INTERORGANIZATIONAL DEVELOPMENT ACTIVITIES: THE LIKELIHOOD AND TIMING OF CONTRACTS

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ABSTRACT

This research examines two critical decisions facing R&D-intensive firms; whether and when to exchange know-how with potential collaborative partners. Empirical results on 104 biopharmaceutical projects suggest that better understanding of organizational boundary decisions requires examination of how both transaction costs, and institutionalization processes in firms and markets affect interfirm transactions.

INTRODUCTION

Interorganizational development activities have become an integral mechanism to commercialize innovations in many industries. In previous research, both transaction cost economics and institutional theory from the sociological perspective have been applied to evaluate the factors that lead organizations to adopt interfirm exchange as a governance mechanism to commercialize innovation. Several authors have recently proposed that a more complete understanding of organizational boundary decisions requires examination of institutional processes from the economics of institutions perspective (Langlois, 1992), as well as examination of how transactional and institutional perspectives coevolve over time.

Transaction cost theory provides a framework to examine factors that influence costs of transactions, and thus the choice of the appropriate governance mechanism. Within this approach, both human factors such as bounded rationality and opportunism, as well as environmental attributes, including uncertainty and the number of possible partners, determine the relative efficacy of contracting (Williamson, 1975). A common critique of the transaction cost framework is that it discounts the importance of institutional factors in the exchange process. Institutional theorists, on the other hand, focus on how the evolution of institutions affects firms. In the economics of institutions tradition the role of institutions that evolve both inside and outside firms is to structure firm exchange relationships (Langlois, 1992). Institutions create predictability of behavior by providing information regarding the likely actions of others. Formal rules, such as property rights and laws; and informal rules, such as norms and customs, evolve over time to solve problems of social interaction. The hypotheses below are provided to test how both transaction cost as well as institutional factors explain the use of know-how markets. Results from an empirical examination of biopharmaceutical projects confirm the significance of both factors in explaining governance decisions.

THEORY AND HYPOTHESES

The core of the transaction cost arguments suggests that asset specificity or the need for highly specialized investments will strongly affect the firm's contracting decisions (Williamson, 1975). Firms are generally assumed to rely less on external contracting for tasks that involve a high degree of asset specificity because of high risks of opportunistic exploitation. Prior research on R&D contracting suggests that asset specificity is especially important in evaluating the efficiency of a knowledge transfer. In prior research these insights have been used to explain the negative effects of contracting for R&D-intensive firms (Mosakowski, 1991) and the prominence of multinational firms in high-technology industries (Teece, 1981). We broaden these arguments by suggesting that not all know-how transactions are equal; the degree of specificity of the knowledge to be transferred affects the choice of the governance mode. We suggest that when the project involves high knowledge specificity (Jensen & Meckling, 1992), the costs of protecting against opportunism and the difficulties of regulating the transaction with incomplete contracts are likely to increase the transaction costs.

> **Hypothesis 1:** The less the knowledge specificity of an R&D project, the more likely that an R&D project will involve a know-how market transaction.

An underlying proposition of the transaction theory is that firms in general would prefer to undertake "similar" activities to which their capabilities are appropriate, and leave other activities to the market (e.g. Coase, 1937). At least two transactional reasons underlie this argument. First, internal organization costs for similar transactions are likely to be lower than for organizing dissimilar activities internally (Masten, Meehan, & Snyder, 1991). Second, more distant activities are potentially less likely to be repeated in the future, and therefore more likely to be governed through market transactions (Williamson, 1975). Consequently, if the innovation process involves combination of specialized complementary assets, controlled by different types of agents, access for these dissimilar assets can be most efficiently secured through contracting. Therefore, in the case of the biopharmaceutical industry we expect biotechnology companies with less previous drug development experience to be more likely to engage in know-how transactions.

> **Hypothesis 2:** The less prior clinical trial experience the R&D-intensive firm has, the more likely that an R&D project will involve a know-how market transaction.

The discussion so far has addressed two complementary explanations for know-how contracting decisions; knowledge specificity and access to complementary assets. These factors, however, do not address the question of why certain firms facing similar transaction cost attributes for their projects transact later than others. The dynamic view on transaction costs suggests that to address this question we need to examine the changes in institutional factors (Langlois, 1992). Hypotheses 3 and 4 below examine how the development of firm- and subfield level institutions affects the timing of know-how transactions.

While previous studies have demonstrated that shared information, trust and direct transactions among exchange partners will reduce transaction costs associated with collaborative relationships (Gulati, 1995), we propose two additional firm-level institutional mechanisms that may affect the information costs in transactions: the seller's previous experience from similar transactions and

the buyer's familiarity with the seller's reputation. Sellers can use experience, organizational rules and arrangements derived from similar transactions, to solve know-how appropriability problems. Moreover, buyers can use the characteristics of the seller's previous contracting behavior in the subfield to reduce transactional uncertainty. We therefore hypothesize the following,

> **Hypothesis 3:** The more prior contracting experience the R&D-intensive firm has, the earlier the timing of know-how transactions in the R&D project development cycle.

At the infancy of a new technological subfield, most knowledge about the technology is tacit. This tacitness of know-how often prevents efficient know-how transfers. As the subfield develops, however, various industry-level institutional structures such as specialized suppliers, industry associations, state agencies, and legal structures develop to support firm interactions through the diffusion of technical, legal and application knowledge among industry participants (Langlois, 1992). Firms will no longer face the same need to develop their tacit projects further in-house because there will now be sufficient knowledge of the technology and availability of institutional structures to support market transactions. We hypothesize:

> **Hypothesis 4:** The more mature the technological subfield, the earlier the timing of know-how transactions in the R&D project development cycle.

METHODS

To test the hypotheses we collected data on a sample of 104 US biotechnology-based therapeutic drugs and in vivo diagnostics development projects in 1976-92. The potential know-how transaction for each project was defined as the first agreement between a biotechnology firm and another company to organize the innovation process for this particular R&D project. Two statistical methods, logistic regression and accelerated event-history analysis were used to model the likelihood and timing of transactions, respectively. For the event-history model, the covariates were measured monthly, and a lagged variable design was used.

There are two dependent variables in the study, Contract probability and Contract timing. Contract probability is coded as a 0-1 dummy variable that records whether a project had involved a know-how transaction by year 1992. Contract timing, the time that the biotechnology company develops the project prior to any contractual relationship, is measured using the date of FDA approval for initiation of human clinical trials as a benchmark of the start of the product's development. The first independent variable, Complexity, measures the level of knowledge specificity. Complex projects involve mammalian proteins, rather than more simple bacterial or yeast alternatives. To capture previous drug development experience Entrant clinical experience is measured as the elapsed time in years since the firm's first project in the subfield entered clinical trials. To test for the effects of previous transaction experience Entrant transaction experience represents the accumulated number of focal firm's alliances within the biopharmaceutical subfield. Finally, two alternative measures were used to capture the industry-level institutional support for know-how transactions. Subfield transaction experience variable is measured as the accumulated number of prior know-how contracts in the biotechnology industry. Post 1982 and Post 1986 variables indicate the period following major institutional events in the biotechnology subfield; the

approval of the first biotechnology drug in the US and the year of the Technology Transfer Act, respectively. We also controlled for whether each biotechnology firm was publicly traded (Public), its cash position (Cash), technological capabilities (Patents) and prior pharmaceutical experience by the CEO (PharmaCEO).

RESULTS

Tables 1 and 2 report the results of the empirical tests. Three of our four hypotheses were strongly supported. Table 1 reports the models explaining transaction probability, and Table 2 provides the results for the models estimating the accelerated failure time using Exponential distribution. In Hypothesis 1 we proposed that knowledge specificity decreases contract probability. The estimated coefficient for the Complexity variable in Table 1 is negative and significant supporting this hypothesis. Hypothesis 2 predicted a positive relationship between the lack of drug development experience and transaction probability. The negative coefficient for Entrant clinical experience is significant, thus providing support for this hypothesis.

Table 1
Logistic Regression Analysis Predicting Contract probability$_t$ Variable

Variables	Model 1	Model 2	Model 3
Intercept	1.866**	2.555***	2.612***
	[0.591]	[0.714]	[0.733]
Complexity		-1.566*	-1.268^
		[0.683]	[0.715]
Entrant clinical experience			-0.572*
			[0.248]
Cash	0.012	0.013	0.024^
	[0.011]	[0.011]	[0.013]
Public	-0.602	-0.371	0.786
	[0.648]	[0.684]	[0.868]
Patents	-0.495*	-0.550**	-0.539**
	[0.199]	[0.204]	[0.204]
-2Log likelihood	69.90	64.01	58.10
Significance test		5.89*	11.8**

^ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed tests)

In Hypothesis 3 we predicted that firms with more transaction experience are likely to transact earlier. However, the coefficient for the Entrant transaction experience variable in Table 2 is positive and significant, suggesting the opposite, longer transaction times for experienced companies. Finally in Hypothesis 4 we proposed that subfield development would lead firms to engage in know-how transactions earlier in product development processes. Since earlier transactions are associated with lower Contract timing values, the estimated negative coefficients for Subfield transaction experience and Post82 provide support for this hypothesis.

Table 2.
Maximum-Likelihood Estimates in Exponential Continuous-time Analysis Predicting Contract timing$_t$ Variable

Variables	Model 1	Model 2	Model 3	Model 4
Intercept	1.634***	1.582***	1.771***	1.976***
	[0.230]	[0.226]	[0.235]	[0.325]
Entrant transaction experience		0.018^	0.034**	0.026*
		[0.010]	[0.012]	[0.011]
Subfield transaction experience			-0.015**	
			[0.005]	
Post 1982				-0.739*
				[0.337]
Post 1986				-0.361
				[0.237]
Complexity	0.519*	0.479*	0.774**	0.716**
	[0.248]	[0.245]	[0.273]	[0.248]
Public	-0.255	-0.465*	-0.239	-0.182
	[0.238]	[0.230]	[0.258]	[0.241]
PharmaCEO	-0.193	-0.127	-0.111	-0.108
	[0.206]	[0.213]	[0.217]	[0.215]
-2Log likelihood	878.14	874.28	866.97	867.28
Significance test		3.86*	11.17**	10.86**

^ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed tests)

DISCUSSION

Taken together, the empirical results of this study support the notion that the use of know-how markets will vary with both transaction cost factors as well as with evolving firm and environmental settings. We find that biopharmaceutical firms with less complex projects and little pharmaceutical drug development experience are more likely to use interfirm know-how transactions. Furthermore, both the evolution of firm contracting experience as well as the maturation of the institutional environment were found to affect the timing of transactions.

Not all of our expectations, however, are confirmed by the data. We hypothesize that the evolution of firm-level institutions would increase earlier transactions (Hypothesis 3). In fact, we find the opposite. Why? One reason might be that firms with previous transactions have less need or time pressure to engage in contracting, possibly because they have been able to use previous contracting relationships for accumulating appropriate resources. This result is especially interesting in the light of prior work which has proposed that path-dependency guides the transaction behavior of firms (Eisenhardt & Schoonhoven, 1996).

This paper has three main contributions for research. First, the study provides an empirical examination of how evolving institutional factors affect intraorganizational development activities. Our

study thus responds to calls for investigation of the connections between industry evolution and interorganizational collaboration (e.g. Aldrich & Fiol, 1994). Second, this study examines how the development of organizational rules and arrangements affects governance decisions. These firm-level institutions have received little attention in the transaction context, and provide an example of conditions under which certain transactors can face both high asset specificity and low transaction costs (Dyer, 1997). Third, this study provides insights on how institutionalization affects the timing of transactions. Several authors have proposed that the weakest element in transaction cost theory is the explanation of how the organizational designs change over time. This is an especially important dimension in industries where windows of opportunities close quickly, but has been largely ignored in prior research.

From the practical standpoint managers at entrant biopharmaceutical firms need to decide whether and when they engage in an interfirm know-how exchange to acquire access to external resources. Our analysis demonstrates that the timing of this strategic decision can be strongly influenced by the evolution of institutional factors. Thus, the success of a technical innovation can strongly depend on complementary institutional innovations in the social and political infrastructure.

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