The Impact of Exit Decisions on Successful R&D Alliances

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In this paper, we focus on the impact of exit decisions on successful R&D alliances. Specifically, we investigate how product exit choices influence the firm's entry into successful strategic alliances. This longitudinal study examines 10 years of product development in the pharmaceutical industry over a sample of 87 firms. Our findings reveal that firms exiting declining research fields are more likely to form successful R&D alliances than firms expanding into these declining fields.

INTRODUCTION

Conditions of alliance success and failure have interested scholars for some time (Anand & Khanna, 2000; Kale & Singh, 2001; Kogut, 1988; Park & Ungson, 2001). Some causes of alliance success have included defining the scope of the alliance in advance, complementary assets, and co-opetitors capabilities (Afuah, 2000, Khanna, 1999; Rothaermel, 2001). Success in new product alliances has also been studied. Findings have included the benefit to small firms of engaging in R&D alliances, the importance of advocacy within the firm, and the type of innovation by first movers and followers in product markets (Green, Welsh, & Dehler, 2003; Kalaignanam, Shankar, &Varadarajan, 2007; Robinson & Chiang, 2002). While this research has examined some of the conditions for success in new product alliances, no research currently examines how the firm's exit decisions enhance the likelihood of successful R&D alliances. The purpose of this study is to consider the impact of choices made within the firm with regard to research exit and how those decisions impact the firm's entry into R&D alliances. As such, our understanding of alliances will be enhanced by considering how exit from a research area may actually be a positive factor in alliance success. This study also provides several methodological contributions. Measures are developed from patent data for exit decisions. Finally the paper uses a longitudinal dataset which creates a stronger foundation for causality.

LITERATURE REVIEW

Alliances are voluntary arrangements between two or more firms, often with competing interests and multiple purposes, which involve sharing resources and knowledge with the purpose of developing products, processes, or services (Gulati, 1998; Sampson, 2005). In the context of the current study, patentable products are developed by the partners through cooperative research and represent R&D alliances.

Although alliances offer promise to businesses that use these arrangements, these alliances often fail (Kogut, 1998). In fact over 40 percent of alliance partners are dissatisfied with the result of their business arrangement (Bleeke & Ernst, 1993). Causes of this failure may include coordination challenges, governance issues, poorly defined scope and fundamental conflicts of interest (Kogut, 1998; Oxley & Sampson, 2004; Sampson, 2005).

Elements leading to alliance success have also been studied. Prior alliance experience with specific partners, general alliance experience with other partners, behavioral uncertainty, firm age of alliance participants and possession of complementary assets have all been related to alliance success (Anand & Khanna, 2000; Lai & Chang, 2010; Rothaermel, 2001; Rothaermel & Boeker; 2008, Sampson, 2005). In the following section we consider the impact of the firm's order of entry on subsequent alliance success.

THEORY AND HYPOTHESIS

Product Development, Product Exit, and R&D Alliances

In this section we explore the relationship between exit from research in technological fields and the formation of R&D alliances. More specifically we address the question whether firms that exit from declining research areas are more likely to form successful R&D alliances. Dosi (1988) discusses several ways that organizations develop knowledge bases. The most common method to increase technological knowledge in the firm is through in house R&D. Firms develop products along a particular trajectory which is influenced by prior events. Development of products along a particular trajectory increases the organizations ability to innovate in that direction (Sydow, Schreyogg, & Koch, 2009).

Grant (1996) also observes that firms can coordinate knowledge more efficiently in many instances. She suggests that when firm's product and knowledge bases are not well aligned, opportunities exist to exchange knowledge outside the firm.

Little research has explored factors influencing the firm's exit in research fields; however some related research on product markets has been conducted. The following discussion and arguments are based on the fact that product development and exit involve various subcomponents. One example of this can be found in research activity that leads up to the actual product. Clearly there is not a one to one relationship between research activity and product development; however that activity is nevertheless indicative of the organizations technological trajectory and goals with regard to product development.

Green et al (2003) finds that products having greater levels of management advocacy are less likely to be terminated. Management advocacy is also influenced by resource investments and technical and business experience related to the product. De Figueiredo and Kyle (2006) observe that competition increases the likelihood of product exit. They further find that more innovative products have a lower exit rate. Competition may be fierce in high tech industries such as pharmaceuticals. This suggests that product exits will occur with relatively greater frequency. Counterbalancing this is that exit from more innovative products will occur more slowly. One response to competitive pressures within an industry is to form alliances (Gimeno, 2004). Additionally the need to develop new products should increase the value and likelihood of alliance formation (Gerwin & Ferris, 2004). If less innovative products are being dropped then it seems likely that firms will seek to develop more innovative products than the ones they discontinued. However the development of new products may require the change of the firm's current technological trajectory and movement into new technological fields.

Uncertainty also influences alliance formation when technological uncertainty and government regulation is high (Lopez-Gamero, Molina-Azorin, & Claver-Cores; Tushman & Anderson, 1986). When firms exit product markets, their need to replace products introduces technological uncertainty. One option for addressing technological uncertainty is to share the risks of research with a partner. Thus the uncertainty arising from the firm's movement out of familiar technological fields should encourage the firm to seek R&D alliances. Decentralization can further enhance innovation by engaging multiple sources of information and enhancing interaction (Damanpour, 1991). Decentralization may also enhance knowledge production within firms (Pertusa-Ortega, Zaragoza-Saez, & Claver-Cortes, 2010). Firms exiting product markets often need to produce new knowledge within the firm. Similarly, alliances can be a productive form of decentralization. Taken together, the need to produce new knowledge within the firm as a result of product exits will enhance the need to decentralize through alliances.

More generally what do firms signal when they build on their existing technological base or exit from product markets? They might be signaling their satisfaction or dissatisfaction with the product development process. When innovation in a specific area increases, firms may be implying that they are satisfied with their expertise in that area and wish to continue development (Sydow et al, 2009). Conversely firms exiting product markets may be implying that they lack the expertise or resources to continue innovation in that area or simply their belief that exiting unproductive technological fields may free up resources for innovation in other areas.

Firms exiting existing product markets may free up resources to be used on other projects. The first place for firms to look would be in house R&D. However the needed knowledge and resources may be lacking within the firm. In these instances firms may have sufficient incentive to engage in R&D alliances in spite of the risks of knowledge appropriation by other firms. On the other hand, firms building on existing product knowledge possess fewer reasons to risk losing their valuable knowledge to potential partners.

Hypothesis 1: Firms exiting early from research in declining product development fields in the pharmaceutical industry will form more successful R&D alliances than firms that exit research later from these fields.

METHODS

Sample

The sample consists of publicly traded firms in the pharmaceutical industry (SIC codes 2833 and 2834). This industry is a subset of the industries used by Schilling and Phelps (2007) in their study of interfirm collaboration networks. They specifically chose firms from industries designated as high technology by the Bureau of Labor Statistics. These firms were chosen for two reasons. This study examines product exit choices; therefore choosing an industry that has a moderate to large amount of product development occurring is essential in order to examine its effect on alliance formation. Secondly, patent data are used to determine measures of product development. Therefore, it is essential that firms in the selected industry file patents so that other measures can be constructed from the patent data.

Companies were chosen that had data available in January 1997 on Mergent Online. Mergent Online provides a database of 15,000 U.S. companies listed on the NYSE, AMEX, and NASDAQ exchanges. This database consists of active and inactive firms. The list of firms chosen from Mergent was accessed by SIC code and year selections. Firms in this study were listed as United States businesses or businesses whose primary headquarters was located in the United States. The primary purpose in choosing firms based in the United States was to control for cultural differences across countries that might influence alliance formation.

Dependent Variable

The dependent variable in this study is total partnerships formed. In this study partnerships represent R&D alliances that produced patents. As a result, this variable defines successful R&D alliances rather than R&D alliances in general since such alliances are not guaranteed to produce patentable results. The partnerships were obtained from the patents filed. When multiple company names appeared in the assignee field, these were treated as partners in that specific patent. In this study, the concern is with alliances formed outside of the company. Therefore, alliances formed between the company and its subsidiary or permanent joint ventures were not included in this measure. All partnerships consist of two or more companies that are separate entities. Partnerships are considered to be dyadic. Therefore, when these partnerships consist of more than two entities, all two party combinations are included in the partnership count. Thus a three party alliance contains three two party combinations.

Independent Variables

The independent variable chosen for the study of R&D alliance formation is product exit. This variable is measured using structural decomposition analysis (SDA). SDA is an econometric technique that is designed to isolate the elements of change. The development of these measures followed the work of Mendonca and Fai (2007). The authors measure technological change using patent data from high technology industries. In the original paper, these measures were constructed for industries, however in the current study; our measure of product exit replaces industry with firms. At the firm level, Mendonca and Fai's variables can be used to examine product exit choices. The measure is calculated as follows:

t-1, t = subscripts for initial year and final year of the period under consideration
Let
p = a patent class (1….N)
j = a firm (1…N)
t = year (1…10)
i = industry (1..3)

τ = technologies share of patents in the patent class. $\tau = \frac{p}{k}$ where k is the total of all patents.

ϕ = firm j's share of all patents in a patent class. $\phi = \frac{p_j}{p}$

The following equation defines the measure:

$$\sum_{p=1}^{N} (\tau_{pt} - \tau_{pt-1})(\phi_{pt} - \phi_{pt-1}) \text{ for a firm j in an industry i.}$$

The measure for exit from a declining research field is represented by the extent to which firms have lost total share of patents through movement out of the declining fields referred to as product exit. When the second term is negative, product exit is measured. The measure represents decreases in the patent share of a product class in the technological environment from the previous period. When the first term is also negative, the firm is decreasing their share of a patent class from the previous period. Taken together the equation represents the decline of the firm's technology in a specific area when the share of patents in the in that technological area is decreasing. When both terms are negative, the firm is exiting from a declining technological field. However when the first term is positive, it shows that the firm is increasing their patent holdings in a declining technological field. When the number resulting from this equation is positive, firms are exiting from declining research fields.

Mendonca and Fai (2007) reduced the patent classes into 9 broader classes. However in the current study, the actual patent classes provided by the United States Patent and Trademark Office (USPTO) are used to avoid contamination of the measure by misclassification. The data for these measures is obtained from the USPTO. First total patents issued by year are obtained. Next, total patents per year for each class that any firm in the database filed is determined. Finally the total number of patents filed by each firm in each class in each year is obtained. From this data, exit is measured.

Control Variables

Ahuja (2000) suggests a number of control variables that might affect alliance formation. Four of those variables are included in this study. Current ratio controls for financial liquidity and is the ratio of current assets to current liabilities. Ahuja suggests that the desire for liquidity might drive firms into partnerships. Return on assets (ROA) represents financial performance. Financial performance might influence firms to engage in partnership activity, either in order to improve that performance or perhaps as an indicator that the firm has the financial ability to follow through on partnership obligations. The third variable included is debt/equity ratio which measures the leverage characteristics of the firm. The amount of leverage might affect partnerships linkages due to the need to spread commitment by engaging in partnerships. The fourth variable, solvency indicates long term commitments of the firm (Gulati, 1995). Businesses engaging in long term projects with uncertain returns, a common occurrence in the pharmaceutical industry, might engage in partnerships to reduce the risk associated with long term commitments and the uncertainty associated with those commitments. Financial data for current ratio, ROA, debt/equity and solvency are obtained from Mergent Online. In some instances data are unavailable for certain companies in a given year. In these instances, additional information about the indicators is obtained by calculating the ratios from balance sheet data supplied by Compustat. Calculated results are compared to Mergent Online results for the same indicators to ensure that the indicators are calculated consistently. Total patents are also used as a control variable in this study since patents are used to obtain information about partnerships, location, and prior experience. It seems reasonable that firms filing more patents will also have more partnerships and more prior partnerships.

Proximity to partners is also added as a control variable. Closer proximity also benefits those firms by lowering coordination costs such as travel by key employees and shipping needed supplies (Porter, 1998). The ability to work closely with suppliers and complementors lowers the need for vertical integration. Proximity may also lead to closer relationships through better communication. Rich communication channels resulting from face to face meetings could enhance information exchange Individuals in clusters additionally may interact with each other in social situations since they live in close proximity. Familiarity in multiple contexts with individuals from other firms may lead to trust. Trust in turn may increase the possibility that firms will form alliances with one another (Uzzi, 1996, 1997). Distance was measured two ways. First distance was measured as a dichotomous variable with 1 indicating the partner firms were within 50 miles of each other. Additionally, the actual distance was obtained from the website www.geobytes.com/city**distance**tool.htm.

Finally, prior alliances are added as a control variable. Firms with prior experience in partnerships are more likely to have developed expertise in working with those partners (Li, Eden, Hitt, & Ireland, 2008). This expertise may take the form of routines or even tacit knowledge about how best to work with others to develop new products. Familiarity and expertise reduce uncertainty and make risk sharing with other firms more likely to succeed. In this study, the total number of prior alliances that were repeated in the current year was totaled for each year for each firm.

Model and Estimation

The dependent variable in this study, total partnerships is a positive count variable with a mean of .77 and a variance of 2.4. OLS regression is generally considered inappropriate when the dependent variable exhibits overdispersion. Two alternatives to OLS are Poisson and negative binomial regression. Poisson regression assumes an equal variance and mean while negative binomial regression has been developed to handle forms of count data when the assumptions of Poisson regression are not met as in the current study (Greene, 1997). Negative binomial distribution takes the form: $\ln \lambda_i = \beta' x_i + \varepsilon$. The disturbance term ε can reflect specification error or cross-sectional heterogeneity, λ_i represents the mean and variance of the distribution, and x_i is a vector of regressors.

In the context of panel analysis, another choice must be made between random and fixed effects. The general form of the panel regression equation is $y_{it} = i\alpha_i + X_i\beta + \varepsilon_i$ (Greene, 1997). The difference between fixed and random effects is determined by the approach taken to the term α_i which represents the individual effect. In random effects models, α is a group specific disturbance in which a single draw enters the regression identically in each period. The random effect model preserves degrees of freedom but assumes that individual effects are uncorrelated with other regressors. Conversely, the fixed effects model assumes that the individual effects are unknown parameters that must be estimated. Fortunately, the Hausman test allows one to determine which model is more appropriate (Greene, 1997). The null hypothesis that random effects was appropriate was rejected (p=.0106). Therefore the model used in this analysis is a fixed effects negative binomial model. Finally, the model uses an unbalanced panel design.

In unbalanced designs, groups may be missing data and group sizes may vary. Stata 10 is used to conduct all statistical analysis and provides routines to conduct the model analyses.

RESULTS

Descriptive Statistics

Table 1 reports descriptive statistics for the study variables. Two of the product development variables, early movers and followers are significantly related to total patents which make sense given that patent data was used to generate these variables. However the other two product development variables product development and product exit are not significantly related to total patents. Among the control variables, current ratio, return on assets and total patents are significantly related to total partnerships. Current ratio is a measure of liquidity and suggests that lower liquidity may be associated with R&D partnership formation since the coefficient is negative. ROA is positively associated with total partnerships suggesting that the size of the firm in financial terms may promote R&D partnerships.

TABLE 1
DESCRIPTIVE STATISTICS AND CROSS-LEVEL CORRELATIONS [A]

Variable	Mean	s.d.	1	2	3	4	5	6	7
1. D/E	.41	5.14	1						
2. Solvency	.38	.75	.07	1					
3. CR	5.43	6.86	.01	0.16***	1				
4. ROA			.03	.03	.06	1			
5. Distance	1881	1833	-.06	.12	-.01	-.08	1		
Location	.353	.48	.04	-.10	-.01	.13	-.53***	1	
7. Prior	.62	.49	-.11	-.05	.14	-.06	.04	-.08	1
8. Total Patents	13.65	38.12	.02	-.05	.14***	.12*	-.13	.17	-.04
9. Product Exit	.00	.002	.00	-.01	-.07	.06	-.09	.03	-.04
10. Total partnerships	.77	2.39	.03	.03	-.07*	.08*	0	-.02	.15

[a]n=870 * p<.05 ** p<.01 ***p<.001

Variable	8	9	10
8. Total Patents	1		
9. Product Exit	.20***	1	
10. Total partnerships	.23***	-0.03	1

TABLE 2[A]
NEGATIVE BINOMIAL MODELS WITH FIXED EFFECTS FOR R&D PARTNERSHIP CREATION

Variables	Model 1		Model 2	
Constant	16.43	548.76	17.24	994.28
Independent				
Product exit			50.23**	16.14
Control				
D/E	0.003	0.012	0.07**	0.01
Solvency	-.025	.125	-.027	.125
CR	-.006	.015	-.0008	.018
ROA	.004	.003	.004	.003
Location	.277*	.134	.263†	.134
Distance	.000	.000	.000	.000
Prior	.078***	.008	.092***	.010
Total Patents	.001	.001	.001	.001
df	7		8	
Log Likelihood	-199.17		-185.12	
Log-Likelihood ratio			28.1	
Wald X^2	110.42		113.00	

n=119 † p<.10 * p<.05 ** p<.01

Regression Models

The results of the fixed effects negative binomial regression analysis are reported in Table 2. Model 1 is the controls only model while model 2 adds the product exit variable. Model fit is significantly improved when product exit is added to the control variables.

In both models, prior experience with alliance partners is significantly related to the likelihood that firm's will have more total partnerships. In both models, location and prior experience are significantly related to total partnerships. Model 2 supports hypothesis 1 that exit from declining research fields is related to successful R&D partnerships (β=. 50.23 p< .01). The positive coefficient indicates that when firms are decreasing their holdings in a declining technological field, they form more R&D alliances that produce patents.

DISCUSSION

In this study we enhance our understanding of strategic orientation, R&D alliances and innovation. The ability to exit from unproductive products increases the likelihood of entering successful R&D alliances. Firms that adapt to changing market conditions in the form of exiting unproductive fields may hold a competitive advantage over less nimble competitors within their industry due to their ability to form more productive R&D alliances. Alliances and networks provide instances where groups of firms work together for a common goal. Exiting declining technological fields makes firms into more attractive partners. For these firms, the awareness of the inadequacy of previous products produces a sufficient incentive to seek alliance partnerships.

Importantly, these firms are entering successful R&D alliances. Sampson (2005) observes that alliances may face considerable coordination challenges, uncertainty, and cultural differences. Thus the success of alliances in this study is all the more remarkable. It may be that the pressure of leaving familiar technological fields and using slack resources outweighs the problems typically associated with alliances.

Among control variables, prior experience with partners was a highly significant predictor of total partnerships. Two elements might cause this relationship to occur. First firms seem to find it easier and possibly safer to ally with known partners rather than to venture into new alliances. Familiarity breeds trust which increases alliance effectiveness making future alliances more sensible (Perry, Sengupta, & Krapfel, 2004). When these alliances occur repeatedly, they contribute to the total number of partnerships. Thus total partnerships represent a way of doing business for firms that repeat alliances with known partners. Secondly, it may be that managerial styles are represented by the use of prior partners such that these decision makers are more oriented to developing partners and sharing the glory and benefits of R&D discovery. Additionally firms that engage in frequent alliances may have a developed ability to handle alliances in terms of coordination and cultural issues. Some firms have a department dedicated to alliances for instance. Another interesting finding comes from the theory of clusters (Porter, 1998). In this study, actual distance was not related to alliances but the dichotomous variable that measured whether firms were within 50 miles of each other was significant. Normally a continuous variable provides more information than a dichotomous variable, however close proximity seems to be important here. Firms that were within 50 miles of each other formed more successful R&D alliances suggesting that physical proximity does benefit successful alliances since members of the firm can interact with each other more readily.

A limitation of the study is the somewhat small size of the sample that may have hindered the ability to find more significant relationships. Additionally, focusing on pharmaceuticals may fail to uncover important industry effects. Further, the firms used in this study had publicly available information. This precludes privately held firms. However it seems reasonable to believe that the publicly held firms filed more patents and engaged in more R&D partnerships which were the variable of interest in this study. We also incorporated product development variables at the firm level that in Mendonca and Fai's (2007) study were previously incorporated as technological change variables at the industry level. It might be argued that the relationship between the industry and the firm level are quite different and that the product development construct might have a different meaning. Nevertheless, the product development variables measure changes in the patenting patterns within the firms studied and provides valuable information not previously available. It might be interesting to consider the broader technological change environment in concert with the product development construct. In this instance, multilevel models over time could produce important discoveries.

On the positive side, this study uses a longitudinal design that allows two elements in the chain of causality to be examined. First the study determines which items covary and the study also examines the change over time in those relationships. Secondly, the inclusion of a ten year period allows the pharmaceutical industry to experience more than one historical change or event reducing the possibility of historical bias which could result from a cross sectional study. Third, the element of product development order of entry and exit are added as possible antecedents to alliance formation. This is also the first time that product exit choices have been used in the context of R&D alliances. Finally, understanding the antecedents of successful R&D alliance formation may inform decision makers about the reasonableness of forming partnerships with other firms and entities.

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