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.

- *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 $\mu_i \leq \beta_i$. 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.

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

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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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	$\phi[s_t(1-s_t)](1-\omega)\left\|a_{1,t} - a_{2,t}\right\|$
ϕ	Bargaining propensity	0, 1, or 2
ω	Index of switching cost	$0 \le \omega \le 1$
B_t	Switching cost function	$\omega\left\|X_{1,t} - X_{2,t}\right\|$
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

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

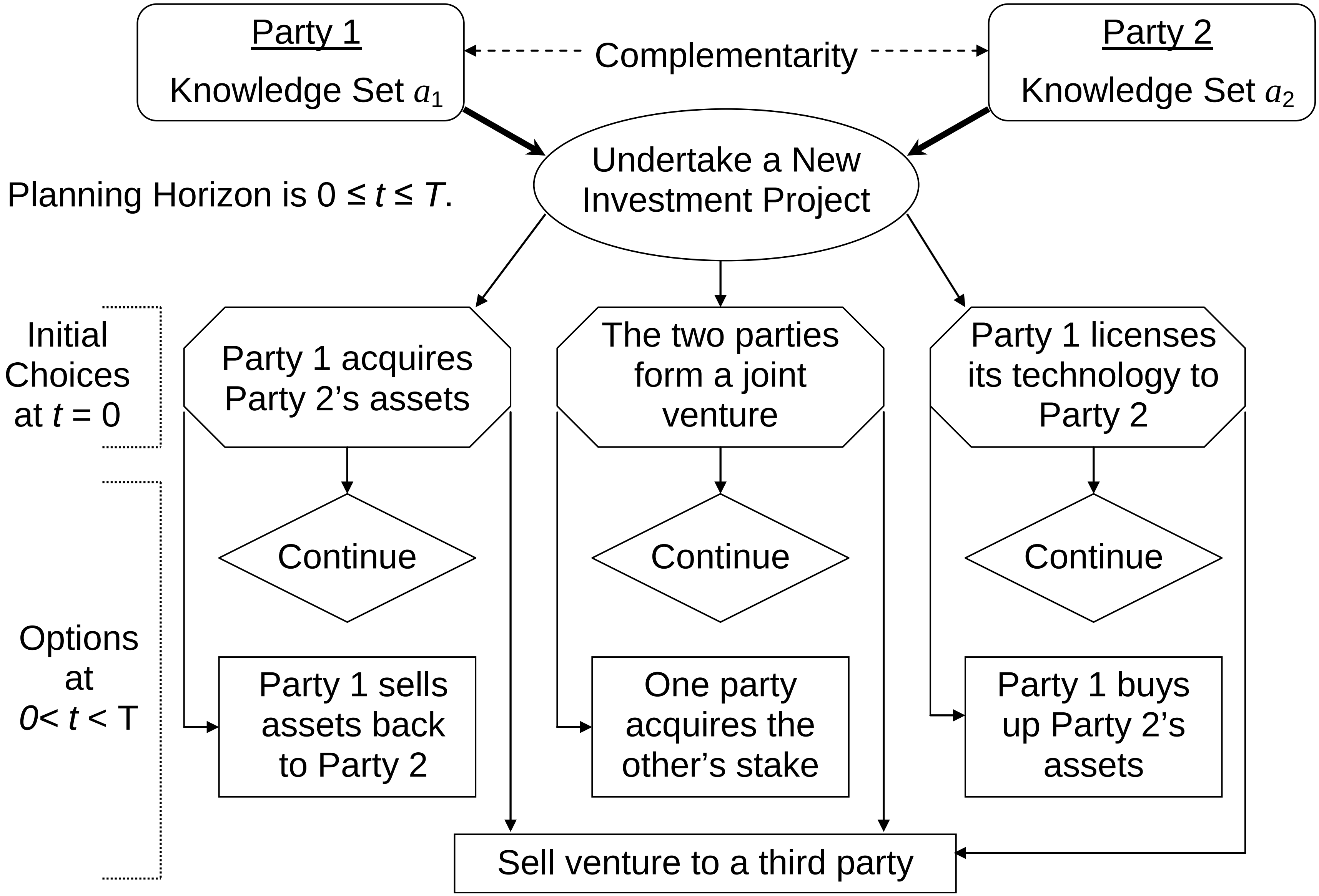
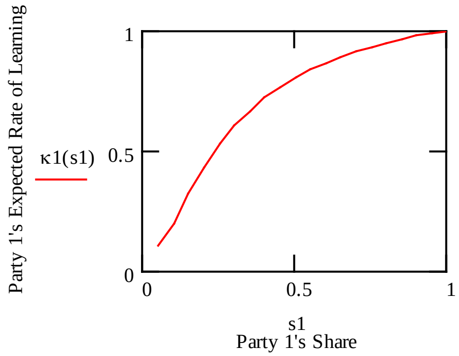
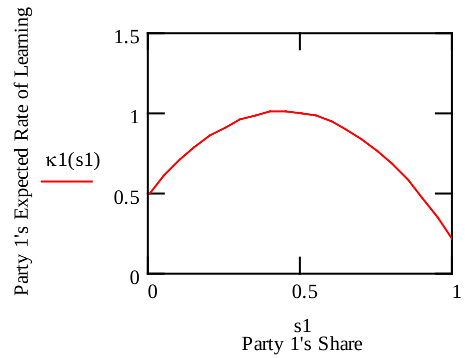
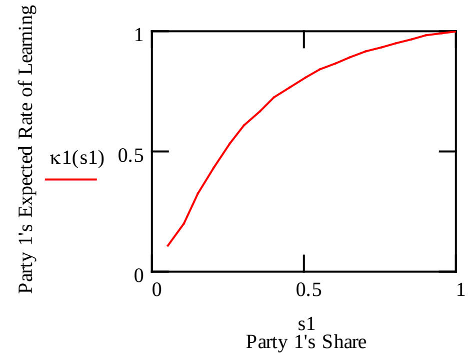
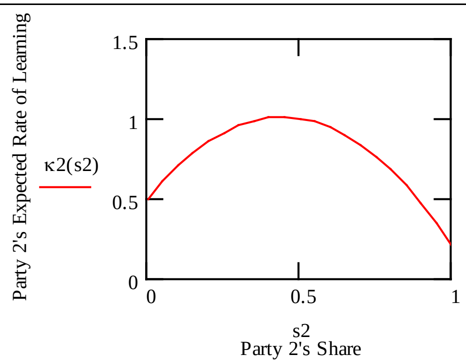


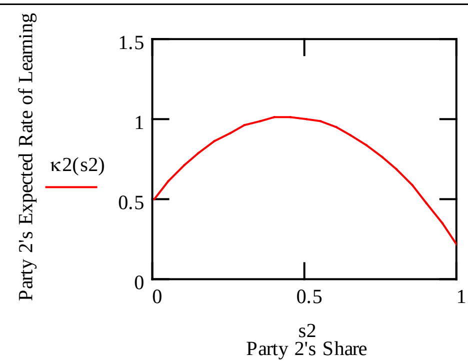
Figure 2. Graphic Depictions of the Three Scenarios

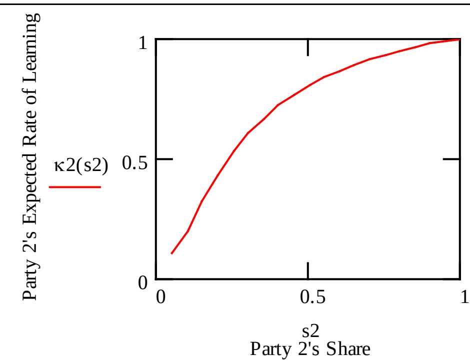
<table>
<tr><th></th><th>Scenario 1</th><th>Scenario 2</th><th>Scenario 3</th></tr>
<tr><td>Party 1</td>
<td>

$\kappa_1 = 0.1 + 1.156\exp(-0.25s)$</td>
<td>

$\kappa_1 = 0.2 + 2.9s - 2.6s^2$</td>
<td>

$\kappa_1 = 0.1 + 1.156\exp(-0.25s)$</td></tr>
<tr><td>Party 2</td>
<td>

$\kappa_2 = 0.2 + 2.9(1-s) - 2.6(1-s)^2$</td>
<td>

$\kappa_2 = 0.2 + 2.9(1-s) - 2.6(1-s)^2$</td>
<td>

$\kappa_2 = 0.1 + 1.156\exp[-0.25(1-s)]$</td></tr>
</table>

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/

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

Error! Not a valid link.

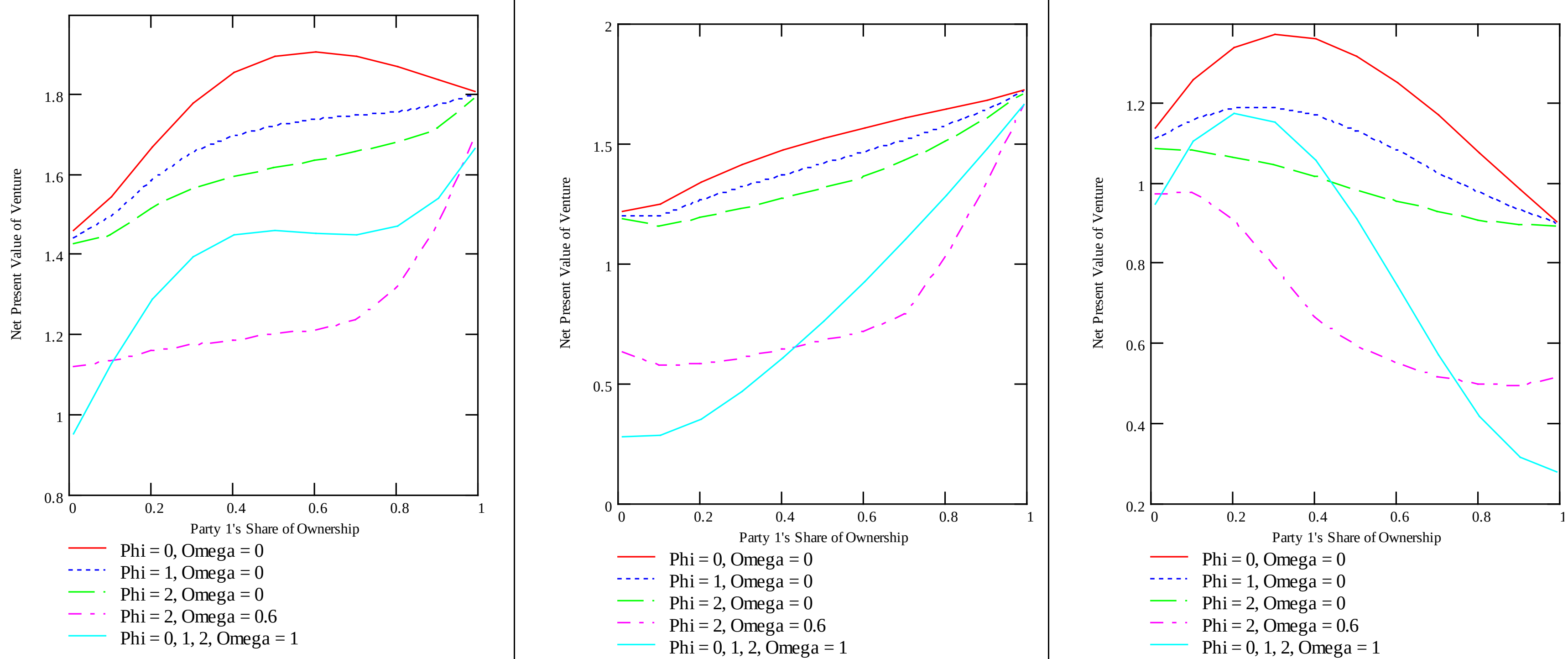
Note: This graph is based on Scenario 2, with the optimal share structure being 50:50 for both $\phi = 0$ and $\omega = 0$ and for $\phi = 2$ and $\omega = 0$.

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 $\omega = 0$.

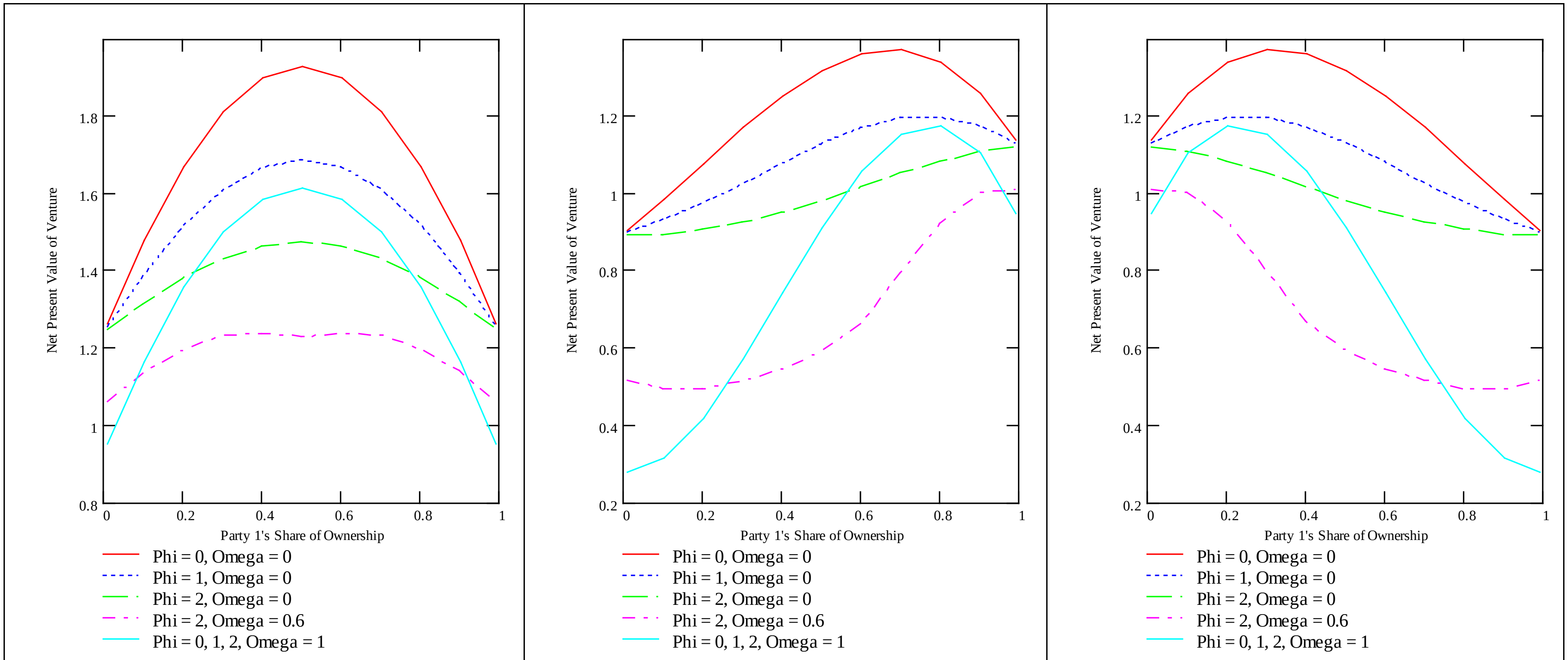
Figure 5. Influence of Absorptive Capacity, Bargaining Cost and Switching Cost on Initial Choice of Ownership Structure under Scenario 1 [a]



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.

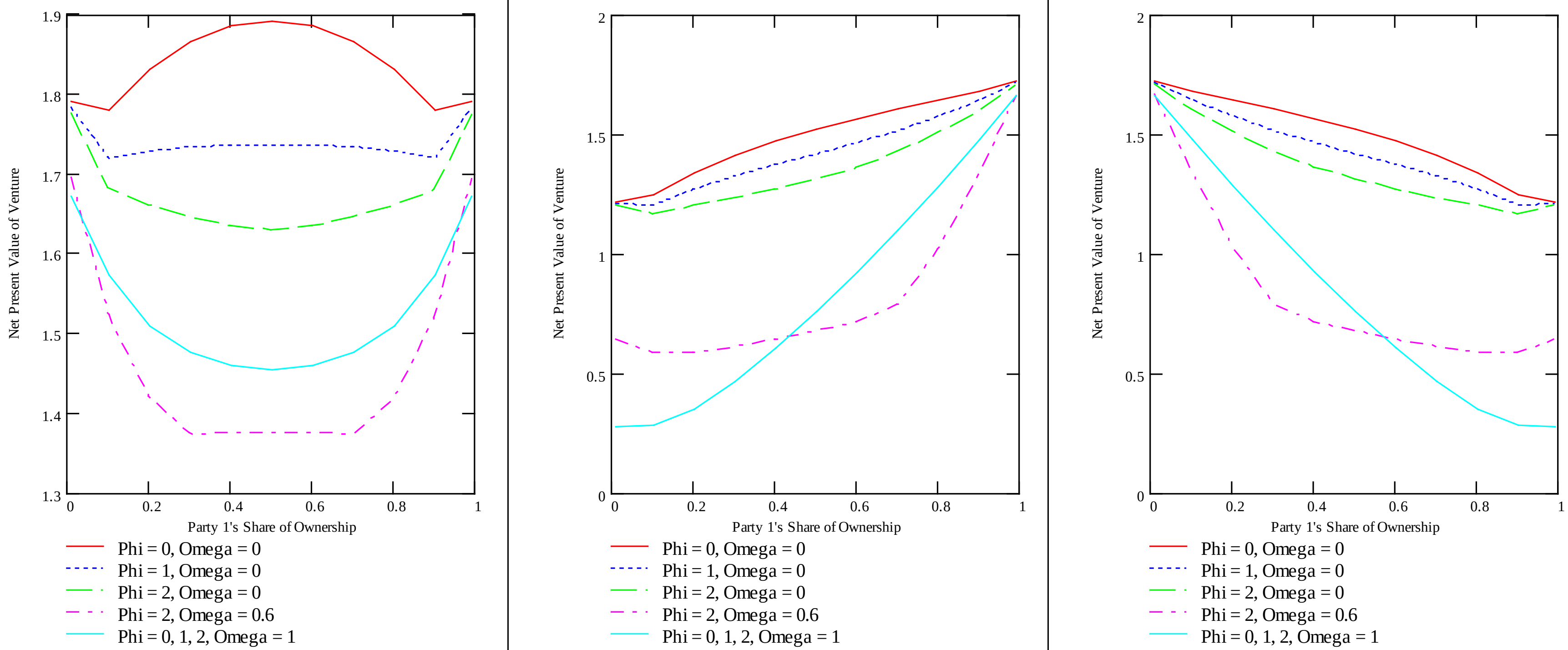
Figure 6. Influence of Absorptive Capacity, Bargaining Cost, and Switching Cost on Initial Choice of Ownership Structure under Scenario 2 [a]



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.

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.