MANAGEMENT SCIENCE
Vol. 37, No 1, January 1991
Printed in U S A

JOINT VENTURES AND THE OPTION TO EXPAND AND ACQUIRE*

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This article develops the perspective that joint ventures are created as real options to expand in response to future technological and market developments. The exercise of the option is accompanied by an acquisition of the venture. It is hypothesized that the timing of the acquisition should be triggered by a product market signal indicating an increase in the venture's valuation. Based on a sample of 92 manufacturing joint ventures, this hypothesis is tested by estimating the effect of product market signals on the hazard of acquisition. The results indicate that unexpected growth in the product market increases the likelihood of acquisition; unexpected shortfalls in product shipments have no effect on the likelihood of dissolution. This asymmetry in the results strongly supports the interpretation of joint ventures as options to expand.
(JOINT VENTURES; TERMINATION BY ACQUISITION; REAL OPTIONS; OPTION TO EXPAND; LEARNING)

A fundamental problem facing the firm is the decision to invest and expand into new product markets characterized by uncertain demand. The problem is exacerbated when the new business is not related to current activities. In this sense, a firm's initial investments in new markets can be considered as buying the right to expand in the future.

In current parlance, the right to expand is an example of a "real option," real because it is an investment in operating as opposed to financial capital, and an option because it need never be exercised.[1] For many investments, such as the purchase of new capital equipment to reduce costs in aging plants, the option value is insignificant. In industries where the current investment provides a window on future opportunities, the option to expand can represent a substantial proportion of the value of a project, if not of the firm.[2]

An analysis of joint ventures provides an interesting insight into investment decisions as real options. The task of building a market position and competitive capabilities requires lumpy and nontrivial investments. As a result, it is often beyond the resources of a single firm to buy the right to expand in all potential market opportunities. A partner, especially one which brings the requisite skills, may be sought to share the costs of placing the bet that the opportunity will be realized.

This perspective is related to the use of joint ventures to share risk. Pure risk-sharing arises in cases, such as bidding on oil lots, where firms have committed capital downstream (such as in refineries) but are dependent upon availability supplies of a finite resource. Multiple joint ventures among firms in the oil industry are analogous to collective insurance.[3]

In many industries, however, joint ventures not only share risks, but also decrease the total investment. Because the parties bring different capabilities, the venture no longer requires the full development costs. Due to its benefits of sharing risk and of reducing overall investment costs, joint ventures serve as an attractive mechanism to invest in an option to expand in risky markets.

* Accepted by Richard M. Burton; received January 17, 1989. This paper has been with the author $3\frac{1}{2}$ months for 2 revisions.

[1] See Myers (1984) for an interesting qualitative discussion of real options and Mason and Merton (1985) for an extensive analytical treatment.

[2] See Kester (1984) for an interesting tabulation of the option value of many large firms.

[3] For a study of joint ventures in the oil industry, see Mead (1967). Note, however, that the decision whether to pump the oil can be viewed analytically as an option to wait. See McDonald and Siegel (1986).

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However, in the event the investment is judged to be favorable, the parties to the joint venture face a difficult decision. To exercise the option to expand requires further commitment of capital, thus requiring renegotiation among the partners. One possible outcome is that the party placing a higher value on this new capital commitment buys out the other. Thus, the timing when it is desirable to exercise the option to expand is likely to be linked to the time when the venture will be acquired.

The exploration of the link in the timing of the acquisition of joint ventures and of the exercise of the option to expand is the focus of the following empirical investigation. The first two sections apply an option perspective to joint ventures. A distinction is made between acquisitions motivated by industry conditions and those stemming from the desire to expand in response to favorable growth opportunities. The third section develops the central hypothesis that the timing of the acquisition is related to a signal that the valuation of the venture has increased. This signal is proxied by two measures derived from the growth of shipments in the venture's industry. The effects of these industry signals on the likelihood of a venture terminating by an acquisition are tested by specifying and estimating a hazard model, while controlling for industry and other effects.

The same model is then tested on the likelihood of dissolution. If the option interpretation is correct, a signal that the venture's value has increased should lead to an acquisition; a signal that it has decreased, however, should not lead to dissolution, as long as further investment is not required and operating costs are modest. Strong support is found for the option argument.

These results run counter to prevailing presumptions in organizational theories that firms engage in cooperative ventures as buffers against uncertainty and that managerial discretion is severely limited by environmental volatility. In the view of Pfeffer and Nowak (1976), joint ventures are instruments to manage the dependency of the partner firms on the uncertainty of resources. Recent work in organizational mortality, as influenced by the seminal articles by Hannan and Freeman (1977) and McKelvey and Aldrich (1983), has advanced the proposition that managers are severely curtailed in their abilities to affect the prospects of survival of their firms.

To the contrary, an option perspective posits that joint ventures are designed as mechanisms to exploit, as well as buffer, uncertainty. Because firms have limited influence over the sources of uncertainty in the environment, it pays to invest in the option to respond to uncertain events. Joint ventures are investments providing firms with the discretion to expand in favorable environments, but avoid some of the losses from downside risk. In this regard, real option theory provides a way to ground the trial and learning aspect to joint ventures.

Real Options

The assignment of the right to buy and sell equity in the joint venture is a common feature of many agreements. For example, in a recent announcement of a joint venture in the area of power generation equipment, Asea Brown Boverie received the option to buy the venture at some time in the future. Westinghouse, as the partner, has the right to sell its ownership interest. In the vernacular of financial markets, the terms of the venture provides a call option to Asea Brown Boverie and a put option to Westinghouse.

In drawing up a joint venture agreement, it is common practice to give first rights of refusal to the contracting parties to buy the equity of the partner who decides to withdraw. Sometimes, one party is given the priority to acquire in the case of termination. The legal clause serves to regulate the assignation of the rights to the underlying option. Such a clause may establish not only who has the first right to acquire, but also may set pricing rules.

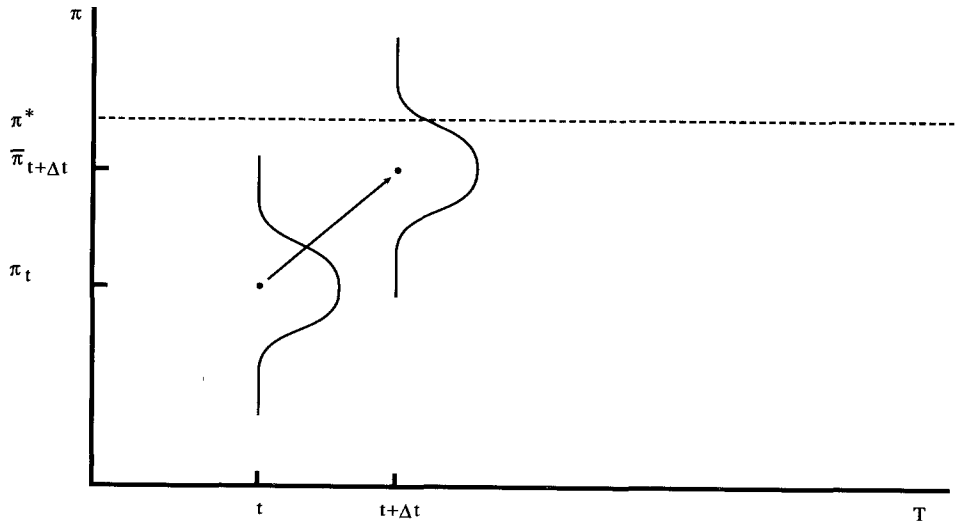

FIGURE 1. Expected change in π_t.

The legal clause outlining acquisition rights should not be confused with the real option itself. Legal clauses serve simply as a way proactively to outline ownership rights in response to unspecified contingencies involving the failure of the cooperation. The termination of the venture by acquisition is not, therefore, necessarily equivalent to the creation and exercise of an option similar to those found in financial markets.

However, an economic option is often inherent in the decision to joint venture and the decision to exercise this option, as explained below, is likely to promote the divestment of the venture by one of the parties. Joint ventures are real options, not in terms of the legal assignation of contingent rights, but, like many investments, in terms of the economic opportunities to expand and grow in the future. The value of any investment can be broken into the cash flows stemming from assets as currently in place and those stemming from their redeployment or future expansion (Myers 1977). Because these latter cash flows are only realized if the business is expanded, they represent, as Myers first recognized, the value of growth opportunities.

The intuition behind this argument can be explained by following the notation of Pindyck (1988). Given an investment of K, the value of the venture can be decomposed in terms of both assets in place and the embedded options:

$$V_j = F_j(K, \pi) + O_j(K, \pi), \tag{1}$$

where V is the value of the venture as estimated by the jth firm, $F_j(K, \pi)$ is the value of the assets in their current use, $O_j(K, \pi)$ is the valuation of the future growth opportunities, and π is the current value of an uncertain state variable. The difference between $F_j(K, \pi)$ and $O_j(K, \pi)$ is that the latter is not equivalent to the discounted cash flows of expected earnings, because the firm maintains the flexibility to choose among investment alternatives—including not to invest—in the future.

As both the value of the assets in place and the option can be potentially affected by current assets and opportunities of the partner firms, the valuations of the venture will differ among the parties. For several [illegible]

Changes in the value of these assets depend on the stochastic process determining the current value of the embedded option, where the state variables are prices, either of production or the inputs. In Figure 1, we illustrate the implications of this process by assuming that changes in a state variable (indicated as π) are normally distributed over time and depict a cross-section of the path. The expected value ($\bar{\pi}_{t+\Delta t}$) is the current [illegible] the expected increase; the variance is σ^2. If realization of π [illegible] is greater than

For one of the partners to make the acquisition, the net value of purchasing the joint venture must be at least equal to the value of purchasing comparable assets on the market. This condition is likely to be satisfied due to the gain in experience in running the venture. If it does not hold, there was no advantage and, hence, no value to the option by investing early. But even if this condition does not hold ex post, a joint venture, as Balakrishnan and Koza (1988) point out, affords the possibility to learn the true value of the assets. As information is revealed, the acquisition is completed or withdrawn. From this perspective, regardless of other motives such as managerial experience, there is a bias to buy out the venture relative to other acquisition prospects simply due to better valuation information.

Timing of Exercise

As apparent from the above analysis, an acquisition or divestment is often a foreseen conclusion to the venture. The investing firms may be indifferent to whether a partner or a third firm purchases the venture. The reward is the capital gains return on the development efforts.

From this perspective, the timing of the acquisition is of critical significance. Simply stated, the acquisition is justified only when the perceived value to the buyer is greater than the exercise price. For a financial option, the terminal value is given by the stock price and the exercise price as set by the initial contract:

$$W = \max(S_t - E, 0], \tag{2}$$

where W is the value of the option, S is the price of the stock at time t, and E is the exercise price. (In this case, S_t is the state variable which we denoted earlier as π.) As the cost of purchasing the option is sunk, these two parameters determine, ex post, the value of the option when exercised.[7]

The joint venture analogue to equation (2) is

$$W_j = \text{Max}((1 - \alpha)V_j - P, 0). \tag{3}$$

That is, the value of the option to acquire (W) is equal to the value to the jth firm of purchasing the remaining shares in the venture minus P, where $\alpha > 0$ and <1 and is the current share owned by firm j and P is the price of purchasing the remaining shares. (P is either negotiated between the parties or set according to a contractual clause.)[8]

For financial options, it is well established that an option should be usually held to full maturity (Hull 1989, pp. 105–129). Exceptions to this rule depend upon dividend policy on the underlying stock, where it may pay to exercise the option before payment to shareholders. Obviously, in the case of joint ventures, the acquisition is only carried out if $(1 - \alpha)V_j > P$.

But the exercise of the option to acquire the joint venture is likely to be immediate for two reasons. First, the value of the real option is *only* recognized by making the investment and realizing the incremental cash flows. If the investment in new capacity is not made in a period, the cash flows are lost. Second, the necessity to increase the capitalization of the venture invariably requires a renegotiation of the agreement, often leading to its termination.[9] The option to expand the investment is likely to coincide with exercising the option to acquire the joint venture.

[7] Ex ante, the value of the option is determined by not only by the known parameters, but also the stochastic process determining the value of the venture.

[8] As the acquisition price is likely to be state dependent, it is important to note that McDonald and Siegel (1986) provide a solution for an option where the value of the underlying asset and exercise price are both stochastic.

[9] The comments of one of the referees helped clarify the necessity of both conditions. See also Doz and Schuen (1988) for a discussion of negotiating problems stemming from different evaluations of the venture's growth potential.

Consider a pure research venture between two parties. Both parties provide initial funding and a pre-established contribution to costs. As long as the initial investment is sunk and additional capital commitments are not required, increased variance in the value of the technology raises the upside gain. (Of course, variable costs must be paid, but these "carrying" costs apply as well to some kinds of financial options.) Since the option need not be exercised, the downside is inconsequential. At any given time, whether it pays for one party to buy the venture is dependent upon the buy-out price and the valuation of the business as a wholly-owned operation.

But once it is profitable to exercise the option, there are sound reasons not to wait. The option value of the venture is realized by investing in expansion. The requirement to contribute further capital leads to a difficult renegotiation. By now, the partners have information to know that the original equity share may not reflect the division of benefits. This deviation can be expected to be compounded when the option to expand becomes economically viable, as the partners are likely to differ in their appraisal of these opportunities. Thus, the allocation of new capital burdens often forces a revaluation of the distribution of benefits. Buying out the partner is a common outcome.

The timing of the exercise of the option to terminate the venture by acquisition is, thus, influenced by two considerations: the initial base rate forecast underlying the valuation of the business and the value of the venture to each party (or third parties) as realized over time. For the acquisition to take place, the acquisition price P must be greater than the valuation placed on the assets by one of the partners. These considerations lead to the following hypothesis: *The venture will be acquired when its valuation exceeds the base rate forecast.*

Selective Cues and Market Valuation

Unlike the case for a contingent security, there are no written contracts and financial markets that indicate changes in the value of a real option. Testing this hypothesis is, clearly, difficult given the impossibility to collect data on changes over time of both partners' evaluations of the option to expand. Nor is it likely that managers possess clear base-rates and valuation signals by which to guide a decision to exercise the option to expand. Consequently, the specification of the above hypothesis raises important questions about what information and environment cues managers use to time the exercise of the option.

Despite theoretical interest and laboratory experiments, most of the research on environmental cues informing managerial decisions has been oriented to identifying biases in the interpretation of information rather than in the selection of the information itself. Of some guidance is the finding of Bowman (1963) that adherence to a consistent rule derived from previous decisions performs better than the decisions actually made, suggesting that the efficiency of decisionmaking is impaired due to biases in the selection cues.[10] More recent research has especially pointed to biases derived from base-rate errors and the salience, or availability, of information. Several studies have shown that individuals wrongly calculate probabilities by weighting recent information too heavily or failing to incorporate information on the marginal probabilities.[11] Base-rates are, thus, frequently ignored, especially when the causal relationships are not explicit.

Whereas experimental research has validated a number of heuristics used in selecting information, there is little guidance for establishing the base rates that might be used for irregular decisions, such as the acquisition of a joint venture. We would expect, as Camerer

[10] See also Kunreuther (1969) and the analysis of similar "bootstrapping" models in psychology by Camerer (1981).

[11] See Tversky and Kahneman (1982) and the discussion in Hogarth (1982, pp. 38–42).

(1981) notes, that individuals rely upon only a few cues of those available. We experiment with two time-varying specifications of the market cues relevant to the acquisition decision: a short-term annual growth rate and an annual residual error from a long-term trend in shipments.

The short-term annual growth rate is calculated as

$$G_{t,j} = [PS_{t,j} - PS_{t-1,j}/PS_{t-1,j}], \tag{4}$$

where the growth rate is set equal to changes in the value of product shipments (PS) for the jth industry over an annual interval $[t-1, t]$. The residual error is derived from the error from an estimated regression of the time trend in shipment growth:

$$R_{t,j} = PS_{t,j} - [a_j + b_j t], \tag{5}$$

where the residual error is the forecasting error from a linear time trend for the jth industry with intercept a and slope coefficient b. (The appropriateness of the linear specification is discussed below.)

It is essential to recognize that the above variables vary with time. Both specifications are derived from a constant dollar series of industry shipments [illegible]

mark. The residual error indicates that decision makers establish a long-term base-rate for each industry's historical growth and look at year to year departures from this trend. Unlike the growth measure, it assumes that managers act to acquire or divest when a market cue signals a rise in valuation relative to a long-term trend.

These two variables are, by our argument, proxies for changes in the unobserved state variable (given as π earlier) that determines the value of the joint venture. As our interest does not lie, however, in the pricing of the option but in the likelihood (or hazard) of acquisition, differences in the scales of the proxies are unimportant to the estimations, as described below. Positive movements in the value of industry shipments signal improved investment opportunities and an increase in the value of the real option embedded in the venture. Because the exercise of the option requires a decision to expand the investment and, hence, a renegotiation of the capital commitment of the parties to the venture, the likelihood of an acquisition should increase with positive movements of the proxy variables.

Acquisition and Value of Assets in Place

Joint ventures can, of course, be acquired for reasons other than as the outcome to negotiations [illegible]

as to slow an erosion in customer confidence. Since this know-how may be essentially organizational—such as, the procedures by which an American firm are effectively managed, a joint venture serves as a vehicle of managerial and technological learning (Kogut 1988; Lyles 1988). In this case, a joint venture is a phased divestiture with a future exercise date.

The importance of this motivation is especially important in industries where there are few competitors. Tying up a potential acquisition target prevents other parties from making the acquisition, a threat which is particularly troubling in concentrated industries where there are few acquisition targets. Through the acquisition, full ownership is attained without adding further capacity to the industry by entering with a new plant.

Data Collection

In the above analysis, we related the likelihood of termination of a joint venture by acquisition to increases in the valuation of the embedded option and to industry conditions leading to divestment of existing assets. To test the effect of these two factors on the likelihood of acquisition, data were collected from both questionnaire and archival sources. Information on joint ventures was first acquired from the publication *Mergers and Acquisitions* for the years 1975 and 1983.[12] The sample included only ventures located in the United States in order to eliminate variance in political environments across countries. Moreover, all ventures had at least one American partner given the difficulty of gathering information on non-American firms. Of the 475 firms contacted in two mailings, 55.5% responded. However, due to a number of factors, such as misclassifying a contract as a joint venture or announcing a venture which never occurred, only 140 responses were

TABLE 1

Descriptive Statistics and Correlation Matrix

	Mean	Standard Deviation	Lowest	Highest
A = Acquisition	0.4	0.49	0.0	1.0
B = Concentration	40.11	20.76	8.0	96.0
C = R&D	0.51	0.50	0.0	1.0
D = Production	0.57	0.50	0.0	1.0
E = Marketing/Distribution	0.53	0.50	0.0	1.0

Spearman Correlation Matrix

	A	B	C	D	E
A	—				
B	0.19	—			
C	0.05	−0.08	—		
D	0.05	−0.04	−0.07	—	
E	0.10	−0.08	−0.05	−0.07	—

we use the four-firm concentration ratio at the four-digit SIC level (*Concentration*) as a proxy for industry maturity that promotes the use of joint ventures as vehicles of planned divestment. Since concentration ratios are published for every fifth year, we employ the ratio nearest the midpoint of the venture's life. (As the ratios are highly correlated across years, there is little difference in results using this procedure or other alternatives.)

As discussed earlier, two different proxies are specified for the central hypothesis that the likelihood of an acquisition is related to the occurrence of a signal of an increase in the value of the venture. The two measures discussed earlier (*Annual Growth* and *Annual Residual Error*) are estimated from unpublished Department of Commerce data on annual shipments (i.e., goods sold) at the four-digit level in constant 1982 dollars for the years 1965 to 1986. Both of these variables are drawn from industry data.

The annual growth data is derived directly from the shipment series. To normalize the data, each industry time series was divided by the first year of the series; thus each series begins with 1965 set to 100. By first differencing the normalized series and dividing by the lagged year, growth in shipments were calculated for each year. This measure was then entered into the analysis as a time-varying covariate with a one-year lag.[13] The time-varying specification means that for a venture alive in 1978, the value of the growth variable is set equal to the annual growth of the venture's industry for 1977. If the venture survives to the next year, the growth covariate is updated to the realized growth rate in 1978.

The residual error is calculated in several steps. First, we again used the normalized series of shipments for each four-digit SIC industry. Second, a time trend was derived by a linear regression. The residual is calculated as the forecasting error for each year, using the estimated linear time trend as the base-rate predictor and the actual normalized shipment as the realized value. The residual error was also entered into the analysis as a time-varying covariate with a one-year lag.

The use of a linear fit for estimating the time trend is justified on a few grounds. With the exception of a few industries, the F-test indicated that the linear specification resulted in rather good fits. Thus, the simple linear model provides a good estimate of the

[13] The lag is motivated by pragmatic and design concerns. Since the shipment data ends in 1986, a lag would have been necessary for the ventures surviving to 1987. Also, as the ventures can terminate at any time during a given year and as the termination date usually follows by several months the decision, it is more conservative to take the lag value.

long-term trend. Moreover, several studies have found that linear rules are commonly adopted by individuals to establish expectations (Hogarth 1982). In some industries, a linear estimate is a poor one and unlikely to be widely maintained. Indeed, as we find below, the exclusion of outliers on the residual measure leads to much better results.

Descriptive statistics are provided for the variables in Table 1. The correlation of the variable *Acquisition* with the covariates is misleading, for the later regressions use time to acquisition as the basis of ordering the likelihoods. It, nevertheless, provides some insight into the underlying relationships. Evident from the table is the low degree of collinearity among these variables. We do not report the time-varying variables, since it would require reporting a covariate for each year of the sample.

Statistical Specification

To incorporate the effects of the unobserved stochastic process and the time-varying covariates, we use a partial likelihood specification to estimate the influence of these factors on termination by acquisition among a sample of joint ventures. Partial likelihood estimates the influence of explanatory variables (or covariates) on the hazard of termination without specifying a parametric form for the precise time to failure. Instead, it rank orders ventures in terms of the temporal sequence of terminations. For each event time, it specifies a likelihood that the observed terminated venture should have terminated, conditional on the covariates of the ventures at risk:

$$L_i(t_i) = h_0(t_i)(\exp(BX_i + BX_i(t_i)/h_0(t_i)))[\Sigma_j(\exp(BX_j + BX_j(t_i)))]. \qquad (6)$$

For simplicity, the coefficients and covariates are given as vectors B and X, respectively, with i indexing the venture which failed at time t_i, j indexing the ventures at risk at time t_i, $h_0(t_i)$ is the baseline hazard, and L is the likelihood for the ith event. The time-varying covariates (*Annual Growth* and *Residual Error*) are indexed by the time of the event (t_i).

It should be noted that the partial likelihood is general in its specification. The parametric assumptions are the linearity imposed on the coefficients and the log-additivity of the baseline hazard and covariate terms. The distribution of the baseline hazard is nonparametric and entirely general. By leaving the baseline hazard unspecified, no bias is incurred by misspecifying the stochastic process by which unobserved variables influence the observed hazard rate. While efficiency is lost by ignoring the exact termination times, the estimates are consistent; the efficiency loss has been shown to be modest (Efron 1977; Kalbfleisch and Prentice 1980).

This generality is achieved by restricting the baseline hazard to be the same for all the ventures. By this assumption, $h_0(t_i)$ cancels out. As shown first by Cox (1972), this likelihood is equivalent to allowing only the conditional probabilities to contribute to the statistical inferences. No information on the precise timing of, or the elapsed time to termination is required; hence it provides a partial, rather than full maximum, likelihood estimate. Consequently, we do not need to know the functional form of the baseline hazard and, implicitly, the underlying process generating changes in the valuation of the venture or the boundary condition giving the point of exercise of the option.

The partial likelihood is calculated as the product of the individual likelihoods. Estimation proceeds by maximizing jointly the likelihoods that the ith venture should terminate conditionally on the characteristics of the other ventures at risk at the time of termination. We use the Newton-Raphson algorithm by which to estimate numerically the coefficients and standard errors. There is no constant or error term. A positive coefficient indicates that increases in the covariate tend to increase the likelihood of termination; a negative coefficient indicates the reverse.[14]

[14] See Allison (1984) and Kalbfleisch and Prentice (1980) for the treatment of tied data.

Statistical Results

The statistical results are given in Table 2. As can be seen from the Student T scores, the principal hypotheses are confirmed under a two-tail significance test. Concentration is significant at .002. In concentrated industries, joint ventures appear to be used as an intermediary step towards a complete acquisition. A complementary but more speculative interpretation is that joint ventures are also often part of the restructuring of mature industries, either due to new, and perhaps foreign, competition or to efforts to stabilize the degree of rivalry. By acquiring the assets, a shifting of ownership occurs without an increase in industry capacity.

Ventures with R&D activities or marketing and distribution activities are more likely to be acquired at .1 significance under a two-tail test and at .05 under a one-tail. The production variable is positive, though insignificant.

The most interesting comparison is between the growth and residual error variables. The growth variable has a positive effect on acquisitions and is significant at .05. The residual error coefficient, on the other hand, is indistinguishable from a null effect.

Given the sample size, it is important to look at the effect of possible outliers. Large residuals might be generated by a poor fit of the linear trend line. The trend lines for ten industries (in which there are twelve ventures) have significance levels worse than .05. Of these twelve ventures, six terminated by acquisition. Their elimination from the sample changed the results only mildly.

A more direct way to identify outliers is to plot the residual errors and growth rates for each industry. The electronic computing machinery industry (SIC 3573) stands out dramatically from the rest. For 1986, for example, the residual error for computers was 30 times greater than the next highest industry. The remarkable trait of the industry is that since these growth rates have been sustained for two decades and more, negative residual errors are generated even when the growth rate is still substantially above the mean and median for the whole sample. As three of the four ventures in this industry terminated in an acquisition, the estimates are strongly affected.

TABLE 2

Partial Likelihood Estimate of Covariates' Effects on Log Likelihood of Acquisition

Variable Name	Full Sample (1)	Without Computer Industry (2)	Without Computer Industry (3)	Without Computer Industry (4)
Concentration	0.26	0.02	0.03	0.02
	(3.16[a])	(2.84[a])	(3.08[a])	(2.59[b])
R&D	0.58	0.70	0.57	0.70
	(1.67[c])	(1.88[c])	(1.58)	(1.91[c])
Production	0.16	0.10	0.20	0.06
	(0.44)	(0.26)	(0.56)	(0.16)
Marketing/Distribution	0.61	0.66	0.59	0.62
	(1.75[c])	(1.76[c])	(1.63)	(1.66[c])
Annual Growth	0.03	0.22	0.03	—
	(2.25[b])	(1.28)	(1.89[c])	—
Residual Error	0.0001	0.006	—	0.01
	(0.45)	(2.88[a])	—	(3.48[a])
$N =$	92	88	88	88

Significance under two-tail T-test: (T-statistics in parentheses).

[a] $P < .01$.

[b] $P < .05$.

[c] $P < .10$.

Reestimating the regression equation without these four ventures gives strikingly different results. Significance levels for the other variables stay largely the same. The most striking change is in the positions of the residual error and growth variable. Both are now positively signed, but the residual error variable is significant at .01. The coefficient on the growth variable is indistinguishable from the null hypothesis. These results are much kinder to the proposition that managers are sensitive to a long-term intra-industry base rate which serves as a standard by which to evaluate annual changes.

The decline in significance of the growth variable is partially the result of the collinearity with the measure of the residual error. Unusually high (low) growth is likely to result in larger (smaller) residual errors. The correlations for *Annual Growth* and *Residual Error* ranged as high as .85 for one year, though often were much lower. Since collinearity tends to raise the standard errors, the loss in significance for *Annual Growth* should be interpreted with some caution.

To address this confounding, *Annual Growth* and *Residual Error* were entered separately into the regression analysis. The results are given in equations (3) and (4) of Table 2. Whereas *Annual Growth* is only significant at .1, *Residual Error* is significant at .001. It is reasonable to conclude that the decision by managers whether to acquire or divest the joint venture is more significantly sensitive to annual departures from a long-term trend than to short-term indices of industry growth.[15]

Discussion of Market Signals

The above findings indicate that increases in excess of the long-term trend in shipment growth are significantly related to the timing of the acquisitions of ventures. Such a relationship suggests that managerial decisions are cued by market signals that the venture's value has increased. Because of the level of aggregation of our sample, the cue may be indirectly related, that is, there are intervening variables (e.g., revenues to the venture) between the variables we chose and the direct cues bearing on managerial choice.

In turn, it could be argued that the take-off in growth signals industry consolidation, thus forcing exits. Conceptually, this objection is weak, for a shake-out should occur when the market does poorer than its historical record. The relationship between *Residual Error* and the likelihood of acquisition suggests the opposite, namely, acquisitions tend to occur when the market does better than its historical record.

To test whether consolidation leads to divestment, we calculate a new variable *Change in Concentration* which indicates the percentage change in the four-firm concentration at the 4-digit SIC level during the life of the venture.[16] The results given in equations (1) and (2) of Table 3 show no support that consolidation leads to an increase in acquisition.

Another interpretation of the findings is that managers are myopic and fail to consider that short-term deviations may be outliers. Frequently, this error is referred to as ignoring regression to the mean or the law of small numbers (Hogarth 1982; Tversky and Kahneman 1971). Incidences of annual growth rates and residual errors, in other words, may reflect extreme values of a random process.

That managers do not simply react to any short-term change can also be addressed empirically. If short-term myopia leads to a divest and acquire decision, then it should lead to a dissolve decision when the market turns down. We can test this proposition by estimating the same model for the likelihood of termination by dissolution.

This test is especially important if the argument that joint ventures frequently serve as real options is correct. The nature of an option should be kept in mind. Once the

[15] Though the coefficient to *Annual Growth* is larger, they are not comparable due to the differences in their measurement.

[16] As concentration is only published for every fourth year, we took the starting year closest to the year of birth of the venture and the closing year closest to the year of termination or censorship.

TABLE 3

Partial Likelihood Estimates of Covariates' Effects on Log Likelihood of Termination

	Acquisition		Dissolution	
Variable Name	Full Sample (1)	Without Computer Industry (2)	Full Sample (3)	Without Computer Industry (4)
Concentration	0.03 (3.14[a])	0.03 (2.90[a])	0.01 (1.16)	0.01 (1.16)
R&D	0.59 (1.66[c])	0.75 (1.96[c])	0.53 (1.30)	0.53 (1.30)
Production	0.16 (0.45)	0.10 (0.27)	−0.18 (−0.43)	−0.17 (−0.43)
Marketing/Distribution	0.62 (1.75[c])	0.69 (1.83[c])	0.30 (0.73)	0.30 (0.74)
Annual Growth	0.03 (2.23[b])	0.02 (1.22)	−0.01 (−0.77)	−0.01 (−0.77)
Residual Error	0.0001 (0.39)	0.007 (2.93[a])	0.003 (0.72)	0.003 (0.72)
Change in Concentration	0.143 (0.14)	0.59 (0.60)	— —	— —
$N =$	92	88	92	88

Significance under two-tail T-test: (T-statistics in parentheses).
[a] $P < .01$.
[b] $P < .05$.
[b] $P < .10$.

capital is committed, the downside risk is low, especially if there is a market for the acquisition of the assets and operating costs are not high. The selling of the venture means that one firm puts a higher value on the assets; it does not mean the venture is unprofitable.

Though it should not be expected that the same covariates should be theoretically related to dissolution, we include them in order to make the results comparable.[17] These results are given in columns 3 and 4 of Table 3. As can be seen, there is no significant relationship between dissolution and the growth and residual error measures.

The insignificance of the *Annual Growth* and *Residual Error* variables lends further support to the options argument. For if joint ventures are designed as options, then as long as the investment is sunk and the operating costs are moderate, downward movements should not lead to dissolution. Rather, it pays to wait and see if the process generates more favorable outcomes. The asymmetry in the acquisition and dissolution results supports strongly the interpretation that joint ventures are designed as options.

Conclusion

This article has investigated the proposition that joint ventures are designed as options that are exercised through a divestment and acquisition decision. The statistical investigation analyzes what factors increase the likelihood of an acquisition. These factors have been shown to be unexpected increases in the value of the venture and the degree of concentration in the industry.

There is a wider implication of this study for theories of organizational behavior. At least since Knight's (1921) observations, it has been widely claimed that risk reduction can be achieved through organizational mechanisms, or what Cyert and March (1963)

[17] For an analysis of the dissolution of joint ventures, see Kogut (1989).

labelled "uncertainty reduction." But firms, if not other organizations, may also profit from uncertainty.[18] Such profit taking might be achieved through a more flexible production process or organizational design, as described by Piore and Sabel (1984). It might also be achieved by investments in joint ventures which serve as platforms for possible future development. After decades of research on the mechanisms of reducing risk, a look focusing at the way which organizations benefit from uncertainty appears promising.[19,20]

[18] In some cases, they may even seek higher risk (Myers 1977; Bowman 1980).

[19] One of the more interesting directions of population ecology is the comparison between strategies which differ by their ability to survive under varying conditions of risk. See, for example, Brittain and Freeman (1980).

[20] The author would like to acknowledge the research assistance and suggestions of Kristiaan Helsen and the comments of Ned Bowman, Colin Camerer, Weijian Shan, Gordon Walker, and the anonymous referees. The research has been funded under a grant from AT&T under the auspices of the Reginald H. Jones Center.

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