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On the Dynamics of Innovative Strategic Alliances in Korea*

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International industrial and technological cooperations are a necessity for firms to sustain competitiveness in a globalized world. Thus, the purpose of this study is to simulate the formation and success of innovative strategic alliances and international joint ventures, in particular, for Korea. Especially for such high risky market entries it is argued that incorporating a suitable treatment of irreversibility, uncertainty and flexibility related to a multinational enterprise (MNE) entry decision gives further insights to the expansion, dissolvement, and optimal timing of joint ventures in Korea.

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1. INTRODUCTION

The decision on how to enter a foreign market has become crucial to an internationalizing firm. 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. The turmoil caused by the Asian crisis and their aftermath created a very volatile environment in this region. The increased uncertainty affected foreign portfolio investments and foreign direct investment, respectively. Although Korea's inward FDI flow for 2004 was 7.7 billion US$, inward FDIs' average volatility (1998-2004) accounts for 49%.[1)2)] Another interesting fact about Korea's inward FDI is that only a relatively small number of industries, i.e. chemical, IT and electronics, food and transportation, accounted for the major shares of inward FDI over the years. While the importance has declined for the chemical industry recently, the amount of the remaining industries mentioned has risen steadily.[3)] Facts about the type of entry and their annual distribution are rare, however. As Hong (1998) reports, the number of new strategic alliances in Korea was 256 in 1996. However, only 82 were on a national level. Thus, roughly two-thirds of the strategic alliances were initiated with at least one foreign partner.[4)] Excluding the number of joint sales, OEM and tech-imports from the data, Hong (1998) reports 27 alliances due to joint R&D activity and 34 alliances due to an equity joint venture. According to Lim (2004), Korea still shows the highest number of international strategic

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[1)] See UNCTAD (2004, 2005).

[2)] Volatility is determined by the coefficient of variation, i.e. standard deviation divided by mean. See World Bank (1997).

[3)] See Seo *et al*. (2002).

[4)] Since the 1990s, South Korean firms have strengthened strategic technological alliances with foreign firms mainly in response to the upward pressure on technology protectionism. Illustrative of such activities is the case of LG Philips LCD, which is a joint venture between LG Electronics Inc. and the Netherlands-based Philips Electronics N.V.. Together with their core competitor Samsung Electronics both companies took up 22.0% and 19.7% each of the global LCD market in 2004.

alliances in North East Asian countries, however, there is a declining trend to be observed. Due to the fact that competitiveness is pursued through cooperation, Lim (2004) points out the necessity for cross-border industrial and technological cooperation in order for a better economic and sustainable development. He asserts that Korean firms, especially those in the core IT-industries, should promote the formation of strategic alliances with Japanese and Chinese counterparts. These stylized facts highlight the importance of foreign direct investment in innovative sectors in form of joint ventures (JVs). Thus, in order to promote such processes, one has to understand what drives the preferences for investing, performing, maintaining, and abandoning cross-border cooperative platforms between firms.

2. REVIEW OF THE LITERATURE

The economics of international joint ventures has gained significant interest in the research community over the years, (e.g., Marjit *et al*., 1995; Broll and Marjit, 2005). So far, however, 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.[5)] Consequently, flexibility was identified as the hallmark of modelling the multinational firm (e.g., Buckley and Casson, 1998). Given this context, real options theory has recently generated significant interest in the international business field (e.g., Kogut and Kulatilaka, 1994; Buckley and Tse, 1996; Gilroy and Lukas, 2006). In brief, real option theory suggests to view FDI as a platform in the expansion abroad indicating that the initial investments carry a high option value due to possible new subsequent

[5)] For another approach to deal with uncertainty in the context of FDI see e.g., Aizenman and Marion (2004).

investment opportunities. It is clear that this fact is most obvious for international joint ventures. Possible project interdependencies within international joint ventures (IJV) allow for strategic flexibility calling for an interpretation of IJVs as platform investments (e.g., Kogut, 1991). 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 an IJV does not indicate its failure but the exploitation of its flexibility. Lately, this idea has become a building block for empirical research (see e.g., Reuer and Leiblein, 2000; Reuer and Tong, 2005). In addition, the modelling of immanent real options in the IJV context was further extended by several authors (e.g., Chi and McGuire, 1996; Pennings and Sleuwaegen, 2004; Lukas, 2005).

The remainder of the paper is organized as follows. First, we will present the model: a two-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 serves as a platform, i.e. an important prerequisite to further expand a MNEs presence in the new market. After this phase of close collaboration, the second 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. Against the recent background of international joint ventures within Korea, the results are discussed and implications on a broader level are deduced.

There are some obvious factors related to Korea that are not explicitly modelled or simulated here. As informal empiricism shows Korea was relatively closed to FDI and to joint ventures prior to the 1997-1998 crisis. The internal capital market treated favourably the large *Chaebol* conglomerates prior to 1997-9898. As Gilroy (1993) noted earlier there is a growing recognition of the importance of network externalities, or “economies of cooperation” in the areas of information processing, learning and acquisition of technological capability, which belong to the core of the technological platform development process as significantly observed in the historical situation of Korea. As Ohmae (1990) once stated: "Not every kind of plant grows well in the same patch of soil. And patches of soil can vary considerably in the kinds of growth they support." The ongoing discussion of strategic alliances as a possible key for the continuation of Korean growth and welfare gains need to be studied further as the consequences of the rising integration of Korea in the world's international trade and investment flows within the world network structures beyond the national *Chaebol* structures emerges. These developments may be interpreted in light of a common technological base for the nations involved, or it may simply be that different production stages are integrated through the use of regional resources and market complementarities, thus offering a significant infrastructural element for subsequent trade and technological flows among the Korean enterprises and their partners.

3. THE MODEL

The analysis presented exemplifies the common situation facing typical equity-based international joint ventures between two private enterprises. International joint ventures (IJV) permit enterprises to integrate complementary resources encompassing firm-specific knowledge such as marketing or technological expertise or an amalgamation of various expertises. As commonly observed at a practical level, however, we assume that only a subset of total existing overall knowledge is exchanged freely among the participating IJV firms which is sufficient to fulfil some agreed upon objective such as a specific R&D collaboration. In addition, it is pointed out that one firm is a foreigner to the new market, namely the multinational enterprise (MNE) which has chosen a local partner in Korea.

The choice of which entry strategy an enterprise chooses has no influence upon the profit rates of other enterprises. Moreover, the value of the chosen FDI mode $v(t)$ is ex ante unknown and follows a geometric Brownian motion. 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

$$\frac{dv}{v} = (r - \delta)dt + \sigma dz^Q, \tag{1}$$

where r is the risk-free interest rate, δ represents the opportunity costs of delaying the project, σ^2 designates the variance of dv/v, and dz^Q indicates a Wiener process with non-zero drift.[6] Equation (1) states that over a time increment dt relative changes in the project value v are subject to a drift, i.e. $(r - \delta)$, and a random movement σdz which reflects the uncertainty surrounding the project.[7]

The initial equity stake the MNE shareholder has invested is ε, which generates a portfolio of two exclusive strategic options. The interval of time necessary for the partners to become acquainted with each other is $[t_0, t_1]$. At the end of this time span T, i.e. $T = t_1 - t_0$, the MNE has to decide whether it prefers to continue collaboration with the host partner by exercising the right to convert the IJV into a cross-border merger, i.e. by acquiring at a later date the remaining shares $(1 - \varepsilon)$. On the other hand, offsetting such a strategy, the MNE might find it more favourable to prematurely divest the growth option and dissolve the IJV

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[6] In this setting, δ represents the foregone cash flows if the firm chooses not to invest immediately.

[7] While assuming perfect capital markets, the risk-free interest rate serves as the proper discount rate. When deviating from this assumption, r has to be replaced by a subjective discount rate μ which comprises the risk attitudes of the investor. In addition, the martingale measure Q has to be replaced by the subjective probability measure P. Consequently, riskier projects have to be discounted with a higher μ than those with lower risk profiles.

later by selling its own share ε to the local partner.[8)]

We denote the optimal threshold separating both of these strategies by ξ. The option value F, the optimal trigger points v_U^*, v_L^* (representing the actual timing of the subsequent investment/divestment) and ξ may be solved for recursively (see Lukas, 2005). From Dixit and Pindyck (1994) as well as Merton (1973) the results for a perpetual call option, and a perpetual put option respectively, are commonly known. Thus, they are just summarized briefly.

Under the assumption of a perpetual time to maturity and corresponding boundary conditions the flexibility value for a perpetual call option results to

$$C(v)=\left[(1-\varepsilon)\frac{1}{\beta_1}\left[\frac{1}{(1-\varepsilon)}\frac{\beta_1}{\beta_1-1}I\right]^{(1-\beta_1)}\right]v^{\beta_1}\quad for\ \ v<v_U^*, \tag{2}$$

with I designating the cost for acquiring the rest of the equity stake $(1-\varepsilon)$ and $\beta_1=\frac{1}{2}-\frac{(r-\delta)}{\sigma^2}+\left(\left[\frac{(r-\delta)}{\sigma^2}-\frac{1}{2}\right]^2+\frac{2r}{\sigma^2}\right)^{1/2}$ as a constant.[9)] If $v\geq v_U^*$ the usual net present value (NPV) criterion applies which generates a value of $(1-\varepsilon)v-I$ for the investment. In such a case, there is no premium on flexibility to be observed.

From this, the optimal trigger value v_U^* for the merger and acquisition (M&A) strategy can be deduced which results to

$$v_U^*=\frac{1}{(1-\varepsilon)}\frac{\beta_1}{\beta_1-1}I. \tag{3}$$

[8)] 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.

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

In contrast, if the MNE terminates the IJV it will obtain a perpetual put option. Upon exercising the second stage, the MNE forsakes the existing project with value εv and attains subsequently its abandonment value κ (see e.g., Chi, 2000).

The respective strategic flexibility value is thus

$$P(v)=\left[-\frac{1}{\beta_2}\varepsilon\left(\frac{\beta_2\kappa}{(\beta_2-1)\varepsilon}\right)^{1-\beta_2}\right]v^{\beta_2} \quad for \;\; v>v_L^*, \tag{4}$$

where by $\beta_2=\frac{1}{2}-\frac{(r-\delta)}{\sigma^2}-\left(\left[\frac{(r-\delta)}{\sigma^2}-\frac{1}{2}\right]^2+\frac{2r}{\sigma^2}\right)^{1/2}$ is again a constant. Like for the call option, no premium for flexibility is observed for project values below v_L^*. Consequently, the project has a value of κ-εv if $v\le v_L^*$.

The corresponding optimal threshold value v_L^* for initiating a divestment strategy results to

$$v_L^*=\frac{\beta_2}{\beta_2-1}\frac{\kappa}{\varepsilon}. \tag{5}$$

Consequently, the value of the chooser option is determined by

$$F=e^{-r(t_1-t_0)}E^Q\left[\max\{P(v),C(v)\}\right], \tag{6}$$

with $E^Q(\ldots)$ as the expectations operator under the martingale measure Q. This results in solving the following integral

$$F = e^{-r(t_1-t_0)}[\int_{-\infty}^{v_L^*}(\kappa-\varepsilon v)d\Phi(v)+\int_{v_L^*}^{\xi}Bv^{\beta_2}d\Phi(v)$$
$$+\int_{\xi}^{v_U^*}Av^{\beta_1}d\Phi(v)+\int_{v_U^*}^{\infty}((1-\varepsilon)v-I)d\Phi(v)], \quad (7)$$

where $d\Phi(v)$ denotes the implied probability measure. In order to derive a closed form solution for the complex chooser option one has to determine the aforementioned optimal threshold ξ. Thus, ξ is determined by the intersection of $P(\xi)$ and $C(\xi)$. From $A\xi^{\beta_1}=B\xi^{\beta_2}$ we get

$$\xi^{\gamma}=\frac{-\frac{\varepsilon}{\beta_2}(v_L^*)^{1-\beta_2}}{((1-\varepsilon)v_U^*-I)(v_U^*)^{-\beta_1}}, \quad (8)$$

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

Solving equation (7) results in[10)]

$$F=\kappa e^{-rT}N(d_3)-\varepsilon ve^{-\delta T}N(d_4)+Bv^{\beta_2}N(d_7)-Bv^{\beta_2}N(d_8)$$
$$+Av^{\beta_1}N(d_5)-Av^{\beta_1}N(d_6)+(1-\varepsilon)ve^{-\delta T}N(d_1)-Ie^{-rT}N(d_2), \quad (9)$$

with v as the value of the overall IJV at time t_0, $N(\ldots)$ as the cumulative normal distribution and

$$d_1=\frac{\ln\left(\frac{v}{v_U^*}\right)+(r-\delta+\frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}}, \; d_2=\frac{\ln\left(\frac{v}{v_U^*}\right)+(r-\delta-\frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}},$$

10) For a detailed derivation of the results please refer to Lukas (2005).

$$d_3 = \frac{\ln\left(\frac{v_L^*}{v}\right) - (r - \delta - \frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}}, \; d_4 = \frac{\ln\left(\frac{v_L^*}{v}\right) - (r - \delta + \frac{1}{2}\sigma^2)T}{\sigma\sqrt{T}},$$

$$d_5 = \frac{\beta_1 \ln\left(\frac{v_U^*}{v}\right) - (r + \frac{1}{2}\beta_1^2\sigma^2)T}{\sigma\beta_1\sqrt{T}}, d_6 = \frac{\beta_1 \ln\left(\frac{\xi}{v}\right) - (r + \frac{1}{2}\beta_1^2\sigma^2)T}{\sigma\beta_1\sqrt{T}},$$

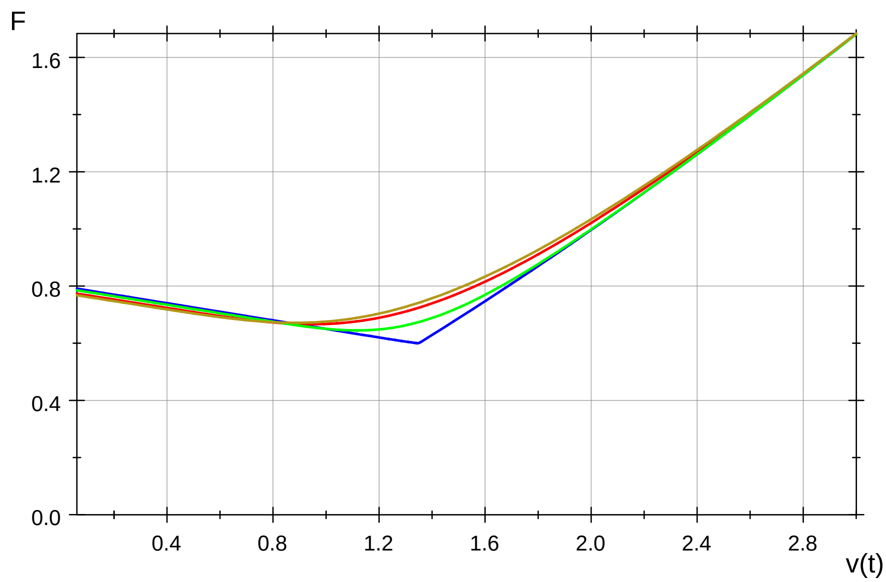
$$d_7 = \frac{\beta_2 \ln\left(\frac{\xi}{v}\right) - (r + \frac{1}{2}\beta_2^2\sigma^2)T}{\sigma\beta_2\sqrt{T}}, \; d_8 = \frac{\beta_2 \ln\left(\frac{v_L^*}{v}\right) - (r + \frac{1}{2}\beta_2^2\sigma^2)T}{\sigma\beta_2\sqrt{T}}.$$

4. RESULTS AND SIMULATIONS

The value of the international joint venture's flexibility F is composed of the option value to stop the IJV (i.e. the first to fourth term) and the growth option value reflecting the value of the subsequent cross-border merger strategy (i.e. the remaining terms). As the calculations suggest, F increases for greater times to maturity (i.e. $T = (t_1 - t_0)$), higher uncertainty and higher abandonment values. In contrast, it decreases for higher sizes of the initial equity and for high acquisition costs. Figure 1 below graphically summarizes some of these results.

From the standard literature, the comparative-static outcomes for the respective trigger values v_L^* and v_U^* are familiar. 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 are, and the higher the aggregate investment uncertainty is. Furthermore, the trigger value is additionally dependent

Figure 1 Value of Acquisition/Divesture Option *F* with Respect to *v*(*t*) and Time of Joint Collaboration *T*



upon the size of the equity share ε so that v_U^* increases as ε increases. The situation reverses for the trigger value of the divestment stage. Low uncertainty levels correlate with a high threshold value v_L^*. The magnitude of this effect is further enhanced the lower the initial equity share ε or the greater the recovery value κ is.

The chooser option is a path dependent derivative. Consequently, conjectures regarding the kind of termination the MNE chooses at time t_1 can only be inferred in combination with the threshold ξ. As mentioned above, at t_1 the MNE selects a strategy that offers the maximum return. Given v_{t_1} is greater than ξ, the MNE will continue its present strategy of collaboration until the above mentioned threshold v_U^* is attained turning it into a merger. In situations where v_{t_1} is less than ξ, the MNE will further collaborate while at the same time opt out to dissolve the IJV. It can now be stated that the optimal threshold ξ may be characterized by two distinctive trends with respect to its dependence on project uncertainty. When a MNE has majority possession of an IJV, the threshold increases the greater the level of aggregate uncertainty given. As a result, there is a noticeable trend toward sell out due to the fact that a MNE will require a higher project value to compensate for the corresponding risks of implementing the merger strategy option.

In the case of a minority IJV, however, ξ is inversely dependent on project uncertainty. As such, the likelihood for a subsequent merger increases as project uncertainty levels rise. Moreover, in situations where the threshold ξ has (not yet) been reached, the propensity to commence (sell off) the investment is even faster the lower the uncertainty σ is (this follows from the fact that only small upward (downward) movements of $v(t)$ are necessary to attain the respective threshold value). A decrease in abandonment value κ diminishes both trends. The dependence of ξ on uncertainty with regard to ε is illustrated below in figure 2.

In order to derive implications on the dynamics of Korean IJVs we choose the IT industry as a reference. This sector leads Korea's industrial R&D activities by accounting for roughly half of Korea's R&D expenditures.[11] In addition, this sector faces growing foreign direct investment trends. From 1997 on the relevance of IT driven FDI inflow has risen from 5.4% incipiently to 42.3% in 2001.[12]

Choosing I as numeraire, we presume the respective values $I = 1$ and κ equals 0.8. However, unlike for financial securities, there are neither written contracts nor financial markets for real options in general. To simulate the dynamics of the model, one has to look for proxies that represent trend and substitutes or twin assets that capture the surrounding uncertainty of $v(t)$'s dynamics. As far as the

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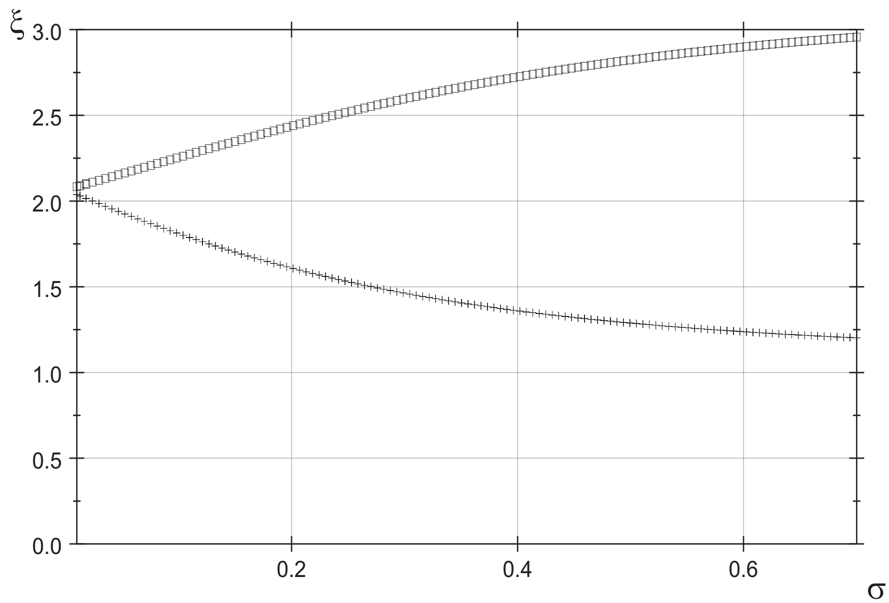
[11] See KISDI (2005).
[12] See KISDI (2002).

Figure 2 Influence of Uncertainty σ and Equity Share ε on ξ



risk-free interest rate is concerned, it is comfortable to refer to a treasury bond with equivalent maturity as the option right. We will use Korea's 10 year Treasury bond yield as of October 2005 which results to $r = 0.054$, i.e. 5.54 %.[13)]

In addition, we collected data on announced international innovative joint ventures in Korea for the IT industry which was compiled from several sources.[14)] In order to compare the results, we also collected data on international joint ventures for a more mature industry, i.e. the chemical sector. While the majority of IJV data were mostly limited with respect to initial equity stake or location base, 43 international joint ventures have been identified in Korea with utilizable data.

[13)] See e.g., Clark (1997) who used a 30 year STRIP instrument.

[14)] The Korean government established a Foreign Investment Promotion Act in 1998 which lowered the restriction on equity transactions significantly. Thus, we only accounted for international joint ventures initiated after 1998.

From the data we derived the mean equity stake for both industries ($\varepsilon_{IT} = 0.52$, $\varepsilon_{CH} = 0.53$) and an average cooperation time frame (min. 6 years). In order to take account for the uncertainty in a sector, we choose the 5 year mean of the historical volatility derived from the Korea Composite Stock Price Index (KOSPI) IT industry ($\sigma = 37\%$) and Chemical industry ($\sigma = 26\%$) sub indices, respectively.[15) 16)] The minimum cooperation period for companies in both industries was fixed to 7 years while the simulated time horizon was 24 years. Costs for the stages were set to be proportional to the initial stake in the venture.

Furthermore, we treat the Korean IT sector to be more competitive than the Chemical sector. As noted earlier, δ is a proxy for the foregone cash flow if the firm does not initiate the project immediately. As a result, we assume that the forgone cash flow is greater for firms in the Korean IT-sector, i.e. $\delta_{IT} > \delta_{CH}$. For the sake of simplicity we choose $\delta_{IT} = 0.01$ and $\delta_{CH} = 0.005$ respectively. The results of the simulations are given in figure 3.

For the Korean chemical industry the simulation results are as follows. After the collaboration period, there is a 83% chance that the joint venture will decide to continue and secure FDI flows to Korea in the future. Thus, the chance for divestment is 17%. With respect to what will be realized at the end of the given time frame, 17% of the simulation ended with divestment while for 82% of the simulation the joint venture is still operating. This implies the fact that possible M&A, although occurred with a 1% chance can be neglected. In this context, the corresponding thresholds were not reached in the given period. With respect to the timing of divestment and merger, respectively one can note that there is a great chance that the joint venture will end right after the fixed cooperation period ends while M&A is possible at the end of the forecasted time frame.

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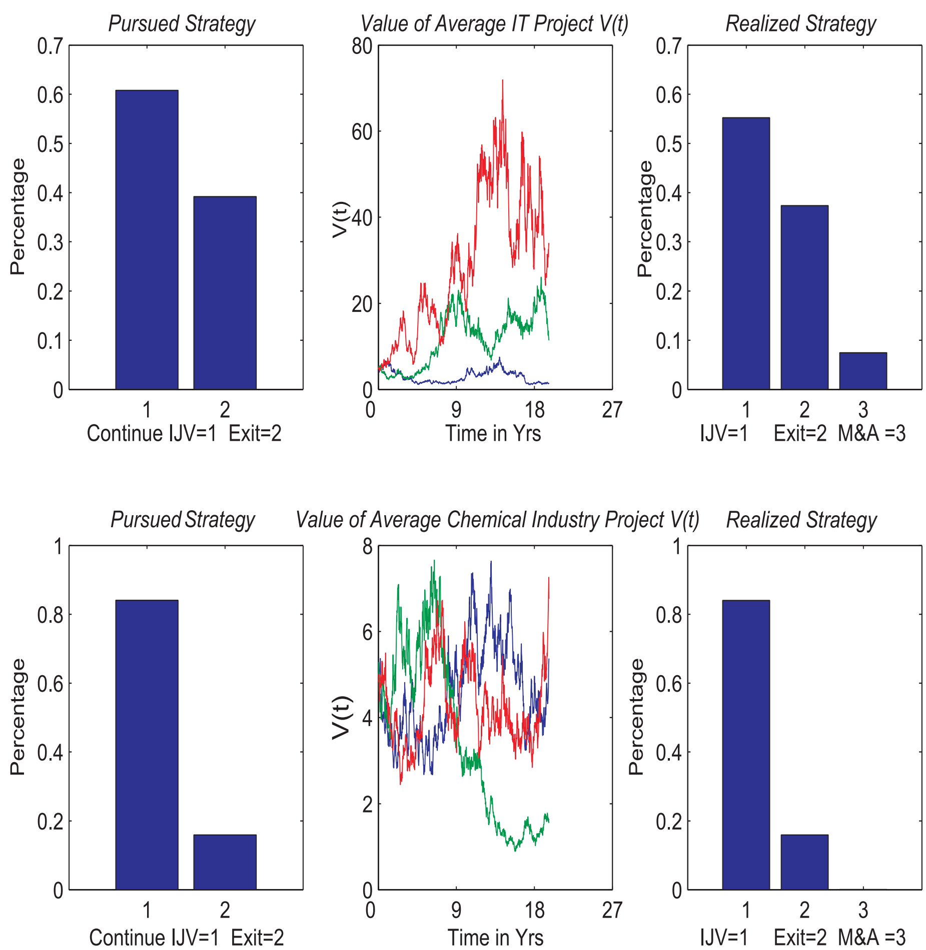
15) Indices are a reasonable proxy in real option valuation since they comprise market and industry specific risk. In order to abstract from crisis driven volatility, we focus on the period from 2000 to 2004.

16) See Miller *et al*. (2004) for an option approach to value a Korean IT-infrastructure project. In this context, the authors use a cash flow volatility of 60%.

Figure 3 Simulation Results for the IT and Chemical Industry in Korea



As international joint ventures in the Korean IT industry are concerned, the picture is quite different. Although there is an almost 61% chance that the joint venture will decide to continue cooperating, divestment is much more realistic than for the chemical industry. In this context, there is a fear of FDI divestment flows out of Korea in the future. At the end of the forecasted time horizon, there is still a perceived chance of 38% that the divestment takes place as prognosted. On the opposite, there is a 55% of chance that the partners are still in a stable joint venture. Interesting, though, that roughly 7% of the simulation forecast an acquisition strategy. Like for the chemical industry joint ventures in the IT sector tend to end just after the collaboration period. On the contrary, however, a M&A strategy tend to occur on average 4 years after the fixed cooperation period, i.e. in year 11.

5. SUMMARY

The expansion of multinational enterprises into Korea is a path dependent process which is reflected in the fact that the observed internalization processes happened not only to be a unidirectional path. Therefore, strategic reorientation, divestment or withdrawal must be considered as serious strategies, too. While the necessity for inward FDI in form of cross-border industrial and technological cooperation has been recognized to promote economic growth and sustainability, little effort has been done in simulating the long-term success of international joint ventures in Korea. Analyzing Korea's IT and Chemical Industry, the model presented here depicts the influence of foreign investor's subsequent investment/divestment options on FDI patterns. 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 modelled in the literature, but also driven by the flexibility to dissolve the venture. Implications for governmental policies in order to attract and stabilize FDI flows can be deduced from the model. Moreover, the study provides new opportunities for further in-depth Korean empirical research under an option framework.

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