture by selling out the partner. Finally, we will discuss our main findings.

3 The Model

IJVs are configured in many different ways. Consequently, different combinations are associated with different kinds of behavior (see e.g. Tallmann 1992). The complexity of IJVs is furthermore driven by the fact, that not only economic factors such as profit or market-share have an impact on IJVs but other factors like e.g. legal, technological and cultural factors (e.g. Geringer and Hebert 1989, Contractor and Lorange 1988, Hennart 1988). Thus, explicit assumptions are particularly crucial when modeling an IJV. This paper focuses on a representative equity-based joint venture between two private firms that combine complementary resources. These resources comprise firm-specific knowledge, which is either related to technology or marketing expertise or both. For simplicity it is assumed, that the firms only share a subset of their overall knowledge, however in an amount that secures the agreed objective, such as e.g. the solution to a new product development. Furthermore, it is assumed that only one firm is a foreigner to the new market, namely the MNE which choses a local partner in the host country.

Consider a MNE that has to decide whether to enter a new geographical market via a joint venture with a host country candidate or sticking to its current export serving strategy. [4] It is assumed that the foreign investor is risk neutral and that market entry through foreign direct investment follows a three stage process and that each stage is connected to some sort of sunk costs.[5] The choice of which entry strategy an enterprise chooses has no influence upon the profit rates of other enterprises in the foreign market. Moreover, the value of the chosen FDI mode is ex ante unknown and follows a geometric Brownian motion. Thus, $dV(t)$ represents the value evolution of the foreign investment project:

$$dV(t) = \alpha V(t)dt + \sigma V(t)dB(t), \tag{1}$$

with α as the corresponding growth rate of the project values, $dB(t)$ represents a Wiener process with zero mean and variance equal to dt and σ^2 designates the variance of $dV(t)/V(t)$ due to environmental risk. Assuming a perfect capital market, the existence of a unique martingale measure Q can be used to modify the stochastic differential equation, which results in:

$$dV(t) = (r - \delta)V(t)dt + \sigma V(t)dB^Q(t), \tag{2}$$

where $dB^Q(t)$ is now a stochastic element with non-zero drift. We will use this expression for any further consideration on the value of the claims.

During the first stage of setting up an operation physical presence costs of the order of I_1 emerge. With respect to Buckley and Casson (1998b) it is assumed that this up front cost incurs additional costs of market entry that differ with respect to the chosen entry strategy. In particular, the authors identify learning costs m, adaptation costs a and trust-building costs q, i.e. those for technology transfer, marketing expertise and intermediate output flow, as important once-and-for-all set up cost for IJVs. Consequently, it is assumed that these costs combined with the *ex ante* specified costs I_0 for acquiring the equity stake χ make of the set-up cost I_1 which can be formulated more explicitly:[6]

$$I_1 = \eta(a, q, m) I_0. \tag{3}$$

where η is an increasing function in the additional costs.

The first phase represents the initial phase of an international joint venture, e.g. the establishment of a physical presence by either holding minority, majority or an equal stake of the collaborative venture. Let χ refer to the initial equity stake, the MNE investor wishes to invest in. Then the value of such a market entry for the MNE is equal to:[7]

$$\tilde{F} = E^Q \left[\frac{[\chi V + \hat{F} - I_1]^+}{e^{r(t_1 - t_0)}} | \mathcal{F}_0 \right] \tag{4}$$

given the filtration $\mathcal{F}_0$. $\hat{F}$ represents the value of flexibility due to subsequent routes of action.

Due to the fact, that an international joint venture involves co-ownership as well as co-management, both partners are comprised to a risk that obstacles to a smooth decision-making process will arise over the course of the project. Consequently, it is worthwhile to consider a certain period of time in which the partners become acquainted and can check if joint work is possible for the sake of the venture. We will designate this time with T. After this period, the MNE can either decide to exercise the option to expand its foreign market presence by acquiring the rest $(1 - \chi)$ of the equity stake. For simplicity, we assume that the MNE will buy the remaining stake so the resulting equity becomes 1 and equals a cross-border merger. However, if the environment turns out to be unprofitable, the MNE can dissolve the joint venture buy selling out its stake to the partner. Thus, the venture will be an equity joint venture if $0.05 < \chi < 1$ (see e.g. Gomes-Casseras 1987).

Formalizing the optimization problem in this manner is similar to the analytics of two financial options; a compound option and a complex chooser option. A compound options simply refers to option rights on options. The chooser option, however, is a path dependent derivative which allows the holder to chooser whether their option is a call or a put at a particular date. It is worthwhile to note, that the methodological foundations and solution of this optimization problem have been analyzed independently. The first to analyze a compound option was Geske (1979) while perpetual options have been studied by e.g. McDonald and Siegel (1986). Complex chooser options have been analyzed by Rubinstein (1991). While they have been studied in isolation, however, none of the existing literature have brought them into conjunction so far.

It may be demonstrated that for each stage there exists a threshold value at which it is optimal for a MNE to exercise the investment option.[8] The following section briefly summarizes the trigger values which illustrate when it is optimal for an MNE to trigger the first, second, and third stage of the market entry via an IJV.

4 Results

In the following the main findings resulting from the previous introduced assumptions are summarized. It is worthwhile stating, that the solution of the problem in general is determined recursively. However, it is convenient to present the results in a forward looking fashion.

Proposition 1 *The flexibility for an individual MNE to enter the market via an international joint venture is determined by:*

$$
\begin{aligned}
\tilde{F} = {} & \chi V_0 e^{-\delta t_1} N(d_9) - I_1 e^{-rt_1} N(d_{10}) + \kappa I_0 e^{-rt_2} M(h_1, k_3; -\rho) \\
& - \chi V_0 e^{-\delta t_2} M(h_2, k_4; -\rho) + B V_0^{\beta_2} M(h_3, k_7; -\rho) - B V_0^{\beta_2} M(h_3, k_8; -\rho) \\
& + A V_0^{\beta_1} M(h_3, k_5; -\rho) - A V_0^{\beta_1} M(h_3, k_6; -\rho) + (1-\chi) V_0 e^{-\delta t_2} M(h_2, k_2; \rho) \\
& - I_2 e^{-rt_2} M(h_1, k_1; \rho)
\end{aligned}
\tag{5}
$$

where $\rho = \sqrt{t_1/t_2}$, V_0 *states the value of the project at time* $t = 0$, $M(\ldots)$ *designates the bivariate cumulative standard normal distribution with:*

$$
k_1 = \frac{\ln\left(\frac{V_0}{V_U^*}\right) + (r - \delta - \frac{1}{2}\sigma^2)t_2}{\sigma\sqrt{t_2}}, \quad k_7 = \frac{\beta_2 \ln\left(\frac{\xi}{V_0}\right) - (r - \frac{1}{2}\sigma^2\beta_2^2)t_2}{\sigma\beta_2\sqrt{t_2}},
$$

$$
k_2 = \frac{\ln\left(\frac{V_0}{V_U^*}\right) + (r - \delta + \frac{1}{2}\sigma^2)t_2}{\sigma\sqrt{t_2}}, \quad k_8 = \frac{\beta_2 \ln\left(\frac{V_D^*}{V_0}\right) - (r - \frac{1}{2}\sigma^2\beta_1^2)t_2}{\sigma\beta_2\sqrt{t_2}},
$$

$$
k_3 = \frac{\ln\left(\frac{V_D^*}{V_0}\right) - (r - \delta - \frac{1}{2}\sigma^2)t_2}{\sigma\sqrt{t_2}}, \quad h_1 = \frac{\ln\left(\frac{V_0}{V_1^*}\right) + (r - \delta - \frac{1}{2}\sigma^2)t_1}{\sigma\sqrt{t_1}},
$$

$$
k_4 = \frac{\ln\left(\frac{V_D^*}{V_0}\right) - (r - \delta + \frac{1}{2}\sigma^2)t_2}{\sigma\sqrt{t_2}}, \quad h_2 = \frac{\ln\left(\frac{V_0}{V_1^*}\right) + (r - \delta + \frac{1}{2}\sigma^2)t_1}{\sigma\sqrt{t_1}},
$$

$$
k_5 = \frac{\beta_1 \ln\left(\frac{V_U^*}{V_0}\right) - (r - \frac{1}{2}\sigma^2\beta_1^2)t_2}{\sigma\beta_1\sqrt{t_2}}, \quad h_3 = \frac{\beta_1 \ln\left(\frac{V_0}{V_1^*}\right) + (r + \frac{1}{2}\sigma^2\beta_1^2)t_1}{\sigma\beta_1\sqrt{t_1}},
$$

$$
k_6 = \frac{\beta_1 \ln\left(\frac{\xi}{V_0}\right) - (r - \frac{1}{2}\sigma^2\beta_1^2)t_2}{\sigma\beta_1\sqrt{t_2}}.
$$

Proof 1 *See Appendix.*

The first two terms of the solution correspond with the Black-Scholes formula and emphasise the value of waiting to invest. However, substantial contribution to the value of the IJV entry strategy stems from its subsequent flexibility, i.e. the option to choose. This flexibility is composed of the option value to dissolve the IJV (i.e. the third to fifth term) and the option value to grow and turn the IJV into a cross-border merger (i.e. the remaining terms) . As the result indicates, the overall flexibility of the entry strategy is besides uncertainty, costs, amount of equity share and time additionally sensitive to several threshold values which will be discussed in the following.

Neglecting exchange rate effects and switching costs, an enterprise will abandon its current export service strategy if the value development for the foreign direct investment strategy hits a certain threshold value V_1^*.[9]

Proposition 2 *The MNE will switch from export to an international joint venture, i.e. exercising the first stage, if V reaches at least an optimal trigger value V_1^* determined by:*

$$\chi V_1^* + \hat{F}(V_1^*) - I_1 = 0, \tag{6}$$

with I_1 as the initial investment cost and $\hat{F}$ as the flexibility for further expansion or dissolvement.

Proof 2 *See Appendix.*

The value of flexibility, i.e. the value of the complex chooser option, is given by:

$$\begin{aligned}\hat{F} = {} & \kappa I_0 e^{-rT} N(d_3) - \chi V_1 e^{-\delta T} N(d_4) + B V_1^{\beta_2} N(d_7) - B V_1^{\beta_2} N(d_8) \\ & + A V_1^{\beta_1} N(d_5) - A V_1^{\beta_1} N(d_6) + (1-\chi) V_1 e^{-\delta T} N(d_1) - I_2 e^{-rT} N(d_2),\end{aligned} \tag{7}$$

with V_1 as the value of the project at time t_1, $N(\ldots)$ as the cumulative normal distribution and

$$\mathrm{d}_1 = \frac{\ln\left(\frac{V_1}{V_U^*}\right)+(r-\delta+\frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}}, \quad \mathrm{d}_2 = \frac{\ln\left(\frac{V_1}{V_U^*}\right)+(r-\delta-\frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}},$$

$$\mathrm{d}_3 = \frac{\ln\left(\frac{V_D^*}{V_1}\right)-(r-\delta-\frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}}, \quad \mathrm{d}_4 = \frac{\ln\left(\frac{V_D^*}{V_1}\right)-(r-\delta+\frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}},$$

$$\mathrm{d}_5 = \frac{\beta_1\ln\left(\frac{V_U^*}{V_1}\right)-(r-\frac{1}{2}\beta_1^2\sigma^2)T}{\sigma\beta_1\sqrt{T}}, \quad \mathrm{d}_6 = \frac{\beta_1\ln\left(\frac{\xi}{V_1}\right)-(r-\frac{1}{2}\beta_1^2\sigma^2)T}{\sigma\beta_1\sqrt{T}},$$

$$\mathrm{d}_7 = \frac{\beta_2\ln\left(\frac{\xi}{V_1}\right)-(r-\frac{1}{2}\beta_2^2\sigma^2)T}{\sigma\beta_2\sqrt{T}}, \quad \mathrm{d}_8 = \frac{\beta_2\ln\left(\frac{V_D^*}{V_1}\right)-(r-\frac{1}{2}\beta_2^2\sigma^2)T}{\sigma\beta_2\sqrt{T}}.$$

Counterbalancing these costs an enterprise obtains the IJV with value χV given it exercises the investment possibility. Exercising this option the initiated project serves as a platform for a second investment opportunity putting the firm in a position to accrue further potential growth. As noted earlier, the expansion of multinational enterprises is a path dependent process, i.e. expansion may be interpreted as a sequence of investments where each investment feeds back information that can be used to improve the quality of subsequent decisions. (Kogut and Zander 1993). Consequently, the internalization process is not a unidirectional path, often overlooked in international business literature. A firm can anticipate the possibility of competition by investing in a manner that takes subsequent divestment options into account. Thus, divestment or withdrawal must be considered as serious strategies, too. We account for this by assuming that the MNE has a certain time period, in which it can decide how to continue with its market entry strategy. At the end of this period $[t_1, t_2]$, the MNE can decide whether it wants to convert the IJV into a cross-border merger by acquiring the remaining shares $(1-\chi)$ or dissolve the IJV by selling its own interest χ to the local partner. The last step may be justified, because a subsequent innovation renders an existing partner's technology obsolete or due to misappropriation risk. Consequently, the venture is abandoned for the sake of a new venture or for withdrawal from the foreign market. The criteria which strategy the MNE is given by the following proposition.

Proposition 3 *After a certain time T of joint collaboration in the foreign market, the MNE will continue to collaborate with the host partner in the current state if V reaches at least an optimal trigger value ξ determined by:*

$$\xi^{\gamma} = \frac{-\frac{\chi}{\beta_2}(V_D^*)^{1-\beta_2}}{((1-\chi)V_U^* - I_2)(V_U^*)^{-\beta_1}}, \tag{8}$$

with $\gamma = \beta_1 - \beta_2$. Otherwise, the MNE prepares to exit the market.

Proof 3 *See Appendix.*

If the MNE decides to expand into the market, it receives at t_2 a perpetual call option. Let I_2 represent the corresponding cost for acquiring the rest of the equity stake $(1-\chi)$ designating the cost of exercising the third stage call option.[10] By exercising the option the firm obtains a project with value $(1-\chi)V$.

Proposition 4 *Upon deciding to further expand into the foreign market, the MNE will switch from an international joint venture to a cross-border merger, i.e. exercising the third stage, if V reaches at least an optimal trigger value V_U^* determined by:*

$$V_U^* = \frac{1}{(1-\chi)} \frac{\beta_1}{\beta_1 - 1} I_2. \tag{9}$$

Proof 4 *See Appendix.*

On the other hand, if the MNE decides to dissolve the IJV, it will receive a perpetual put option. Upon exercising the third stage, the MNE gives up an existing project with value χV and receives its abandonment value κI_0 with $0 < \kappa < 1$ designating the level of recovered upfront investment outlay I_0 (see e.g. Chi 2000).[11]

Proposition 5 *Upon deciding to dissolve the international joint venture the MNE will exit the foreign market, i.e. exercising the third stage, if V reaches at least an optimal trigger value V_D^* determined by:*

$$V_D^* = \frac{\beta_2}{\beta_2 - 1} \frac{\kappa}{\chi} I_0. \qquad (10)$$

Proof 5 *See Appendix.*

5 Comparative-static Analysis

This section presents a summarization of a comparative-static analysis of the derived individual stage trigger points. If not noted later on, we will assume the following values $I_0 = 1, I_2 = 1, r = 0.03, \sigma = 0.3, \delta = 0.03, \kappa = 0.8$ and $\eta = 1$. Allowing for a collaboration period of length two years, i.e. $T = 2$ the value of the flexibility the MNE has to consider while planning to implement the IJV will be discussed first. From equation (5) it is apparent that the first two terms emphasize the value of waiting to invest. Thus, the comparative statistics of this term are identical with the ones of the Black-Scholes formula, e.g. flexibility is more valuable the longer the possibility to defer the decision exists. However, substantial contribution to the value of the IJV entry strategy stems from its subsequent flexibility, i.e. the value of the chooser option. This flexibility is composed of the option value to dissolve the IJV (i.e. the third to fifth term) and the growth option value which reflects the value of the subsequent cross-border merger strategy (i.e. the remaining terms). As the result indicates, the overall flexibility $\tilde{F}$ of the entry strategy increases with size of initial equity share, uncertainty, and value of the IJV while it decreases for high initial costs. The effect of the level of the divestiture price κ is twofold. While for majority-owned IJV an increase in κ results in an increase of the option value, and flexibility respectively, the opposite can be observed for minority-owned IJVs. Here, an increase in κ corresponds with a decrease of the option value. The following Figure 1 summarizes the results graphically.

==========[INSERT FIGURE 1 HERE]===========

However, of special interest economically is the first trigger point. It permits inferences on the manner in which an enterprise enters a new market based upon the initial equity χ and the corresponding market entry costs. The threshold V_1^* decreases as uncertainty increases, thus indicating that a switching of modes, i.e. from export to an IJV, will further be accelerated.[12] In addition, the threshold becomes lower the higher the planned equity share for the first phase is. This effect, however, is more obvious for high project uncertainties. Due to the fact that a longer period of joint collaboration results in a greater value of flexibility $\hat{F}$ (Figure 2), V_1^* is furthermore decreasing as T increases .

==========[INSERT FIGURE 2 HERE]===========

As equation (6) indicates, the threshold is furthermore sensitive to the additional costs of a IJV. V_1^* is negatively affected (i.e. increasing) if e.g. cultural differences result in high learning costs or high adaptation costs are persistent. Moreover, another interesting result is apparent. While the threshold V_1^*

is significantly sensitive to uncertainty if there is a high recovery value once the IJV is terminated in the future (i.e. high κ), the sensitiveness vanishes if there is a decrease in κ. Consequently, there exists an increased propensity that the MNE's option for initiating a IJV will expire worthless. Figure 3 below illustrates the trigger value for the first stage of an international JV.

==========[INSERT FIGURE 2 HERE]===========

The comparative-static results for the trigger value V_D^*, and V_U^* respectively, are well-known from the standard literature.[13] The threshold value V_U^* becomes larger and so does the propensity to wait with turning the IJV into a merger, the higher the costs of acquiring the remaining shares I_2 are, and the smaller β_1 is. Given that $\partial\beta_1/\partial\sigma < 1$, it follows that an increase in involved aggregate investment uncertainty leads to an increase in V_U^*. In addition, the trigger value is also dependent on the size of equity share χ. If the MNE holds already a majority in the IJV, $1/(1-\chi)$ becomes significantly large, thus indicating an increased propensity to wait before acquiring the remaining shares (i.e. higher threshold value). However, due to the concavity of $V_U^*(\sigma)$, the effect of χ and I_2 is more significant the lower the aggregate uncertainty of the overall project is.

The opposite can be observed for the trigger value of the divestment stage. Low uncertainties correlate with a high threshold value. Due to the dependence of β_2 on σ, V_D^* decreases as uncertainty increases. This effect is further amplified, the lower the initial equity share χ or the higher the fraction of recovery value κI_0 is. However, due to the convexity of $V_D^*(\sigma)$, the effect of κ, χ, and I_0 is more significant the lower the aggregate uncertainty of the overall project is. It is worthwhile to mention, that for low project uncertainty σ both thresholds are close to the costs of the investment opportunities. The following figure summarizes the results of both threshold values.

==========[INSERT FIGURE 3 HERE]===========

However, the chooser option is a path dependent derivative. Thus, implications about the kind of termination the MNE chooses at time t_2 can only be made in conjunction with the threshold ξ. As noted earlier, at t_2 the MNE chooses that strategy, that gives the maximum return according to $\max\{C(V), P(V)\}$. Consequently, if V_2 is greater than ξ, the MNE will stick to its current strategy and further collaborate until the above mentioned threshold V_U^* is reached turning it into a merger. If V_2 is lower than ξ, the MNE will further collaborate while at the same time prefer to dissolve the IJV. From the results derived, ξ shows now two different trends with respect to its dependence on project uncertainty. If the MNE holds a majority in the IJV, the threshold increases the higher the aggregate uncertainty is. Consequently, with increased uncertainty there is a perceived trend toward sell out because the MNE demand a higher project value for compensating the associated risks accompanied with a merger strategy. For minority IJVs, however, ξ is inversely dependent on project uncertainty. Thus, the chance for a subsequent merger is even greater the higher the project uncertainty becomes. Furthermore, given the fact that ξ is (not) reached, the propensity to initiate the investment (divestment) is even faster the lower the uncertainty σ is (i.e. because only small upward (downward) movements of V are needed to hit the corresponding threshold value).[14] Both trends are dampened by a decrease in recovery value κ. Figure (4) depicts graphically the dependence of ξ on uncertainty with respect to different κ, χ combinations.

==========[INSERT FIGURE 4 HERE]===========

6 Summary

In this paper, we briefly reviewed the recent empirical and analytic driven literature concentrating on IJV. While most studies in this field of research is empirical in nature, less effort, however, has been made in scrutinizing the properties of IJV through rigorous theoretical modeling.

It is commonly known that the expansion of multinational enterprises is a path dependent process which is reflected in the fact that the observed internalization processes of MNE happened not only to be a unidirectional path. Consequently, strategic reorientation, divestment or withdrawal must be considered as serious strategies, too. In line with the demand toward a new agenda for modeling the multinational firm, we present a real options model in a continuous time setting given the observed fact of an evolutionary expansion sequence via an IJV. By applying real options methodology, the impetus of subsequent expansion can best be modeled. The model builds on the analytics of two financial options; a compound option and a complex chooser option. While they have been studied in isolation, however, none of the existing literature have brought them into conjunction so far. Thus, the consequent modeling of such a derivate is another important contribution of the paper. It is demonstrated that for each stage there exists a threshold value at which it is optimal for a MNE to exercise the corresponding real option. The results show the new complementary insight, that the choice of investing in the first stage is not only driven by the growth option, as commonly modeled in the literature, but also driven by the flexibility to dissolve the venture. In line with the empirical literature, e.g. Reuer and Tong (2005) this aspect becomes crucial when high uncertainty, e.g. due to political risk, is persistent or if a majority-owned IJV is considered. Another aspect provided by the model is that it explicitly shows how the length of collaboration influences the path dependency of foreign direct investment, and the formation of IJV in particular. While it has been commonly agreed on that IJV are a transitional form of foreign market expansion, less emphasis has been placed on what triggers the choice of termination form. Consequently, the model provides a solution that allows to reveal which kind of termination is chosen by the MNE. Moreover, implications for governmental policies in order to attract FDI can be deduced from the model.

The model introduced here is a first attempt to stress the sequential nature of IJV and to depict the importance of subsequent investment/divestment options on the initial entry decision and their effect on JV termination. This model can be extended in a number of directions. While collaborating in the foreign market, the MNE may profit from learning. Consequently, some of the uncertainty is resolved which can be implemented in the model easily. Moreover, real option rights are to a large extent not exclusive. Competition may cause an erosion of the option value e.g. due to first-mover advantage attempts of potential competitors or due to misappropriation risks. In such a case, it is worthwhile to extend the assumption that the value evolution of a foreign direct investment follows a Brownian motion and to implement Poisson-Jump arguments. Finally, the presented study provides new opportunities for further empirical research under an option framework.

7 Appendix

The values of the investment opportunities $\hat{F}$ and $\tilde{F}$, as well as the optimal trigger points V_U^* and V_D^* (representing the actual timing of the subsequent investment/divestment) may be solved for recursively. First, the values and thresholds for the perpetual call and put option have to be determined. Then the value of the second stage investment possibility $\hat{F}(V)$, i.e. the complex chooser option, along with the corresponding trigger point V_1^* are derived. Finally, the value of the overall entry strategy $\tilde{F}$ is specified.

7.1 Option values of the perpetual claims

From Dixit and Pindyck (1994) as well as Merton (1973) the results for a perpetual call option, and a perpetual put respectively, are commonly known.[15] Thus, they are just summarized briefly. Building on the assumption of a martingale process, the corresponding value process of V is described by the following stochastic differential equation:

$$dV_t = (r - \delta)V_t dt + \sigma V_t dB^Q, \tag{11}$$

where Q indicates the martingale measure. Under the assumption of a perpetual time to maturity and corresponding boundary conditions the solution for a perpetual call option results in:[16]

$$C(V) = \begin{cases} AV^{\beta_1} & if \quad V < V_U^* \\ (1-\chi)V - I_2 & if \quad V \geq V_U^*, \end{cases} \tag{12}$$

with

$$V_U^* = \frac{1}{(1-\chi)}\frac{\beta_1}{\beta_1 - 1}I_2, \tag{13}$$

and

$$A = (1-\chi)\frac{1}{\beta_1}\left[\frac{1}{(1-\chi)}\frac{\beta_1}{\beta_1-1}I_2\right]^{(1-\beta_1)}, \tag{14}$$

$$\beta_1 = \frac{1}{2} - \frac{(r-\delta)}{\sigma^2} + \sqrt{\left[\frac{(r-\delta)}{\sigma^2} - \frac{1}{2}\right]^2 + \frac{2r}{\sigma^2}} > 0. \tag{15}$$

Similar, the solution for a perpetual put option is given by:[17]

$$P(V) = \begin{cases} BV^{\beta_2} & if \quad V \geq V_D^* \\ \kappa I_0 - \chi V & if \quad V < V_D^*, \end{cases} \tag{16}$$

with

$$V_D^* = \frac{\beta_2}{\beta_2 - 1}\frac{\kappa}{\chi}I_0, \tag{17}$$

and

$$B = -\frac{1}{\beta_2}\chi\left(\frac{\beta_2\kappa I_0}{(\beta_2-1)\chi}\right)^{1-\beta_2}, \tag{18}$$

$$\beta_2 = \frac{1}{2} - \frac{(r-\delta)}{\sigma^2} - \sqrt{\left[\frac{(r-\delta)}{\sigma^2} - \frac{1}{2}\right]^2 + \frac{2r}{\sigma^2}} < 0. \tag{19}$$

7.2 Closed-form solution for the complex chooser option

In order to derive a closed form solution for the complex chooser option one has to determine another threshold ξ which is used to simplify the $\max\{\ldots\}$

condition of the chooser option. Thus, ξ is derived by the intersection of $P(\xi)$ and $C(\xi)$ which is easy to solve for perpetual style options.[18] From $A\xi^{\beta_1} = B\xi^{\beta_2}$ we get:

$$\xi^{\gamma} = \frac{-\frac{\chi}{\beta_2}(V_D^*)^{1-\beta_2}}{((1-\chi)V_U^* - I_2)(V_U^*)^{-\beta_1}}, \tag{20}$$

with $\gamma = \beta_1 - \beta_2$.

Referring to the above stated results, the value of the chooser option is given by:

$$\hat{F} = e^{-r(t_2-t_1)} E^Q \left[\max\{P(V), C(V)\}\right]. \tag{21}$$

This results in solving the following integral:

$$\begin{aligned} \hat{F} = e^{-r(t_2-t_1)} [\int_{-\infty}^{V_D^*} (\kappa I_0 - \chi V) d\Phi(V) \qquad\qquad\qquad\qquad & (22) \\ + \int_{V_D^*}^{\xi} B V^{\beta_2} d\Phi(V) + \int_{\xi}^{V_U^*} A V^{\beta_1} d\Phi(V) + \int_{V_U^*}^{\infty} ((1-\chi)V - I_2) d\Phi(V)]. & \end{aligned}$$

where $d\Phi(V)$ denotes the implied probability measure. The first and the last term of the integral are similar with the two parts of the Black-Scholes formula and can be solved in the same manner. However, as both terms in the middle are concerned, special attention is to the V^{β} term. By applying Itô's Lemma dV^{β}, and V^{β} respectively, we get:

$$dV^{\beta} = rV^{\beta} dt + \sigma\beta V^{\beta} dB^Q, \tag{23}$$

$$V_T^{\beta} = V_0 e^{rT - 1/2\sigma^2\beta^2 T + \sigma\beta B_T^Q}. \tag{24}$$

The last two terms of the exponential function can be substituted into a stochastic process $X \sim N(-1/2\sigma^2\beta^2 T, \sigma^2\beta^2 T)$. Exemplarily, the solution is drafted just for only one integral. Thus, the resulting integral

$$e^{-r(t_2-t_1)}\int\limits_{\xi}^{V_U^*} AV^{\beta_1}d\Phi(V) \tag{25}$$

can be transformed by substituting $X = Y - rT$ into:

$$= e^{-r(t_2-t_1)}\int\limits_{a}^{b} AV_1^{\beta_1}e^{rT+s}f_{N(0,1)}(s)ds, \tag{26}$$

with $a = \ln\left(\frac{\xi^{\beta_1}}{V_0^{\beta_1}}\right) - rT$ and $b = \ln\left(\frac{(V_U^*)^{\beta_1}}{V_0^{\beta_1}}\right) - rT$ as lower and upper boundaries. Due to symmetry features of the normal distribution, i.e. $\int_a^b f(x)dx = \int_{-\infty}^{b} f(x)dx - \int_{-\infty}^{a} f(x)dx$, the integral can easily be solved. Finally, by substituting $T = t_2 - t_1$ we get for the whole integral:

$$\begin{aligned}\hat{F} = {} & \kappa I_0 e^{-rT}N(d_3) - \chi V_1 e^{-\delta T}N(d_4) + BV_1^{\beta_2}N(d_7) - BV_1^{\beta_2}N(d_8) \\ & + AV_1^{\beta_1}N(d_5) - AV_1^{\beta_1}N(d_6) + (1-\chi)V_1e^{-\delta T}N(d_1) - I_2e^{-rT}N(d_2),\end{aligned} \tag{27}$$

with V_1 as the value of the overall IJV at time t_1, $N(\ldots)$ as the cumulative normal distribution and

$$\begin{aligned}
\mathrm{d}_1 &= \frac{\ln\left(\frac{V_1}{V_U^*}\right)+(r-\delta+\frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}}, & \mathrm{d}_2 &= \frac{\ln\left(\frac{V_1}{V_U^*}\right)+(r-\delta-\frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}},\\
\mathrm{d}_3 &= \frac{\ln\left(\frac{V_D^*}{V_1}\right)-(r-\delta-\frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}}, & \mathrm{d}_4 &= \frac{\ln\left(\frac{V_D^*}{V_1}\right)-(r-\delta+\frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}},\\
\mathrm{d}_5 &= \frac{\beta_1\ln\left(\frac{V_U^*}{V_1}\right)-(r-\frac{1}{2}\beta_1^2\sigma^2)T}{\sigma\beta_1\sqrt{T}}, & \mathrm{d}_6 &= \frac{\beta_1\ln\left(\frac{\xi}{V_1}\right)-(r-\frac{1}{2}\beta_1^2\sigma^2)T}{\sigma\beta_1\sqrt{T}},\\
\mathrm{d}_7 &= \frac{\beta_2\ln\left(\frac{\xi}{V_1}\right)-(r-\frac{1}{2}\beta_2^2\sigma^2)T}{\sigma\beta_2\sqrt{T}}, & \mathrm{d}_8 &= \frac{\beta_2\ln\left(\frac{V_D^*}{V_1}\right)-(r-\frac{1}{2}\beta_2^2\sigma^2)T}{\sigma\beta_2\sqrt{T}}.
\end{aligned}$$

7.3 Closed-form solution for the compound option

The solution of $\hat{F}$ is valid at time t_1. However, if we want to know what value the compound option has, we have to determine the value of this option at time t_0. Thus, additionally one has to solve:

$$\tilde{F} = E^Q \left[\frac{[\chi V + \hat{F} - I_1]^+}{e^{r(t_1 - t_0)}} | \mathcal{F}_0 \right], \tag{28}$$

given the filtration $\mathcal{F}_0$. The solution procedure is similar to the one provided by Geske (1979). Setting $t_0 = 0$, one has to solve the following integral

$$\tilde{F} = \int_{V_1^*}^{\infty} [\chi V + \hat{F} - I_1] e^{rt_1} d\Phi(V), \tag{29}$$

with respect to the given solution of the foremost closed-form solution for $\hat{F}$. The lower boundary V_1^* represents the threshold for exercising the compound option according to:[19]

$$\chi V_1^* + \hat{F}(V_1^*) = I_1. \tag{30}$$

This results in solving ten integrals and leads to the following expression for the value of the compound option $\tilde{F}$:

$$\begin{aligned} \tilde{F} = & \chi V_0 e^{-\delta t_1} N(d_9) - I_1 e^{-rt_1} N(d_{10}) + \kappa I_0 e^{-rt_2} M(h_1, k_3; -\rho) \\ & - \chi V_0 e^{-\delta t_2} M(h_2, k_4; -\rho) + B V_0^{\beta_2} M(h_3, k_7; -\rho) - B V_0^{\beta_2} M(h_3, k_8; -\rho) \\ & + A V_0^{\beta_1} M(h_3, k_5; -\rho) - A V_0^{\beta_1} M(h_3, k_6; -\rho) + (1 - \chi) V_0 e^{-\delta t_2} M(h_2, k_2; \rho) \\ & - I_2 e^{-rt_2} M(h_1, k_1; \rho), \end{aligned} \tag{31}$$

where $\rho = \sqrt{t_1/t_2}$, V_0 states the value of the project at time $t = 0$ and $M(\ldots)$ designates the bivariate cumulative standard normal distribution which is represented by the term:[20]

$$M(x, y; \rho) = \frac{1}{2\pi\sqrt{1 - \rho^2}} \int_{-\infty}^{y} \int_{-\infty}^{x} e^{-\frac{1}{2} \frac{(x^2 - 2\rho y x - y^2)}{1 - \rho^2}} dx dy. \tag{32}$$

The expression of the cumulative standard normal and cumulative standard bivariate distribution are given by:

$$\mathrm{d}_9 = \frac{\ln\left(\frac{V_0}{V_1^*}\right)+(r-\delta+\frac{1}{2}\sigma^2)t_1}{\sigma\sqrt{t_1}}, \quad \mathrm{d}_{10} = \frac{\ln\left(\frac{V_0}{V_1^*}\right)+(r-\delta-\frac{1}{2}\sigma^2)t_1}{\sigma\sqrt{t_1}},$$

and

$$\mathrm{k}_1 = \frac{\ln\left(\frac{V_0}{V_U^*}\right)+(r-\delta-\frac{1}{2}\sigma^2)t_2}{\sigma\sqrt{t_2}}, \quad \mathrm{k}_7 = \frac{\beta_2\ln\left(\frac{\xi}{V_0}\right)-(r-\frac{1}{2}\sigma^2\beta_2^2)t_2}{\sigma\beta_2\sqrt{t_2}},$$

$$\mathrm{k}_2 = \frac{\ln\left(\frac{V_0}{V_U^*}\right)+(r-\delta+\frac{1}{2}\sigma^2)t_2}{\sigma\sqrt{t_2}}, \quad \mathrm{k}_8 = \frac{\beta_2\ln\left(\frac{V_D^*}{V_0}\right)-(r-\frac{1}{2}\sigma^2\beta_1^2)t_2}{\sigma\beta_2\sqrt{t_2}},$$

$$\mathrm{k}_3 = \frac{\ln\left(\frac{V_D^*}{V_0}\right)-(r-\delta-\frac{1}{2}\sigma^2)t_2}{\sigma\sqrt{t_2}}, \quad \mathrm{h}_1 = \frac{\ln\left(\frac{V_0}{V_1^*}\right)+(r-\delta-\frac{1}{2}\sigma^2)t_1}{\sigma\sqrt{t_1}},$$

$$\mathrm{k}_4 = \frac{\ln\left(\frac{V_D^*}{V_0}\right)-(r-\delta+\frac{1}{2}\sigma^2)t_2}{\sigma\sqrt{t_2}}, \quad \mathrm{h}_2 = \frac{\ln\left(\frac{V_0}{V_1^*}\right)+(r-\delta+\frac{1}{2}\sigma^2)t_1}{\sigma\sqrt{t_1}},$$

$$\mathrm{k}_5 = \frac{\beta_1\ln\left(\frac{V_U^*}{V_0}\right)-(r-\frac{1}{2}\sigma^2\beta_1^2)t_2}{\sigma\beta_1\sqrt{t_2}}, \quad \mathrm{h}_3 = \frac{\beta_1\ln\left(\frac{V_0}{V_1^*}\right)+(r+\frac{1}{2}\sigma^2\beta_1^2)t_1}{\sigma\beta_1\sqrt{t_1}},$$

$$\mathrm{k}_6 = \frac{\beta_1\ln\left(\frac{\xi}{V_0}\right)-(r-\frac{1}{2}\sigma^2\beta_1^2)t_2}{\sigma\beta_1\sqrt{t_2}}.$$

Notes

[1]One distinguishes between contractual and equity joint ventures: In a contractual joint venture the initial investment costs, the risks and the profits of a single project are shared for a specified period, whereas in the latter assets, risks, profit and the participation of ownership in form of equity are shared indefinitely. The common endeavor can have any kind of minority-majority structure or equity can be equally 50:50 relating to financial, technological, know-how contributions.

[2]A detailed introduction to real options is given by Trigeorgis (1998) and Dixit and Pindyck (1994).

[3]Although not explicitly stated, this model can be interpreted as a chooser option, albeit only two discrete states are considered.

[4]It is taken for granted now, that an export strategy is the current preferred strategy for the firm to internationalize.

[5]To simplify the analysis, we also assume that throughout the duration of each stage the option rights are exclusive and furthermore that there are no problems of forfeiture or expiration limits with regard to exercising the respective investment option.

[6]For a *ex post* treatment see e.g. Chi (2000).

[7]This view is justified by the fact, that if the gains are always divided in some fixed proportion then the situation is identical with one firm taking the active role (Buckley and Casson 1996 p. 873).

[8]The derivation of the threshold values are given in the appendix.

[9]For a discussion of exchange rate effects as well as switching costs see e.g. Kogut and Chang (1996). An interpretation of export strategy as a real option itself available to a firm is given by e.g. Broll (1999).

[10]It is assumed that the acquisition price is fixed right from the start. For a justification of this assumption refer to e.g. Beamish and Banks (1997) or Chi and McGuire (1996).

[11]This assumption accounts for the fact that the additional costs cannot be recovered.

[12]We will assume that the value of the current export strategy is independent of uncertainty and can be represented by a simple net present value rule, i.e. $V - C > 0$.

[13]Compare Dixit and Pindyck (1994).

[14]The stylized facts with respect to the timing are consistent with the above depicted comparative statistics of V_U^* and V_D^* respectively.

[15]There is a perpetual nature of foreign direct investment due to the fact that legislation in most countries is such that no specific life span for a company is specified. See Clark (1997, p. 480). In cases where a specified contractual life span exist, the value of the foreign direct investment is a function of time. Consequently, the value of the real option additionally depend on the time left until the real option right matures.

[16]Compare Dixit and Pindyck (1994, p.143 ff.).

[17]Compare e.g. Merton (1990).

[18]If there is not such a perpetual lifespan assumed, ξ has to be determined iteratively, i.e. using Newton-Raphson or quadratic methods instead. See e.g. Nelken (1993).

[19]See e.g. Geske (1979).

[20]Drezner (1978) provides an algorithm to solve the bivariate normal integral.

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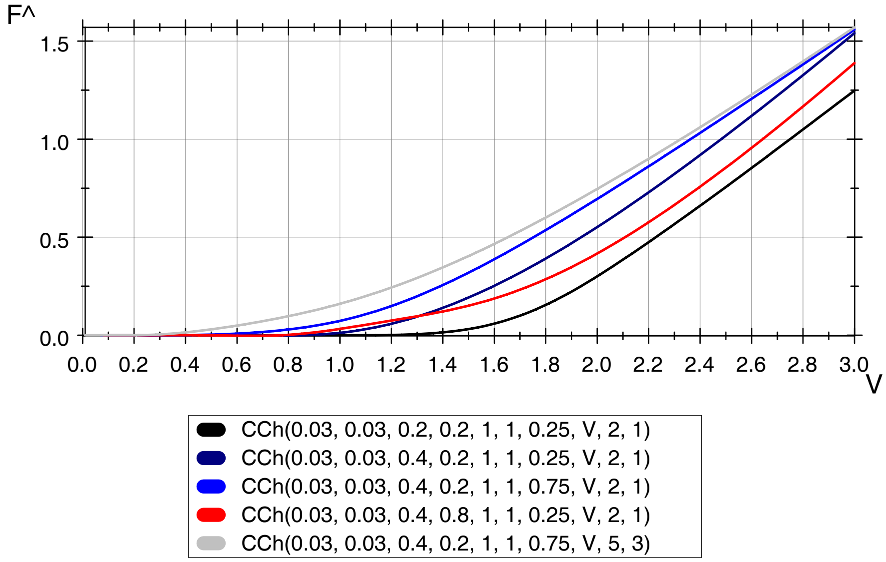

Figure 1. Value of flexibility in transitional IJV $\hat{F}(r, \delta, \sigma, \kappa, I_0, I_2, \chi, V, T, t_1)$ with respect to V and different parameter settings.

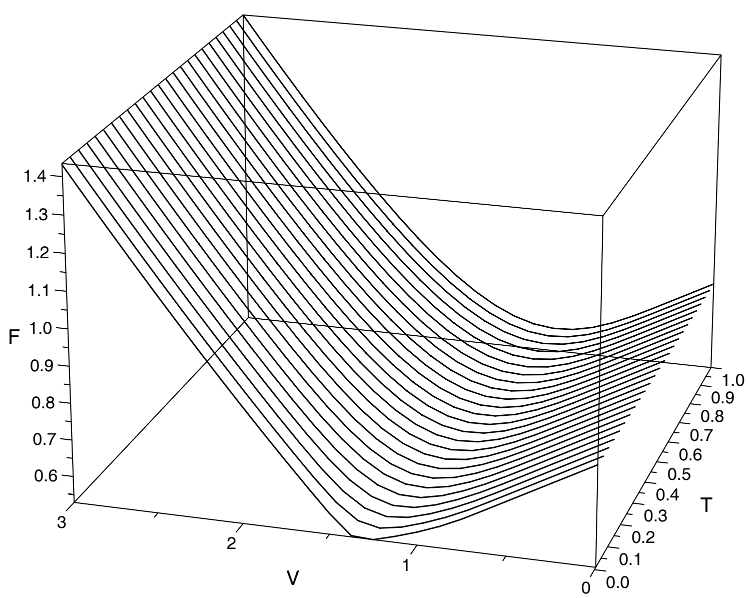

Figure 2. Value of acquisition/divesture option $\hat{F}$ with respect to V and time of joint collaboration T.

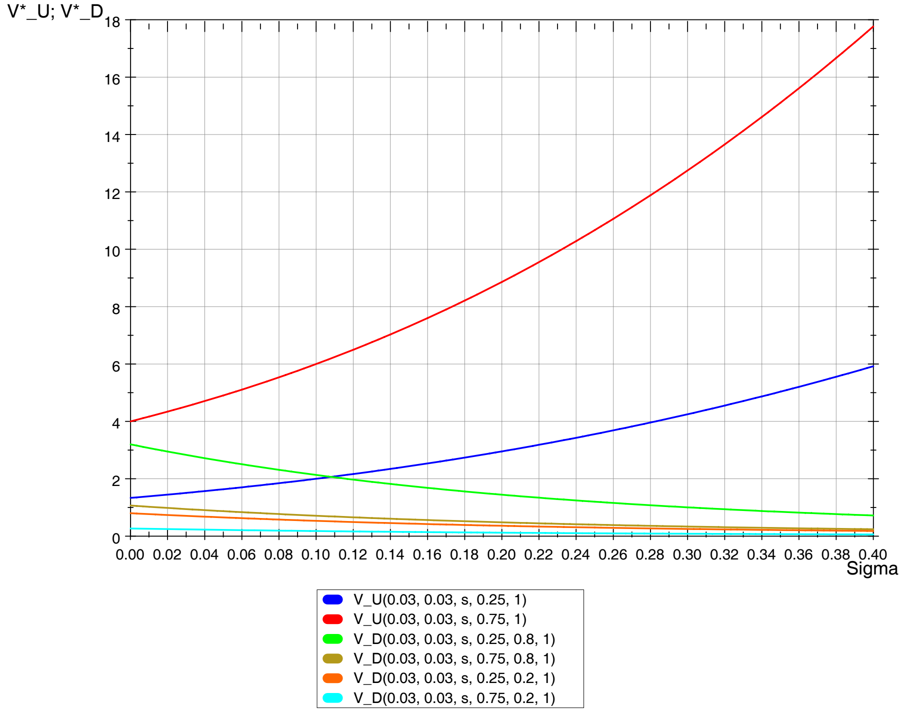

Figure 3. Threshold values of divesture $V_D^*(r, \delta, \sigma, \chi, \kappa, I_2, I_0)$ and acquisition option $V_U^*(r, \delta, \sigma, \chi, I_2)$ with respect to uncertainty σ.

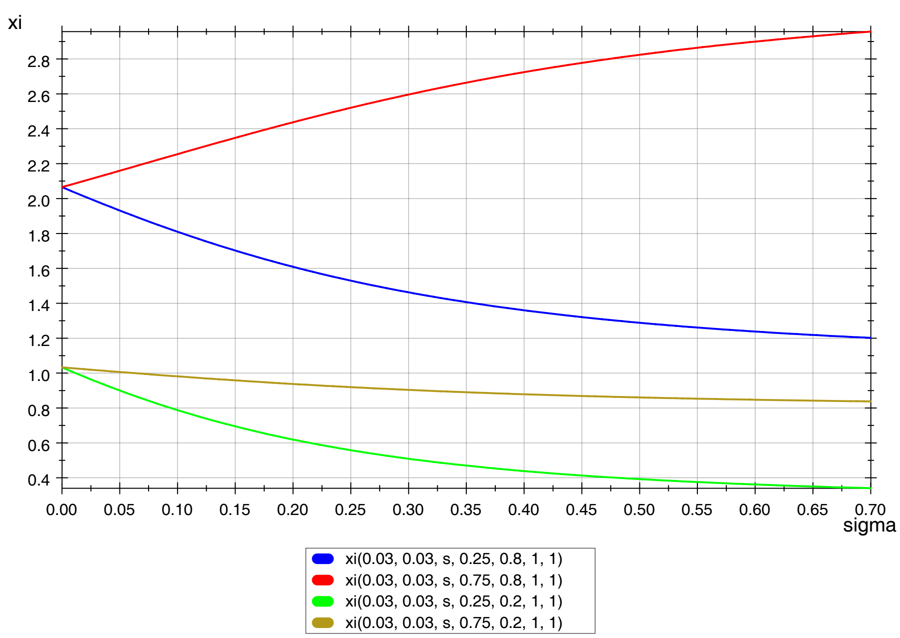

Figure 4. Influence of uncertainty σ and equity share χ on $\xi(r, \delta, \sigma, \chi, \kappa, I_2, I_0)$.