The relationship between HRM, technology innovation and performance in China

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Abstract
Purpose – Human resource management (HRM) is seen as crucial for innovation and firm performance in China. This paper aims to carry out an empirical research to investigate the effects of main dimensions of HRM on technological innovation as well as organizational performance.
Design/methodology/approach – The research uses a sample of 194 high-tech firms surveyed in eight provinces in China.
Findings – This research finds that employee training, immaterial motivation and process control have positive effects on technological innovation, while material motivation and outcome control have a negative influence on technological innovation. It is also found that technological innovation is positively related with performance.
Research limitations/implications – This study does not consider the different influence of every HRM dimension affecting different innovation types. This should be a future research topic.
Practical implications – This study provides useful managerial implication for managers. First, employee training is needed to develop employees’ knowledge. Second, material incentive is needed but not main motivation in Chinese high-tech firms. Third, process control should be emphasized more than outcome control in Chinese high-tech firms.
Originality/value – This study demonstrated that the HRM significantly contributed to technological innovation and firm performance. This study demonstrates that Chinese high-tech firms’ HRM has an important influence on technological innovation, and lead to firm’s superior performance.

Keywords Human resource management, Motivation (psychology), Innovation, Organizational performance, China

Paper type Research paper

Introduction
The relationship between HRM and firm performance has received considerable attention from HRM researchers and innovation researchers in recent years. A vast amount of research has proved the positive relationship between HRM and a given firm performance (Huselid, 1995; Schuler and Jackson, 1987). Research has also been done on the relationship between technological innovation and firm performance (Foster, 1986; Hill and Rothaermel, 2003; Tripsas and Gavety, 2000).

However, several gaps in this research field remain. First, few studies researched the way in which the relative factors in human resource management affect firm performance in technological innovation. Innovation theory holds that firm innovation can help firms seize opportunities in uncertain environments, acquire competitive

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advantages over rivals, and have an important influence on firms’ long-term performance (Hitt et al., 1997). However, few researchers on innovation can find out exactly where innovation comes from (Damanpour and Gopalakrishnan, 1998). Especially, what types of organization control and management incentive in HRM are advantageous for innovation?

Second, most prior research focuses on cases in Western countries; however few focus on emerging economies such as China. Because of the huge difference in the market environment and the management mechanisms between Western countries and China, there should be much different research results on HRM affecting technological innovation and firm performance in China. This provides an interesting context in which to analyze the interactions between HRM, innovation and performance. In the past decade, many high-tech firms have been established in China. In the Beijing High Technology Experimental Zone alone, the number of technology firms has increased from 527 in 1988 to 4,546 in 1998. Sales income from these firms has increased from US$175 million to US$5.7 billion, with annual growth rate of 42.6 per cent (China’s Science and Technology Commission, 1999). In most Chinese high-tech firms, top managers often want to obtain even higher performance through effective technological innovation. However, compared with their counterparts in market economies, the competitive advantage of these high-tech firms is much more constrained by limited financial resources and limited technical and marketing capabilities (Peng and Heath, 1996). This is due to relatively underdeveloped institutional frameworks and a transitional economy. Meanwhile, limitations in the methods and the capabilities in human resource management (HRM) have also constrained these firms’ development. Many top managers of Chinese high-tech firms want to know how relative factors such as employee training, motivation and appraisal and control in HRM affect technological innovation.

Third, most prior research has not focused on high-tech firms. In particular, this shortcoming in the literature is true for high-tech firms in transitional economies. These firms must not be overlooked because they play a significant role in economic and social development in these countries (Bruton and Rubanik, 1997; Zhao and Aram, 1995).

In order to address these significant gaps, drawing on resource based theory and innovation theory, this article aims to investigate HRM, technological innovation and firms performances using a conceptual framework. In addition, we examine the relationship between these factors in Chinese high-tech firms through empirical methods so as to explain the influence of HRM on firms’ technological innovation and performance under China’s transitional economy. The following is the structure of this paper: first, by reviewing literature on HRM, technological innovation and firm performance, we present the conceptual model shown in Figure 1. Second, we discuss the relationships between high-tech firms’ HRM, technological innovation and firm performance, and then present our hypotheses. Next, we describe the study method and the study results, and finally discuss our findings.

Theoretical background and hypotheses
Several researchers have noted that HRM leads to firm sustainable competitive advantage and superior performance, and HRM is an important means of gaining these competitive advantage (Schuler and MacMillan, 1984; Barney, 1991; Wright et al.,
Technological innovation – the development of new products or new technologies – has an important influence on firm performance (Mumford, 2000). In practice, a firm’s technological innovation mainly comes from internal innovation (Pavitt, 1990), and internal innovation mainly comes from the employee with capability. Thus, there is a close relationship between HRM, technological innovation and firm performance. In the long run, efficient HRM can advance a firm’s technological innovation, improve the company’s competitive advantage and increase the company’s performance (Huselid, 1995).

Resource-based theory suggests that a firm’s resources are extremely important for the firm’s development, and that human capital is a key resource of a firm. The function of this resource depends on the employees’ ability and enthusiasm, and on efficient human resource management (Mumford, 2000). In HRM practice, the training of the employees, motivation and effective appraisal and control are the important issues (Huselid, 1995, Schuler and Jackson, 1999).

First, the employee can more rapidly acquire new knowledge and further develop innovation competencies through training (Chi et al., 1989).

Second, the motivation of the employee has direct influence on technological innovation, though there are, as is inevitable, different results from different researchers (Amabile et al., 1986; Hennessey and Amabile, 1998; Baer, 1997, Eisenberger and Cameron, 1996; Redmond et al., 1993).

Third, because technological innovation is a process accompanied with high risk, it is necessary to use effective controls to reduce risk and enhance efficiency. There are two types of major internal controls associated with a firm’s technological innovation: outcome control and process control (Li et al., 2005). Outcome control stresses final performance and entails objective criteria such as return on investment to appraise

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**Figure 1. Conceptual model**
innovation (Hitt et al., 1996). Process control entails subjective and sometimes intuitive criteria for evaluation and emphasizes the long-term performance of the firm (Gupta, 1987). Meanwhile, different control types often depend on relative incentive method. In other words, different incentive methods will influence top managers of the firms to choose different internal control types. Because material incentive is always based on some objective outcomes, there is a close relationship between material incentive and outcome control. Some research indicates that the main difference between a high-tech firm and a traditional firm is that there is a higher educational level of employees and a higher percentage of scientific and technical personnel to total employment in high-tech firms (Riche et al., 1983). In high-tech firms, individuals care more about self-development and pursue self-actualization. And because employees in high-tech firms possess higher knowledge levels and are more independent, they prefer frequent communion with managers (Mumford, 2000). Thus, there should be a close relationship between non-material incentive and process appraisal and control.

Innovation of firms is the basis of economic development and the necessary path of firm development. Innovation makes employees more productive and firms more efficient (Dougherty and Hardy, 1996; Lawless and Anderson, 1996). Therefore, technological innovation can improve firm performance (Dougherty and Hardy, 1996; Li and Deng, 1999).

According to the discussion above, we present the conceptual model in Figure 1.

**Employee training and technological innovation**
Becker (1964) suggests that employee training allows employees to use the new skills. In high-tech firms, employees with more innovation knowledge are important resources of the firms, and they are required to continually attain new knowledge and skills to keep pace with development of technologies. Training can advance employees’ capabilities of accepting new skills and using new knowledge, and improve employees’ competence in innovation. Innovation involves the production of new ideas, or ideas that can be implemented to solve some significant novel problem (Mumford and Gustafson, 1998). As Basadur (1997), Brophy (1998) and Martinsen (1993) note, different innovations emphasize different processes and impose different requirements. As a result, through training, employees can more rapidly acquire new knowledge, and can increase their innovation ability (Chi et al., 1989). Moreover, the people who have broad expertise and knowledge may produce more technological innovation (Mumford, 2000). Therefore, we suggest:

**H1.** Employee training is positively related to the technological innovation of Chinese high-tech firms.

**Employee motivation and technological innovation**
Firm employees require organizational incentives to enhance the innovation process. People’s behavior can largely be explained in terms of two dominant interests: economic gain and social acceptance (Harsanyi, 1969). Both economic gain and social acceptance create incentive for the employee. Thus, the incentives for the employee can also be divided into material incentives and non-material incentives; material incentive is mainly economic gain, and non-material incentive is mainly social acceptance. Material and non-material incentives can meet the different needs of employees in technological innovation activities.
A series of studies by Amabile and her colleagues (Amabile et al., 1986; Hennessey and Amabile, 1998) indicate that extrinsic rewards – concrete tangible rewards such as bonuses, pay increases, and awards – are detrimental to innovation. Mehr and Shaver (1996) also find that rewards based on innovation outcomes can impair innovation. In China, most high-tech firms are small in size and have only recently entered the market. In order to obtain competitive advantage, these firms often have to implement differentiation strategy and do explorative innovation. During China’s economic transitional period, because the capital market is not developed and firms cannot use some methods such as stock rights and option rights as employee incentives, the material motivation method is comparatively simple. Meanwhile, in Chinese high-tech firms, because most employees have a higher salary level, it is difficult to use material incentives to encourage employees to take on higher risk innovation activities. Thus, material incentives may not encourage employee innovation in high risk and long-term projects because of the characteristics of material incentives. Additionally, because the knowledge level of the employees in the high-tech firms is higher than that of traditional firms, the individuals who take part in innovation generally have keen needs for self-actualization (Mumford, 2000). Thus, the individuals who are efficient in innovation may tend to follow their own ideas and interests (Dudeck and Hall, 1991; Gruber, 1996). Thus, material incentives may have a negative relationship with individual enthusiasm, while non-material incentive can meet the needs of self-actualization, and have a positive relationship with technological innovation.

Therefore, we suggest the following hypotheses:

H2. The more emphasis on material motivation the less possibility of technological innovation in Chinese high-tech firms.

H3. The more emphasis on non-material motivation the more possibility of technological innovation in Chinese high-tech firms.

Control and technological innovation

From an organizational control theory, control can ensure that a firm’s activities are accomplished as planned and that activities are completed in ways that lead to the attainment of the organization’s goals (Robbins, 2001). Firms can function well by using the appropriate control method. Because outcome appraisal and control is a relatively short-term performance measure and uses objective criteria such as return on investment and return on assets, this approach is better applied when the environment is less complex and the performance criteria can be specified in advance. On the other hand, process appraisal and control emphasize information collection and information exchange inside the organization to develop subjective assessment using relevant strategic criteria (Hitt et al., 1996; Li et al., 2005).

Technological innovation is the process of combining and reorganizing knowledge to generate new ideas. When firms innovate radically, they generally need to deal with high uncertainty. Mumford (2000) noted that if firms emphasize outcomes too much, they will develop low-level technological innovation. Under China’s transitional economy, because of small firm size, short time of entering the market, and the uncertain market environment, most Chinese high-tech firms need develop a radical product to build their differentiation advantage. In these cases, outcome control cannot be used efficiently to promote effective innovation in these high-tech firms. Meanwhile,
emphasizing innovation outcomes too heavily can make managers and employees focus on the failure risk of the innovation and their self-interest loss; thus, they will abandon innovations with higher risk. Mehr and Shaver (1996) find that there is no positive relationship between specific performance objectives and innovation. However, by using process appraisal and control, the managers and employees will not fear of loss in economic interest and social acceptance as the result of failure of technological innovation. Thus, they will be enthusiastic in carrying out technological innovation activities.

In the innovation process, it may be very difficult for high-tech firms to efficiently evaluate innovation process using outcome indices, and different evaluation standards may be needed for different types of work under different innovation context (Brophy, 1998). Hitt et al. (1996) found that there is positive relationship between strategic process control and internal innovation. Along similar lines, Scott (1995) has argued that innovation work is better managed by directing process and approach rather than specifying a single desired outcome. Therefore, we suggest the following hypotheses:

\[ H4. \text{ Appraisal and control based on innovation outcomes is negatively related to technological innovation in Chinese high-tech firms.} \]

\[ H5. \text{ Appraisal and control based on innovation process is positively related to technological innovation in Chinese high-tech firms.} \]

**Motivation and control**

In addition to employee motivation and control having a direct effect on technological innovation, there is a close relationship between motivation and the control factors (Bradley and Gelb, 1981; Orpen, 1994). In the process of technological innovation, motivation is closely related to innovation appraisal and control.

Because the result of technological innovation is often uncertain, individuals need time to evaluate and to select in multi-goals (Redmond et al., 1993). This requires that firms give the individual freedom to construct his or her work activities in innovation (Mumford, 2000). As Amabile (1997) suggests, too much emphasis on extraneous events – particularly events inducing external performance pressure – may reduce the intrinsic motivation and curiosity needed for innovation work. It is more appropriate to use process appraisal and control for the high-tech firm’s employees. Non-material motivation does not consider objective and measurable criteria very crucial. In high-tech firms, because of employees’ higher knowledge level, non-material motivation is more important. Process control generally uses subjective criteria to measure outcomes (Gupta, 1987) rather than objective criteria. Therefore, non-material motivation can lead employees to set goals for long-term performance, and is positively related with process appraisal and control.

On the other hand, because material incentives require actual objective and measurable criteria, and the incentive degree is based on the appraisal of employee’s performance, appraisal of employee performance based on innovation outcomes is closely related with material incentives. Therefore, for Chinese high-tech firms, we suggest the following hypothesis:

\[ H6. \text{ The more high-tech firms emphasize material motivation, the greater the possibility of outcomes appraisal and control in China.} \]
H7. The more high-tech firms emphasize non-material motivation, the greater the possibility of process appraisal and control in China.

Technological innovation and firm performance
Technological innovation has enormous influence on firm performance (Nohria and Gulati, 1996). For Chinese high-tech firms, technological innovation should also be an important factor influencing the improvement of performance. With more rapid technical change and increasing global competition, it has become clear that the ability of organizations to develop innovative new products and services is a crucial influence on long-term performance (Hitt et al., 1997). Numerous studies have repeatedly shown a positive relationship between a firm’s technological innovation and performance, and concluded that technological innovation is important for firm performance (Abernathy and Utterback, 1978; Foster, 1986). For Chinese high-tech firms in a transitional economy, technological innovation also improves firm performance. Therefore, we suggest:

H8. Technological innovation in Chinese high-tech firms is positively related to performance.

Methodology
Samples
A questionnaire survey research method was used to seek responses from some typical firms in Shaanxi, Henan, Shanghai, Guangdong, Liaoning, Sichuan, Shandong and Shanxi provinces of China. According to a sample frame provided by the Economy Commerce Committee of the eight provinces, we randomly selected 300 high-tech firms as our study firms. Then, interviewers telephoned potential respondents and solicited personal interviews, and 280 firms accepted our survey. Descriptors of the sample are summarized in Table I.

<table>
<thead>
<tr>
<th>Sample characteristics</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industries</strong></td>
<td></td>
</tr>
<tr>
<td>Material industry</td>
<td>5.2</td>
</tr>
<tr>
<td>Chemical industry</td>
<td>9.3</td>
</tr>
<tr>
<td>Electronic industry</td>
<td>40.2</td>
</tr>
<tr>
<td>Engineering industry</td>
<td>25.2</td>
</tr>
<tr>
<td>Medicine</td>
<td>12.9</td>
</tr>
<tr>
<td>Other industry</td>
<td>7.2</td>
</tr>
<tr>
<td><strong>Employee numbers</strong></td>
<td></td>
</tr>
<tr>
<td>50 or less</td>
<td>18.5</td>
</tr>
<tr>
<td>51-200</td>
<td>37.1</td>
</tr>
<tr>
<td>201-500</td>
<td>19.1</td>
</tr>
<tr>
<td>501-1,000</td>
<td>9.3</td>
</tr>
<tr>
<td>1,000 or more</td>
<td>16.0</td>
</tr>
</tbody>
</table>

Table I. Sample descriptors

Note: n = 194
Pilot study

In designing the questionnaire regarding the actual conditions faced by Chinese high-tech firms, we consulted existing questionnaires on the same relative problems from the literature. Using a preliminary draft questionnaire, a pilot test was conducted with 15 firms from Shaanxi, Henan, and Shandong provinces. These responses were excluded from the final study. The questionnaire was revised using the feedback from the pilot study.

Questionnaire

Data was collected through intensive, in-depth interviews and usually one-to-one. Every interview was about one hour to 90 minutes in duration. Our interviewers had face-to-face communication and explanation with the top managers and relevant department directors of the firms; so that the demand of fulfilling the questionnaire was understand by them. Our interviewees were top firm managers, so they had a comparatively deep understanding of the firm’s HRM process and technological innovation activity, and their responses to the questionnaire could actually demonstrate the firm’s condition. The time frame chosen was from 1997 to 2001, because significant restructuring activity occurred during this period.

A total of 280 high-tech firms were surveyed, 200 high-tech firms provided complete information. Unfortunately, six sample firms were ineligible because of company liquidation or inadequate completion of the survey questionnaire. That is, 194 high-tech enterprises had all the necessary data. The overall response rate for the survey was 71.43 percent (200 out of 280), and the effective rate was 69.29 percent (194/280). This response rate is quite high, given that the surveys were completed by CEOs or their designees, whose time is often scarce.

In order to test the latent dangers in common method variance, we took two steps. First, in order to insure the reliability of answers to our questions, we tried collecting data from different managers in the same firm. A total of 56 high-tech firms completed the two surveys. Through correlation analysis, we found there was not a significant difference between answers to the same questions in the two surveys (Pason coefficients were from 0.362 to 0.792). Second, to assess the non-response bias, we compared the responding firms with the non-responding firms and found no significant differences in terms of firm size and age.

Measures

Employee training. Measures of employee training were developed based on the research of Snell and Lau (1994). Employee training was measured by three items:

1. increasing more investment in employee training in the last five years;
2. emphasizing professional training for employees; and
3. encouraging employee learning through systematic courses and learning by doing.

Responses were made on a seven-point scale ranging from 1, strongly disagree, to 7, strongly agree. The Cronbach’s coefficient alpha for this scale is 0.60.

Material incentive. The three items that measured material incentive are mainly based on the scales of Kuratko et al. (1997). They are:
(1) increasing individual material fortune;
(2) increasing opportunity to gain an economic interest in the firm; and
(3) a guarantee of future income for family members.

Responses were made on a seven-point scale ranging from 1, strongly disagree, to 7, strongly agree. The Cronbach’s coefficient alpha for this scale is 0.85.

Non-material incentive. The three items that measure non-material incentive are mainly based on the scales of Kuratko et al. (1997). They are:

1. acquiring social acceptance, praise and honor;
2. obtaining individual opportunity by accepting the challenge of the innovation; and
3. progress of personal in business or work.

Responses were made on a seven-point scale ranging from 1, strongly disagree, to 7, strongly agree. The Cronbach’s coefficient alpha for this scale is 0.78.

Process appraisal and control. In order to study the influence of appraisal and control of innovation process on firms’ technological innovation, we designed measurable items based mainly on the research of Prowse (1995) and Xu and Wang (1997):

1. permitting the employees to make mistakes during the innovation process;
2. a high degree of trust between leaders and subordinates; and
3. building benign relationships between collaborators.

Responses were made on a seven-point scale ranging from 1, strongly disagree, to 7, strongly agree. The Cronbach’s coefficient alpha for this scale is 0.88.

Outcome appraisal and control. In this study, the measures of outcome appraisal and control are mainly taken from the research of Hitt et al. (1996). They are:

1. high requirement on the ROI (return on investment) to the innovation;
2. cash currency being abundant through the innovation; and
3. high increasing speed of net assets through the innovation.

Responses were made on a seven-point scale ranging from 1, strongly disagree, to 7, strongly agree. The Cronbach’s coefficient alpha for this scale is 0.74.

Technological innovation. Items that measure technological innovation were mainly taken from the scales of Zahra et al.’s (2000) research. Technological innovation was measured by five items:

1. frequent introduction of new product ideas into production process;
2. high probability of success for new products being tested;
3. spending shorter periods in new product research and development;
4. radical improvement in the company’s technology; and
5. frequently renewal of equipment.

Responses were made on a seven-point scale ranging from 1, strongly disagree, to 7, strongly agree. The Cronbach’s coefficient alpha for this scale is 0.73.

Firm performance. We measured a firm’s financial performance using four items based on the research of Daily and Johnson (1997):
(1) increasing rate of sales revenue;  
(2) increasing rate of profit;  
(3) increasing rate of net asset ROI (return on investment); and  
(4) increasing rate of market share.

Responses were made on a seven-point scale ranging from 1, strongly reduced, to 7, strongly increased. The Cronbach’s coefficient alpha for this scale is 0.85.

Analyses and result
We tested our model with the statistical software SPSS10.0 and AMOS4.0. Structural equation analysis is a combination of factor analysis and path analysis. Our approach to estimating the structural equations model follows the two-stage procedure recommended by Anderson and Gerbing (1988):

(1) Estimating a model’s reliability and validity, which can assure the variables used in following analysis is reliable and valid. Estimation of a model’s reliability and validity is done with SPSS10.0.

(2) Testing the theoretical model.

The hypotheses were tested using structural equation modeling (SEM) techniques as implemented in AMOS 4.0.

Reliability analysis
Composite reliability assesses inter-item consistency, which was operationalized using the internal consistency method that is estimated using Cronbach’s alpha. Typically, reliability coefficients of 0.70 or higher are considered adequate (Cronbach, 1951; Nunnally, 1978). Nunnally (1978) further states that permissible alpha values can be slightly lower (>0.60) for newer scales. Although the constructs developed in this study are measured primarily on previously validated measurement items and strongly grounded in the literature, they are modified somewhat to suit the Chinese context. Therefore, an alpha value of 0.60 was considered as the cut-off value. As shown in Table II, three Cronbach’s alpha values are more than 0.80 and three between 0.70 and 0.79, but the alpha of employee training is 0.60. These results suggest that the theoretical constructs exhibit good psychometric properties.

Construct validity
Construct validity is the extent to which the items on a scale measure the abstract or theoretical construct (Chandler, 1991; Churchill, 1979). Testing of construct validity concentrates not only on finding out whether an item loads significantly on the factor it is measuring (i.e. convergent validity) but also on ensuring that it measures no other factors (i.e. discriminant validity) (Campbell and Fiske, 1959).

Convergent validity exists if a group of indicators are measuring one common factor. Convergent validity is demonstrated by the statistical significance of the loadings at a given alpha (e.g. $P = 0.05$). A loading of 0.7 indicates that about one-half of the item’s variance (the squared loading) can be attributed to the construct; thus, 0.7 is the suggested minimum level for item loadings on established scales (Fornell and Larcker, 1981). Of the 24 items in the various scales, only three were below this
threshold and three were slightly less than the threshold, implying both the statistical significance of relationships between the items and constructs and reliability of individual items.

Assessment of model fit
As Table III shows, the overall fit of the saturated measurement model is good. With AMOS, the model yielded a chi-square of 176.430 with 175 d.f. Although analysis of

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Items</th>
<th>Item name</th>
<th>Factor loading</th>
<th>α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employee training (ET)</td>
<td>ET-01</td>
<td>Increasing more investment in employee training in the last five years</td>
<td>0.79</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>ET-02</td>
<td>Emphasizing professional training for employees</td>
<td>0.68</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ET-03</td>
<td>Encouraging employee learning through systematic courses and learning by doing</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>Material incentive (MI)</td>
<td>MI-01</td>
<td>Increasing individual material fortune</td>
<td>0.80</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>MI-02</td>
<td>Increasing opportunity to gain an economic interest in the firm</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MI-03</td>
<td>A guarantee of future income for family members</td>
<td>0.87</td>
<td></td>
</tr>
<tr>
<td>Non-material incentive (NI)</td>
<td>NI-01</td>
<td>Acquiring social acceptance, praise and honor</td>
<td>0.80</td>
<td>0.78</td>
</tr>
<tr>
<td></td>
<td>NI-02</td>
<td>Obtaining individual opportunity by accepting the challenge of the innovation</td>
<td>0.83</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NI-03</td>
<td>Progress of personal in business or work</td>
<td>0.87</td>
<td></td>
</tr>
<tr>
<td>Process appraisal and control (PC)</td>
<td>PC-01</td>
<td>Permitting the employees to make mistakes during the innovation process</td>
<td>0.93</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>PC-02</td>
<td>A high degree of trust between leaders and subordinates</td>
<td>0.94</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PC-03</td>
<td>Building benign relationships between collaborators</td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td>Outcome appraisal and control (OC)</td>
<td>OC-01</td>
<td>High requirement on the ROI (return on investment) to the innovation</td>
<td>0.60</td>
<td>0.74</td>
</tr>
<tr>
<td></td>
<td>OC-02</td>
<td>Cash currency being abundant through the innovation</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OC-03</td>
<td>High increasing speed of net assets through the innovation</td>
<td>0.91</td>
<td></td>
</tr>
<tr>
<td>Technological innovation (TI)</td>
<td>TI-01</td>
<td>Frequent introduction of new product ideas into production process</td>
<td>0.69</td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td>TI-02</td>
<td>High probability of success for new products being tested</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TI-03</td>
<td>Spending shorter periods in new product research and development</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TI-04</td>
<td>Radical improvement in the company’s technology</td>
<td>0.68</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TI-05</td>
<td>Frequently renewal of equipment</td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td>Firm performance (FP)</td>
<td>FP-01</td>
<td>Increasing rate of sales revenue</td>
<td>0.90</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>FP-02</td>
<td>Increasing rate of profit</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FP-03</td>
<td>Increasing rate of net asset return on investment</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FP-04</td>
<td>Increasing rate of market share</td>
<td>0.66</td>
<td></td>
</tr>
</tbody>
</table>

Table II. Convergent validity constructs
covariance structure has traditionally relied on a chi-square likelihood ratio test to assess model fit, it is very sensitive to the sample size, number of items, and number of factors in the model. Therefore, other fit indices, including chi-square/df, GFI, NFI, and RMSEA, were used to assess overall model fit. The value of chi-square/df was found to be 1.008, which is a good fit because the recommended range for the ratio of chi-square to degrees of freedom is between 1.0 and 2.0 (Hair et al., 1995). The GFI assesses the correspondence between observed and hypothesized covariance. A good GFI should be 0.90 or higher, and a good AGFI should be near 0.90 or higher. In our model, the GFI is 0.933, and the AGFI is 0.886. The NFI indicates the extent to which the model improves fit compared to a random model, and a value greater than 0.80 is considered indicative of good fit. Our model has an NFI of 0.932 and therefore shows a good fit. The RMSEA value of 0.007 is well below 0.033, indicating a low discrepancy between the implied covariance in the model and observed covariance in the data. Other indicators are reported in Table III. In general, all these results suggest that our model fits the data well.

**Test of hypotheses**

Table IV presents results of the testing of the eight hypotheses, and the final tested path relation is described in Figure 2.

**HRM and technological innovation.** The first set of hypotheses (H1, H2, H3, H4, and H5) predicted the influence of HRM (training, motivation, and control) on tech-innovation. A high-tech firm’s employee training is positively related to technological innovation (0.464, p < 0.05); thus H1 received support. H2 is also supported, showing a negative effect between material incentive and technological innovation (−0.425, p < 0.05). Non-material incentive has a positive effect on technological innovation (0.445, p < 0.1), thus supporting H3. Outcome appraisal and control is negatively related to technological innovation (−0.628, p < 0.01); this support H4. Alternatively, process appraisal and control is positively related to technological innovation (0.485, p < 0.05) supporting H5. These data suggest that for high-tech firms, emphasizing employee training, non-material incentive and process control can advance the firms’ tech-innovation, but emphasizing material incentives and outcome control can impede the firm’s tech-innovation.
### Motivation and control

The second set of hypotheses ($H6$, $H7$) predicted the effect of motivation on control. There is a statistically significant positive relationship between material incentive and outcome appraisal and control ($0.414$, $p < 0.001$), and non-material incentive and process appraisal and control ($0.577$, $p < 0.001$); this supports $H6$ and $H7$. These results indicate that as has been discussed above, motivation and control have a direct effect on a firm's innovation, and that motivation also has a noteworthy effect on a firm's internal control. Material incentives have a significant effect on outcome control, and non-material incentives have a significant effect on process control.

#### Technology innovation and performance

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Path</th>
<th>Standardized regression weights</th>
<th>$p$-value</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H1$</td>
<td>$ET \rightarrow TI$</td>
<td>0.464</td>
<td>0.020 **</td>
<td>Support</td>
</tr>
<tr>
<td>$H2$</td>
<td>$MI \rightarrow TI$</td>
<td>$-0.425$</td>
<td>0.038 **</td>
<td>Support</td>
</tr>
<tr>
<td>$H3$</td>
<td>$NI \rightarrow TI$</td>
<td>0.445</td>
<td>0.069*</td>
<td>Support</td>
</tr>
<tr>
<td>$H4$</td>
<td>$OC \rightarrow TI$</td>
<td>$-0.628$</td>
<td>0.004 ***</td>
<td>Support</td>
</tr>
<tr>
<td>$H5$</td>
<td>$PC \rightarrow TI$</td>
<td>0.485</td>
<td>0.049 **</td>
<td>Support</td>
</tr>
<tr>
<td>$H6$</td>
<td>$MI \rightarrow OC$</td>
<td>0.414</td>
<td>0.000 ****</td>
<td>Support</td>
</tr>
<tr>
<td>$H7$</td>
<td>$NI \rightarrow PC$</td>
<td>0.577</td>
<td>0.000 ****</td>
<td>Support</td>
</tr>
<tr>
<td>$H8$</td>
<td>$TI \rightarrow FP$</td>
<td>0.200</td>
<td>0.023 **</td>
<td>Support</td>
</tr>
</tbody>
</table>

**Notes:** *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$; ****$p < 0.001$**
Technological innovation and firm performance. H8 predicted the effect of tech-innovation on firm performance. There is a positive relationship between technological innovation and firm performance (0.200, \( p < 0.05 \)), and H8 received support. This shows that, as has been certified by many scholars, tech-innovation is important for firms to achieve better financial performance.

Discussion and conclusion

Resource-based theory and innovation theories have confirmed the importance of both HRM and technological innovation on a firm’s performance. In this study, our contributions focus on the building of a conceptual framework that clarifies the relationship between HRM, technological innovation and firm performance, and we examine the effects of high-tech firm’s HRM on technological innovation and firm performance in China. Drawing on resource-based theory and innovation theory, this study demonstrates that a Chinese high-tech firm’s HRM has an important influence on technological innovation, which lead to that firm’s superior performance. Beyond providing a rich description of the relationship between HRM, technological innovation and performance, this study presents several important findings.

First, we find that employee training has direct and positive effects on technological innovation in Chinese high-tech firms. This result provides the support for resource-based theory that continuously enhancing the quality of a firm’s human resources will increases the firm’s competitive advantage. When a firm wants to obtain a competitive advantage in an uncertain economic environment such as China’s, there is a need for higher quality human resources, which can be obtained by training all employees of the firm. For high-tech firms in the countries with an emerging economy such as China’s, there are many market opportunities because of economic transitions and institutional reforms. Thus, employee training helps high-tech firms to not only gain technological progress through increased knowledge, but also to find new market opportunities and to enhance their innovation ability through information exchange and skill improvement.

Our findings show that material incentives are negatively related to technological innovation and that non-material incentives are positively related to technological innovation in Chinese high-tech firms. These findings support the argument of Amabile and her colleagues (Amabile et al., 1986; Hennessey and Amabile, 1998). Meanwhile, the latter finding is also consistent with previous research results that found that allowance of self-growth and independence in the workplace can enhance the technological innovation work of employees in high-tech firms (Dudeck and Hall, 1991; Gruber, 1996; Mumford, 2000).

The results of this study strongly suggest that process appraisal and control is positively related to technological innovation, while outcome appraisal and control is negatively related to technological innovation. Our findings reinforce the work by DeTienne and Koberg (2002) and examine the research of Spender and Kessler (1995), both of whom noted that process control is helpful to innovation. On the other hand, process appraisal and control is of benefit in encouraging risk-taking actions of employees. Thus, our research results validate the view of Mumford (2000), and also support the research of Hitt et al. (1996) as well as Scott (1995).

This study examines the perspective that there is a close relationship between motivation and control (Bradley and Gelb, 1981; Orpen, 1994). Research results suggest
that material incentive is positively related to outcome control, and non-material incentive is positively related to process control. These findings suggest that high-tech firms need effective results measurement and appraisal when they emphasize material incentives. When emphasizing non-material incentives, it is important to use process appraisal and control. These findings indicate that Chinese high-tech firms should choose effective control methods based on the employees’ demands and the needs of high-tech firms to motivate employees.

In agreement with many research results (Abernathy and Utterback, 1978; Foster, 1986; Hill and Rothaermel, 2003; Tripsas and Gavetti, 2000), we further certify that technological innovation is positively related to firm performance during the Chinese economic transitional period. The technological innovation of high-tech firms has an important influence on firm performance, and effective HRM can ensure sustainable technological innovation in Chinese high-tech firms. Therefore, effective HRM can enhance the performance of high-tech firms by increasing technological innovation.

Managerial implications
All of the above findings have useful implications for the managers in Chinese high-tech firms. First, our study suggests that professional employee training can develop employees’ knowledge. Therefore, the top managers of the high-tech firms should further improve employee training so as to promote the firms’ technological innovation. Thus, professional employee training will result in the advancement of a firm’s competitive advantage and performance.

Second, the research results suggest that material incentives are negatively related to technological innovation and that there is a positive relationship between non-material incentives and technological innovation. The above two results also imply that material incentives are perhaps needed for employees, but they can not become the main means of promoting technological innovation in Chinese high-tech firms. The top managers of Chinese high-tech firms should focus more on providing non-material incentives to continuously improve the effect of technological innovation.

From the research results related to the relationship between the incentive and the control, process appraisal and control should be emphasized more than outcome appraisal and control in order to improve the technological innovation. In particular, through the improvement of process appraisal and control, firms may excel in new product development or new production methods. This can improve firm’s competitive advantage.

Limitations and future research
Despite some contributions to the literature and certain practical applications, this study has limitations that should be addressed in future research. First, the cross-sectional data used in the study do not allow for causal interpretation among the factors, although we requested that the sample firms supply data for the most recent five-year period. Ideally, this study would have benefited from a time lag between the measurement of the independent and dependent variables in order for a causal relationship to be determined. We hope that this study will serve as a foundation for new studies in the future.

A second limitation is that this study does not consider the different influences of every HRM factor affecting different innovation types, such as radical innovation and
incremental innovation. Because the strategy of high-tech firms is often different from that of traditional firms, the choice of different innovation types will produce different results. This should be a future research topic. Additionally, our findings and results are unique to the Chinese. We hope this study serves as the basis for an effort to sharpen understanding of the relationship between HRM, innovation, and a firm’s performance in emergent economic countries.

References


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