An Empirical Study on the Impact of R&D Investment and Employee Involvement on Innovation Commercialization: Evidence from IT Firms in China

Li Rui
Tsinghua University, Beijing, China

Using a sample of 126 firms in Chinese IT industry, we developed an empirical model which tests the impact of R&D investment and employee involvement (EI) on innovation commercialization. The results showed that the expenditure of R&D has a positive effect on performance of innovation commercialization, while the number of R&D staff has trivial impact on that. The results also revealed that EI has no direct effect on commercialization performance, but plays a moderating role in the effect of R&D investment on commercialization of innovation. More specifically, the R&D expenditure of a firm with high involvement system has a less positive impact on the number of new products, but a more positive effect on the profit of new products.

Keywords: R&D investment, employee involvement (EI), innovation commercialization, IT firms

Introduction

In the 21st century, with the fierce competition and rapid development of technology, innovation has become the foundation stone to any enterprises in respect of their survival and development (Isaksen & Lauer, 2002). The firm with high innovation capability can integrate, create, and reconfigure their internal and external resources more easily, and utilize the business opportunities in the turbulent environment (Teece, Pisano, & Shuen, 1997). The process of innovation not only includes the creation of business ideas, but also counts in their commercialization where business ideas are commercialized into the real products or services which meet the consumers’ demand (Damanpour, 1991; Duncan, 1976).

The existing studies have discussed the phase from idea generation to the development of patents and invention of new technologies thoroughly, while neglected the commercialization stage where ideas are transformed into real products (Almeida & Phene, 2004; Nerkar & Shane, 2007). There is no doubt that the research on idea creation is vital, but this kind of study makes trivial contribution to the firm who wants to win market repayment (Cai & Gao, 2011). As a result, the commercialization of innovation deserves more attention of innovation scholars.

To realize the commercialization of innovation, a firm needs the investment on R&D activities, to strengthen the technical capability, which can promote the novelty and uniqueness of new product (Teece, 1986; Zahra & Nielsen, 2002). On the other hand, the success of commercialization depends on the knowledge flow and integration among different functions and levels in a firm (Cooper, 2001). Thus, a firm can provoke the potential of employees and drive the knowledge share, by a set of human resource practices, often named after...
“employee involvement (EI)”, including employee suggestion, cross-functional or self-management teams, and delegation of decision power (Chen & Huang, 2009; Lopez-Cabrales, Pérez-Luño, & Cabrera, 2009; Yan & Chen, 2010; Cheng & Zhao, 2006). The prior research has discussed the predictors of innovation commercialization, from the perspective of R&D investment and EI separately, but lack the analysis of the interaction of these two factors.

Therefore, this paper attempts to integrate the content of human resource management and R&D management, analyses the relationship among EI, R&D investment and commercialization of innovation, especially the interaction effect between EI and R&D investment on commercialization, and sheds light on the mechanism of the formation of firm’s innovation.

**Literature Review**

**The Research About R&D Investment**

The innovation process depends on the support of resources, especially the specific investment of firms. Due to the uncertainty and complexity in the development of new knowledge or technology, a firm needs intense engagement in capital and human resource, to make sure the continuity and stability of R&D activity. The importance of R&D investment to firm’s performance has attracted the attention of scholars, and empirical studies on the effect of R&D expenditure or staff on innovation performance in Chinese background proved the positive role of R&D investment (Chen & Luo, 2005; He, Chen, & Wang, 2009). There are some researches, however, which indicate that R&D investment has no effect, or even negative effect on innovation performance (Feng, 2009).

Firstly, this gap derives from the difference in data sources, statistic methods, and the level or interval of research. More importantly, the prior researches only focus on the examination of the correlation between R&D investment and innovation performance, without investigating the mechanism of R&D investment on dependent variables.

From the perspective of knowledge-based view, the R&D investment is viewed as the source of a firm’s exclusive knowledge. The high intensity of R&D activities, which depends on the support of a firm’s investment, can accelerate the development of R&D staff, which means the better absorptive capability, and motivate the upgrade of technology and development of innovation performance (Cohen & Levinthal, 1990). We are aware of, however, that the innovation is the output of complex system, which means that the R&D investment alone can hardly fulfill the commercialization of a firm’s innovation. The reason lies on the fact that a firm’s knowledge is embedded in individuals and functions on the individual’s will. In a word, if the employee who has the ability to utilize knowledge has no desire to use it, or lack the platform to apply it, a firm’s knowledge capital will not be transformed to economic return. The solution to this problem depends on the operation of human resource management, which focuses on the individual’s attitude and ability.

**The Research About EI**

EI means the downside of key resource in organizations and the allowance of low-level staff participating managerial behaviors which are related to the ultimate performance of an organization (Lawler, 1989). There are abundant empirical studies on the effect of EI on firm’s performance after the emergence of this conception. Lots of researches showed that EI has a positive impact on a firm’s indicators of operation performance, such as quality, job satisfaction, absenteeism and turnover, and of financial performance such as sales and profit (Cooke, 1992; Arthur, 1994; Huselid, 1995; Ichniowski, Shaw, & Prennushi, 1997; Guthrie, 2001).
The employee is the basis of firms' innovation capability, because the knowledge acquired by innovation activities is embedded on individuals (Amabile, Conti, Coon, Lazenby, & Herron, 1996). Therefore, a firm can improve its performance by motivating the innovation capability of staff, especially the bottom-line personnel. Employee participation is conducive to the improvement of innovation performance, for its enlargement of low-level personnel power which helps a firm to better utilize the knowledge of employees and facilitate the flow of knowledge (Chen & Huang, 2009; Lopez-Cabrales et al., 2009; Yan & Chen, 2010).

Other studies showed, however, that the EI has no directly positive impact on organizational performance, even considering its benefit to individual’s satisfaction and motivation (Yang & Konrad, 2011). The difference on prior studies revealed that the effect of EI is constrained by several contingency factors (Becker & Gerhart, 1996), especially the knowledge, skill, and ability (KSA) of employees (Chen & Yu, 2010). The KSA, as we know, comes from the intensity of investment on human capital. Thus, the effect of EI is influenced by the condition of R&D investment.

According to previous analysis and using large companies in Chinese IT industry as the sample, this paper aims to discuss the interaction between EI and R&D investment on a firm’s innovation performance measured by commercialization output, to explain the formation of innovation commercialization.

**Hypotheses Development**

**R&D Investment and Commercialization of Innovation**

The key to successful commercialization and new product development (NPD) is to impede the imitation of competitors and keep the superiority of new products. This builds on a firm’s strong technology capability which can increase the complexity, novelty, and uniqueness of new products. The approach of technology capability improvement lies on the investment in R&D activities, without considering the transfer of technology (Fan & Cai, 2012).

H1: The R&D investment has a positive impact on the performance of innovation commercialization.

NPD is a risky activity with a failure rate around 40%-75% (Stevens & Burley, 2003). The previous research indicates that the cause of the failure is that the firm misunderstood the customer’s preference and developed the wrong product failing to satisfy customers’ needs. To solve this problem, the approach of “Customer Knowledge Development” is developed, for those companies which want to understand the customer background, preference, and expectancy (Cooper & Kleinschmidt, 1995; Joshi & Sharma, 2004; Coviello & Joseph, 2012). Due to the rapid change of customer preference, however, the scope and scale of knowledge development cannot be easily defined. Prior studies have showed that the investment of R&D facilitates the customer-relevant learning activities in NPD process (Henard & Szymanski, 2001), and promotes the absorption of customer knowledge. So, the conclusion can be easily drawn that the R&D investment is conducive to the success of NPD.

H1a: R&D expenditure has a positive impact on the number of new products.

H1b: R&D expenditure has a positive impact on the profit of new products.

The existing studies on a firm’s innovation performance are accustomed to consider the effect of R&D expenditure instead of the number of R&D staff. But we know that the subject of knowledge utilization and technology capability development is the employee of R&D department. So, the number of R&D staff reflects the quantity of human capital, and further, the knowledge embedded on human capital, in a firm.
From the view of knowledge management, the development of technology depends on the accumulation of knowledge on technic area, having the characters of cumulativeness and path-dependence. The prior knowledge a firm possessed on a specific area determines the absorptive capability of firms on this area, thus influencing the absorption, transfer, and appliance of knowledge on next time (Cohen & Levinthal, 1990). So, the large number of R&D staff enhances the absorptive capability on technic area, helping the firm to acquire the information about technology better, which facilitates the process of NPD.

H1c: The number of R&D staff is conducive to the increase of new product number.
H1d: The number of R&D staff is conducive to the increase of new product profit.

**EI and Commercialization of Innovation**

The successful development of new products or services relies on the engagement of R&D staff as well as the coordination and integration among different functions in a firm (Cooper, 2001), and more specifically, the staff from R&D department and other departments need to share his or her knowledge (Ruekert & Walker, 1987; Griffin & Hauser, 1996). Because the innovation, varying from the creation based on personal characteristics, is the output of a complex system and requires the comprehensive operation among manufacture, sales and purchase, etc.. As a result, the innovation builds on the technological process and labor division of a firm. The integration among functions has an important effect on the result of NPD and commercialization.

Such cross-functional interactions can be structured and coordinated in two ways, from bureaucratic approaches to a more decentralized participatory mechanism. The empirical study proved that the effectiveness of two ways is different based on the sort of NPD program: the more participative structures are likely to improve the effectiveness and timeliness of the NPD process when the product being developed is truly new and innovative because this kind of project needs the high intensity of communication and interdependence among functions to integrate tacit knowledge. However, more bureaucratic structures may produce better outcomes on less innovative projects, such as those involving line extensions or product improvements because this type of project demands the stability (Olson, Walker, & Ruekert, 1995). So, we think that EI is not a universal panacea for shortening development times and improving success rates across all types of projects.

H2: EI has different impacts on different parts of commercialization performance.

When firms attempt to improve the product, the key is to reduce development time in order to introduce new products or services ahead of the competition and seize the limited market space. So, firms must centralize limited resources, which require rapid decision-making and efficient collaboration (Cooper, 2001). Participatory management disadvantage, however, lies in the fact that allocating elite experts and important resource on every problem-solving team will inevitably result in redundant and a waste of personnel and facilities. Besides, informal communication, participatory decision-making, and democratic solution to the conflict are more time-consuming and less efficient compared with bureaucratic structures (Keller, 2001). Thus, the speed of product improvement will be impeded and the number of new products in a period will decline.

H2a: EI has a negative effect on the number of new products.

However, the number of new products is not relevant with its profit. The new product can be divided into a variety of types according to its novelty, from the “truly new”, “complementary” and “cost-reduction”, etc.. In most cases, the “truly new” products can obtain higher sales and profit due to the obstacle of imitation (Hamilton, 2002). Besides, the novelty of product development is been positively associated with the effectiveness of product diffusion which plays the key role in the market performance of new products (Ernst, Hoyer, & Rübsaamen, 2010).
From this perspective, the profitability of new products and services mainly depends on the novelty and uniqueness of the product design. This creative product requires a high degree of integration between the corporate functions to boost the frequent exchange and transformation of knowledge. Through the implementation of the employee participation in the NPD process, a firm can promote the open exchange of information, reduce the personal obstacles between the different functions, and decline the possibility of delay or loss of important information, thus facilitating the exchange of creative ideas and raising problem-solving ideas. In addition, a substantial and radical innovation means the destruction and restructuring of the habits, culture and thinking mode, and thus vulnerable to conflict with individual defense mechanisms (Argyris, 1978). EI can shape the psychological commitment of corporate members on corporate goals, making employees to internalize organizational innovation goals into their own personal goals, breaking through the shackles of defensive mechanisms, and becoming more easily in the face of innovation and change, thus facilitating the formation of more creative subversive ideas. As a result, companies are more likely to develop strong novelty and uniqueness of the product or service.

H2b: EI has a positive effect on the profit of new products.

The Interaction Between R&D Investment and EI

So far, we have discussed the direct effect of R&D investment and EI on the commercialization of innovation. However, as the prior content referred, the innovation requires the accumulation as well as the utilization of knowledge. R&D investment reflects the engagement in human capital, which can be seen as the basis of knowledge formation; and the EI represents a firm’s recognition of the status of employees, which is the source of employee motivation. The effective combination between the two parts is crucial for the formation of innovation performance. Therefore, the interaction between R&D investment and EI must exist.

In fact, the complex interaction between the R&D investment and employee participation can also be explained from the perspective of complexity theory. The theory sees innovation as the result of complex interactions between different subjects and institutions, and the various elements in the process of innovation interconnect and restrain each other (Stacey, 1995; Brown & Eisenhardt, 1997). This means that when the state of a subject or feature changes, the positive and negative influence will be caused at the same time on the surrounding body. The delicate interplay between such elements will have a major impact after accumulating to a certain extent by the positive and negative feedback.

H3: R&D investment and EI have an interacted effect on the commercialization of innovation.

A firm’s R&D investment represents the focus on technology and the strength of R&D power. When a company has high R&D investment, the R&D personnel will be in a dominant position in the development of new products. For those enterprises that want to accelerate the speed of new product introductions, the dominance of the R&D staff can make the enterprises focus more on their R&D objectives, and will also increase the speed of product design and trial. However, if a firm implements high involvement in human resource management at the same time, which means the firm paying more attention to listen to the views of staff and encouraging democratic decision-making, it needs to spend a lot of effort to integrate heterogeneous information which comes from a variety of channels. As a result, the goal of the NPD process will be more dispersed, and the stability of the internal division of work also declines, which is not conducive to rapid improvement of the product.
It can be inferred that due to the lower efficiency of decision-making and the division of labor in the NPD process in companies with a higher level of EI, the R&D investment’s role in promoting the speed of NPD will be weakened.

H3a: EI plays a negative moderating role in the effect of R&D expenditure on the number of new products. More specifically, in firms with a higher level of EI, the R&D expenditure will have a weakened positive effect on the number of new products.

H3b: EI plays a negative moderating role in the effect of R&D staff on the number of new products. More specifically, in firms with a higher level of EI, the number of R&D staff will have a weakened positive effect on the number of new products.

However, in the process of “truly new” product development and trial, more heterogeneity of knowledge sharing and consolidation is required, which must establish a high degree of dependency and interaction among different functions of firms (Ernst et al., 2010). At this point, if the power of corporate R&D department is too strong, it will play a leading role in the collective behavior of the functions, which is not conducive to the exchange of information integration. Through the implementation of EI, a firm would be more capable of listening to different views of staff, giving the low-level workers more authority, and inhibiting the leading role of R&D sector, thus promoting the exchange of heterogeneous knowledge. In this way, a firm can generate creative ideas about products or services in the NPD process more easily and launch new products and services which have high novelty and uniqueness, resulting in better profits.

It can be inferred that companies with a higher level of EI will have a high degree of knowledge integration and exchange in the development of new products. As a result, the R&D investment’s role in promoting the profits of new products will be strengthened.

H3c: EI plays a positive moderating role in the effect of R&D expenditure on the profits of new products. More specifically, in firms with a higher level of EI, the R&D expenditure will have a strengthened positive effect on the profits of new products.

H3d: EI plays a positive moderating role in the effect of R&D staff on the profits of new products. More specifically, in firms with a higher level of EI, the number of R&D staff will have a strengthened positive effect on the profits of new products.

Methods

Data and Sample

We collect data from the large-scale IT companies. The reason for choosing IT industry is that IT companies tend to make radical innovation, and they have eager desire to fulfill the commercialization of innovation. Besides, the practices of EI in IT firms are typical for academic study. We only choose the large-scale company for two reasons: firstly, they are capable of providing detailed financial statement and data about innovation performance; and secondly, the authenticity of data is easy to identify.

We collected data at the firm level. Surveys were sent to firms in IT industry of different ownership and across the developed and developing areas in China. During April to July 2011, surveys with instructions for administrations were packaged and mailed directly to the head office of each company. To ensure accuracy, reliability, and confidentiality of data administration, we requested that each company contact the researcher directly to further discuss the administration procedure.
To reduce the common methodological bias, we used multiple sources of data. Firstly, we collected archival data on the innovation indicators of organizations, which were provided by the R&D department. Secondly, we employed multiple sources for survey administration. Specifically, the human resources/personnel administration department head completed the measures on employee condition, while the financial department manager was responsible for answering the performance measures. We finally had useable data from 126 companies.

Of all responding companies, 33 were state-owned companies, 59 were private companies, and the rest were foreign investment or joint-ventures. Average company size was 10,646 employees. Average company age was 16.51 years (SD = 12.96); average revenue generated in 2009 was 11,689 million RMB (SD = 4,817 million); average marketing investment was 6,751 million and average number of R&D staff was 895.

Measures

The study measures are as follows:

1. Innovation commercialization: The dependent variable, commercialization of innovation, is measured by phase-specific outcomes in NPD. We choose two indicators, the number and profit of new products, as the measures of commercialization performance. To some degree, the number of new products reflects the speed of a firm’s commercialization, while the profit of new products represents the novelty and uniqueness of a firm’s new products;

2. R&D investment: As for the independent variable, R&D investment is acquired directly from the financial data. We divide the R&D investment into two dimensions: the investment of capital and the investment of human. The former is represented by the expenditure of a firm’s R&D, and the latter is measured by the number of engineers in a firm. To unveil the causality between it and NPD capability, we take the data of last year;

3. EI: Based on the previous conceptualization and operationalization of EI, we measured high involvement HR practices using four items, including “formal employee suggestion mechanisms”, “job rotation opportunities”, “cross-functional or self-management teams”, and “employees’ right to make suggestions using information systems”. The response scales range from 0 (No) to 1 (Yes). The sum of all four items was used as the score of the scale, ranging from 0 to 4;

4. Control variables: Previous innovation research has shown that many factors may influence the innovation performance of organizations (Crossan & Apaydin, 2010). As such, we control for several factors that may have a significant impact in the Chinese context. Consistent with previous research, we controlled for organizational size (number of employees) and organizational age. In addition, the previous year’s performance (revenue of last year) may have an impact on innovation outcomes in the current year. Thus, we controlled for the company’s total staff number, age, and revenue, which were based on archival data.

Results

Reliability Analysis

We examined the reliability by split-half, instead of the common Alpha, as the scale ranges between 0 and 1 (Jiménez-Jiménez & Sanz-Valle, 2005). The results showed that the split-half value was about 0.7, which is acceptable.

To avoid the non-response bias in the research, we collect the data of some key variables from 30 firms which do not respond to our questionnaire. The result of T-test shows that those variables have no difference at the significance level of 0.05, which denies the non-response bias in this study (Armstrong & Overton, 1977).
Correlation Analysis

Table 1 reports the means, standard deviations, and zero-order correlation coefficients among the study variables in the IT industry. We consider the multicollinearity among variables before examining the hypotheses. When we put the number and profit of new products as dependent variables for regression analysis, the VIF of independent variables is less than 10. So, we can judge that there is no serious multicollinearity.

Table 1

Means, Standard Deviations, and Correlations of Variables (N = 126)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm age (year)</td>
<td>18.5</td>
<td>12.9</td>
</tr>
<tr>
<td>Total number of staff (person)</td>
<td>10,646</td>
<td>34,682</td>
</tr>
<tr>
<td>Revenue (million)</td>
<td>11,689</td>
<td>48,172</td>
</tr>
<tr>
<td>R&amp;D expenditure (million)</td>
<td>96.15</td>
<td>403.04</td>
</tr>
<tr>
<td>R&amp;D staff (person)</td>
<td>895</td>
<td>1,665</td>
</tr>
<tr>
<td>EI</td>
<td>1.13</td>
<td>0.57</td>
</tr>
<tr>
<td>Number of new products</td>
<td>48</td>
<td>340</td>
</tr>
<tr>
<td>Profit of new products (million)</td>
<td>6,072</td>
<td>24,957</td>
</tr>
</tbody>
</table>

Note: *: p < 0.05; **: p < 0.01.

Regression Analysis

Hierarchical regression was used to examine our hypotheses. Firstly, we examined the effect of R&D expenditure and EI on the number and profit of new products. Table 2 reports the result of regression analysis. The control variables were entered into Model 1, followed by R&D expenditure and EI into Model 2. In Model 2, the R&D investment was positively associated with the number of new products ($\beta = 0.959, p < 0.01$), while the EI was not associated with dependent variable significantly. The H1a has been supported, but the H2a has been denied. Based on the same procedure, Model 5 shows that the R&D investment has a positive effect on the profit of new products ($\beta = 0.091, p < 0.01$), while the EI has no effect on it. This result supports H1b, but denies H2b.

Table 2

The Result of Regression Analysis (N = 126)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Dependent variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of new products</td>
</tr>
<tr>
<td></td>
<td>Model 1</td>
</tr>
<tr>
<td>Control variables</td>
<td></td>
</tr>
<tr>
<td>Firm age</td>
<td>0.053</td>
</tr>
<tr>
<td>Number of staff</td>
<td>-0.070</td>
</tr>
<tr>
<td>Revenue</td>
<td>0.300*</td>
</tr>
<tr>
<td>Independent variables</td>
<td></td>
</tr>
<tr>
<td>EI</td>
<td>0.020</td>
</tr>
<tr>
<td>R&amp;D expenditure</td>
<td>0.959**</td>
</tr>
<tr>
<td>Interaction</td>
<td></td>
</tr>
<tr>
<td>EI*R&amp;D expenditure</td>
<td>-0.133*</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.067</td>
</tr>
<tr>
<td>$\Delta R^2$</td>
<td>0.067</td>
</tr>
</tbody>
</table>

Note: *: p < 0.05; **: p < 0.01.
Then, we examined our hypotheses about the interaction effect of independent variables. To avoid multicollinearity between the predictors and the interaction items, we standardized the variables of R&D expenditure and EI, and then multiplied them to form the interaction variable. The outcome in Model 3 showed that when the interaction variable was putted in the equation, the interaction has a negative effect on the number of new products ($\beta = -0.133, p < 0.05$), which is consistent with H3a. On the contrary, Model 6 indicated that the interaction between R&D expenditure and EI has a positive impact on the profit of new products ($\beta = 0.032, p < 0.05$), which is consistent with H3c.

To specifically illustrate the direction of the interaction mechanism, we followed the procedures of simple slope analysis suggested by Aiken and West (1991), and set EI as a moderator. As shown in Figure 1, for high levels of EI, the R&D expenditure was less positively associated with innovation performance. However, when the level of EI is lower, the relationship between R&D expenditure and number of new products became more robust. These results were consistent with H3a. As shown in Figure 2, the EI played a positive moderating role in the effect of R&D expenditure on the profit of new products, which is consistent with H3c.

The same procedure had been used for the examination of relationships among the number of R&D staff, EI, and innovation commercialization. However, the results showed that the number of R&D staff and EI have no significant impact on dependent variables, including the number and profit of new products. So, H1c, H1d, H3b, and H3d had not been supported.

**Figure 1.** The interaction between EI and R&D expenditure in predicting the number of new products.

**Figure 2.** The interaction between EI and R&D expenditure in predicting the profit of new products.
Conclusion and Discussion

Conclusion

Through the empirical analysis of 126 firms in Chinese IT industry, three critical conclusions can be drawn:

Firstly, R&D investment makes enormous contribution to the performance of innovation commercialization.

Data analysis indicates that there is a significant positive correlation between R&D expenditure and firms’ number and profit of new products, which also suggests that R&D expenditure is a contributing element for firms to realize innovation commercialization. However, compared to R&D expenditure, the indicator of the number of R&D staff has no significant correlation with the indicators of innovation commercialization, which suggests that the number of R&D staff has a trivial impact on the performance of innovation commercialization.

We believe that the result of data analysis is related to the characteristics of sample firms. R&D expenditure, to some extent, demonstrates the human capital investment that a firm made to its employees, and suggests the expertise and skills of R&D staff. For high-tech firms, R&D staff’s quality is much more important than its quantity. Consequently, R&D expenditure has a heavier impact on the performance of innovation commercialization than the number of R&D staff.

Secondly, EI makes contribution to commercial innovation of firms by making an impact on the transmission efficiency of R&D investment, instead of generating a direct positive correlation.

The fact that EI is able to contribute to innovation commercialization of firms has been supported by extensive research. However, the data analysis above indicates that there is no significant correlation between EI and the performance of innovation commercialization. EI comes into effect by making an impact on the relationship between R&D investment and the performance of innovation commercialization. We draw a conclusion that in the process of improving innovation commercialization, R&D investment generates the major effect while EI generates the moderation effect, a conclusion that deviates from the current research conclusion.

The reason which lies behind the deviation refers to the sample. The sample selected in this paper is composed of Chinese major IT firms, which on average own more than 10,000 employees, including some bellwether like Huawei, ZTE, China Mobile, and China Unicom. The systematic and complexity of the innovation of these major firms, which have a longer R&D period and a bigger effort in innovation, are completely different from small-size firms. Consequently, the innovation relies heavily on the enormous input of resources and mature resource allocation system. If firms adopted a cost-control strategic orientation and made less-than-necessary investment on R&D, EI, which may ignite employees’ initiative, could hardly meet the complicated demand from innovation. Thus, the R&D investment of these major firms reveals their strategic orientation and it is the decisive factor of firms’ innovation performance. EI, as a staff management measure, is hard to make an impact on the innovation performance solely.

Thirdly, the mechanism of EI varies from different output indicators of innovation commercialization.

When analyzing the mechanism of EI, we found something interesting: EI plays a negative moderating role in the effect of R&D investment on the number of new products, while generating a positive moderation influence on the effect of R&D investment on the profit of new products. The impact of EI is never constant, as it generates various effects based on different output indicators of innovation.
We believe that the difference among the impacts of EI is attributed to firms’ innovation style. When a firm conducted incremental innovation, in unit time it might be able to launch more new products, which, however, might be featured with less novelty. Otherwise, if a firm was dedicated to radical innovation, its R&D period might be stretched, its knowledge integration might be more difficult, and it might take a longer time to launch a new product. As a result, however, the novelty and uniqueness of the new products would likely to be improved and the revenue of new products would likely to be higher. The implementation of EI may jeopardize the stability of firms’ inner specialized division of labor, the goal congruence of developing new products, and thus the incremental innovation. However, EI is able to promote knowledge integration and communication, thus favoring radical innovation.

**Discussion**

**Theoretical contribution.** Firstly, this paper discussed how to promote firm innovation from innovation commercialization perspective. How to improve firm innovation capability and promote firm innovation has been a heated issue in the field of both theory and practice. Massive research, focusing on how to stimulate employees’ creativity and how to transform the creativity into technical advance, has generated support for firm inner management. However, innovation has to be commercialized eventually. Thus, the process of innovation commercialization has not been valued by many prior researches. This paper, by exploring the process of firms’ innovation commercialization and by taking the performance of innovation commercialization as outcome indicator, tries to analyze the way the performance of innovation commercialization was formed, and provides detailed advice on firm innovation management.

Secondly, this paper integrated the theoretical outcome of human resources management and technology R&D management. Firm innovation, which derives from the joint effect of various factors including strategy, organization and human resources, etc., needs to be analyzed systematically. Prior researches have studied the impacts of R&D investment and EI on firm innovation, from R&D management perspective and human resources management perspective respectively. However, the interaction effect between R&D investment and EI on innovation performance has not been studied thoroughly by prior researches. This paper is dedicated to making up the deficiency.

Thirdly, the analysis in this paper is based on objective data. To acquire firms’ relative performance indicators, most current management studies on firm innovation adopt subjective scale with look-back questionnaire, which is likely to create subjective bias and information distortion (Olson et al., 1995). Thus, analysis and verification demand objective data, which is likely to be collected in practice. There are several reasons: (1) firms are not willing to provide sensitive objective data; and (2) it is hard to make a reasonable comparison among the objective data from different industries. Based on the research method deficiency of prior researches, this paper collected the objective data by communicating with respondents in various channels and set the data analysis within pool of the scale firms in IT industry, which solves the problem to some extent. Thus, the research conclusion may be able to serve extensive reference.

**Managerial implication.** The conclusion of this paper provides practical advice for firms’ inner innovation management.

Firstly, for the executives in large firms, an increase in R&D investment, especially R&D expenditure, is the basis of successful innovation. In a highly competitive market, the management mode based on cost-control orientation is being less effective. To acquire sustainable competency, firms have to adopt the strategic
orientation of innovation, which is featured with enormous R&D investment. Only based on sufficient resource investment can innovation management be conducted and measures that intended to ignite employees’ initiative and creativity being effective.

Secondly, the conclusion of this paper offers firms a principle on the strategy of developing new products. Based on the competitiveness, the key of firms in relatively mature market is to provide frequent product updates and increase market share, which requires constant improvements of products. For instance, in fast moving consuming industry, the incremental improvements of the product package always generate surprise. However, the market position of firms in an unstable environment is hardly maintained by updating current products step-by-step. In this case, a brand new product is needed to appealing potential customers, thus the firm can acquire first mover advantages.

In this way, managers are able to come up with measures to promote EI by identifying the environment and basic mode of NPD. If a firm which hoped to conduct fast updates on service or product, the managers would adopt more centralized and top-to-bottom management mode. Otherwise, if a firm hoped to improve the novelty and uniqueness of product, EI would be a great measure.

Limitation and further research. Firstly, this paper excluded the difference among types of new products. As addressed above, based on the novelty of product, new product type can be classified as “truly new”, “complementary”, “incremental” and “cost-reduction”, etc.. The developing mode of different types of new product varies, so does the level of R&D investment and the method of employee management. This paper attempts to use the number and profits as indicators of different types of new product, without classifying the NPD project directly. Therefore, the future researches should pay more attention to the classification among different NPD projects, to explore the approach of commercialization more deeply.

Secondly, this paper disregarded the other factor input other than R&D investment. In practice, a series of programs including production, purchase, marketing and facilities, etc., are involved in innovation commercialization and firms have to allocate resources among each of them. Thus, the investment in production, marketing, and human resource management is supposed to be considered as an antecedent of innovation performance. Moreover, the interaction lies among various factor input, thus firms’ innovation capability becomes a core competence of ambiguous cause. This paper ignored this issue either. Research in the future may be done by collecting the data which indicate firms’ investment in various functions and analyzing the mutual impact of various factor input, thus we can discuss the complexity and cause ambiguity of the development of innovation capability.

Finally, the sample included only Chinese large-scale companies in the IT industry. Thus, further research is needed to determine the extent to which these findings extend to other countries, industries, and scales of companies.

References


