２Ｃ２９

The Effect of Organizational and Human Resource Management on Innovation

○羽田尚子（中央大学）
伊藤恵子（専修大学）

1. Introduction

In this study, we analyze the relationship between firms' innovation output and organizational and human resource management in research units within a firm which should determine the rate and direction of firm-level innovation. We use the firm-level data underlying the Japanese National Innovation Survey conducted by the Ministry of Education, Culture, Sports, Science and Technology in 2009. We can define firm-level innovation output as the sales from innovative products and to distinguish new-to-the-market sales. We also define firm-level information on within-firm R&D organizational changes or evaluation systems for researchers with the data.

2. Data

For our empirical analyses below, we eliminate observations for firms that did not provide information on their total sales amount. As a result, we are left with 3,837 observations for 2009.

As for internal factors which affect firms' innovation activities, we focus on organizational and human resource management within a firm. We aggregate the 11 questions regarding organizational and human resource management for the purpose of efficient R&D into 8 items and group them into 3 broad categories.

O1) Promotion for cooperation and coordination across business units or divisions at the firm as a whole

- Interdivisional cooperation/teams: The firm implemented rotation of employees across divisions or created project teams across divisions.

- Interdivisional meetings/systems: The firm held meetings across division or introduced systems which accumulate, exchange, or share information across divisions.

O2) Human resource management on R&D personnel

- Board members with R&D background: The firm assigned a person from the R&D division as a board member.

- Personnel assessment reflecting R&D outcome: The firm reflected the R&D outcome to the assessment of researchers or engineers.

- Incentive payment: The firm introduced an incentive payment scheme for the employees' invention.

- Employment or re-employment of retired researchers or engineers: The firm employed or re-employed researchers or engineers who reached retirement age.

O3) Restructuring R&D organization

- Creation/relocation/integration/reorganization of R&D centers or divisions: The firm created, relocated, integrated, or reorganized centers or divisions of the firm's R&D activities.

- Increased authority for researchers/engineers: The firm increased or extended the authority of researchers or engineers.

3. Empirical Analysis

First, we estimate a probit model in order to investigate factors which determine whether a firm innovates or not.

$$y_i = \begin{cases} no\ innovation & if\ \ y_i^* > 0 \\ innovation & if\ \ y_i^* \leq 0 \end{cases}$$

where $y_i^* = X_i\beta + \varepsilon$ is a latent innovation variable for firm i indicating propensity to innovate, and y_i is the corresponding observed binary variable which takes one for innovators. We use two innovation variables as follows:

P1) Product innovation: Introduction of new or significantly improved products during the preceding three years.

P2) Process innovation: Introduction of new or significantly improved production processes during the preceding three years.

P1) and P2) are indicators to explain a propensity to innovate for a firm, but do not indicate how large/significant the impact of new or significantly improved products in the market where the firm operates. Therefore, we further define multiple and ranked discrete innovation variables y_i^o which take into account the significance of innovation. We then estimate the determinants of innovation success, employing the ordered probit regression. To identify the significance of innovation, we characterize the innovative products in terms of the newness of the products. The dependent variable is the discrete alternatives for all firms with: (0) no product innovation; (1) product innovation; (2) new-to-the-market innovation, ordered in this manner.

$$y_{1i}^o = \begin{cases} no\ product\ innovation & if\ y_i^* \leq c_1 \\ product\ innovation & if\ c_1 < y_i^* \leq c_2 \\ new-to-the-market\ product\ innovation & if\ c_2 < y_i^* \end{cases}$$

c_1 and c_2 are threshold parameters. We specify the latent variable y_i^* for firm i indicating the degree of significance of product innovation as $y_i^* = X_i\beta + \varepsilon$.

We use the following information to construct a variable representing the significance of product innovation:

S1) New-to-the-market product innovation: Whether the firm introduced any new or significantly improved product to the market where the firm operates during the past three years.

Only firms with product innovation answer this question, and we thus assign a value of zero for all non-innovating firms. The firms answering that the innovative products they introduced are not new-to-the-market products take one for the variable. The firms answering that they introduced any new or significantly improved products to the market where the firm operates take two for the variable.

As for the explanatory variables, X_t, we include R&D intensity and firm size. R&D intensity, which is measured as the ratio of R&D expenditure to total sales in logarithm, is included as a proxy for firms' innovation inputs. Firm size, which reflects access to finance, scale and scope economies, differences in the firm organization such as group membership and vertical or horizontal integration, and so on, is measured as the firm's total sales amount in 2006 in logarithm.

The explanatory variables of our main focus are dummy variables representing firms' organizational and human resource management. We prepare the following 8 dummy variables for firms' management practices corresponding to O1), O2) and O3) in section 2. We also include 11 industry dummies to capture technological opportunity conditions, industry-targeted innovation policies, and industry-specific demand growth effects, and structural effects such as the intensity of competition.

4. Empirical Results

The results of the probit estimation (average marginal effects) are shown in Table 1. Looking at the results, while some types of organizational and human resource management commonly affect both product and process innovation, there are some other types of management practices differently affect product and process innovation. More specifically, promotion for cooperation and coordination across business units or divisions (i.e., interdivisional cooperation/teams and interdivisional meetings/systems), personnel assessment reflecting R&D outcome, and creation/relocation/integration of R&D centers positively affect both product and process innovation. While interdivisional cooperation and meetings have a higher marginal effect on process innovation than personnel assessment and restructuring of R&D center, the latter two factors have a higher marginal effect on product innovation than the former two factors. These results may suggest that horizontal communication across divisions is more important for process innovation while personnel assessment and drastic changes in R&D organization are more important for product innovation.

On the other hand, the results show that board members with R&D background positively affect product innovation, implying that top-down R&D decision may speed up the decision making and promote product innovation. However, employment or re-employment of retired researchers or engineers negatively affects product innovation, implying that age diversity has a negative effect on firm's likelihood to innovate. The negative effect of employment of retired researchers or engineers may indicate that experiences and competences of retired researchers or engineers may be too

disconnected from those of younger researchers or engineers or that a socio-emotional conflict is created between retired and younger researchers or engineers.

Table 1. Estimated marginal effects for the probit model of innovation:
Product innovation v.s. process innovation

	product innovator			process innovator		
	dy/dx	s.d		dy/dx	s.d	
Log of R&D/sales	0.303	0.180	*	-0.033	0.157	
Log of sales(2006)	0.026	0.004	***	0.019	0.004	***
Interdivisional cooperation/teams	0.078	0.017	***	0.123	0.018	***
Interdivisional meetings/systems	0.111	0.017	***	0.166	0.017	***
Board members with R&D background	0.073	0.028	***	-0.024	0.030	
Personnel assessment reflecting R&D outcome	0.127	0.021	***	0.076	0.024	***
Incentive payment	0.027	0.021		-0.018	0.023	
Employment or re-employment of retired researchers or engineers	-0.044	0.018	**	0.022	0.019	
Creation/relocation/integration of R&D centers	0.156	0.021	***	0.105	0.024	***
Increased authority for researchers/engineers	0.047	0.034		0.082	0.035	**
Industry Dummies	YES			YES		
Nb. of observations	3837			3837		
LR^2	864.27			964.28		
R^2	0.2319			0.2237		

* Significant at 10%, ** at 5%, *** at 1%.

The effect of incentive payment is not significant, but personnel assessment reflecting R&D outcome has a significantly positive marginal effect on both product and process innovations. It increases the probabilities to introduce new products and new production process by 12.7% and 7.6%, respectively. These results imply that while monetary incentives may not improve the propensity to innovate, it is important for managers to evaluate and appreciate researchers' outcome in order to motivate the researchers and realize successful innovation.

The result of the ordered probit estimation (average marginal effects) is shown in Tables 2. The results are consistent with those in Table 1, and we confirm that many of the organizational variables have a significantly positive marginal effect on the outcome and that the magnitude of the marginal effects are larger for the new-to-the-market product innovation (outcome=2). These results imply that organizational management is relevant for successful innovation and that it is even more important for firms to realize breakthrough innovation (new-to-the-market innovation). However, again, incentive payment does not have a statistically significant effect. In addition, employment or re-employment of retired researchers or engineers has a negative marginal effect on product innovation.

Table 2. Estimated marginal effects for the ordered probit model of innovation: New-to-the-market product innovation

	Outcome: no product innovation(0)<product innovation(1)<new-to-the-market product innovation(2)				
	Outcome=1 (observations: 731)			Outcome=2 (observations: 487)	
	dy/dx	s.d.		dy/dx	s.d.
Log of R&D/sales	0.087	0.047	*	0.114	0.061 *
Log of sales(2006)	0.010	0.002	***	0.013	0.002 ***
Interdivisional cooperation/teams	0.036	0.007	***	0.047	0.010 ***
Interdivisional meetings/systems	0.049	0.007	***	0.065	0.010 ***
Board members with R&D background	0.024	0.010	**	0.031	0.012 **
Personnel assessment reflecting R&D outcome	0.043	0.008	***	0.056	0.010 ***
Incentive payment	0.002	0.008		0.003	0.011
Employment or re-employment of retired researchers or engineers	-0.012	0.007	*	-0.015	0.009 *
Creation/relocation/integration of R&D centers	0.053	0.008	***	0.070	0.010 ***
Increased authority for researchers/engineers	0.029	0.012	**	0.038	0.016 **
Industry Dummies	YES				
Nb. of observations	3837				
LR^2	1018.12				
R^2	0.1611				

* Significant at 10%, ** at 5%, *** at 1%.

5. Conclusion

In this study, we analyzed the relationship between firms' innovation outcome and organizational and human resource management in research units within a firm. We found a positive relationship, which suggests that management practices are important to realize product innovation. In particular, we found that some types of management practices such as interdivisional cooperation/teams, broad members with R&D background, personnel assessment reflecting R&D outcome, and creation/relocation/integration of R&D centers had a strong positive impact on breakthrough innovation. Moreover, personnel assessment reflecting R&D outcome consistently had a large positive effect on product innovation, while incentive payment and employment or re-employment of retired researchers or engineers had an insignificant or even negative impact on product innovation. These results suggest that human resource management on R&D personnel is an important determinant of innovation success and that appreciating R&D outcome is likely to motivate researchers and to promote breakthrough innovation.