A Dynamic Model of the Choice of Mode for Exploiting Complementary Capabilities

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Paper citation:

Chi, Tailan. (2009) A Dynamic Model of the Choice of Mode for Exploiting Complementary Capabilities. *Journal of International Business Studies*, 40 (3), 365-387.

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Chi, Tailan. (2009) A Dynamic Model of the Choice of Mode for Exploiting Complementary Capabilities. Journal of International Business Studies, 40 (3), 365-387. Publisher's Official Version: http://dx.doi.org/10.1057/jibs.2008.65/ Open Access Version: http://kuscholarworks.ku.edu/dspace/

A Dynamic Model of the Choice of Mode for Exploiting Complementary Capabilities

(Running Title: A Dynamic Model of Modal Choice)

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Accepted for publication in *Journal of International Business Studies*, 27 (2), pp. 285-307, 2009.

Acknowledgements

This study received financial support from the Center for International Business Education and Research at the University of Illinois and the School of Business at the University of Kansas. We would like to thank Professor Yadong Luo and three anonymous reviewers for their valuable comments and suggestions. We would also like to thank Mark Feldman, Michael Leiblein, Constanta Mindruta, Bart Taub, seminar participants at INSEAD, Ohio State University, Tilburg University and Waikato University and conference participants at the Academy of Management, Academy of International Business and the Strategic Alliance Conference at Ohio State University for helpful comments. We would also like to thank Yong Li for research assistance.

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Abstract

This paper examines the choice of mode for an MNC and a local firm to exploit their complementary capabilities. We develop a combined real options and game-theoretic model of modal choice by incorporating a range of factors drawn from the dynamic capabilities theory and transaction cost or organizational economics. The factors scrutinized in the model include the parties' absorptive capacities, frictions in knowledge and asset markets and associated incentive problems, cost of switching from one mode to another and cost associated with power-jockeying. The model uses simulation to examine how these factors interact to influence the choice of mode. The results identify a number of conditions for one factor to dominate another and help to reconcile different theories that have made contradicting predictions with regard to the effects of such factors as uncertainty and capability divergence on the optimal choice of mode.

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INTRODUCTION

International business scholars recognized as early as in the 1970s that a crucial role of multinational corporations (MNCs) is cross-border transfer of knowledge such as technology, marketing expertise and management know-how (e.g., Dunning, 1974). Since then, research at both the country level and the firm level has revealed that knowledge transfer is a two-way street involving learning by both multinational and indigenous firms (e.g., Contractor & Lorange, 1987; Contractor & Lorange, 2002; Dunning, 2003). A necessary condition for such learning to create value is the possession by the two firms of knowledge-based complementary capabilities. However, this is not a sufficient condition: it does not guarantee that any joint effort to exploit the complementarity will yield a positive joint value for the two firms. Whether the potential value can be realized also depends on the efficiency of the mode that the two parties choose to exploit their complementary capabilities.

In the context of international business, licensing, joint venture (JV) and acquisition represent a typical spectrum of modes that an MNC and a local firm can use to exploit their joint capabilities. Scholars in international business and strategic management have devoted considerable attention to analyzing the relative efficiency of these modes. One stream of work highlights the influence of absorptive capacities of the parties (e.g., Cohen & Levinthal, 1990; Hamel et al., 1989; Kumar & Seth, 2001). A second stream focuses instead on transaction costs characteristics of the mode (e.g., Buckley & Casson, 1976; Hennart, 1988; Rugman, 1981; Teece, 1986).

Previous theoretical work on the choice of mode has for the most part relied on the method of comparative statics to analyze the equilibrium choice, without explicitly accounting for the effects of possible ex post adjustments based on new information received. A likely source of such new information is learning by each party involved in the venture, including knowledge acquired from the other party, which can alter their respective abilities to profit from the venture under the current mode relative to an alternative mode of operation. The possibility of making mode adjustments ex post provides the participating parties with valuable options, and differences in the value of options embedded in various modes could alter the optimal initial mode choice.

Since Kogut (1991) first demonstrated the role of options embedded in a JV, a number of researchers have examined the dynamics of modal choice either theoretically or empirically. On the theoretical front, mathematical models have been used to analyze the effects of the option to switch modes on the *management of market risks* (Buckley et al., 2002), *mitigation of transaction costs* (Chi & McGuire, 1996), and *design of JV contracts* (Chi, 2000). Existing models of real options in the context of mode choice, however, either are highly simplified with a single stochastic variable, or examine at most only a pair of modes, or do not consider how learning may be moderated by the choice of mode. This inevitably limits their ability to analyze the choice in a precise manner.

On the empirical front, a number of studies have scrutinized transaction-specific and institutional factors that influence the flexibility of alliance contracts (including the use of an explicit option clause), the likelihood of contract renegotiation, and the sources of option value embedded in a JV (Arino & De la Torre, 1998; Luo, 2005; Luo, 2007; Reuer & Arino, 2002; Reuer & Tong, 2005; Tong et al., forthcoming). These empirical analyses not only provide evidence for some of the propositions derived from existing theoretical models but also challenge the field to develop richer theoretical models with new rigorously-derived testable propositions. As pointed out by Buckley and Casson (1998), the use of formalized modeling in theory development gives a theory greater precision by making its assumptions explicit and its reasoning less error-prone, thus also contributing to rigor in further empirical analysis.

The objective of this study is to develop a dynamic model of modal choice that extends the existing models in two significant ways. First, the model allows the choice of mode to vary continuously from one end of a continuum with the local firm holding full ownership (as in a licensing agreement) to the other end of the continuum with the MNC holding full ownership (as in an acquisition by the MNC of the local firm). This setup enables the integrated model to examine factors that affect the choice along a full spectrum of modes ranging from licensing through joint venturing to acquisition, including the distribution of ownership between two JV partners. Second, the model explicitly examines the effects of both absorptive capacity and transaction costs problems on the choice of mode, integrating into a single model two theoretical lenses that have evolved largely independently in the past. These two theoretical lenses, namely, dynamic capabilities theory and transaction cost or organizational economics, serve as the basis for our selection of factors to consider in the choice of mode. [1] Specifically, our model incorporates the following factors.

1. Uncertain, and possibly divergent, evolution of the capabilities of the participants in the venture, particularly in the face of differing absorptive capacities between the participants (e.g., Cohen & Levinthal, 1990; Hamel et al., 1989; Kumar & Seth, 2001).
2. Existence of frictions in knowledge and asset markets and the associated incentive problems facing the participants (e.g., Barzel, 1989; Buckley & Casson, 1976; Hennart, 1988; Rugman, 1981; Teece, 1986; Williamson, 1985).

3. Potential bargaining problems that arise from the participants trying to tip the balance of bargaining power in their favor during the operation of the venture (e.g., Masten, 1988; Milgrom & Roberts, 1990; Klein, 1992).
4. Presence of a mode switching cost due to institutional constraints or contractual restrictions (e.g., Hart & Tirole, 1987; Williamson, 1983).

Although existing theories have examined each of the above factors as an important determinant of modal choice, none has put them in an integrative model to scrutinize their interactions and identify conditions for one to dominate another. The results from our model show that these factors are not orthogonal and that their interactions can alter their effects on the choice of mode.

Given that different theories sometimes make opposing predictions with regard to a factor's effect on the choice of mode, our integrative model is able to identify a number of conditions for one theoretical factor to dominate another. For example, a real options view suggests that market uncertainty can increase the likelihood of JV formation against its alternatives such as acquisition because of certain flexibilities embedded in a JV (Folta, 1998; Seth & Kim, 2001). In contrast, a proposition of the governance branch of transaction cost economics is that high uncertainty in the product or input market tends to heighten contractual hazards and thereby decreases the likelihood of hybrid organizational forms such as JVs (Williamson, 1991). The results of our model suggest that uncertainty can either favor or disfavor the formation of JVs, and also identify the conditions for each outcome to hold. Similarly, it has been argued that in a JV, differential rates of learning will result in the party with less learning capacity losing out (Hamel et al., 1989). In contrast, we find that differential learning is not necessarily an impediment to joint venturing. Our analysis identifies conditions under which differential learning is value-creating or value-destroying and assists in suggesting mechanisms for countering the drivers of value destruction.

The theories on which our modeling methodology is based are real options theory and game theory. Each addresses different types of dynamics in ventures for the exploitation of complementary capabilities between two parties: the real options approach addresses the interactions of a purposeful player with nature under uncertainty, and the game-theoretic approach addresses interactions between two purposeful players (Brennan & Trigeorgis, 2000). The combination of these two approaches in our model improves analytical precision and has the potential for gaining additional theoretical insights relative to static models.

In order to develop a mathematically tractable model that sheds light on our main focus of interest, we refrained from including certain contractual forms from the spectrum of choices being examined in our model. For instance, the model does not consider variations of non-equity contracts (e.g., the MNC contracting for the service of the local firm) or variations in a JV contract that cause control rights to deviate from cash flow rights. In addition, some of the factors being studied in the model are not fully endogenized due to the technical difficulty (perhaps infeasibility) of doing so. What we aim to accomplish is to develop a discrete-time stochastic model that takes into account the theoretical effects of those factors on the net present value (NPV) of the investment project so as to study their interactions in influencing the choice of mode.[2] For instance, existing models show that imperfect performance measurement causes participants in a joint production process to use residual claimancy as an incentive mechanism and that a party's contribution is an increasing function of its residual bearing (Cooper & Ross, 1985; Eswaran & Kotwal, 1985). Rather than modeling imperfect performance measurement directly, our model makes assumptions about the extent of measurement difficulty in the venture and incorporates the theoretical relationship between residual bearing and performance incentives in its component functions.

THE MODEL

We focus on an investment project that involves exactly two parties, Party 1 and Party 2. Specifically, we designate Party 1 as an MNC contemplating entry into a foreign market and Party 2 as an indigenous firm possessing certain resources (e.g., country-specific management expertise) complementary to those of the MNC (e.g., technology). The choice of mode in the model is represented by a single variable, $0 \le s_t \le 1$, that represents the share structure of the venture's equity at time *t*. Specifically, we define s_t as the MNC's share, so the local firm's share is $1 - s_t$. This variable serves as an index for the distribution of both residual claimancy (Barzel, 1989) and residual control rights (Grossman & Hart, 1986) between the two firms. While the parties can stipulate special contractual clauses that cause control rights to diverge somewhat from cash flow rights (Chi & Roehl, 1997), the ownership structure is still a good first-order approximation to the allocation of both these rights. The focus of the study, as explained earlier, is the choice of modes rather than the use of special contractual clauses unrelated to the ownership structure. We assume that it is economically infeasible for the local firm to acquire the MNC (e.g., due to its lack of expertise in managing a much larger and more diversified company) or license its country-specific knowledge to the MNC (e.g., due to the tacitness of its knowledge). These assumptions are realistic in the situation being modeled and also keep the model tractable. Under these assumptions, we can interpret (a) $s_t = 0$ as the MNC licensing its technology to the local firm; (b) $0 \le s_t \le 1$ as the two firms forming a JV; and (c) $s_t = 1$ as acquisition by the MNC of the local firm's relevant assets. Our definition of JVs is relatively broad, including both de novo JVs and partial acquisitions.

In the model, the parties choose one of these modes in the initial formation of the venture and can also alter the mode after the venture goes into operation. We assume that the formation of the venture requires an initial investment I_0 and that an ex post alteration of the mode gives rise to a switching cost B_t. Both I_0 and B_t will be specified later in this section. The possibility of switching modes after the start of the venture constitutes real options for the parties to exploit. We focus on ventures that leave the switching decision to negotiation between the two parties, rather than giving either party the right to acquire or divest the relevant ownership stake at a predetermined price, since the vast majority of multiparty ventures do not specify an explicit option clause.[3]

Given the choice among the three modes specified above, the initial investment I_0 may be shared by the two parties or undertaken by one of them. In the case of acquisition or licensing, the initial investment I_0 will include the acquisition price paid by the MNC or the value of the assets that the local firm devotes to the venture, plus the cost of any new assets purchased and the cost of shifting existing assets from their current uses to the new venture. I_0 is assumed to be invariant to the mode of organization as there is no reason to expect the sum of the two parties' upfront investments in the venture to vary systematically with the choice of mode. To reduce the complexity of the model, we make two additional simplifying assumptions. First, the two parties can alter their initial choice of mode only once after the venture goes into operation, i.e., for $0 < t < T$, where T is the length of the planning horizon. Second, the alteration of the venture's share structure is limited to the follow-on options depicted in Figure 1: continuation of the current mode, one party acquiring the stake held by the other, and sale of the venture to a third party. We will refer to the option to take over the other's stake as *the option to acquire* since acquisition by one party at an ex post negotiated price is equivalent to divestiture by the other.

******* Insert Figure 1 here *******

In this model, a party can realize its payoff from the venture in one of two ways: (1) profit from the venture's operations in each time period when the party is an equity holder and receives at least part of the profit, and (2) acquisition of the other's stake (divestiture of its own stake) at a price below (above) the value that the party places on the venture's assets.

Profit Function

In order to solve the model numerically, we give the venture's rate of profit in each period a specific functional form: $\pi_t = q_t(p_t - c) - C_t(\phi) + \varepsilon$, where q_t is the demand for the venture's output at time t, p_t is the unit price of the output, c is the unit cost, $C_t(\phi)$ is a potential bargaining cost, and ε is a random variable with an expected value of zero. We assume an affine demand function $q_t = m \cdot v_t - k \cdot p_t$, where k is a constant and $m \cdot v_t$ represents the maximum demand at $p_t = 0$. In this function, m reflects exogenous market conditions and v_t is a function that reflects the parties' abilities and incentives to generate demand. Both m and c are assumed to be uncertain at $t = 0$ but become known as m_H or m_L and c_H or c_L, respectively, after the initial investment I_0 is made.[4] The realizations of m and c are by assumption independently distributed. The functional form of v_t is specified as $v_t = s_t a_{1,t} + (1 - s_t) a_{2,t}$, where $a_{1,t}$ and $a_{2,t}$ index the respective capabilities of the two parties.[5] We define capabilities as the rent-earning potential of the knowledge (including skills and organization routines) that a firm possesses. A change in $a_{i,t}$ for $i = 1,2$ represents a change in their capabilities. We assume that each party's capabilities evolve stochastically over time and include not only capabilities acquired on its own but also capabilities absorbed from the other party up to the current time. The specifications of the profit function and its components imply that the rate of profit increases in each party's capabilities.

Evolution of Capabilities

We use a discrete stochastic process to model the evolution of the parties' capabilities. Specifically, we assume that the changes in $a_{1,t}$ and $a_{2,t}$ in each time increment Δt follow a joint 5-jump distribution as follows:

Outcome:	Both Up	Up/Down	No Change	Down/Up	Both Down
$a_{1,t+\Delta t}$	$a_{1,t} \cdot u_1$	$a_{1,t} \cdot u_1$	$a_{1,t}$	$a_{1,t}/u_1$	$a_{1,t}/u_1$
$a_{2,t+\Delta t}$	$a_{2,t} \cdot u_2$	$a_{2,t}/u_2$	$a_{2,t}$	$a_{2,t} \cdot u_2$	$a_{2,t}/u_2$
Probability:	p_{UU}	p_{UD}	p_{HH}	p_{DU}	p_{DD}

where $u_1 > 1$ and $u_2 > 1$ are referred to as "jump" parameters that define the potential upward and downward changes in $a_{i,t}$ in a given time increment.[6]

As can be seen, in a given time increment the index of each party's capabilities either jumps up by a factor of u_i or jumps horizontally (i.e., stays constant) or jumps down by a factor of $1/u_i$. An increase in a party's rent-generating capabilities can come about because it has acquired new knowledge or found new applications of its existing knowledge, whereas a decrease can result from the dissemination or obsolescence of its knowledge. The three possible types of changes in $a_{1,t}$ and $a_{2,t}$ in combination yield five possible transition probabilities that describe the evolution of $a_{1,t}$ and $a_{2,t}$. For instance, $p_{UD} > p_{DU}$ means that Party 1's rent-earning ability is expected to grow faster than that of Party 2. Based on the derivations of Kamrad and Ritchken (1991) and Chi (2000), the transition probabilities can be defined in terms of the expected rates of growth μ_i, the volatility of growth σ_i, the correlation between their rates of growth ρ and a number of other parameters.[7]

Let μ_i denote the expected annualized rate of change in $a_{i,t}$ over Δt, i.e., $\mu_i = \frac{E[\Delta a_{i,t} / a_{i,t}]}{\Delta t}$. It captures the expected rate of change in Party *i*'s capabilities. Since the actual rate of change in $a_{i,t}$ is subject to randomness, we use σ_i to denote the standard deviation of the random component. We use ρ to denote the coefficient of correlation between the rates of changes in $a_{1,t}$ and $a_{2,t}$ and capture the likelihood of convergence of the parties' capabilities. Changes in $a_{1,t}$ and $a_{2,t}$ necessarily reflect learning by each of the parties, which fundamentally drives the kind of dynamics being analyzed in this study. The assumption of complementarity in our model implies that the knowledge sets of the two parties partially overlap and that the overlapping portion of their knowledge sets is likely to grow due to knowledge transfer in the process of the venture (Mowery et al., 1998). However, $a_{1,t} = a_{2,t}$ in our model implies only an equality of their abilities to earn rent from the venture rather than a complete convergence of their knowledge sets.[8]

We expect that ex post a party's learning reflects first, its capacity to absorb new knowledge both independently and from the other party, and second, the efficiency of the chosen mode in facilitating knowledge transfer. So, we decompose μ_i into two components: $\mu_i = \beta_i \cdot \kappa_i(s_t)$. Here, β_i is meant to reflect Party *i*'s innate capacity to learn, and $\kappa_i(s_t)$ is meant to reflect the relative efficiency of the different modes for Party *i* to acquire knowledge. These two components are discussed in more detail below, drawing on two complementary perspectives on learning. Specifically, the dynamic capabilities perspective provides a theoretical basis for modeling an organization's innate capacity to learn, and the organizational economics perspective provides a theoretical basis for modeling the organizational efficiency of learning and knowledge transfer.

Absorptive Capacity

We treat β_i as an exogenous parameter. Recent work in strategy research suggests that a firm's capacity to acquire new knowledge derives from the possession of related knowledge and the extent and scope of such knowledge (Cohen & Levinthal, 1990; Teece et al., 1997). One may assess the firms' relative absorptive capacities by comparing the scopes of their operations in terms of both industry and geography, their R&D and advertising expenditures, and their patent portfolios.

Market Frictions and Incentives

The choice of mode will influence how each party's capabilities evolve. There are essentially three ways to combine complementary knowledge to generate synergy: the first is for one party to transfer its knowledge to the other, the second is for one party to acquire from the other the assets that embody the knowledge, and the third is for the two parties to form a JV that involves the sharing of knowledge and assets.

The first way of combining knowledge can suffer from frictions in knowledge markets that arise from tacitness of knowledge. The transfer of tacit knowledge entails substantial effort from the knowledge possessor in person-to-person training, which is likely to be difficult to measure and monitor, giving rise to the potential for shirking (Hennart, 1982; Teece, 1982). In the absence of these measurement and monitoring difficulties, market transactions in the form of licensing are efficient. However, if these difficulties are significant, modes that give the knowledge possessor a greater stake in the outcome from the transfer of its knowledge (e.g., acquisitions and JVs) tend to be more efficient. The second way of combining knowledge can suffer from frictions in asset markets. If only a subset of each firm's assets is relevant for the new venture but is inseparable from its other assets, the costs of acquiring just that subset of assets may be prohibitive.[9] Finally, in the presence of frictions in both knowledge and asset markets, neither licensing nor acquisition is an efficient way to combine knowledge. A JV that gives both parties some incentives to contribute their knowledge without requiring partial sale of either party's relevant assets is likely to be the most efficient mode (Barzel, 1989; Hennart, 1988).

Therefore, ownership structure can be considered to mediate the relationship between frictions in knowledge and asset markets and evolution of each party's capabilities.[10] Our definitions of $\kappa_1(s_t)$ and $\kappa_2(s_t)$ reflect three different combinations of knowledge and asset market characteristics that are described in the following three scenarios, which are graphically depicted in Figure 2.

******* Insert Figure 2 here *******

Scenario 1

- *Assumption 1.A.1*: Both parties' contributions to the venture derive from tacit knowledge, giving rise to frictions in the markets for both parties' knowledge.
  - Given the tacitness of the MNC's knowledge, a licensing agreement provides insufficient incentive for the MNC to make the effort in transferring all of its knowledge.
  - Acquisition by the MNC of most or all of the ownership of the local firm or a de novo JV with the MNC being the dominant parent is also likely to inhibit the potential for knowledge transfer to the local managers. Under such arrangements, the MNC will be the dominant party making most of the key decisions. Some critical pieces of its knowledge are likely not transferred to local managers because the MNC may find it most efficient to manage the venture via expatriates.

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- *Assumption 1.A.2*: The MNC has a broad scope of operation and its relevant assets are inseparable from the rest of the firm, so that there are significant frictions in the market for the MNC's relevant assets, making it infeasible for the local firm to acquire the MNC.

- **Implication 1.A**: the mode that maximizes the potential for knowledge transfer from the MNC (Party 1) to the local firm (Party 2) is a JV with the two parties holding relative equal shares.

- *Assumption 1.B*: The local firm has a narrow scope of operation or its relevant assets are separable from the rest of the firm, so that the market for the local firm's relevant assets is efficient, making it efficient for the MNC to internalize the local firm's knowledge via acquisition.

- **Implication 1.B**: Sole ownership of the venture by the MNC provides the best potential for knowledge transfer from the local firm (Party 2) to the MNC (Party 1). Note that sole ownership by the MNC in this paper is defined as its acquisition of the local firm.

Under this scenario, $\kappa_1(s_t)$ is an increasing function of the MNC's share and $\kappa_2(s_t)$ first rises and then falls as the local firm's share rises. We specify $\kappa_1 = H_1 + K_1 \exp(-1/L_1 s_t)$ and $\kappa_2 = H_2 + K_2(1-s_t) - L_2(1-s_t)^2$, where H_i, K_i and L_i are constants such that $\max(\kappa_i) = 1$, which makes $\mu_i \le \beta_i$. In Figure 2, the assumed values of H_i, K_i and L_i are provided in the bottom of each graph.

Scenario 2

- *Assumption 2.A*: Both parties contribute tacit knowledge to the venture, as in Scenario 1.
- *Assumption 2.B*: There are significant frictions in the markets for both parties' relevant assets.

- **Implication 2**: Shared ownership of the venture yields better potential for knowledge transfer between the two parties.

Under this scenario, $\kappa_2(s_t)$ is as specified in Scenario 1 and $\kappa_1(s_t)$ takes the same functional form as $\kappa_2(s_t)$ in Scenario 1 but with *s* replacing $1-s$ in the function.

Scenario 3

- *Assumption 3.A*: The knowledge that the MNC to the venture is relatively explicit and codified, so the market for MNC's knowledge operates efficiently.
- **Implication 3.A**: A licensing agreement provides the best potential for knowledge transfer from the MNC (Party 1) to the local firm (Party 2).
- *Assumption 3.B*: The market for the local firm's assets is efficient (same as *Assumption 1.B*).
- **Implication 3.B**: Sole ownership of the venture by the MNC provides the best potential for knowledge transfer from the local firm (Party 2) to the MNC (Party 1), as in Scenario 1.

Under this scenario, $\kappa_1(s_t)$ is as specified in Scenario 1 and $\kappa_2(s_t)$ takes the same functional form as $\kappa_1(s_t)$ in Scenario 1 but with $1-s$ replacing *s* in the function.

From the MNC's perspective, what distinguishes Scenarios 1 and 3 from Scenario 2 is the economic feasibility for the MNC to internalize the local firm's knowledge through acquisition. One may assess this feasibility by examining whether the existing business scope of the MNC includes the business area of the local firm and/or has any experience in operating in the local firm's country or region. What distinguishes Scenarios 1 and 2 from Scenario 3 from the local firm's perspective is the economic feasibility for the local firm to acquire the MNC's knowledge through licensing. One may assess this feasibility by examining whether the MNC has previously transferred its technology to an unaffiliated party.

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Ex Post Negotiation, Switching Cost and Bargaining Cost

Let $X_{1,t}$ and $X_{2,t}$ denote the two parties' respective valuations of the venture's assets at $0 \le t < T$ based on the NPV of the venture under sole ownership. The formulae for computing the values of $X_{1,t}$ and $X_{2,t}$ are derived in the Appendix. As noted earlier, we focus on the by far most common arrangement whereby the parties do not specify an explicit option clause in their initial contract and must negotiate a transfer of their equity stakes ex post. Specifically, we assume that the negotiation of the acquisition follows a Nash cooperative game (Fudenberg and Tirole, 1991), so that there is a guaranteed transfer of ownership if this is Pareto-optimal but the price is open to negotiation.[11] Let R_t be the negotiated price for transferring equity stakes between the two parties (expressed in terms of the entire venture's value). Obviously, the negotiated price must fall within the range set by their respective valuations of the venture, i.e.,

$$\min[X_{1,t}, X_{2,t}] \le R_t \le \max[X_{1,t}, X_{2,t}].$$

In this paper, we focus on the total value of the venture rather than each party's individual payoff, where the price falls within this range is immaterial to our results.[12] However, it is worth noting that they will be motivated to bargain over the price and that the final price will depend on their relative bargaining power.

Let $\omega \in [0,1]$ denote the portion of the gain from trade that is lost due to a switching cost in exercising the option to acquire. A positive ω can arise from the contractual environment (e.g., legal fees and imperfections in the property right regime) as well as contractual restrictions regarding termination of the current arrangement that the parties impose on themselves. For instance, one contract may allow the parties to terminate their arrangement and all accompanying obligations by sending the other a written notice three months in advance. Another contract may include additional agreements such as exclusive agency representation and royalty payments with fixed terms that also have to be settled in order for the parties to conclude a buyout. The switching cost is likely to be higher under the second than under the first contractual stipulation. We define the total switching cost as

$$B_t(\omega) = \omega\left|X_{1,t} - X_{2,t}\right|$$

Note that there will be no incentive for the parties to attempt an ex post acquisition when $\omega = 1$, which can result from a highly restrictive termination clause in their contract.

The possibility that they will negotiate an equity transfer in the future may cause the parties to jockey for power during the operation of the venture, resulting in a bargaining cost that dissipates earnings from the venture (Klein, 1992; Masten, 1988). To incorporate this kind of bargaining cost in our model, we make the following assumptions:

(i) There is no costly bargaining if one party maintains sole ownership and thus full control of the venture.[13]

(ii) Neither party has an incentive to jockey for power if a high switching cost (i.e., in the case of $\omega = 1$) eliminates any gain from exercising the option to acquire. Here, a high ω creates a mutual hostage taking situation that diminishes their incentives to influence the balance of bargaining power between them (Williamson, 1983).

(iii) The parties are likely to invest more resources in power jockeying as there is a greater difference between their respective abilities to earn rent from the venture's assets without the other's involvement (i.e., as $\left|a_{1,t} - a_{2,t}\right|$ is larger).

Based on these assumptions, we define the bargaining cost as

$$C_t = \phi[s_t(1-s_t)](1-\omega)\left|a_{1,t} - a_{2,t}\right|,$$

where ϕ is a parameter that indexes their bargaining propensity. It reflects the level of difficulty faced by the parties in preventing power-jockeying behaviors that have the potential to destroy value. Existing empirical studies have often used the presence of past and current business ties (e.g., Gulati, 1995) and the partners' perceptions of the "shadow of the future" (e.g., Parkhe, 1993) as indicators of low propensity for two partners to engage in such behavior. Even though in our model the form of the bargaining cost function is assumed to be common knowledge, the dependence of the function's value on the two stochastic variables $a_{1,t}$ and $a_{2,t}$ implies that the parties do not know ex ante the magnitude of the bargaining cost. Since the value of ϕ determines the expected bargaining cost, we will in the rest of this paper refer to ϕ as the level of bargaining cost or simply bargaining cost. The kind of power jockeying represented by ϕ is a form of non-cooperative behavior that is not fully endogenized in our model. One could, in principle, model the relationship between the JV partners as a non-cooperative game, but such a setup would greatly complicate the model. It is worth noting that this type of bargaining cost was only discussed briefly by Chi (2000) and has not been explicitly modeled in prior work. Also, since the effect of $C_t(\phi)$ is to dissipate the profit from a JV, it is consistent with the scenario where the JV loses income because one of the partners sets up a competing operation.

Objective Function and Solution Technique

The NPVs of the various follow-on options at $0 < t < T$ are as follows:

i) In the case where they continue the current arrangement, the NPV of the project is $\pi_t(s_0)e^{-r(\Delta t)} + E[J(a_{1,t+\Delta t}, a_{2,t+\Delta t}, \hat{s}_{t+\Delta t})|s_0]e^{-r(\Delta t)}$, where r denotes the discount rate, $\pi_t(s_0)$ denotes the profit that is to accrue if the venture is continued in its current form until the next period and $E[J(a_{1,t+\Delta t}, a_{2,t+\Delta t}, \hat{s}_{t+\Delta t})|s_0]$ represents the maximized NPV of the venture at time $t + \Delta t$. This NPV will be equal to either $X_{i,t}$ or $X_{j,t}$ if the initial arrangement is a licensing agreement or an acquisition.

ii) In the case where Party *i* acquires ex post whatever stake Party *j* may have in the venture and becomes the sole owner, the NPV of the project is $X_{i,t} - B_t(\omega)$.

iii) In the case where Party *j* acquires ex post whatever stake Party *i* may have in the venture and becomes the sole owner, the NPV of the project is $X_{j,t} - B_t(\omega)$.

iv) In the case where the venture is sold to a third party, its NPV is $S(\pi_{t-\Delta t})$, the exact functional form of which is specified in the Appendix.

Hence, the NPV of the venture given optimized decisions at any time *t* can be defined as

$$J(a_{1,t}, a_{2,t}, \hat{s}_t) = \max \begin{Bmatrix} \pi_t(s_0)e^{-r(\Delta t)} + E[J(a_{1,t+\Delta t}, a_{2,t+\Delta t}, \hat{s}_{t+\Delta t}) | s_0]e^{-r(\Delta t)}, \\ X_{i,t} - B_t(\omega), \\ X_{j,t} - B_t(\omega), \\ S(\pi_{t-\Delta t}) \end{Bmatrix}$$

where s_0 denotes the initial share structure. If the initial mode of organization is either acquisition or licensing, the second or third choice will be irrelevant in subsequent periods.

Based on the above definitions, the NPV of the venture at its very beginning is simply

$$Z(\hat{s}_0) = \max\{\pi(s_0)e^{-r(\Delta t)} + E[J(a_{1,\Delta t}, a_{2,\Delta t}, \hat{s}_{\Delta t}) | s_0]e^{-r(\Delta t)}\} - I_0,$$

where $\hat{s}_0 \in [0,1]$ is the optimal initial mode. We assume that the initial cost of negotiating the venture is included in I_0. Now we can link the four factors that we examine to four parameters in our model: (i) β_i represents the absorptive capacities of the parties; (ii) ω, the cost of switching modes; (iii) $\kappa_i(s_t)$, frictions in knowledge and asset markets and the associated incentive issues for knowledge sharing; and (iv) ϕ, the bargaining problem that arises from potential power jockeying activities. In the discussion of our results, the expression "the NPV of the venture" will refer to $Z(\hat{s}_0)$.

The model specified above is solved numerically using the procedure of dynamic programming based on the work of Kamrad and Ritchken (1991). The numerical computation was done on the software package MathCAD. In our numerical derivation, we assume $T = 3$ and $N = 3$, which makes the length of each time period Δt exactly one year. One may think of this as an arrangement whereby the parties agree to review the venture's ownership setup at the end of each year. This, however, is not the only interpretation because with a larger N the results of the model will approximate those of a continuous-time model in which the choices are available at virtually any point in time. The results of our analysis indicate that a small N such as 3 does not alter the results qualitatively but substantially reduces programming and computational complexity. The values of the parameters that were used to generate the simulation results reported in the paper are given in Table 1. It should be noted, however, that we ran many more simulations than reported in the paper to make sure that the reported results are "general" in the sense that a reasonable range of values are checked for each of the main parameters with no inconsistency found in the results. For instance, even though most of the reported results are based on $\rho = 0.3$ and $\sigma_i = 0.2$, we checked the results for a much wider range of each parameter (specifically, $-1 \leq \rho \leq 1$ and $0.1 \leq \sigma_i \leq 0.6$, with increments of 0.1). Nevertheless, the generality of the results presented in the next section should be interpreted in the context of our simulation methodology, as they are not analytically derived.

******* Insert Table 1 here *******

Even though specification of our model in some aspects (particularly the 5-jump process and the game-theoretic setup) is similar to the one set up by Chi (2000), our model differs in a number of important aspects. First, the evolution of the stochastic variables (i.e., the capabilities of the parties) is moderated by the ownership structure, enabling the model to examine the effect of modal choice on learning. Second, the inclusion of bargaining propensity (represented by ϕ) in the model enables it to scrutinize in a precise manner the interactions of this factor with other factors. Third, the model focuses on the choice among licensing, JV and acquisition rather than the structure of JVs. As shown in the next section, the results from our model shed new light on a number of theoretical questions on modal choice.

RESULTS

At our first level of analysis, we focus on only the JV mode of organization to examine how the likelihood of divergence between rent-earning capabilities of two partners affects the NPV of the JV mode under different levels of bargaining cost. Next, we broaden our analysis to investigate how absorptive capacity, switching cost and bargaining cost interact to influence the values of the different modes in the presence of incentive problems that arise from frictions in knowledge and asset markets.[14]

Both Parties Can Win the JV "Learning Race"

An influential stream of research (e.g., Hamel et al., 1989; Hamel, 1991) views a collaborative venture as a learning race whereby the partners compete to acquire the other's proprietary knowledge and highlights the JV partners' concerns about losing their proprietary knowledge before they acquire that of their partner's. The learning race perspective implies first, that potential divergence of the partners' capabilities destroys value and second, that it is critical to circumscribe one partner's ability to learn the other's core skills. The results of our model, however, show that a larger ex post divergence of rent-earning capabilities can create more value under certain circumstances. Our results (see Figure 3) not only identify a condition for such divergence to create or destroy value but also suggest some mechanisms for remedying its potential value destruction effect.

******* Insert Figure 3 here *******

The horizontal axis in Figure 3 represents the correlation between the rates of growth in the two parties' capabilities (ρ). A perfect correlation (i.e., $\rho = 1$) means that the two parties' capabilities will move in complete synchrony. The lower the correlation is (i.e., the more toward the left side of the graph), the more likely are their capabilities to diverge (i.e., one party ending up more capable of earning rents from the venture than the other if it gains sole ownership and control). Figure 3 shows that the effect of a higher chance for ex post divergence in capabilities on the venture's NPV can be either positive or negative depending on the level of bargaining cost.[15] A higher ex post divergence in rent-earning capabilities between the partners (i.e., a smaller ρ) creates value under low bargaining propensity (e.g., $\phi = 0$) and destroys value under high bargaining propensity (e.g., $\phi = 2$). This suggests that the propensity for power jockeying in the collaborative venture is the key factor determining the effect of the divergence.

Proposition 1. In the presence of the option to acquire, the likelihood of asymmetric learning is a potential source of value creation (destruction) when bargaining propensity is low (high).

First, consider the case when bargaining propensity is low ($\phi = 0$). As the downward sloping curve in Figure 3 shows, in this case the venture has a higher NPV (so that both parties win) as the two parties' rent-earning capabilities are more likely to diverge (i.e., as ρ is smaller). The reason is that the higher likelihood of divergence provides greater opportunities for the two parties to gain from trade in their ownership stakes ex post by exercising the option to acquire.

Now consider the case when bargaining propensity is high. As the upward-sloping curve in Figure 3 shows, in this case the venture has a higher NPV as the two parties' rent-earning capabilities are more likely to converge (i.e., as ρ approaches 1). The reason for this result is that the lower likelihood of divergence is assumed to reduce the extent of power jockeying in our model and thus reduces value destruction from the associated bargaining cost, even though it also reduces the value of the option to acquire (note that the value of the option becomes zero when ρ approaches 1). This result suggests that in the presence of high bargaining cost both parties can expect to win when there is a low likelihood for their rent-earning capabilities to diverge during the venture (i.e., when ρ is higher). The two parties may be able to reduce the potential value dissipation from bargaining by structuring the JV in two possible ways: (1) arrange extensive personnel exchanges between the two parent firms so that they can acquire the other's knowledge simultaneously; (2) each party uses their own personnel to keep exclusive control over those functions of the venture that require their proprietary knowledge so that they can successfully wall off their proprietary knowledge from the other.

Alternatively, the JV contract could be structured to weaken the incentives for power jockeying to arise in the first place. As explained earlier, the bargaining cost in our model primarily stems from power-jockeying by the parties during the venture's operation to boost their relative bargaining power in a possible future negotiation of the venture's breakup. Reducing the incentive for power-jockeying would entail weakening the effect of any such activities on the parties' bargaining power. This might be accomplished by specifying ex ante a formula for dividing the gains from trade in their ownership stakes that is largely independent of any alteration in their relative bargaining power during the venture's operations. However, it may sometimes be costly to specify ex ante the precise price at which one party can acquire the stake of the other (Chi, 2000), and in this case, the parties could elect to raise the switching cost $B_t(\omega)$. This mechanism will be discussed in greater detail in another subsection below.

In short, our results show that capability divergence per se is not value-destroying – what destroys value in the presence of a high likelihood for capability divergence is high bargaining propensity on the part of the JV partners. As we discussed above, the way to curb such value destruction is to reduce the incentives for and adverse effects of bargaining. Some authors who have argued for the importance of trust in JVs also recognize that contractual mechanisms that reduce inter-partner bargaining are conducive to trust building (e.g., Das & Teng, 1998).

How Does Uncertainty Affect the Viability of JVs?

Our results can also shed some light on the effect of uncertainty on the economic efficiency of the hybrid organizational form of JVs. As mentioned in the introduction, real options theory and the governance branch of transaction cost economics seem to make opposite predictions about the influence of uncertainty on the economic viability of hybrid organizational forms such as JVs. According to Williamson (1991), greater uncertainty can take two forms: more numerous disturbances occur or there is an increase in the variance of disturbances. Looking from the governance branch of transaction cost economics, he posits that a hybrid form of organization (such as a JV) is "disfavored by greater variance" (p. 292) relative to the market or hierarchy form of governance, since "greater defections" would be likely to occur in the case of high variance. Proponents of real options theory, however, consider uncertainty as consisting of both an upward potential and a downward risk and see a possibility for structuring a sequence of investments that allow the investor to exploit the upward potential while keeping the downward risk limited (Dixit & Pindyck, 1994). Kogut (1991, p. 20) suggests that the possibility for the partners of a JV to alter its structure though an ex post acquisition gives this mode an advantage in managing risk over its alternatives in situations of higher uncertainty. We believe that an integration of these two seemingly opposing theoretical perspectives can provide a more nuanced understanding the relationship between uncertainty and the viability of JVs.

In our model, the level of volatility in the growth of the two parties' capabilities (indexed by σ_i) increases the likelihood for their capabilities to diverge for $\rho < 1$ and thus also the incentives for them to jockey for power in the venture's operation. Hence, one may suspect that greater volatility will have an effect similar to that of lower correlation between the growths in their capabilities, depressing the NPV of a JV under high bargaining cost (i.e., a nontrivial ϕ).

******* Insert Figure 4 here *******

The picture that emerges from our analysis is not as straightforward, however. The result from our model suggests that there are two opposing forces at work: Greater volatility increases both (i) the bargaining cost function $C_t(\phi)$ and (ii) the gain from trade in ex post acquisition. The net outcome depends on which effect dominates. Under the assumed functional forms and parameter values of our model, the NPV of a JV first falls and then rises as the level of uncertainty (measured by σ_i) is increased. An illustration of this result is provided in Figure 4. This suggests that the rising value of the option to acquire will eventually overtake the rising value dissipation from costly bargaining as the level of uncertainty increases — where the inflexion point occurs depends on the level of bargaining cost. It is interesting to see that the segment of the curves to the left of the inflexion point is consistent with the prediction of the governance branch of transaction cost economics while the segment of the curves to the right of the inflexion point is consistent with the prediction of real options theory. In addition, as bargaining becomes more costly (i.e., as ϕ gets larger), the inflexion point shifts to the right, and the segment of the curve that conforms to the prediction of the transaction cost economics expands.

Proposition 2. In the presence of the option to acquire, the effect of uncertainty on the viability of the JV mode tends to be positive (negative) at a relatively low (high) level of bargaining cost.

Is "Market Failure" a Necessary Condition for JV Formation?

Figures 5-7 contain results for the three scenarios regarding frictions in knowledge and asset markets and their influence on the parties' learning as moderated by the venture's ownership structure. The three panels in each figure correspond to the three different combinations of the parties' relative absorptive capacities (i.e., high-high, high-low and low-high).[16] The five X-Y plots in each panel depict how the venture's NPV varies with its ownership structure (s_t) under five different combinations of the levels of switching cost (ω) and bargaining cost (ϕ).

Note that it is possible that under certain conditions some of the modes will yield negative returns while others will represent a profitable investment. For example, consider Panel C of Figure 5. If the level of investment is twice as high as assumed in this graph, the returns to licensing would be negative whereas the returns to JV or acquisition would be positive. This shows that, although the strength and complementarity of the capabilities of the parties is constant, the efficiency of the mode of combining the capabilities matters in influencing whether the project is profitable or not. So, the decision of whether or not to invest in a new project can be subject to the mode of investment being considered.

******* Insert Figures 5-7 here *******

An intriguing result from our model is its prediction of the formation of JVs that according to existing theories on JVs (e.g., Hennart, 1988; Chi 1994) apparently have no reason to exist. We first note that, consistent with extant theory, when both parties' contribute tacit knowledge to the venture and there are significant frictions in the market for both parties' assets, the optimal mode is a JV whether the option is present or not (as the all Panels of Figure 6 show). However, our results also indicate that under certain conditions, even when transactions via the knowledge or asset market can be carried out efficiently between the two parties, the presence of the option can alter the optimal mode to a JV and influence its share structure. At the end of this subsection, we also show how our identification of the precise underlying conditions of JV formation enables us to reconcile the apparent inconsistency between our findings and the predictions of prior theory.

First, consider the case when both parties have high absorptive capacities. Panel A of Figures 5 and 7 shows that the presence of the option (i.e., the absence of significant switching cost) changes the optimal mode when both parties have high absorptive capacities, even if at least one of them can internalize the other's knowledge via acquisition or licensing,. Note that there are two solid curves in each graph. The upper solid curve is derived under the assumption of $\omega = \phi = 0$ and thus represents the case where there is neither switching cost nor bargaining cost. The lower solid curve represents the case in which the option to acquire the other's stake and divest one's own stake to the other is not available because setting $\omega = 1$ in effect eliminates all gains from the exchange of ownership stakes in the venture.[17] So, the lower solid curve shows the venture's NPV in the absence of the option. The vertical difference between these two solid curves measures the value of the option under the assumption of zero bargaining cost. The vertical distance between the lower solid curve and the dotted or dashed curve measures the value of the option under moderate ($\phi = 1$) or high ($\phi = 2$) bargaining cost.

Under the condition that both parties contribute tacit knowledge to the venture, the lower solid curve in Panel A of Figure 5 (Scenario 1) shows that in the absence of the option, the global optimum is acquisition (but there are two local maxima because Party 1 learns best under full ownership while Party 2 learns best under shared ownership). When both parties learn best under full ownership, as represented by Panel A of Figure 7 (Scenario 3), the lower solid curve shows that in the absence of the option, the optimal ownership arrangement is either acquisition or licensing. However, if the value of the option is not dissipated by the switching cost and if there is no bargaining cost, the optimal mode becomes a JV under both Scenario 1 and Scenario 3, as can be seen from a comparison of the lower solid curve with the upper solid curve in Panel A of Figures 5 and 7. The difference between the shapes of the two curves in Panel A of Figure 7 is particularly striking: the NPV under a JV is the lowest in the absence of the option but becomes the highest when the option can be fully exploited.

The reason that the presence of the option can cause the optimal mode to switch to JV is as follows. When both parties have high absorptive capacity and both are capable of exploiting the potential value of the venture under full ownership, they both have high probabilities of exercising the option to acquire the other’s stake. This causes the value of the option to be particularly high under a JV, as shown by the vertical distance between the lower solid curve and the upper solid curve in Panel A of Figure 7. Even though the value of the cash flows under a JV is low in this scenario, the mode that allows the two parties to maximize the sum of the option value and the cash flow value is a JV.

Note that this effect is contingent on the absence of significant bargaining cost. The direct effect of bargaining cost, indexed by ϕ, is to reduce the venture’s earnings in each period when the chosen mode involves shared ownership. This negative effect on the periodic earnings can be expected to pull down the venture’s NPV under shared ownership. This can be seen graphically in the figures by inspecting the dotted and dashed curves, which depict how the NPV varies with the share structure under positive bargaining cost (i.e., $\phi = 1,2$) and zero switching cost (i.e., $\omega = 0$). The two curves fall below the upper solid curve for $0 < s < 1$ but approach that curve at both ends for $s \to 0$ and $s \to 1$. Hence, the negative effect of bargaining cost on the NPV under shared ownership can cause the optimal mode to switch to sole ownership (as shown in Panel A of Figures 5 and 7).

Our discussion in this subsection so far allows us to outline a set of jointly sufficient conditions for a JV to be the optimal mode of organization for two parties to exploit their complementary assets.

Proposition 3. Given uncertainty about the growth of each party's capabilities, a JV will dominate other modes if both partners have high absorptive capacities and if there is no significant bargaining or switching cost.

Note that "uncertainty about the growth of each party's capabilities" here refers to not only stochastic evolution of the parties' capabilities but also a reasonable likelihood that their capabilities will diverge. This result holds even if one or both parties can internalize the other's knowledge via acquisition or licensing to exploit synergy between their respective sets of knowledge (Scenario 3).

Second, consider the case when the absorptive capacities of the parties are asymmetric. We refer to the parties' absorptive capacities as symmetric if $\beta_i \approx \beta_j$ and as asymmetric otherwise. Symmetry in absorptive capacity does not imply that the parties have competencies in the same areas; in fact, we assume that their expertise is in different areas (at least initially). We find that the presence of the option alters the optimal initial share structure when the party with higher absorptive capacity cannot effectively acquire the other's knowledge via acquisition or licensing due to significant frictions in asset and knowledge markets (see Panel C of Figure 5 and Panels B and C of Figure 6). As shown by the lower solid curve, the ownership structure that maximizes the venture's NPV in the absence of the option to acquire is a JV in which the party with higher absorptive capacity owns 80% of the equity. In the absence of the option, the optimal ownership share is to give the party with lower absorptive capacity a 20% stake; the effect of this small ownership stake is to encourage it to contribute its tacit knowledge to the venture. However, in the presence of the option to acquire (as shown by the upper solid curve in the same graphs), the optimal share structure shifts toward a more equal division of the venture's equity between the two parties. In this case, there is a higher probability that the party with higher absorptive capacity will acquire the other's stake than sell its own stake to the other. Hence, letting the party with lower absorptive capacity hold more shares initially increases the value of the option that is more likely to be exercised, i.e., the more competent party acquiring the other's stake.[18] We can outline the influence of the option to acquire on the JV's share structure as follows:

> Proposition 4. Given uncertainty about the growth of each party's capabilities, asymmetric absorptive capacities and the absence of significant bargaining cost, the presence of the option to acquire influences the share structure of the JV towards greater equality of the partners' proportional share ownership.

The results discussed so far in this subsection suggest that the value of the options embedded in a JV can cause the parties to choose a less efficient mode (JV) over more efficient ones (licensing or acquisition) in terms of organizing the venture's productive activities. It may be tempting to say that the results contradict the logic of transaction cost-based theories (e.g., Hennart, 1988; and Chi, 1994). However, the transaction cost economics literature has long recognized that economic efficiency entails the minimization of the sum of production cost and transaction cost rather than transaction cost alone (Williamson, 1975). It should be noted that the "production function" of the venture being scrutinized in our model involves the generation of not only a product or service but also an intangible asset in the form of real options. What causes the apparent contradiction is that the most efficient mode for the generation of the product or service is not the same as the most "efficient" mode for the generation of the option value. The innovation of our model is that it explicitly recognizes a type of "production" in uncertain investment projects that remained unrecognized in existing transaction cost-based theories.

Furthermore, it should also be noted that the question of choosing the optimal organizational mode would be irrelevant in our model if transaction costs were nonexistent. For example, if incentives did not matter and if the two parties could find out each other's true capabilities without the close interactions in a JV setting, they should be able to achieve a Pareto-optimal outcome through a combination of the following two contracts:

a) A contract that transfers either the relevant knowledge or the relevant assets from one party to the other.
b) An option contract that exploits the uncertainty about their capabilities.

In brief, our model under certain conditions makes a different prediction on the optimal choice of mode for exploiting complementary capabilities than existing theories, but the new insight is due to an integration of the real options logic with the transaction cost economics logic.

When is Acquisition or Licensing a Superior Mode?

Further inspection of the graphs in Figures 5-7 also reveals a number of conditions under which acquisition or licensing is likely the optimal mode.

The results shown in Panel B of Figure 5 and Panels B and C of Figure 7 are based on two assumptions: (i) the two parties' absorptive capacities are *asymmetric* and (ii) the market for the knowledge or assets of at least one of the parties is subject to low friction. The graphs in these three panels suggest that the highest-NPV mode under these assumptions tends to be one that gives full ownership to the party who has a high absorptive capacity and can acquire the other's knowledge or assets without encountering significant market frictions.

The assumptions made in Panel A of Figure 5 and Figure 7 are (i) the two parties' absorptive capacities are *symmetric* (different from above) and (ii) the market for the knowledge or assets of at least one of the parties is subject to low friction (same as above). The plots in each of these two panels except the solid one on the top all assume either or both of the following: (1) mode switching involves a significant cost ($\omega \geq 0.6$) and (2) the two parties have a high propensity to bargain ($\phi \geq 1$). The results represented by these plots suggest that the highest-NPV mode tends to be one that gives full ownership to the party who can acquire the other's knowledge or assets without encountering significant market friction if the two parties face either (1) a high switching cost or (2) a high bargaining cost.

Finally, we examine the more complex graphs in Panel C of Figure 5 and Panels B and C of Figure 6. The results shown in these panels are based on the assumptions that (i) the two parties' absorptive capacities are *asymmetric* and (ii) the market for knowledge or assets of the party with a low absorptive capacity is subject to high friction. The dashed curve in each of the three graphs suggests that the highest-NPV mode under these assumptions tends to be one that gives full ownership to the party with a high absorptive capacity if the parties have a high bargaining propensity ($\phi = 2$) but expect the cost for mode switching to be low ($\omega = 0$).

The following proposition summarizes the three conditions explicated above.

Proposition 5. Acquisition (licensing) is likely to be a superior mode if the MNC (local firm) (i) has a significantly higher absorptive capacity and can acquire the local firm's assets

Chi, Tailan. (2009) A Dynamic Model of the Choice of Mode for Exploiting Complementary Capabilities. Journal of International Business Studies, 40 (3), 365-387. Publisher's Official Version: http://dx.doi.org/10.1057/jibs.2008.65/ Open Access Version: http://kuscholarworks.ku.edu/dspace/

(MNC's knowledge) without encountering significant market friction, (ii) can acquire the local firm's assets (MNC's knowledge) without encountering significant market friction but faces either a high bargaining cost or a high switching cost, or (iii) has a significantly higher absorptive capacity but faces a high bargaining cost and a low switching cost.

Condition (iii) corresponds to situations where the parties could benefit from a JV but potential opportunism makes it too costly for them to do so. The result discussed in the next subsection suggests a potential remedy for such problems.

The Value-Destroying Effect of Flexibility

As discussed above, the level of switching cost can alter the optimal mode and share structure. Another intriguing insight that can be gained from examining the effects of bargaining and switching costs is that the option to acquire the other's stake or divest one's own stake to the other can under some conditions destroy value and thus is better eliminated. This issue is particularly germane to consider in the context of Scenario 2 where both parties contribute tacit knowledge to the venture and both learn best under shared ownership. In each of the panels of Figure 6, the lower solid curve represents $\omega = 1$ and thereby eliminates the option. Compare this with the dashed-dotted curve representing $\omega = 0.6$ and $\phi = 2$, where the option to acquire still exists but both switching cost and bargaining cost are high.

Note that in Panel A the highest point of the lower solid curve is above the highest point of the dashed-dotted curve. This suggests that the optimal mode is to have shared ownership in the venture but make it prohibitively costly for each to acquire the other's stake under the following conditions: (1) the parties both have high absorptive capacity and face difficulty acquiring the other's knowledge due to tacitness and (2) bargaining cost is high. The intuition behind this result is that such an arrangement can motivate the parties to focus on exploiting the synergy between their resources rather than wasting their resources in power-jockeying activities. Now consider Panels B and C of Figure 6. In the presence of both high switching cost and high bargaining cost, as represented by the dashed-dotted curve, the value-destroying effect of the option actually causes sole ownership to dominate shared ownership even though both parties learn best under shared ownership. Once again, the implication is that, by choosing a shared ownership mode and eliminating the option (as in the case represented by the lower solid curve), the parties can significantly increase the venture's NPV. So, when bargaining cost is high, it pays to make the exercise of the option very restrictive in the termination clause of the JV contract so that the parties see little gain from power jockeying.

The above discussion suggests the following proposition:

Proposition 6. In the presence of (i) uncertainty about the growth of each party's capabilities, (ii) frictions in both knowledge and asset markets and (iii) high bargaining cost, two parties with high absorptive capacity who undertake a JV to exploit complementary knowledge will be likely to restrict the option of one party to acquire the other.

CONCLUSION

In this study, we build a theoretically pluralistic model to identify four factors that are expected to influence the choice of mode for exploiting synergy between complementary assets of two parties in the presence of uncertain learning. These are: (i) absorptive capacities of the parties; (ii) frictions in knowledge and asset markets and the associated incentive issues for knowledge sharing, (iii) bargaining cost and (iv) switching cost. We use a combined real options and game-theoretic approach to investigate our central research question: How do these factors interact in influencing the choice of modes for exploiting complementary capabilities?

Our results highlight that for two parties to exploit their complementary assets in a new venture, the presence of the option to acquire the other party's stake in the venture can alter the optimal mode and share structure. When switching and bargaining costs are low and when the parties' absorptive capacities are symmetric, the mode that provides the highest NPV in the presence of the option to acquire the other party's stake tends to be a JV. However, when the parties' absorptive capacities are asymmetric, sole ownership by the party with higher absorptive capacity (via acquisition or licensing) tends to be favored over shared ownership, particularly if the knowledge of the party with lower absorptive capacity is explicit. Their possession of complementary tacit knowledge once again tends to favor joint share ownership. We also note that the presence of high bargaining cost changes the optimal mode: if the optimal mode involves shared ownership, the negative effect of bargaining cost on the NPV under shared ownership can cause the optimal mode to switch to sole ownership. The joint effect of high bargaining cost and high switching cost is particularly interesting to consider in the case where both parties share tacit knowledge and learn best under shared ownership. In such a case, the option to acquire has a value-destroying effect so that sole ownership dominates shared ownership. The parties could mitigate the value-destroying effect of potential bargaining and enable themselves to exploit their synergy more efficiently, however, by imposing restrictions on their exercise of the option.

The results of our model also shed light on two important theoretical issues in the study of JVs. First, we find that potential asymmetric learning between JV partners can be a source of value creation as well as source of value destruction. This result suggests that the concern over asymmetric learning in the stream of research known as the learning race perspective reflects only one side of the picture. Second, some authors see an apparent contradiction between the real options theory and the asset specificity branch of transaction cost economics in predicting the effect of uncertainty on the economic viability of such hybrid organizational modes as JVs (Seth & Kim, 2001). The results of our model show that uncertainty can affect the viability of JVs positively or negatively and the direction of effect depends on the level of bargaining cost.

Our study can be extended in several directions. First, we currently assume that the parties can only acquire the other's stake in its entirety after the initial agreement. An extension can be to allow finer adjustments in the ownership structure ex post (e.g., an increment of 10%). Second, the focus of our current paper is on the influences of the parameters on the initial choice of mode. Our model can also be used to examine how the parameters of the model affect the optimal rule for switching between the different modes of organization at $t \in (0,T)$. Third, the current model assumes that the parties do not receive any new information about the demand and cost conditions without making the initial investment so that there is no value in waiting to invest. The model can be modified to allow new information to arrive perhaps at a slower rate without the initial investment and study the trade-off between investing now and investing later. Fourth, our model can be expanded to endogenize each party's decision on whether to engage in power jockeying (e.g., by making ϕ a choice in a non-cooperative game) in a given period depending on how their respective capabilities evolve. Such an expanded model can be used to examine the dynamics of trust building in a collaborative venture.

Finally, we have described how the key parameters of the model may be reflected in empirically measurable variables. This discussion provides the basis for empirical researchers to operationalize our propositions regarding the effects of these parameters on the choice of mode for empirical testing. Our model focuses on the effects of interactions between different parameters on the choice of mode, particularly the interaction of the partners' bargaining propensity (ϕ) with other parameters such as uncertainty (σ_i) and asymmetric learning (ρ). In exploring the implications of the model, we assume a range of alternative conditions representing frictions in knowledge and asset markets. In a recent review of empirical studies on the choice of entry mode in international business, Brouthers and Hennart (2007: 403) point out that although existing empirical studies have examined the main effects of some of these parameters (e.g., uncertainty) and market frictions (e.g., asset specificity), few have analyzed their interaction. They argue that, when the prediction of a theory is based on the joint effects of two factors, a proper test of the theory must examine the interaction effects. In addition, prior empirical work does not account for the range of the interactions that our model predicts, e.g., the effect of the interaction of uncertainty with the bargaining propensity of the partners (Zhao et al., 2004).

The insights from our model illustrate value in using a theoretically pluralistic approach to studying the choice of mode for exploiting complementary capabilities. The economic viability of a mode depends not only on the presence of complementarity between the capabilities of the parties but also on the efficiency of the chosen mode for combining the capabilities (e.g., Contractor & Lorange, 1987). The efficiency of a mode in turn depends on both the absorptive capacities of the parties (e.g., Cohen & Levinthal, 1990) and the transaction cost characteristics of the mode (e.g., Hennart, 1988). As our simulation results show, an otherwise profitable project might not be worth undertaking if the chosen mode is inefficient and seriously dissipates the rent from the potential synergy between the two parties. In other words, the choice of *how* to structure a venture can have a critical influence on *whether* to undertake it.

ACKNOWLEDGEMENTS

This study received financial support from the Center for International Business Education and Research at the University of Illinois and the School of Business at the University of Kansas. We would like to thank Professor Yadong Luo and three anonymous reviewers for their valuable comments and suggestions. We would also like to thank Mark Feldman, Michael Leiblein, Constanta Mindruta, Bart Taub, seminar participants at INSEAD, Ohio State University, Tilburg University and Waikato University and conference participants at the Academy of Management, Academy of International Business and the Strategic Alliance Conference at Ohio State University for helpful comments. We would also like to thank Yong Li for research assistance.

Chi, Tailan. (2009) A Dynamic Model of the Choice of Mode for Exploiting Complementary Capabilities. Journal of International Business Studies, 40 (3), 365-387. Publisher's Official Version: http://dx.doi.org/10.1057/jibs.2008.65/ Open Access Version: http://kuscholarworks.ku.edu/dspace/

NOTES

[1] Williamson (1985) distinguishes several efficiency-based approaches to the study of contracting and refers to his own approach as the governance branch of transaction cost economics. The other approaches that are included in his classification scheme are the measurement branch of transaction costs economics (e.g., Alchian & Demsetz, 1972; Barzel, 1982), property rights (e.g., Coase 1960), and agency theory (e.g., Jensen & Meckling, 1976). Although the term transaction costs is sometimes used narrowly to refer to only the costs of market transactions that Williamson's approach focuses on, we use the term broadly in this paper to refer to any costs of organization that have been discussed by any of the efficiency-based approaches to the study of contracting. Although scholars in international business generally use the term *transaction cost economics* to refer to the broader literature on contracting, scholars in strategic management often prefer to use the term *organizational economics* instead.

[2] Our definition of NPV includes both the value of discounted cash flows and the value of options. In other words, we use the concept of dynamic rather than static NPV.

[3] Reuer and Tong (2005) and Richards and Indro (2002) find the incidence of explicit option clauses to be below 5%.

[4] Note that there is no value of waiting to commence the venture in our model because the parties by assumption cannot receive any new information on any of the uncertain variables (e.g., m or c) without making the investment I_0.

[5] The specification of v_t as a weighted average of $a_{1,t}$ and $a_{2,t}$ embodies the results from prior models on collaborative ventures such that a party's contribution to a joint production process tends to rise with its residual claimancy, which is represented by s_t or $1 – s_t$ in our model (Chi, 1996; Cooper & Ross, 1985; Eswaran & Kotwal, 1985).

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[6] Kamrad and Ritchken (1991) first proposed this distribution as a way to approximate the continuous stochastic process of multidimensional geometric Brownian motion. The process has been used to model not only the values of financial assets such as stock prices but also the values of real assets such as investments in technology (Grenadie & Weiss, 1997) given that both types of assets reflect stocks, as opposed to flows, whose values have a lower bound of zero.

[7] The exact definitions of the probabilities are provided in the Appendix.

[8] Our model does not explicitly consider the possibility that the local firm out-learns the MNC and becomes a competitor in the global market. However, this possibility is not material to our study in that the difference that it can make to the results is quantitative rather than qualitative.

[9] As Hennart (1988: 371) points out, the inseparability or indivisibility of a firm's assets arises from the condition of firm specificity. Firm-specific assets are those assets of a firm that have a lower economic value if the firm's ownership to the assets is severed. The fall in the value of the assets under separate ownership stems from a loss of efficiency, or a rise in transaction costs, in the exploitation of the complementarity that exists between the assets in question and the other assets of the firm (Williamson, 1985).

[10] Because s_t is the policy variable in our model, its presence in μ_i through $\kappa_i(s_t)$ gives it an effect on the evolution of $a_{1,t}$ and $a_{2,t}$, thus making the stochastic process a "controlled" process. It should also be noted that s_t in our model influences both each party's contribution to the venture in a given time period and the party's learning over time, so it has both a static effect and dynamic effect on the payoff from the venture.

[11] From a game-theoretic perspective, such a cooperative game is applicable when the negotiating parties have complete information about each other's capabilities and preferences. In this paper, we assume away information asymmetry to keep the model tractable. This assumption

allows the model to provide a first-order approximation and focus on the Pareto-optimal choice of mode that can serve as a benchmark for subsequent research based on variant assumptions.

[12] Although our results do not depend on the price of the acquisition, for completeness we include a discussion of the determination of this price in the Appendix.

[13]In this paper, we assume a party to have full control over the venture's operation whenever it holds sole ownership to the venture. In a JV, the partners share the ownership rights, and their control rights to a specific aspect of the venture's operation are either specified in the JV contract or subject to negotiation ex post.

[14] We also varied the means and standard deviations of the changes in m and c, which are also specified as stochastic variables in the model, and found their effects to be completely predictable on the basis of simple option reasoning and do not qualitatively alter the effects of any other variable. Because those results do not differ from those obtained from earlier models, they are not reported in this paper.

[15] Note that the results presented in Figure 3 are based on the assumption that the option to acquire is not subject to any switching cost (i.e., $\omega = 0$). It should also be noted that the possible causes for capability divergence in our model include not only one party acquiring the other's core competencies (the main concern of the learning race perspective) but also the party able to learn faster on its own.

[16] For completeness, we also computed the results for the case where both β_1 and β_2 are low. Not only is this case uninteresting in the context of our study, which focuses on the influence of capacity to learn, but the results we obtained also add little new information to what the other three cases already show.

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[17] In our model, the level of ϕ is irrelevant when $\omega = 1$ because the bargaining cost function $C(t)$ is scaled by $(1-\omega)$.

[18] Chi and McGuire (1996) argue that the option to acquire in a JV will create a greater value if a smaller initial share is allocated to the party that is likely to value the venture's assets less ex post. Our result is consistent with this suggestion but links the expected asymmetry in valuation explicitly to the difference in absorptive capacity between the two parties.

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APPENDIX

In this appendix, we specify the transition probabilities and related parameters, define the price at which the venture can be sold to a third party, derive a party's valuation of the venture's assets at time $t > 0$ and specify their negotiated acquisition price.

Transition Probabilities and Related Parameters

Based on the derivations of Kamrad and Ritchken (1991), we define the jump parameters as $u_i = \exp(\sigma_i \sqrt{\Delta t})$ with $i = 1,2$ and the five transition probabilities as:

$$p_{UU} = \frac{1+\rho}{4\lambda^2} + \frac{\sqrt{\Delta t}}{4\lambda}\left(\frac{\alpha_1 - \sigma_1^{\,2}/2)}{\sigma_1} + \frac{\alpha_2 - \sigma_2^{\,2}/2}{\sigma_2}\right),\ p_{UD} = \frac{1-\rho}{4\lambda^2} + \frac{\sqrt{\Delta t}}{4\lambda}\left(\frac{\alpha_1 - \sigma_1^{\,2}/2}{\sigma_1} - \frac{\alpha_2 - \sigma_2^{\,2}/2}{\sigma_2}\right),$$

$$p_{HH} = 1 - \frac{1}{\lambda^2},\ p_{DU} = \frac{1-\rho}{4\lambda^2} - \frac{\sqrt{\Delta t}}{4\lambda}\left(\frac{\alpha_1 - \sigma_1^{\,2}/2}{\sigma_1} - \frac{\alpha_2 - \sigma_2^{\,2}/2}{\sigma_2}\right), \text{ and}$$

$$p_{DD} = \frac{1+\rho}{4\lambda^2} - \frac{\sqrt{\Delta t}}{4\lambda}\left(\frac{\alpha_1 - \sigma_1^{\,2}/2]}{\sigma_1} + \frac{\alpha_2 - \sigma_2^{\,2}/2}{\sigma_2}\right),$$

where λ, ρ, α_i and σ_i are constants. The parameter ρ represents the coefficient of correlation between the changes in $a_{1,t}$ and $a_{2,t}$ and thus measures the likelihood that the rent-earning capabilities of the two parties will converge. As can be seen from the definition of u_i, the value of σ_i influences the size of the upward and downward jumps and thus the volatility of $a_{i,t}$ via u_i, determining the volatility of the stochastic process. If the discrete process is used to approximate a continuous stochastic process of geometric Brownian motion, α_i and σ_i would represent the drift and volatility parameters, as in $da_{i,t}/a_{i,t} = \alpha_{i,t}dt + \sigma_i w_t$, where w_t is a standard Brownian motion or Weiner process. As shown by Chi (2000), α_i can be defined as a function of expected growth rate μ_i and other parameters:

$$\alpha_i = \frac{\frac{1}{2\lambda^2}\left(2-u_i-\frac{1}{u_i}\right)+\frac{\sqrt{\Delta t}}{4\lambda}\sigma_i\left(u_i-\frac{1}{u_i}\right)-1+\exp(\mu_i\Delta t)}{\sqrt{\Delta t}\,\frac{u_i^2-1}{2u_i\lambda\sigma_i}}.$$

Price of Venture's Assets to a Third Party

We define this price as a power function of the venture's profit in the current period π_t:

$S(\pi_t)=\gamma^{\frac{\pi_0}{\pi_t}}I_0$, where $\gamma < 1$ is a parameter, π_0 is the expected profit at t = 0, and I_0 is the initial investment required to start the venture. This function specifies the price to be a fraction of the initial investment I_0 and allows the fraction to increase with the venture's current operating profit. Its form is consistent with the framework suggested by Kamien and Schwartz (1991) for analyzing salvage values. The presence of this option has the effect of raising the venture's terminal value and therefore the NPV to the two parties.

A Party's Valuation of the Venture's Assets

As explained earlier in the text, each party's valuation of the venture's assets should reflect the dynamic present value that they can gain from operating the venture until the end of the planning horizon T without the other party involved as an owner. We assume that the rent-earning potential of the venture is exhausted by $t = T$ so that neither party can get more than S_T by continuing the venture. This means that whoever owns the venture at the end of the planning horizon will sell it to a third party at $S(\pi_{T-\Delta t})$. So, if Party i is the sole owner of the venture at the beginning of the last period T, the present value of the venture's assets to Party i is just $X_{i,T}=S(\pi_{T-\Delta t})$. For $0 < t < T$, the party faces the choice between continuing the venture until the next period or selling the assets to a third party. Then, the present value of the venture to the party is just $X_{i,t}=\max\{\pi_t+E(X_{i,t+\Delta t})]e^{-r(\Delta t)},S(\pi_{t-\Delta t})\}$ for $t > 0$ and $E(X_{i,1})e^{-r(\Delta t)}$ for $t = 0$.

Specification of Acquisition Price

We assume that the parties play a Nash cooperative game in negotiating an acquisition price, so that their negotiated price is a weighted average of the their respective valuations,

$$R_t = \theta X_{i,t} + (1-\theta) X_{j,t},$$

where $i = 1,2$ and $j = 2,1$. The weights imply how much of the gain from the exchange accrues to each party, since the party whose valuation is weighted more heavily receives a smaller gain in the exchange. Hence, in the case of an ex post acquisition, the values that the acquirer and divestor get from the exchange are $X_{i,t} - s_j R_t$ and $s_j R_t$, respectively, in the absence of any switching cost, assuming Party *j* to be divestor.

Table 1. Definitions of Parameters, Variables and Functions

Notation	Variable or Parameter	Functional Form or Value Used in Numerical Computation
s_t	Party 1's ownership share	$s_t \in [0,1]$ denotes Party 1's share
I_0	Initial investment	1
t	Current time	$0 \le t \le T$
T	Length of planning horizon	3
N	Number of discrete periods	3
τ	Future time	$t < \tau \le T]$
r	Discount rate	0.1
π_t	Venture's periodic profit at t	$q_t(p_t - c)$
c	Unit production cost (a binary random variable)	c_H = 1.1052, c_L = 0.9048
q_t	Demand at t	$m \cdot v_t - k \cdot p_t$
p_t	Price charged at t	
k	Sensitivity of demand to price	2
m	A binary random variable reflecting exogenous market conditions	m_H = 3.0535, m_L = 2.0468
v_t	The parties' abilities to generate demand at t	$s_t a_{1,t} + (1 - s_t) a_{2,t}$
ε	Noise in the profit function	$E(\varepsilon) = 0$
C_t	Bargaining cost function	$\phi[s_t(1-s_t)](1-\omega)\lvert a_{1,t} - a_{2,t}\rvert$
ϕ	Bargaining propensity	0, 1, or 2
ω	Index of switching cost	$0 \le \omega \le 1$
B_t	Switching cost function	$\omega\lvert X_{1,t} - X_{2,t}\rvert$
β_i	Party i's capacity to learn	0.1 or 0.0
$a_{i,t}$	Index of Party i's rent-earning capabilities	Stochastically distributed
u_i	"Jump" parameter	See Appendix
$p_{UU}, p_{UD}, p_{HH}, p_{DU}, p_{DD}$	Transition probabilities	See Appendix
μ_i	Expected annualized rate of change in $a_{i,t}$	$\beta_i \kappa_i$
κ_i	Influence of market frictions on Party i's learning	See Figure 2
α_i	"Drift" parameter	See Appendix
σ_i	"Volatility" parameter	0.2
ρ	Coefficient of correlation between $\Delta a_{1,t}$ and $\Delta a_{2,t}$	Varies from 0 to 1 in Figure 3, otherwise fixed at 0.3
λ	"stretch" parameter	1.11803
$X_{i,t}$	Party i's valuation of the venture's assets at $t \in (0,T]$	See appendix
R_t	Price for transferring equity between the parties	$\theta X_{1,t} + (1-\theta) X_{1,t}$
θ	Party 1's relative bargaining power	$0 \le \theta \le 1$
S	Price of the venture's assets to a third party	See appendix
γ	Parameter in the definition of S	0.8
$J(a_{1,t}, a_{2,t}, \hat{s}_t)$	Maximized NPV at $t > 0$	See text
$Z(s_0)$	Maximized NPV at $t = 0$	See text

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Figure 1. Initial Choice of Share Structure and Implicit Follow-on Options

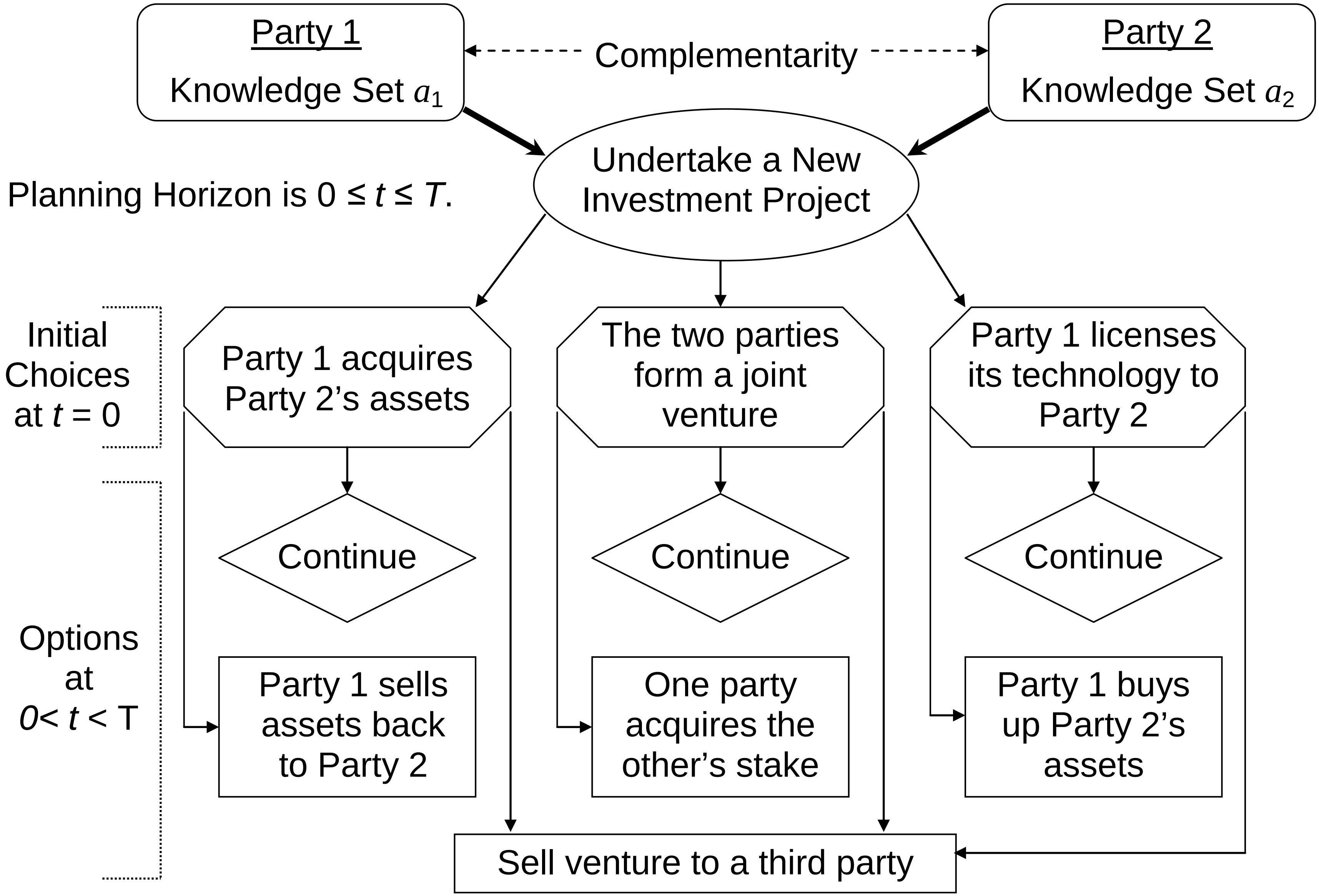

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Figure 2. Graphic Depictions of the Three Scenarios

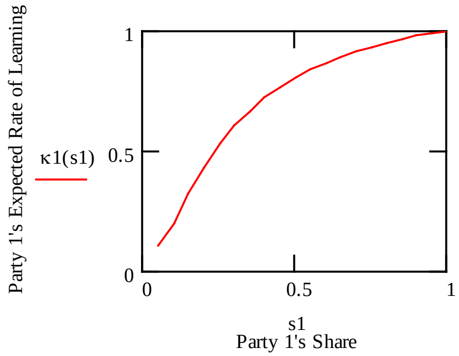
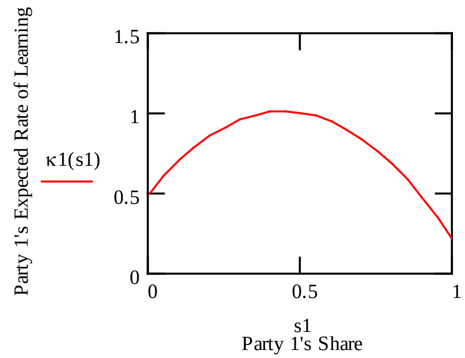
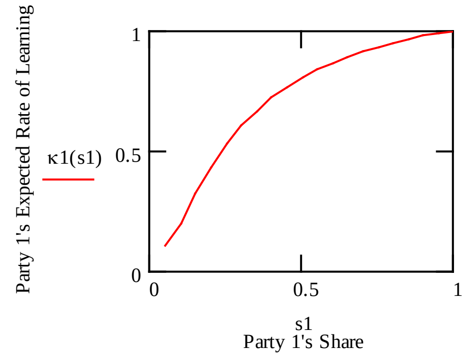
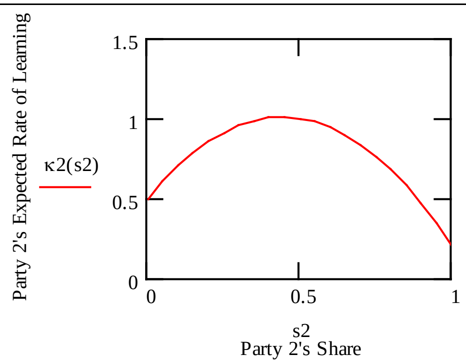
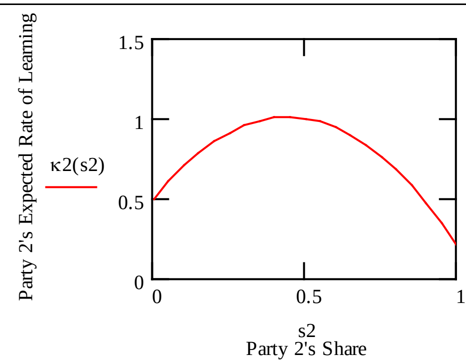
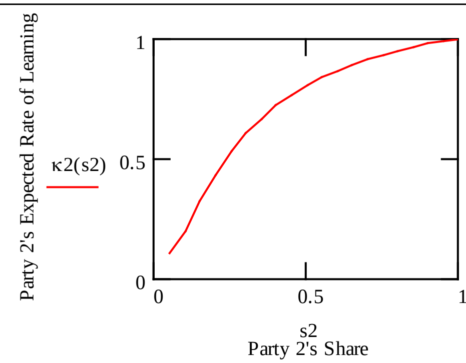
	Scenario 1	Scenario 2	Scenario 3
Party 1	 $\kappa_1 = 0.1 + 1.156\exp(-0.25s)$	 $\kappa_1 = 0.2 + 2.9s - 2.6s^2$	 $\kappa_1 = 0.1 + 1.156\exp(-0.25s)$
Party 2	 $\kappa_2 = 0.2 + 2.9(1-s) - 2.6(1-s)^2$	 $\kappa_2 = 0.2 + 2.9(1-s) - 2.6(1-s)^2$	 $\kappa_2 = 0.1 + 1.156\exp[-0.25(1-s)]$

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Figure 3. Effect of Capability Divergence on the Net Present Value of a Joint Venture

Error! Not a valid link.

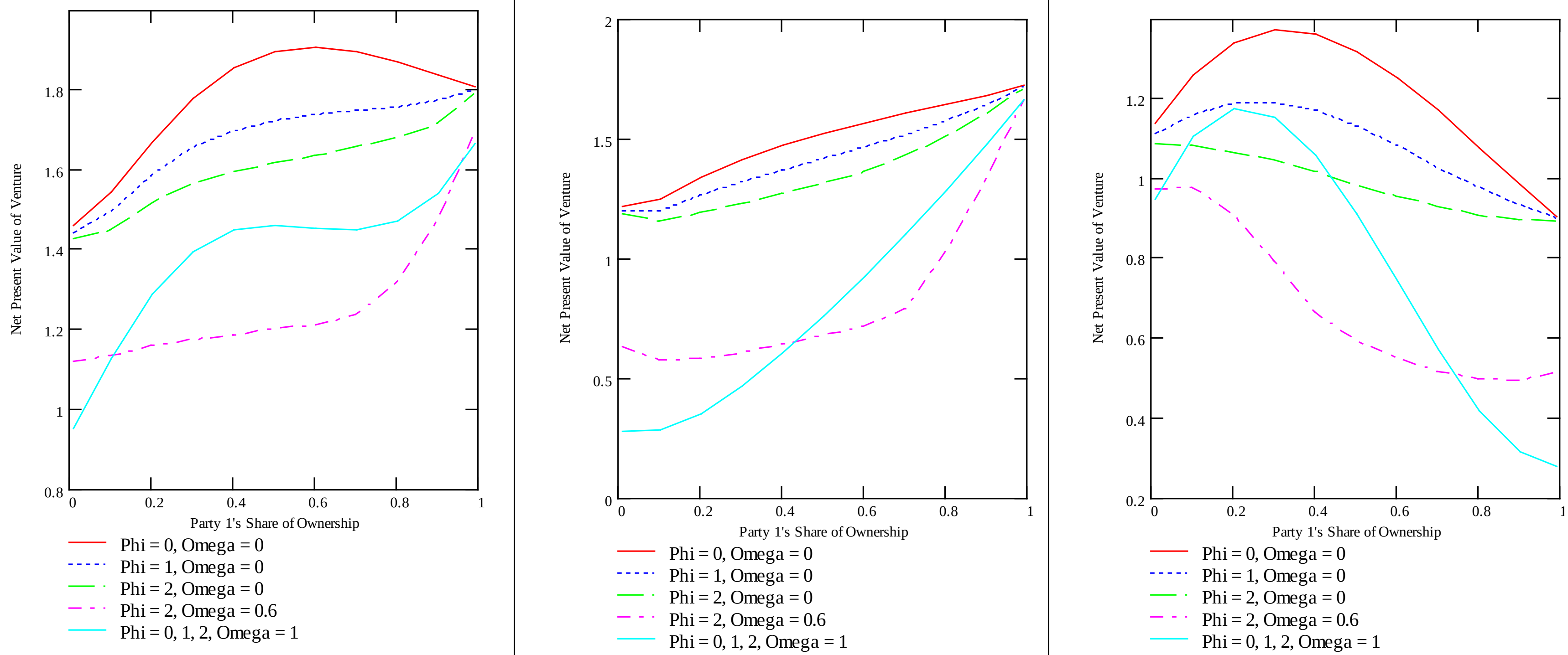
Note: This graph is based on Scenario 2, with the optimal share structure being 50:50 for both $\phi = 0$ and $\omega = 0$ and for $\phi = 2$ and $\omega = 0$.

Figure 4. Effect of Uncertainty on the Net Present Value of a Joint Venture

Error! Not a valid link.

Note: This graph is based on Scenario 2, with the optimal share structure being 50:50 for $\sigma_1 = \sigma_2$, $\beta_1 = \beta_2 = 0.1$, $\rho = 0.3$, $\phi = 2$ and $\omega = 0$.

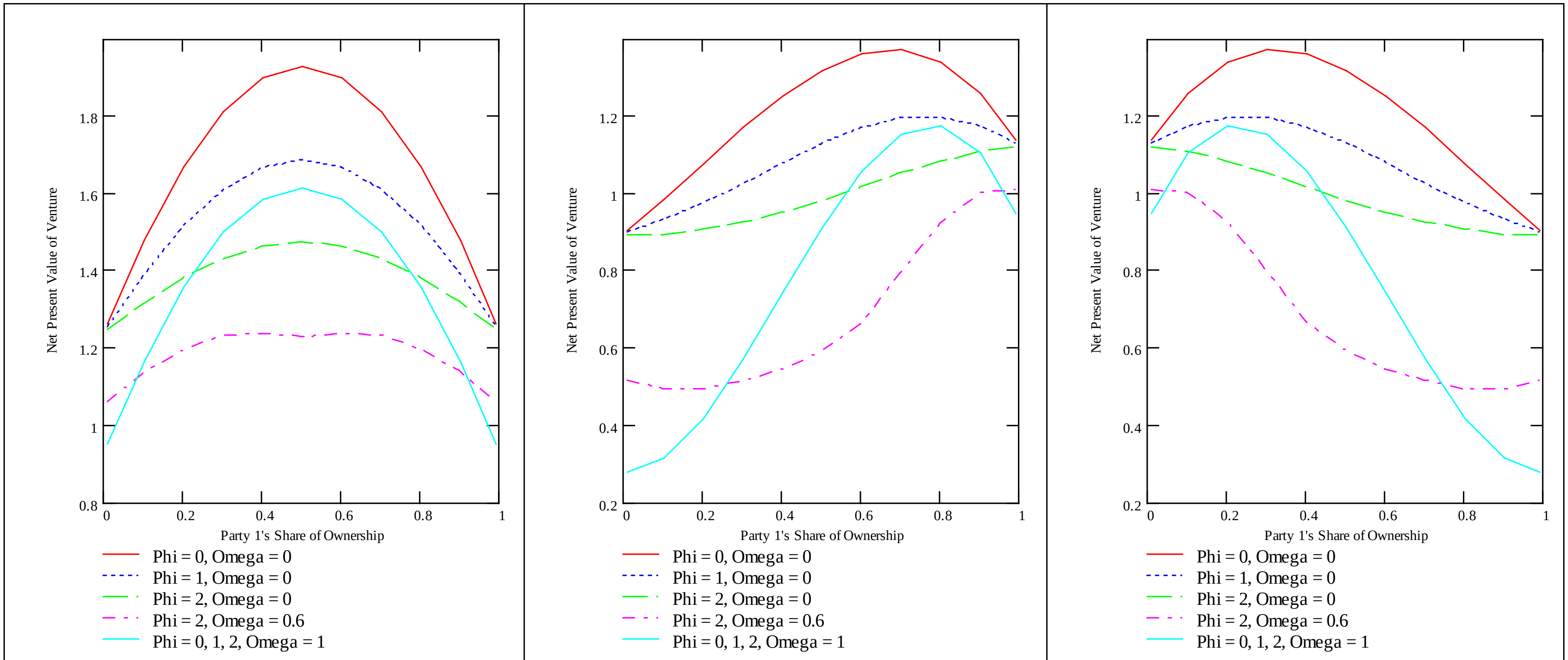
Figure 5. Influence of Absorptive Capacity, Bargaining Cost and Switching Cost on Initial Choice of Ownership Structure under Scenario 1 [a]



Panel A. High β_1 and High β_2	Panel B. High β_1 and Low β_2	Panel C. Low β_1 and High β_2

[a] Scenario 1: Both parties' contribute tacit knowledge to the venture and there are significant frictions in the market for Party 1's relevant assets but the market for Party 2's assets is efficient. Party 1 learns best by internalizing Party 2, and Party 2 learns best under shared ownership.

Figure 6. Influence of Absorptive Capacity, Bargaining Cost, and Switching Cost on Initial Choice of Ownership Structure under Scenario 2 [a]



Panel A. High β_1 and High β_2 | Panel B. High β_1 and Low β_2 | Panel C. Low β_1 and High β_2

[a] Scenario 2: Both parties' contribute tacit knowledge to the venture and there are significant frictions in the markets for both parties' relevant assets. Both learn best under shared ownership.

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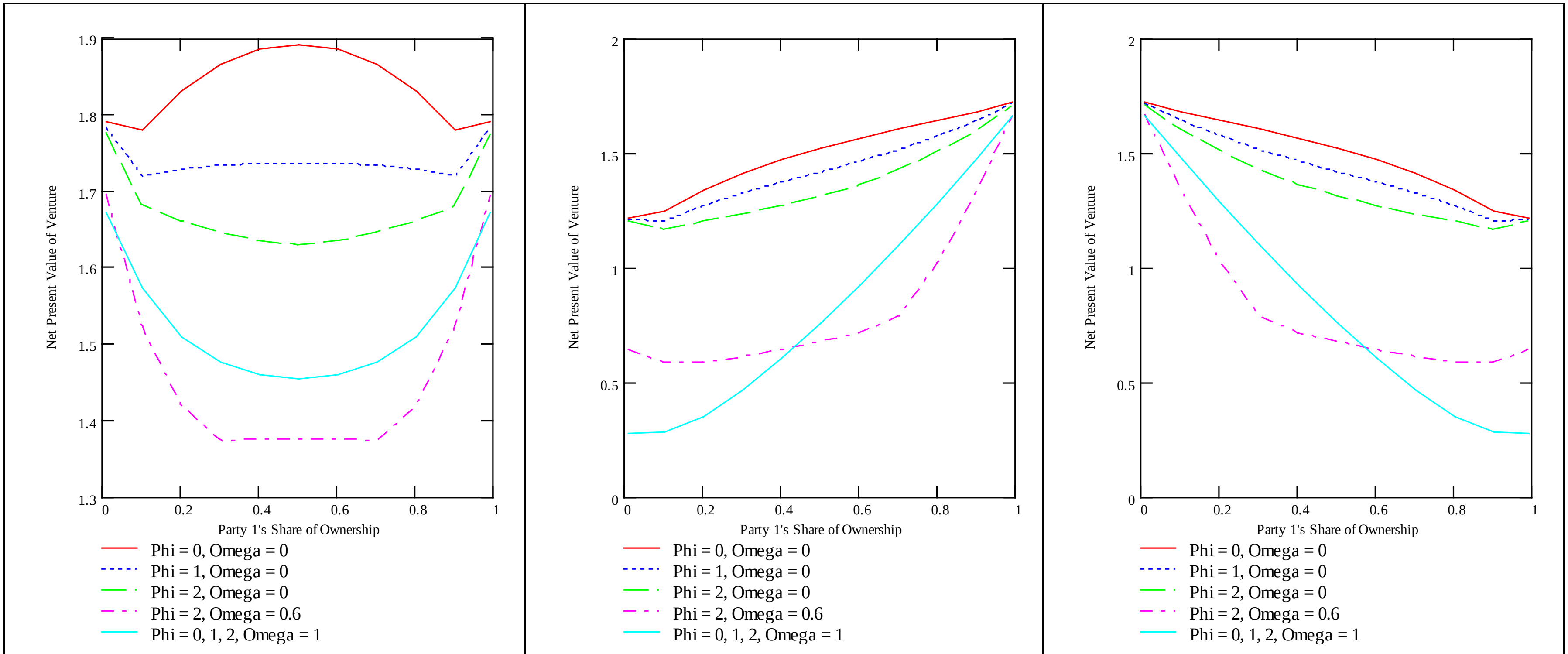
Figure 7. Influence of Absorptive Capacity, Bargaining Cost and Switching Cost on Initial Choice of Ownership Structure under Scenario 3 [a]



Panel A. High β_1 and High β_2	Panel B. High β_1 and Low β_2	Panel C. Low β_1 and High β_2

[a] Scenario 3: Party 1 contributes explicit knowledge, Party 2 contributes tacit knowledge and there are significant frictions in the market for Party 1's relevant assets but the market for Party 2's assets is efficient. Party 1 learns best by internalizing Party 2, and Party 2 learns best under full ownership.