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R&D FUNDING AND PROJECT PERFORMANCE: THE MODERATING ROLES OF EXPLORATIVE AND EXPLOITATIVE ASSISTANCE

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ABSTRACT

Based on agency theory, this study not only analyzed the main effects of private R&D and public R&D on project performance, but also explored how outside explorative and exploitative assistance moderates R&D funding sources – project performance relationship. Hypotheses tests in a sample of 91 R&D projects supported our predictions.

INTRODUCTION

New products and technological innovations are substantial premiums for firms to carry out R&D projects. Prior research in project management literatures treats R&D funding as a facilitator of product and technological innovations that can allow firms to perform better (Hagedoorn & Cloudt, 2003; Jang & Huang, 2005). However, previous studies regarding the R&D funding are likely to distinguish between private and public funding sources (David et al., 2000; Gonzalez & Pazo, 2008; Hall, 2002). These literatures have tended to emphasize whether private R&D or public R&D contribute to product and technological innovations. However, the answers of these efforts have reported equivocal findings, and thus we contend that it has important implications among private R&D, public R&D and project performance. Moreover, prior studies on different R&D funding sources have devoted considerable effort to measuring the effectiveness of governmental innovation policy in developed countries using firm-level data (Billing et al., 2004; Eshima, 2003; Tomiura, 2007). Such research has tended to emphasize more on internally tangible resources rather than externally intangible consultant's knowledge. Hence, the concept of outside consulting assistance has attracted interest into our study, using a set of project-level data. Accordingly, the purpose of this study targets this issue by designing to pursue two research questions: (1) how does project performance difference between private R&D and public R&D? (2) take outside consulting assistance into account, how do the two

general classes of explorative and exploitative assistance moderate the R&D—performance relationship?

THEORETICAL BACKGROUND AND HYPOTHESES

R&D funding and project performance

R&D funding within firms refers to the validated expenses and subsidies used to conduct R&D activities for the development of technological innovations, process improvements, and productive capacities under specific R&D plans (David et al., 2000). R&D funding can be conceptualized as public and private sources. Public R&D refers to the form of government subsidies in the financing of firm's R&D activities by way of government R&D grants (David et al., 2000; Gonzalez & Pazo, 2008; Wu, 2005), while private R&D is the outlays invested and financed by the firm in the R&D project for the development of product and process innovations (Hu, 2001; Ozcelik & Taymaz, 2008). The influence of R&D funding source on the performance is often studied in the context of agency theory (Billing et al., 2004; Le et al., 2006). Agency theory has its foundations in the separation of principal and agent as a central aspect of the corporate governance system. This separation has an agency problems associated with it. Agency problems arise from the differing risk preferences and asymmetric information between principal and agent (Eisenhardt, 1989; Hall, 2002; Jensen & Meckling, 1976). R&D projects can be framed through this principal–agent relation. Some R&D projects are characterized with high uncertainty that they are neither immediate nor certain to realizing any commercial value. This uncertainty would make firms reluctant to invest in such high risk R&D projects. Hence, firms would be inclined to apply for the gratuitous government-sponsored funds to finance these risky R&D projects. Furthermore, when firms in themselves possess sufficient and reliable information about the likelihood of high-risk investment than the government agencies, this information asymmetry phenomenon enables them to use subsidies instead of their own R&D efforts. Hence, publicly-funded R&D may breed inefficiency and do not help R&D projects perform better. On the other hand, based on agency theory, R&D projects are willing to use their own funds for investment in physical equipment and substantial professionals, because the estimated risk of the R&D activities is acceptable, and the probability of future success is high. In other words, firms with an internal source of R&D funds are inclined to be more productive to improve the long-term value. Therefore, the above discussion leads to our first hypotheses in this study.

Hypothesis 1a: Private R&D funding is positively related to project performance.

Hypothesis 1b: Public R&D funding is negatively related to project performance.

A contingency view of the R&D funding – project performance relationship

How do a firm's R&D funding sources affect its project performance? The above discussions on R&D funding sources describe a firm's decision concerning the private R&D and public R&D. However, a firm's project performance is not simply a function of these decisions. Instead, these decisions and project performance are contingent upon another important factor: outside consulting assistance. Indeed, outside consultants may assist R&D projects to transfer emerging technology and new knowledge during product and technological innovation process (Chrisman & McMullan, 2004; Fey & Birkinshaw, 2005). Furthermore, outside consultants are also likely to improve existing and established product-market efficiency (Beckman et al., 2004; Semadeni, 2006). Collectively, we believe that outside consulting assistance can be a valuable source of "exploration of new and emerging possibilities" and "exploitation of established and existing certainties." (Benner & Tushman, 2002; He & Wong, 2004; March, 1991, 1996, 2006). Therefore, we argue that outside consulting assistance, such as explorative assistance and exploitative assistance, would affect project performance under different sources of R&D funds.

An *explorative assistance* offers R&D projects with the opportunity to acquire emerging technology and generate new knowledge from outside consultants (Cassiman & Veugelers, 2006; Chrisman & McMullan, 2004; Laursen & Salter, 2006). Outside consultants can provide explorative assistance to help privately-funded R&D projects to successfully possess an advanced technology, effectively absorb new knowledge, and subsequently move into commercial markets (Christensen et al., 2005; Feldman & Kelley, 2006; Laursen & Salter, 2004). Conversely, focal projects with gratuitous publicly-funded R&D tend to invest high risk R&D activities. However, if they are less willing to accept outside explorative assistance, the risks of the internal R&D activities are relatively higher than if they involve more explorative assistance, thereby making more harmful to project performance. Therefore, the above discussion leads to our second hypotheses, which is dealing with the moderating effect of explorative assistance.

Hypothesis 2a: Explorative assistance will positively moderate the relationship between private R&D funding and project performance.

Hypothesis 2b: Explorative assistance will negatively moderate the relationship between public R&D funding and project performance.

An *exploitative assistance* indicates that outside professional consultants can provide their experience and expertise to help the specific case of R&D projects in product and technological innovation activities aimed at improving existing product-market positions (Benner & Tushman, 2002; He & Wong, 2004). Indeed, privately-funded R&D projects with outside exploitative assistance tend to successfully overcome competency traps that limit their

ability to improvements in established components, openly exchange information that abets the progress of R&D projects initiated, and effectively exploit opportunities that profit in existing niche markets (Christensen et al., 2005; Laursen & Salter, 2006; Phene, 2006). Conversely, focal projects with publicly-funded R&D tend to invest high risk R&D related activities. However, if they are less willing to accept outside exploitative assistance on an ongoing basis, the risks of the internal R&D activities are relatively higher than if they exist more exploitative assistance, thereby making more harmful to project performance. Hence, the above discussion leads to our third hypotheses, which deals with the moderating effect of exploitative assistance.

Hypothesis 3a: Exploitative assistance will positively moderate the relationship between private R&D funding and project performance.

Hypothesis 3b: Exploitative assistance will negatively moderate the relationship between public R&D funding and project performance.

METHODS

Data collection and sample

The sample of this study was constructed from the file of Industrial Development Bureau (IDB), Ministry of Economics Affairs (MOEA) of Taiwan. From this file, there are a total of 324 R&D projects in the database. We employed both secondary sources and questionnaire survey to collect data. R&D funding, project performance, and control variables were drawn from the database while outside consulting assistance was collected from the questionnaire survey. Personalized and Detailed questionnaires were then sent to the managers responsible for the R&D projects. Follow-up reminders and thank-you e-mails were sent after two weeks until we had a satisfactory level of response and concluded the data collection. It represents a 28.09 response rate. The possibility of non-response bias was checked by comparing the respondents to the original population sample. The calculated t-statistics and the χ^2 tests are all insignificant, suggesting that there are no differences between the respondent and non respondent groups.

Measures

Project performance. We created a measure of project performance by standardizing and summing cost decrease and revenue increase in thousands of NT dollars resulted from the R&D activities, because investment in such activities is likely to reduce production cost and raise productivity. Data on cost decrease and revenue increase were obtained from the IDB database.

R&D funding. Following Hagedoorn and Cloudt's (2003) study, we measured private R&D as the firm's expenditures on the R&D activities and public R&D as the amount of subsidy provided by the government to the project. Data on both public R&D and private R&D for each project were also drawn from the IDB database.

Outside consulting assistance. We developed 12 Likert-scale items to measure the extent of explorative and exploitative assistances from the outside consulting firms. To generate items for explorative and exploitative assistances, we carefully examined existing literature and conducted pretest interviews with three project managers to help design survey instruments. We measure explorative assistance ($\alpha=.89$) with a 7-item scale to assess the extent to which the technology are transferred from outside consulting firms, and knowledge are created by outside professional research organizations, universities, business associations and governmental labs. Moreover, we measure exploitative assistance ($\alpha=.91$) with a 5-item scale to assess the extent to which outside consulting firms assist the R&D project to improve existing product-market efficiency (e.g., improve yield, improve existing product quality, reduce production cost or improve internal process, reduce material consumption, improve production flexibility).

Control variables. We controlled for four variables in this study. Project duration time was measured as the number of months that outside consultants provided the consulting assistance for the R&D project. Consultant type was coded '0' if the assistance was provided by private consulting firms and '1' by research institutes and universities. Age was computed as the number of years from the founding date. Finally, number of consultant professionals involvement were measured as the number of outside consultants involved in the R&D project.

RESULTS

This study attempts to analyze the relationship among R&D funding sources, outside consulting assistance and project performance. The hypotheses were tested using OLS regression techniques in a sample of 91 R&D projects. Hypothesis 1a, stating that private R&D is positively related with project performance, is strongly supported as it is highly significant in all of our regression models. Hypothesis 1b, stating that public R&D is negatively related with project performance, also receives strongly supported as it is highly significant in all of our regression models in which it is present. Next, we examined the contingent roles of explorative assistance between R&D funding sources and project performance. Our regression results provided marginal support for hypothesis 2a regarding the positively moderating effect between private R&D and explorative assistance on project performance ($\beta = 1.765$, $p < .10$), while the results provided general support for hypotheses 2b regarding the negatively moderating effect between public R&D and explorative assistance on project performance as well ($\beta = -1.857$, $p < .05$). Finally, the

contingent roles of exploitative assistance between R&D funding sources and project performance not only revealed strongly support for hypotheses 3a regarding the positively moderating effect between private R&D and exploitative assistance on project performance ($\beta = 1.665$, $p < .001$), but also provided strongly support for hypotheses 3b regarding the negatively moderating effect between public R&D and exploitative assistance on project performance as well ($\beta = -1.823$, $p < .001$). To help provide a clearer understanding of the implications of the interaction terms in our regression models, we plotted the trend showing the above relationship. All tables and figures are available from interactive paper session titled “Research on R&D”.

CONCLUSION

This study offers three contributions. First, we apply agency theory to analyze the R&D project performance from different R&D funding sources. Second, the results reveal that explorative assistance and exploitative assistance appear to moderate the above link. These findings advance theory by developing an amalgam of agency theory and exploration versus exploitation views and further offering evidence consistent with our theorizing. Third, our theory and findings offer theoretical implication that are particularly relevant in light of recent R&D funding sources on project performance and current regulatory trends towards receiving two differential amounts of outside consulting assistance to help R&D projects achieve and sustain better performance. Each of these contributions is discussed below. Based on data from the Taiwan government agency, our findings provide some support for the hypotheses that private R&D is positive related to the project performance, whereas public R&D is negative related to project performance. Moreover, the interaction of R&D funding sources with consulting assistance reveals that R&D projects with explorative and exploitative assistance by outside consultants appear to have higher levels of project performance. Specifically, explorative and exploitative assistance will be both helpful on the effects of different R&D funding sources on R&D project performance. Finally, the theoretical contribution of this study provides insight as to how various R&D funding sources may affect project performance under two general classes of outside consulting assistance. We identify explorative and exploitative assistance by carefully examining existing literature (He & Wong, 2004; March 1991, 1996, 2006), and show that for each the relationship between R&D funding and project performance significantly varies when the level of outside consulting assistance changes. Therefore, this study extends the previous literature on exploration and exploitation concerning the management consulting research.

REFERENCES AVAILABLE FROM THE AUTHOR(S)

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