

## An empirical investigation of joint venture dynamics: Evidence from U.S.–Japan joint ventures

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### Abstract

Joint ventures generate information and lead to substantial information exchanges between the partner firms stemming from their interactions. Therefore, joint ventures are expected to have a feedback effect on their parent firms. We propose to test jointly the following hypotheses. First, there are two interaction scenarios between the joint venture partners: the parent firms become more alike in their competitive capabilities or their competitive capabilities become more dissimilar but complementary. Second, long-lasting joint ventures are those in which partner firms' competitive capabilities have become dissimilar but complementary. Using the partial least squares (PLS) technique and cross-sectional data on U.S.–Japan joint ventures in Japan we obtain supportive empirical evidence.

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### 1. An investigation of joint venture dynamics

The proliferation of joint venture activities has attracted increasing

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interest in both business and academic circles. In the Japanese context, for instance, joint ventures are often a preferred form of entering into new markets compared to mergers and acquisitions, the popular means of diversification in the US and the UK (Odagiri, 1992, p. 185). Most studies on joint ventures, however, have not explicitly addressed the dynamic aspects of joint ventures. A joint venture generates information and leads to substantial information exchanges, planned or unplanned, between partner firms.<sup>1</sup> Thus, a joint venture has the potential for substantial effects on the parent firms. This feedback effect warrants a study on the dynamic influence of a joint venture on its parent firms.

This paper attempts a first step in this direction. The focus is on the evolution of partner firms' intangible competitive capabilities. We argue that over time parent firms' respective intangible competitive capabilities will either become more different but remain complementary, or that they become more similar. We further suggest that a joint venture will last in the former case and it will likely be dissolved in the latter case. Based on cross-sectional data from US–Japan joint ventures in Japan and the partial least squares (PLS) technique, we find positive empirical results for a joint test of our hypotheses. We believe that these influences of a joint venture on its parent firms have implications for the strategic thinking of a joint venture.

This paper is divided into four sections. The next section reports the theoretical argument. In the third section, we present an empirical investigation of our theoretical result. In the concluding section, we discuss the implications of our results and the potential for future research.

## **2. Theoretical discussion**

We suggest two hypotheses that will be tested jointly. The first is that joint ventures often have a feedback effect on their parent firms' competitive capabilities. Over time, their competitive capabilities either become similar or dissimilar yet complementary. The second hypothesis is that the continuity of a joint venture depends on the development of the latter case.

A joint venture expectedly has a feedback effect on its parent firms. In a joint venture, the parent firms are jointly involved in investment, production, marketing, and other management activities. The parent firms directly or indirectly, consciously or unconsciously, exchange information about their respective markets, pricing policies, production processes and the like. They expose each other to their way of operating. While not all of

<sup>1</sup> See, for example, Haerem et al. (1994, p. 8) for some likely examples of information sharing.

the above exchanges will necessarily take place, some of them will. Hence, a definite by-product of a joint venture is information generation and exchange between the partner firms.

Feedback from a joint venture manifests itself in changes to the parent firms' physical and intangible assets. Examples of changes in physical assets are building of plants and capacity. Examples of changes in intangible assets are manifold. They include improving production technologies and related skills, augmenting marketing knowledge, skills and networks, and possibly enhancing some special management skills like management of a foreign labor force.

Our discussion will focus on the comparison of the parent firms' intangible competitive capabilities over the life span of a joint venture. Change in physical assets is not a desirable focus because it may take place even if there is no stimulating learning from a joint venture. For instance, production scale may change in response to changes in market demand. Furthermore, the physical scale of a firm is often a reflection of the firm's underlying intangible competitive capabilities. For example, superior production and marketing skills allow a firm to produce and deliver goods to consumers at a cost lower than its competitors' and will lead the firm to have a physical scale larger than its competitors. While involvement in a joint venture may lead to some initial changes in physical capacity, further changes are often a reflection of changes in underlying intangible competitive capabilities.

As a joint venture evolves, due to the interactions and information exchanges between the joint venture partners, an organizational osmosis takes place.<sup>2</sup> As a consequence of conscious or unconscious organizational learning, parent firms' intangible competitive capabilities may become similar. We call this convergent development.

Another plausible scenario is that a joint venture leads the parent firms to discover benefits of co-operative specialization. By way of illustration, let us consider the case of a firm with superior production skills forming a joint venture with a partner with considerable marketing skills. The joint venture enhances the value of the partner firms' respective intangible competitive capabilities. The parents will then have more incentive to maintain and further develop their respective intangible assets. Furthermore, the technical partner may find that it is less able than the marketing partner to maintain and further develop marketing skills, even if it can copy the marketing partner's current skills in marketing. On the other hand, the marketing partner may have the same attitude towards the technical partner's competi-

<sup>2</sup> Certain types of difficulty that joint ventures in cooperative research and development efforts face over time are discussed in Imai and Itami (1984, p. 307). Also, information exchanges are an essential function of Japanese corporate groups (Odagiri, 1992, p. 185).

tive edge in production skills. In other words, the joint venture leads to the mutual recognition of the respective parent firms' different comparative advantages in the development of intangible competitive capabilities. If the parent firms specialize in and yet share their intangible competitive capabilities, their intangible competitive capabilities become more dissimilar but remain complementary. We call this divergent development. This is similar to Teece's (1992, p. 20) argument that "(a)lliances facilitate reciprocal specialization among firms".

Our second hypothesis is on the consequence of convergent and divergent development. We argue that in the case of a divergent development a joint venture will remain intact while in the case of a convergent development a joint venture will likely be dissolved. The hypothesis is built on the literature of common motivations for joint ventures.

There are at least three theoretical perspectives on joint ventures: namely, transaction costs, organization learning, and strategic behavior (Kogut, 1988). The transaction costs explanation posits that a necessary condition for a joint venture is that there are economic benefits to both parent firms in pooling their resources into a joint venture. Joint venture is preferred by the parent firms to other arrangements like leasing, licensing, and out-right acquisition when "(there is) high uncertainty over specifying and monitoring performance, in addition to a high degree of asset specificity" (Kogut, 1988, p. 320). Intangible assets fit the description. The firms possessing dissimilar and yet complementary intangible competitive capabilities will find obvious pooling benefits. Due to the nature of the involved intangible resources, a transaction costs joint venture is a means to pool them.

Hence, when a joint venture undergoes a divergent development, the joint venture will remain intact because of the transaction costs motive. Divergent development may occur independently of the original motive of the joint venture.<sup>3</sup> Such a development is consistent with the cooperative incentives among the parents which influence the stability of a joint venture (Kogut, 1988, p. 329).

The situation is different if a convergent development takes place. If a joint venture is a transaction costs type at the outset, the transaction costs motive disappears following a convergent development because firms no longer need to rely on the other partners' capabilities. The joint venture will then be dissolved.

<sup>3</sup> The parents of joint ventures that have experienced divergent development will have an incentive to merge or will be merged by investors seeking for synergies. Yet they may not merge because of the usual transaction costs reason that leads to the joint venture in the first place. See Kogut (1988, pp. 320–321). This reasoning also explains why durable joint ventures are usually international. A merger takes place much more readily when both parents are domiciled in the same country.

Alternatively, a joint venture may be motivated by organization learning. The explanation for this type of a joint venture hinges on the extreme difficulty in transferring a firm's tacit knowledge outside of its boundary. (Here, we regard tacit knowledge as a kind of intangible competitive capability.) Because tacit knowledge is more often than not embedded in an organization, transferring it is feasible only by absorbing the recipient into the organization (Kogut, 1988, p. 323). When two firms agree to a mutual exchange of their tacit knowledge, the effective and often unique means of doing so is a joint venture.

Given the non-trivial involvement and investment in a joint venture, the intangible competitive capabilities a joint venture partner aspires to learn must be different and yet complementary to its existing competitive capabilities. The organization learning explanation for a joint venture, therefore<sup>4</sup> implies that parent firms at the outset possess different and yet complementary intangible competitive capabilities. If the joint venture partners experience a convergent development, the organization learning is a success. Yet, the motive for maintaining the joint venture now disappears and the joint venture will be dissolved.<sup>4</sup>

There is also the strategic motive for joint ventures. The explanation is the usual industrial organization type of argument – firms pool their resources to exploit their market power. For instance, two firms may form a joint venture in research and development. Such a joint venture may have a deterrent effect on potential entrants besides allowing some economies of scale in product development. Also, two firms may form a joint venture to exploit together uncultivated sales potential in order to avoid costly competition.

A strategic joint venture which experiences a divergent development will turn into a transaction costs joint venture as we argued earlier. While a convergent development may not change the strategic motive in forming a joint venture, it is well known that entry deterrence and collusive agreements are not durable. For instance, Suslow (1992) found that the median life of contractual cartels is only 2.8 years. She also found that the short life of collusive behavior is due to environmental uncertainty while industry structure characteristics and collusive organization variables have only very weak influence on contractual duration. The implication is that, barring a divergent development, collusive joint ventures have a very short life.

Finally, there may be joint ventures that are motivated by reasons other than the three we have just discussed. For example, a joint venture may simply be set up for the purpose of accessing the Japanese market. Strictly

<sup>4</sup> If divergent development occurs (i.e. firms do not learn each other's skills but rather further specialize in the skills they already have), the partners may continue to collaborate in recognition that cooperation and specialization is advantageous. The joint venture now fits the description of a transaction costs joint venture.

speaking, such a motive is not different from the organizational learning motive; the US parent is learning how to access the Japanese market. As joint venture cooperation leads to diffusion of organizational information, convergent development may take place and the joint venture will be dissolved because it has served its purpose. Or, divergent development may take place and the joint venture stimulates cooperative specialization. In general, independent of the original motives, as long diffusion of organizational information takes place, convergent/divergent development will take place. A joint venture will continue when a divergent development takes place because of the transaction costs reasons.

There may be other non-systematic reasons for a joint venture to continue even if there are no apparent economic motivations. However, these joint ventures will appear as noise in a statistical test that identifies systematic trends. If the noise is important enough, an empirical test of our hypotheses will fail. Hence, we turn to an empirical examination of our hypotheses.<sup>5</sup>

### **3. Empirical evidence**

It is convenient to restate the hypothesis we investigate empirically: joint ventures have a feedback effect which leads to convergent or divergent development. In a convergent development, partner firms' intangible competitive capabilities become similar and their joint venture will be dissolved. In a divergent development, partner firms' intangible competitive capabilities become dissimilar yet complementary. Their joint ventures will last.

The most desirable way to test the hypothesis would require bivariate time series for parent firms' respective intangible competitive capabilities over the history of a joint venture.<sup>6</sup> Such a test, however, is often not feasible due to the lack of data. An indirect cross-sectional test, though, is feasible. Let us conceptually divide joint ventures into young, middle-aged and old subgroups. Our joint venture dynamics suggest that, due to survival bias, partner firms in durable joint ventures (i.e. old joint ventures) have experienced divergent development. The rationales for forming a joint venture (e.g. transaction costs, organizational learning) suggest that the parent firms in many young joint ventures possess dissimilar and likely to be

<sup>5</sup> Some joint ventures may exist because of government ownership constraints. While these restrictions on ownership do not necessarily change our theoretical results, we conduct our empirical test using a sample of joint ventures whose ownership is not subject to government restrictions.

<sup>6</sup> An example of such analysis is found in Suzuki (1993) who measures the degrees of R&D spillovers and technology transfer over time among firms by specifying a firm's cost function to depend on its own, as well as other firms', R&D capital and other variables.

complementary intangibles. Joint ventures in the middle-aged subgroup are a mixed bag: some are experiencing divergent development while others are experiencing convergent development. The partner firms experiencing the latter are likely going to dissolve their joint ventures.

In aggregate, then, the intangible competitive capabilities of the parent firms of joint ventures in the middle-aged subgroup show less dissimilarity and complementarity when compared to those in the young and old subgroups. Therefore, in a cross-sectional study an index measuring the degree of dissimilarity and complementarity of the parent firms' intangible competitive capabilities should exhibit a U-shaped relationship with the age of a joint venture. That is, the index assumes a large value more often in the young and old subgroups of joint ventures than in the middle-aged subgroup. Our empirical examination will proceed along this line. The statistical technique we use is PLS which is explained below.

We hasten to point out that the U-shaped relationship between age and 'divergence' (dissimilar but complementary) in parent firms' intangible competitive capabilities is a consequence of pooling joint ventures cross-sectionally. The U-shaped relationship has no causal content. Nevertheless, evidence of the U-shaped relationship corroborates the co-existence of the two descriptive joint venture dynamics, namely, convergent and divergent development.

### 3.1. *Data and Variables*

Our data sample is that which was used in Nakamura (1991). The sample contains 41 subsidiaries in Japanese manufacturing industries that are jointly owned by US and Japanese parent firms. The sample period is 1984–1988. The data were primarily collected from Toyo Keizai Shimposha (1989) which contains information on large subsidiary firms with at least 20% foreign ownership and on smaller subsidiary firms with at least 49% foreign ownership and a capitalization of at least 50 million yen. The manufacturing industries included are: chemicals, general machinery, and electrical equipment. The percentage distribution among the three industries are 43.9%, 22% and 34.1%, respectively. Data for Japanese parent firms were collected from Nihon Keizai Shimbunsha (1988) and Toyo Keizai Shimposha (1985–1991). Data for US parent firms were collected from *Compustat Tapes*, *Moody's Industrial Manual*, and various issues of *Value Line Investment Survey: Ratings and Reports*. Where there is more than one US or Japanese parent firm, the data for the parent firm with largest ownership share in the joint venture were used. If two largest parent firms from the same country have equal ownership share in a joint venture, the parent firm whose product lines resemble the joint venture's best was used.

Relying on data from only one region with parents from two specific

countries makes our results less general than we would like. Yet our sample offers some advantages. First, the homogeneity in background of the joint ventures in our sample is a desirable advantage from a statistical point of view. For instance, culture will not be a source of variation in our study because all joint ventures in our sample have the same cultural background. Another advantage of our sample is that most US–Japan joint ventures are rather large.<sup>7</sup> By their sheer size they are likely to be regarded seriously, among available alternative investment opportunities, by their parent firms and are thus more likely to have a non-trivial impact on their parent firms.

It is important not to include in our sample joint ventures that are forced by government regulations because the role of government coercion is suppressed in our theory. While historically there were regulations in Japan that restricted foreign ownership, these regulations were changed in 1973 to permit foreign firms to obtain, subject to certain exceptions, full ownership. In 1977 only 7% of US firms' subsidiaries in Japan reported that they were required to limit their US parent firms' equity while in 1982 the fraction decreased to 3% (Contractor, 1990). It appears safe to claim that shared ownership in our sample is not chosen because of government ownership regulations.

To increase the reliability of the variables, we use their average over the data period. For instance, if a joint venture was started in 1960 and we have data for the joint venture from 1984 to 1986, then the age variable for the joint venture is 25 years, which is the average of 24, 25 and 26 years.

Some descriptive statistics of the important variables in our sample are reported in Table 1. Both the US and Japanese parent firms appear to be rather large firms. The mean sales for US parent firms is \$9.31 billion while the mean sales for Japanese parents is 1172.7 billion yen. Given the dollar–yen exchange rates in the period, the Japanese parents appear to be somewhat smaller than the US parents. The age of the joint ventures ranges from 3 to 32.5 years with a mean of 15.7 years. Hence, our sample contains a significant number of stable joint ventures which is necessary for our intended investigation. The US percentage ownership ranges from 20% to 90% with a mean of 52%. 18% of the joint ventures have a US ownership exceeding 50%. US ownership is exactly equal to 50% for 51% of the joint ventures and is less than 50% for the remaining 32%. (Nakamura and Yeung, 1994, analyze such US ownership in detail.)

Because our focus is on parent firms' intangible competitive capabilities,

<sup>7</sup> Among all the foreign subsidiaries of U.S. firms in 47 countries, those in Japan had the highest country specific mean sales in both 1977 and 1982 (U.S. Department of Commerce 1980, 1985).

Table 1  
Descriptive statistics for the parent firms and the joint ventures in sample<sup>a</sup>

		Mean	S.D.	Min.	Max.
U.S. parent	Sales in billion dollars	9.3087	15.718	0.0966	83.994
	R&D/sales (%)	3.8923	3.1145	0.00	17.186
	Foreign sales/total sales (%)	23.068	13.343	0.00	55.250
Japanese parent	Sales in 1000 billion yen	1.1727	3.3381	0.0146	16.427
	R&D/sales (%)	3.4783	2.9619	0.00	12.773
	Foreign sales/total sales (%)	22.563	18.411	1.0000	64.000
Joint venture	Sales in billion yen	12.159	18.580	0.7845	94.602
	Age	15.744	7.2302	3.0000	32.500
	U.S. % ownership	51.63	12.13	20.00	90.00
	Japanese parent R&D/sales – U.S. parent R&D/sales	2.6645	2.9760	0.0403	15.53
	Japanese foreign sales/total sales – U.S. foreign sales/total sales	16.909	14.667	0.0000	57.10

<sup>a</sup> Data = average for available annual data from 1984 to 1988; sample size = 41.

we pay attention to the parent firms' R&D spending and foreign sales. The former is often a proxy for production intangibles in the economics literature. The latter is a measure of a firm's international marketing capability or is a measure of a firm's multinationality which is positively influenced by the presence of intangible skills (see Morck and Yeung, 1991, 1992). On average, both parent firms have rather large and comparable R&D spending and foreign sales. The mean R&D/sales ratio for US parent firms and Japanese parent firms are 3.89% and 3.48%, respectively. The mean foreign sales/total sales ratio for US parent firms and Japanese firms are 23.07% and 22.56%, respectively.

The differences between the joint venture parents' R&D spending and percentage foreign sales give a glimpse of the difference between the joint venture parents' important intangible competitive capabilities. In R&D/sales 39% of the difference (Japan – US) and in foreign sales/total sales 46% of the difference (Japan – US) are positive. There is no discernible industry pattern in both the signs and the magnitudes of these differences. The means for the absolute value of these differences are 2.67% and 16.9%, respectively. The mean for the absolute difference in R&D/sales is 74% of the parent firms' average R&D/sales while the mean for the absolute difference in foreign sales/total sales is 72.3% of the parent firms' average foreign sales/total sales. Perhaps due to the presence of a significant number of durable joint ventures, it appears that on average the parent firms' intangible assets are quite dissimilar.

### 3.2. A PLS Approach

The favored statistical technique in testing our hypothesis is the PLS approach. PLS is a general multivariate estimation technique of which canonical correlation, principle component analysis, and multiple regression can be regarded as special cases (Fornell, 1987). While regression tests are straightforward to apply and easy to interpret, they have the drawback of relying on noisy approximations for unobservable phenomena, or in our case the measurement of the parent firms' intangible capabilities. Moreover, regression analyses would implicitly impose an algebraic relationship between the unobservable variables and their less than perfect proxies.

PLS allows a more flexible interplay between our data and the unobservable phenomenon. In a PLS approach, we explicitly recognize the relationship between joint venture parents' intangible capabilities as a latent variable. We use proxies for intangible assets and for joint venture parents' mutual dependence to construct manifest variables for the latent variables. The relationship between the manifest variables and the latent variable is estimated endogenously.

Other advantages of PLS include no assumptions as to the underlying distribution of the data, the ability to estimate models with limited sample sizes, and the capacity to estimate multiple dimensions of latent variables. However, because of the lack of underlying distribution assumptions, numerical methods such as bootstrapping or jackknifing are necessary to test hypotheses involving PLS estimates. PLS has been used recently by researchers in corporate strategy (e.g. Cool et al., 1989 and Fornell et al., 1990) and by economists (e.g. Adelman et al., 1987).

Generally, a model for PLS estimation consists of two parts: (1) the inner (structural) model and (2) the outer (measurement) model. The inner model captures the structural relationship of the latent variables and is represented by:

$$\mathbf{H} = \mathbf{B}^* \mathbf{H} + \mathbf{w} \quad (1)$$

where  $\mathbf{H}$  is an  $(m \times 1)$  vector of latent variables (some endogenous and some exogenous),  $\mathbf{B}$  is an  $(m \times m)$  matrix of coefficient parameters for  $\mathbf{H}$ , and  $\mathbf{w}$  is a vector of residuals.

The outer model captures the manifestation of the latent variables in terms of observable measures. It can be presented by:

$$\mathbf{Y} = \mathbf{A}_Y^* \mathbf{H} + \mathbf{v} \quad (2)$$

where  $\mathbf{Y}$  is a  $(p \times 1)$  vector of manifest variables for  $\mathbf{H}$ ,  $\mathbf{A}_Y$  is a  $(p \times m)$  matrix, and  $\mathbf{v}$  is a residual vector. Roughly, PLS calls for an iterative regression fitting of both the inner and the outer models to capture the

relationship between the latent variables and the manifest variables as well as the relationship between the endogenous and latent variables.

The inner model which we estimate has only one endogenous latent variable, namely, 'divergent-convergent development'.<sup>8</sup> This latent variable is explained by four exogenous variables: age, industry dummies, and ownership distribution ( $|\text{US share} - 50\%|$ ). Following our discussion in the theoretical section, age is naturally included as an exogenous variable explaining the latent variable (divergent-convergent development).

There are two reasons to incorporate industry dummies. First, as Kogut (1989) showed, the stability of a joint venture depends on industry conditions. Our latent variable may then have an industry pattern. Second, there may be a cluster of transaction costs joint ventures by industry. If there is also a cluster of age by industry, our result may be quite spurious in the sense that 'age' is capturing industry effects.<sup>9</sup>

Finally, we are concerned that there may be a systematic relation between uneven joint venture ownership and joint venture stability. Highly uneven ownership shares may reflect uneven contribution and bargaining power between the partner firms and may also affect the interaction between them. We therefore include in our list of explanatory variables a measure of uneven ownership: the absolute value of the US percentage ownership  $-50\%$ .<sup>10</sup>

In the outer model, the exogenous latent variables (age, industry dummies, and ownership distribution) are their own manifest variables. The endogenous latent variable, 'divergent-convergent development', has two manifest variables: (1) *RDXFS* – the difference in parent firms' respective R&D spending/total sales times the difference in parent firms' respective foreign sales/total sales, and (2) *JVUPTRADE* – the sum of the joint venture's exports to the US parent/total sales and its imports from the US parent/total procurement.

As previously explained, divergent development in a joint venture means that the parent firms' intangibles are becoming more dissimilar yet complementary. Divergent development may therefore manifest itself in the form of greater differences in the proxies capturing parent firms' respective intangibles in production (R&D/sales) as well as in international marketing (foreign sales/total sales). The differences, therefore, would be opposite in

<sup>8</sup> The latent variable is normalized to zero mean and unit variance in actual estimation. We interpret its having a high positive value as an indication of extensive divergent development while a large negative value as an indication of extensive convergent development.

<sup>9</sup> However, our observable statistics show no discernible age pattern by industry.

<sup>10</sup> Our results do not change qualitatively when uneven ownership is captured by categorical variables, as in Blodgett (1992), instead of a continuous variable.

sign. In other words, divergent development may manifest itself in the form of a more negative *RDXFS*.

The manifest variable, *RDXFS*, is likely to be very noisy (and that is why a latent variable approach is called for). Consider a joint venture parent possessing superior production intangibles. Its dominant production skill also gives it substantive foreign sales. In this case, the R&D/sales and percent foreign sales of the parent may both exceed that of its joint venture partner. Thus, the *RDXFS* variable may be positive even though the joint venture parents' intangibles are indeed dissimilar but complementary.

We therefore use the intra-firm trade variable (*JVUPTRADE*) as another manifest variable. The shipments to or from the technologically advanced parent to its joint venture will indicate that it finds some competitive capabilities of the other parent useful (and thus complementary to its existing technological advantage). Divergent development may also manifest itself in the form of more internal trade between the joint venture and its parent firms. Hence, divergent development is associated with a greater (more positive) *JVUPTRADE*. (We unfortunately do not have the required data to capture trade between a joint venture and its Japanese parent.)

The above suggests that the signs of the loadings of our latent variable on the two manifest variables are opposite – negative for *RDXFS* and positive for *JVUPTRADE*.

In our inner model (Eq. 1),  $H$  is specified as a  $5 \times 1$  column vector with 'divergent–convergent development' on the first row followed by the four exogenous variables on the other rows.  $B$  is a  $5 \times 5$  matrix. In  $B$ 's first row the first entry is zero and the remaining ones are non-trivial coefficients. By our model design,  $B$ 's first column is also a zero vector. The part of  $B$  outside of the first column and the first row is a  $4 \times 4$  identity matrix. In our outer model (Eq. 2)  $Y$  is a  $6 \times 1$  column vector (the six entries are *RDXFS*, *JVUPTRADE*, age, industry dummies, and ownership distribution).  $A_Y$  is then a  $6 \times 5$  coefficient matrix and  $H$ , of course, is the  $5 \times 1$  column vector of latent variables as in the inner model.

An iterative two dimensional PLS approach was applied to capture the U-shaped relationship between our latent variable (divergent–convergent development) and the exogenous variable, age.<sup>11</sup> In the first dimension, the

<sup>11</sup> We also obtained empirical results supporting a U-shaped relationship with a single dimension PLS model incorporating a quadratic specification. In this model we incorporated both age and age squared as exogenous variables. We found that age is negative and significant while age squared is positive and significant, as expected from a U-shaped curve. A two-dimension PLS model, however, is preferred for two reasons. First, the two dimensional approach does not limit the mathematical form of a U-shaped relationship to be quadratic. Second, the two dimensional approach does not suffer from the multicollinearity problem arising from the highly collinear age and age squared variables.

above PLS model was estimated as is laid out. In the second dimension, the manifest variables for ‘divergent–convergent development’ in the outer model,  $Y$ , were replaced by the prediction errors based on estimates obtained in the first dimension.<sup>12</sup> Then, the PLS model was re-estimated to obtain results for the second dimension. A U-shaped relationship between divergent development and age would mean that the coefficients of age in the latent variable equation in the inner model (i.e. Eq. 1) in the first and in the second dimension are opposite in sign. To illustrate, say, when the U-shaped relationship is approximated by a curve upward sloping in age in the first dimension, the prediction errors will typically be first mostly positive and then mostly negative as the variable age increases. As a consequence, the prediction error will have a negative relationship with age in the second dimension.

We estimated our PLS model using *LVPLSX* by Lohmoller (1987). In the current context, our estimation procedure consists of the following steps. (1) Start from a weight model:  $H = G*Y$  where  $G$  is a  $5 \times 6$  parameter matrix. Using the manifest variables  $Y$ , some initial values for  $G$  and the weight model, we obtain  $est(H_0)$  (an estimate for  $H_0$ ) which is then normalized to zero mean and unit variance. (2) The normalized  $est(H_0)$ , the inner model, and ordinary least square OLS (applied equation by equation) are then used to obtain a new estimate for  $H$ ,  $est(H_1)$ , which is then normalized to zero mean and unit variance. (3) The normalized  $est(H_1)$ , the manifest variables ( $Y$ ), the weight model and OLS (applied equation by equation) are then used to obtain another estimate for  $H$ ,  $est(H_2)$  which is then normalized as before. (4) Repeat step 2 and then step 3, and so on. The iteration is terminated when  $est(H_k)$  and  $est(H_{k-1})$  are within five decimal places of each other. (5) The convergent estimates of  $H$  and OLS are then used to estimate the equations in the inner model,  $H = B*H + w$ . Also, the convergent estimate of  $H$ , the manifest variables ( $Y$ ) and OLS are used to estimate the equations in the outer model,  $Y = A_Y^*H + v$ .

The method used to estimate standard errors is the jackknife method presented in Shao (1989). In this procedure we first create from the original sample a large population of sub-samples each with a fixed but smaller sample size. From this population, a specific number of sub-samples were randomly selected.<sup>13</sup> The PLS model was estimated for each of the selected sub-samples. Coefficient estimates from these runs were used to calculate

<sup>12</sup> In our case, the prediction errors for  $Y$  were obtained as follows. In fitting the first dimension, we obtained estimated values for the latent variables and for the parameters in the outer model. Together they led to predicted values for  $Y$ , the vector of manifest variables.  $Y$  minus the predictions of  $Y$  were the prediction errors used.

<sup>13</sup> The sample size of the sub-samples used is 21 (eliminating 20). From the pool of sub-samples 200 are randomly selected to carry out the jackknife procedure.

Table 2  
PLS model: 'divergent development' as an endogenous latent variable

Exogenous variables <sup>a</sup>				Loading on divergent development <sup>b</sup>	
Age	Chem. <sup>c</sup>	Mach. <sup>c</sup>	U.S. share -0.5	<i>RDXFS</i>	<i>JVUPTRADE</i>
Dimension 1					
-0.309**	-0.021	0.110	0.164	-0.8637***	0.6508***
(0.159)	(0.122)	(0.160)	(0.168)	(0.1082)	(0.2090)
$R^2$ (explaining the latent variable) = 0.1715					
Reliability of the manifest variable as a measure of the latent variable = 0.7325					
Dimension 2					
0.410***	0.021	-0.157	-0.194	-0.8714***	0.7913***
(0.137)	(0.859)	(0.337)	(0.128)	(0.2322)	(0.2325)
$R^2$ (explaining the latent variable) = 0.2925					
Reliability of the manifest variable as a measure of the latent variable = 0.8316					

\*\* =  $P < 0.05$ , one-tail test, \*\*\* =  $P < 0.01$ , two-tail test.

Note that the more divergent the development is, the more positive the latent variable becomes.

<sup>a</sup> The estimates presented below are for the relevant parameters in  $B$  in the inner model (Eq. (1)). They capture the influence of the exogenous variables on the latent variable, divergent development.

<sup>b</sup> These loading estimates are for the relevant parameters in  $A_Y$  in the outer model. They basically indicate the influence of divergent development on the manifest variables *RDXFS* and *JVUPTRADE*.

<sup>c</sup> Chem. and Mach. are industry dummies indicating 'chemical' and 'general machinery'. The omitted category is electrical equipment. Jackknife standard errors are in parentheses.

the jackknife standard errors. Note that this procedure is different from the  $n - 1$  jackknife procedure (see Shao, 1989).

Our estimation results are presented in Table 2. The results are consistent with our hypotheses. The effects of age on the latent variable (divergent-convergent development) in the first and second dimensions are indeed opposite as hypothesized. It is negative in the first dimension and positive in the second, which is consistent with a U-shaped relationship between the latent variable and the age of a joint venture. In both dimensions, the effect is statistically significant. Also, in both dimensions, the effects of the latent variable (divergent-convergent development) on the manifest variables are significant with the expected signs: negative on *RDXFS*, the first manifest variable, and positive on *JVUPTRADE*, the second manifest variable.

We now turn to some validity issues of our estimates. A few joint ventures in our sample are quite small relative to the size of their parents. These small joint ventures may be too insignificant to have any considerable impact on its much larger parents. To examine such firm size effect, we

repeated our statistical work discarding joint ventures which are small in relation to either their US parent or Japanese parent firms. We first discarded the smallest 10% and then the smallest 20%. In both cases, we still obtained essentially the same empirical results (positive, significant and reliable).<sup>14</sup>

The validity of the manifest variables is legitimately a serious concern. Our statistical results indicate a high degree of reliability between the two manifest variables as a measure of the latent variable. Measures of reliability are 0.73 in the first dimension and 0.83 in the second dimension.<sup>15</sup>

Still, there is a concern about whether the outlying values of the manifest variables drive our results.<sup>16</sup> Table 1 reveals that the difference between the parents' R&D sales and foreign sales/total sales can be quite large (15.53 and 57.10, respectively). To check if our results were affected by outliers, we re-ran our PLS regression excluding the two highest and the two lowest readings of *RDXFS*, which represent 10% of the sample. We found that our results did not change and remained highly significant. When we excluded the five highest and five lowest readings of *RDXFS*, we found that our results were qualitatively similar to our reported results but were only very marginally significant. Our interpretation is that the largest absolute values of *RDXFS* indeed strengthen our results, but are not the driving force of our results.

We also examined the validity of our hypothesis by considering how well our estimated latent variable could predict the out-of-sample stability for the joint ventures in our sample during the three-year period from 1989 to 1991. This period immediately follows our sample period. According to our hypothesis, a joint venture having a low score for the latent variable would be more likely to be dissolved.

Four out of 41 of our sample joint ventures experienced a change in their parent firms due to mergers and acquisitions. In these cases, the estimated scores for the latent variable became not representative because the scores were estimated for the previous parent firms. We therefore excluded these cases. For the remaining 37 cases, we assigned a dummy value of one if a joint venture was dissolved, or if one of the parents became a passive minority partner while the other parent took over the management of the joint venture. Otherwise, the dummy was set equal to zero.

Six out of the 10 joint ventures with the lowest latent variable scores have the dummy variable equal to one. On the other hand, only 7 out of the

<sup>14</sup> We also note that a joint venture whose sales are much smaller than its parents' is not necessarily unimportant from the parent firms' perspective.

<sup>15</sup> This reliability measure represents the portion of the total variation in the sum of the manifest variables explained by the latent variables. The measure is similar to the  $R^2$  in OLS.

<sup>16</sup> We are grateful to a referee for drawing our attention to the point.

remaining 27 cases have the dummy variable equal to one. (That is, 60% versus 26%.) A chi-square statistic for the hypothesis that the dummy variable is equally distributed between zero and one in the two sub-samples is 3.72. The hypothesis is rejected at a 10% level. We also ran a logit regression of the dummy variable on the rank order of the latent variable,<sup>17</sup> the industry dummies and the uneven ownership distribution variable. The rank-ordered latent variable is significant at a 10% (one-tail test) level. Hence, our empirical estimates appear to have acceptable predictive power in support of our hypothesis.

In summary, our empirical results appear to be robust and support the contention that convergent–divergent development between joint venture partners takes place. Moreover, divergent development leads to joint venture longevity.

It will be useful to report a simple case to illustrate divergent development.<sup>18</sup> The joint venture in question is in the electronics industry formed in 1961. The original intent of the joint venture was to build an electronic component (microwave tubes) in Japan to serve the Japanese market (a typical market access motive). The US partner brought with it component design and manufacturing knowledge, a result of its R&D. The joint venture did the manufacturing. The Japanese partner brought with it market access and knowledge in Japan; it marketed the joint venture's product to Japanese users. The joint venture was then a typical US–Japan joint venture for that period in which technology was traded for market access.

Apparently, what followed was a series of new product developments and cooperation between the two parents. The Japanese parent, benefitting from the technology transfer from the US partner, began to show strengths in designing and producing high quality and sophisticated 'parts and components'. That is, the Japanese parent showed its strength in commercializing technology. The US parent has always been highly successful in designing high value-added applications of 'components and parts' in high-tech systems including military defense systems. The Japanese parent strengths benefitted the US parent, and vice versa. The two parents built on their respective specialities and yet cooperated. The joint venture was then used as a circuit for cooperation and product development; the fruits of the cooperation were marketed to the US and Japanese users via the respective

<sup>17</sup> The rank order for the latent variable is a more appropriate independent variable than the score of the latent variable itself because our latent variable is likely to be an ordinal measure.

<sup>18</sup> We focus on divergent development because convergent development is quite well known and case examples are readily available, for example, in Hamel et al. (1989). The sources for the reported case are the *Wall Street Journal*, various business magazines, trade journals, brokerage reports, and company annual reports.

parents.<sup>19</sup> In essence, the joint venture became an innovation center as a meaningful outcome of the divergent development. (See also Yoshihara, 1994.)

The parents' company reports explicitly mentioned that the joint venture led to mutually beneficial yet different developments in the two parents. In the process, inter-dependence and cooperation were recognized and fostered by the parent firms. Notwithstanding some significant changes in their own respective business, the parent firms still regard the joint venture as an important on-going concern in its own right.<sup>20</sup> In 1987, the US parent and the Japanese parent rewrote their joint venture agreement. The new agreement formalized the evolved utilization of the joint venture and the pattern of exchanges between the parents which were unanticipated at the outset of the joint venture. In 1990, the joint venture itself established a production facility in Thailand, apparently to take advantage of inexpensive inputs there. The case illustrates what we mean by divergent development, or co-operative specialization over time.

#### **4. Conclusions**

Partner firms in a joint venture interact substantially in investment, production, pricing policy, marketing and other aspects of management. These interactions lead to significant information generation and exchanges between the partner firms. A joint venture, therefore, is expected to have a feedback effect on its parent firms.

We proposed two dichotomous scenarios: the parent firms' intangible skills become alike or they become dissimilar yet complementary. In the former case, the joint venture will be dissolved while in the latter case the joint venture will remain intact. We obtained some preliminary evidence for such joint venture dynamics.

The dichotomy of the joint venture dynamics into convergent and divergent developments of the parent firms' intangible assets and the linkage of these developments with the longevity of a joint venture has certain implications. First, for academic research, the above results suggests that age has to be controlled for in studying the motivations for joint ventures. Due to the presence of divergent development and survival bias, the

<sup>19</sup> Note that markets for these products are often not accessible to foreigners because of implicit or explicit 'buy national' policies in high-tech and defense-sensitive product markets.

<sup>20</sup> Our information sources do not shed much light on the internal factors that led to the cooperative development in the joint venture. However, it appears that transfer and creation of knowledge took place within the joint venture. The case fits well with Kogut's (1989, p. 197) speculation that such activities are related to more potent cooperative incentives which make a joint venture less likely to be dissolved.

transaction costs type of joint ventures will be more likely to be observed in joint ventures with a longer history.

Second, the two scenarios outlined above represent two polar modes of strategic thinking. Strategic alliances, a concept popularized by scholars in management like Hamel et al. (1989), suggest that joint ventures are extended grounds for competition between the joint venture partners. A goal for strategic alliances is to learn from a joint venture partner about its competitive capabilities and to become less dependent on the partner over time. Thus, the concept suggests convergent development as a frame of mind in participating in a joint venture.

On the other hand, divergent development, as a frame of mind in participating in a joint venture, represents a collaborative specialization thinking which Teece (1992) expounded on. Here a joint venture is not extended grounds for competition but is a true form of cooperation over time that when successfully implemented leads to savings in the development of competitive capabilities.

The joint venture dynamic examined suggests that the objective and the usefulness of a joint venture can change over time. A strategic collusive joint venture can turn into a joint venture of the transaction costs type. An organizational learning joint venture can fail to deliver the original objective. Yet it can become a profitable joint venture motivated by formidable transaction costs. A transaction costs type joint venture can become non-functional because of unplanned organizational learning – the two partners end up possessing each other's intangible skills. Managers therefore need periodically to conduct a critical re-evaluation of the usefulness and the appropriate objective of a joint venture.

The proposed dichotomous joint venture dynamic opens up questions. We need to understand the deciding environmental and organizational factors for the two development paths. For instance, what are the characteristics of the goods and also of the factor markets most suitable for divergent development? What organizational form and incentive system are most conducive to collaborative behavior among joint venture managers? Also, what are the game theoretic concerns that lead to the collaborative specialization outcome rather than the strategic organizational learning outcome? Further research along these avenues is warranted. Kogut (1989) identified some industry conditions which affect joint venture stability. While his results do not directly answer the questions posed here, they do provide a base from which to pursue future research.

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### **Appendix. Joint ventures in the sample**

The following are the joint ventures included in the sample and their parent firms as of November 1988. Nihon MRC (US parent(s)= Materials Research; Japanese parent(s)= Mitsubishi Corp., Midoriya Electric.); Tel-Varian (Varian Associates; Tokyo Electron); Yokogawa Medical (General Electric; Yokogawa Electric); STS Corp. (Sundstrand; Teijin Seiiki); Tel-Genrad (GenRad, Inc.; Tokyo Electron); 3M Health Care (3M; Sumitomo Electric, NEC; Daido-Sprag (Dana Corp.; Daido Tokushuko, Tokushu Seiko, Daido Kogyo); Mitsui-Cyanamid (American Cyanamid; Mitsui-Toatsu Chemicals); Mitsui Zosen Eimco (Envirotech Corp.; Mitsui Shipbuilding); Ohkura Rosemount (Rosemount Inc.; Ohkura Denki); Toyo-Petrolite (Petrolite Corp.; Toyo Ink); Asahi-Ohlin (Olin Corp.; Asahi Glass); Eye Lighting (General Electric; Iwasaki Electric); Niigata Masoneilan (Dresser Industries; Niigata Tekkosho); Sumitomo Eaton (Eaton Corp.; Sumitomo Heavy Industries); Harima M.I.D. (Mead Corp., Inland Container; Harima Chemicals); Japan Butyl (Exxon Chemical; Japan Synthetic Rubber); Hirose Cherry (Cherry Electrical Products; Hirose Denki); Union Showa (Union Carbide; Showa Denko); Drive Systems (General Electric; Sumitomo Heavy Industries); Toshiba Silicone (General Electric; Toshiba Corp.); Bailey Japan (Bailey Controls; Kyokuto Trading); Moog Japan (Moog, Inc.; Nozaki Industries); Nichicon-Sprague (Sprague Electric; Nichicon); Japan Meltex (Enthone, Inc., Masten Wright, Iwaki, Meiji Tsusho); Asahi-Penn (PPG Industries; Asahi Glass); Nalken Corp. (Vista Chemical; Japan Oxysocol); Burndy Japan (Burndy Corp.; Furukawa Electric, Sumitomo Electric); Nikki-Universal (Allied-Signal; Nikki); Ube Cycon (General Electric; Ube Industries); Japan Fawick (Eaton Corp.; Mitsui and Comp., Joji Fujita); NSK Torrington (Torrington Co.; NSK); Sumitmo Naugatuk (Dow Chemical; Sumitomo Chemical); Yokogawa-Hewlett-Packard (Hewlett Packard; Yokogawa Electric); Oki Unisys (Unisys Corp.; Oki Electric, Mitsui and Co., Mitsubishi Electric, Nihon Unisys); Mitsubishi Precision (Singer Co.; Mitsubishi Electric, Mitsubishi Heavy Industries, Mitsubishi Bank, Mitsubishi Corp.); Nippon Petroleum Refining (Caltes; Nippon Sekiyu); Lucidol Yoshitomi (Pennwalt Corp.; Yoshitomi Pharmaceutical); New Japan Radio (Rahtheon; Japan Radio; DKB, Fuji Bank, LTBj); Nissan Ferro Organic (Ferro; Nissan Chemicals).

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