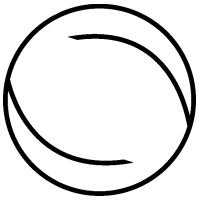
Strategic Human Resource Practices and Product Innovation

Sjoerd Beugelsdijk

Organization Studies 2008; 29; 821
DOI: 10.1177/0170840608090530



Strategic Human Resource Practices and Product Innovation

Sjoerd Beugelsdijk

Abstract

Using creativity theory as a heuristic device, I develop hypotheses on the relation between strategic human resource practices and a firm's capability to generate product innovations. My empirical tests in a sample of 988 Dutch firms indicate the importance of task autonomy, training and performance-based pay for generating incremental innovations. Regarding radical innovations, the results point to the importance of task autonomy and flexible working hours. The use of standby contracts is associated with significantly lower levels of innovativeness. We also find interaction effects between individual HR practices, between HR practices and firm size, and between HR practices and R&D intensity.

Keywords: innovation, human resource management, creativity

Sjoerd Beugelsdijk
Nijmegen School of Management, The Netherlands

Organizational renewal, especially product innovation, is generally considered a core challenge for firms to survive and prosper in today's economic environment (Baumol 2004; Danneels 2002). Despite the scholarly attention to the role of knowledge in creating a competitive advantage, only scant attention has been paid to the internal organizational structure of firms and innovation outcomes (Argyres and Silverman 2004: 930; Greve 2003: 685; Kang et al. 2007; Wiklund and Shepherd 2003). In this paper, the relationship between the internal organization structure, more specifically a firm's strategic human resource (HR) practices, and its innovative output is explored. A major strength of this study is the theoretically informed context-embedded selection of HR practices in explaining why some firms are more innovative than others.

The goal of the present study is to complement the existing body of knowledge on HR practices with a large-scale empirical study, and at the same time contribute to the discussion on why some firms are more innovative than others. Drawing on insights from creativity theory,[2] hypotheses on the relationship between a firm's HR practices and its ability to produce innovations are developed. We are not so much trying to push the frontier on creativity research, but use it as a framework to theorize on the relationship between innovation and strategic HRM (SHRM) and empirically relate HR practices to innovation. Starting from the resource-based view (RBV) of the firm, it is argued that HRM that is strategically oriented towards the fostering of creativity promotes the ability of firms to generate (product) innovations, thereby contributing to a sustained competitive advantage. By doing so, I respond to the recent plea of Colbert (2004) to explore the creative aspects of the RBV in SHRM.

Organization Studies
29(06): 821–847
ISSN 0170–8406

DOI: 10.1177/0170840608090530

Using a sample of 988 Dutch firms, the relationship between a set of six HR practices and the fraction of radically and incrementally changed products in a firm's total sales is explored. We find that firms with decentralized organizational structures and a focus on employee empowerment, as reflected in the use of task autonomy and flexible working hours, generate more product innovations. We also find that performance-based pay and training and schooling are positively associated with incremental innovation, but not with radical innovation. For both types of innovation we find that the use of standby contracts has a negative effect. Finally, a number of these HR practices are moderated by size of the firm and its R&D intensity. In general, the findings suggest that in contrast with radical innovation, incremental innovations are relatively easier to 'organize' in the sense that by implementing certain HR practices, managers can increase a firm's incremental innovative output.

The paper proceeds as follows. In the next section the theoretical background of the study is sketched. Drawing on established insights from creativity theory and HR literature hypotheses are developed relating HR practices to a firm's innovative output. The data and methods are then described, and empirical results presented. We conclude with a discussion of the findings and suggestions for future research.

Innovation and HR Practices

RBV, Contingency Approaches and HRM

The field of HR is generally perceived to consist of three broad approaches (Delery and Doty 1996): the contingency or best fit approach (e.g. Becker and Gerhart 1996; Jackson and Schuler 1995; Lengnick-Hall and Lengnick-Hall 1988; Miles and Snow 1984), the universalistic or best practice approach (e.g. Arthur 1994; Huselid 1995; Pfeffer 1994, 1998) and the configurational approach. Whereas the best practices approach typically argues that some HR practices are always better than others and that therefore all organizations should adopt these practices (Marchington and Grugalis 2000), contingency scholars argue that for HR practices to be effective they must be consistent with other aspects of the organization. Youndt et al. (1996) posit that these two approaches are in fact complementary. They claim that individual HR practices or bundles (consistent systems) of HR practices directly affect organizational performance. Moreover there is evidence that 'the impact of HR practices on firm performance may be further enhanced when practices are matched with the competitive requirements inherent in a firm's strategic posture' (Youndt et al., 1996: 837). In fact, Delery and Doty (1996) label this a configurational approach, in which there should both be horizontal fit (internal consistency of HR practices) and vertical fit (congruence of HR system and other organizational characteristics).

Although in all the above approaches the human resources of a firm are presented as fundamental for a firm's competitiveness, it is especially the best practice approach in which the resource-based view (RBV) of the firm is explicitly

taken as a starting point (Barney 1991). Whereas the RBV of the firm is often presented as being at odds with approaches that explicitly include contextual variables, this is not entirely true. To some extent the contingency perspective fits the RBV of the firm. As Datta et al. (2005) note, the RBV of the firm argues that the resources contribute more or less *depending on a firm's competitive environment* (Barney 1995). In other words, whereas there seems to be a tendency to either use a resource-based perspective on SHRM (Colbert 2004), or apply a contingency approach, this dichotomy is not so strict. This paper starts from a RBV of the firm, but in operationalizing our relevant HR practices we take the broader socioeconomic environment into account.

Given the general importance that strategy scholars attach to a firm's ability to innovate, it is remarkable that the literature on SHRM has hardly taken this into account (Kang et al. 2007). Although a firm's human resources are seen as particularly important for providing a sustained competitive advantage and play an essential role in a firm's ability to be entrepreneurial (Wiklund and Shepherd 2003), most empirical contributions have concentrated on SHRM and its effect on financial performance, turnover or productivity. To my knowledge only Shipton and colleagues have tested the relationship between HRM and innovation in a statistical study (Shipton et al. 2005, 2006a,b). Though a supportive learning climate is not included in the 'classic' list of HR practices, they do find that organizational innovation is enhanced when such a climate exists.

Theorizing on HR Practices

In developing hypotheses relating HR practices to innovativeness insights from the HR literature with creativity theory are combined. Acknowledging that creativity concerns the generation of ideas and not so much the actual innovation (Unsworth 2001; Van Dijk and Van den Ende 2002), creativity theory is a useful heuristic device to theorize on the relationship between HR practices and innovation, because HRM focused on the creative performance of employees is considered an important part of the innovative capability of firms and the resulting competitiveness (Amabile 1988). 'Factors in the work environment, such as supervisory support and social influences resulting from group interaction, are proposed to be important antecedents to creativity' (Perry-Smith 2006: 85). Theorizing on HR practices and innovation using creativity as a conceptual lens is also attractive, because the field of HR is often criticized for lack of theories and ad hoc measures (Colbert 2004; Delery and Doty 1996).

Acknowledging the relatedness of this specific HRM focus and organizational learning theory, we do not explicitly aim to contribute and advance our understanding of the latter. The HR-innovation route runs through creativity theory and in a way fits the antecedents of Zollo and Winter's (2002) knowledge evolution cycle (see also Nonaka et al. 2006). As Zollo and Winter state, the point of departure of this cycle lies in the stage where individuals and /or groups in firms respond to old problems in novel ways or new challenges on the basis of a combination of external stimuli and routines developed internally (Zollo and Winter 2002: 343). The primary interest is not the learning process itself, but the nature of the relationship between (creativity-promoting) HR practices

and the extent to which firms generate product innovations. In other words, the mediating creativity effect is not tested directly, with focus placed on HR practices and innovative output.

In conceptualizing creativity we follow extant literature defining creativity as the production of novel ideas that are useful and appropriate to the situation (Unsworth 2001). Oldham and Cummings (1996) are even more specific and perceive creativity as the product or outcome of a product development process. Based on an extensive review of the literature on creativity,[1] Oldham and Cummings (1996) concentrate on two key contextual elements that promote the creative performance of employees. These are job complexity and supervisory style, and can be found in other works as well (Amabile 1983, 1988; Amabile et al. 1996; Drazin et al. 1999; Kanter 1988).

Hypothesis Development

Job complexity is associated with high levels of autonomy, skill variety, identity, significance and feedback. Complex jobs are expected to support and foster creativity, especially the proactive type. 'Creatively solving an open problem involves both scanning the environment to find a problem and defining the problem in such a way that it can be solved' (Unsworth 2001: 294). Job complexity is directly related to human capital training as actively developing employees' knowledge and skills that are critical to new product development facilitates learning in organizations (Crossan et al. 1999; Hatch and Dyer 2004; Lau and Ngo 2004). 'Superior learning performance comes from better human resources and from better practices to develop firm-specific human capital and deploy it to learning activities' (Hatch and Dyer 2004: 1173). Moreover, literature on organizational commitment and human resource theory suggests that providing training facilities may create positive employee attitude and commitment (Benson et al. 2004). Hence, training-focused HR practices are associated with higher innovative performance.

Next to training, creativity can also be enhanced if employees are exposed to a broad range of perspectives and information, and teamwork is argued to be a fruitful mechanism to achieve this (Nonaka and Takeuchi 1995; Kang et al. 2007). In particular, cross-functional teams are suggested as a critical organizational design for fostering creativity and innovation (Lau and Ngo 2004: 688). 'Heterogeneity in decision making and problem solving styles produces better decisions through the operation of a wider range of perspectives and a more thorough analysis of issues' (Richard 2000: 165). Through experiencing variety, employees may be less inclined to resist change and new ideas and willing to at least consider their potential benefits (Shipton et al. 2006b). Moreover, recent literature on teams suggests that teams are not only relevant for creative renewal, but are important means to compete in a dynamic environment (Gilson et al. 2005; Postrel 2002), a conclusion that is especially relevant for firms that wish to innovate. In sum, 'an organization with a diversity of perspectives should have more resources to draw on and should be more creative and innovative' (Richard 2000: 166). This is important not just to promote knowledge exchange, but also because 'airing minority viewpoints improves the quality of

thought, performance and decision making' (Richard 2000: 165). In terms of HRM this implies that an HR practice such as task rotation can be expected to contribute positively to a firm's innovativeness. Formally,

Hypothesis 1: We expect a positive relationship between a firm's use of training and task rotation, and its ability to generate product innovations.

Job complexity and supervisory style are obviously interrelated, for example regarding job autonomy and skill development. With respect to supervisory style, Oldham and Cummings write that 'supervision that is supportive of employees is expected to enhance creative achievement' (Oldham and Cummings 1996: 611). A supportive supervisory style is associated with facilitating employee skill development and training, a concern for employees' needs and feelings and the use of voice as opposed to exit as a feedback mechanism. A controlling supervisory style on the other hand reduces intrinsic motivation and lowers creative performance. Moreover, it reduces flexibility, affecting creativity and innovation in a negative way. In terms of classical HRM terminology, supervisory style and job complexity are both related to the degree of task autonomy granted. Employee empowerment and self-discretion allow employees to address problems and opportunities that arise contemporaneously (Lepak and Snell 1999; Kang et al. 2007). Task autonomy and employee empowerment foster creativity and innovation and provide ground for exploratory learning (Drucker 1999). Moreover, task autonomy allows employees to anticipate changing conditions, and this greater flexibility will be beneficial for dealing with the intrinsic uncertainty of the innovation process (Sanchez 1995; Griffin et al. 2007). Empowering employees to make relative autonomous decisions regarding the tasks performed and the planning of these tasks increases individual task adaptivity and proactivity (Griffin et al. 2007). Formally,

Hypothesis 2: We expect a positive relationship between a firm's use of job autonomy and flexible working hours, and its ability to generate product innovations.

One related aspect of the relationship between employer and employee that is frequently found in the literature on HR and firm performance is the importance attached to performance-based pay systems. Although such pay systems are generally perceived to affect performance in a positive way by strengthening performance incentives, the relationship between performance-based pay and innovation may be more complex (Bloom 1999; Guthrie 2001; Shipton et al. 2005). Whereas individual performance-based pay may contribute to proactive creativity by stimulating initiative and unprompted proposals for improvements (Lau and Ngo 2004), this may at the same time negatively affect the contributory creativity. The willingness to help solve collective problems in which an employee is not directly involved may decrease when individual rewards are introduced. Most types of innovation require team-based approaches, and individual rewards may erode the necessary feelings of 'we-ness' crucial for knowledge exchange and innovation.

On the other hand, although individual performance-based pay systems may erode intrinsic motivation, when structured in the right way (aligning individual and organizational goals) these reward systems may be expected to affect

creativity in a positive way (Amabile et al. 1996; Gottschalg and Zollo 2007; Shipton et al. 2006a). Reward systems such as gain sharing and stock ownership may motivate employees to develop norms and goals to improve the team's performance, thereby not necessarily eroding the contributory creativity (Kang et al. 2007). Hence, regarding the relationship between individual performance-based pay systems and a firm's innovativeness we are agnostic. Formally,

Hypothesis 3a: We expect a positive relationship between a firm's use of performance-based pay systems and its ability to generate product innovations.

Hypothesis 3b: We expect a negative relationship between a firm's use of performance-based pay systems and its ability to generate product innovations.

Given the necessity of firms to respond and adapt to changing environmental contingencies, HR scholars have emphasized the importance of flexibility. In addition to the 'internal' job flexibility of employees in terms of task autonomy and flexible working hours, flexibility is also perceived in terms of 'external' workforce flexibility. A considerable literature exists on the relationship between a firm's use of flexible labour market arrangements, HR practices and firm performance (Michie and Sheehan 2005). Given the wave of deregulation in the 1980s and 1990s and calls for labour market flexibility in Great Britain, New Zealand and a number of European countries, this issue has particularly been explored by scholars from these countries (e.g. Michie and Sheehan 2003, UK; Kleinknecht 1998, The Netherlands). Although the relationship between workforce flexibility and performance may be contingent on the nature of the work performed, the main finding from this literature is that flexible employment arrangements may be beneficial for the reduction of wage costs and may yield increased allocative efficiencies in the short run, but there may be clear negative effects on the long-run capability of firms to innovate. One of the reasons mentioned by Arulampalam and Booth (1998) relates to workers on flexible short-term employment contracts not (or to a lesser extent) being involved in work-related training. Davis-Blake et al. (2003) have shown that a 'blended' workforce consisting of both standard employees and nonstandard employees — with the latter referring to temporary and part-time work — has a negative effect on employer–employee relationships. They mention reduced loyalty and worsened relations between managers and employees. Hence,

Hypothesis 4: We expect a negative relationship between a firm's use of short-term employment contracts and its ability to generate product innovations.

Methodology

Sample

The database has been developed on the basis of information provided by the Chamber of Commerce. Firms selected have at least five employees. The observation in the sample is at the establishment level. In order to allow for

generalization, the overall sample is stratified according to industry and size of the firm (with a slight overrepresentation of service firms in the health sector). The firm-specific data were obtained through face-to-face interviews. More specifically, they are based on survey questionnaires applied in person. On average, each interview lasted 60 minutes. Interviews were held during late 1999, mainly with directors (60 percent) or heads of the human resource department (19 percent). Research assistants from the Institute for Labour Studies at Tilburg University were responsible for the actual interviewing. In contrast with many HR studies in which a bias has been observed towards large multi-unit and multinational firms (Tansky and Heneman 2003), the sample includes small and medium-sized firms. The total number of firms for which data was obtained is 988. All data relate to the year 1998. For more details regarding the exact formulation of the questions and the methodology applied, reference is made to the Institute for Labour Studies.[2]

Measures

Innovation

The dependent variable is measured as the share of new products in total sales. In our analysis we distinguish between the fraction of radically (new for the industry) and incrementally (new for the firm) changed products in total sales. The sum of the fraction of radical and incremental innovation equals a firm's total innovation. The validity of this measure for innovation has been confirmed in the literature (Mairesse and Mohnen 2002).

HR Practices

In choosing the set of HR practices, we build on the theoretical framework and hypotheses, and simultaneously ground the selection in existing empirical literature. The institutional environment is taken into account by not simply copying items previously identified as relevant in different, mainly Anglo-Saxon settings[3] (Boselie et al. 2001; Oliver 1997). This leads to an initial selection of 12 HR practices, which we factor analyse to (a) test for latent structures (bundles), and (b) reduce the number of variables. Table 1 provides an overview of these 12 HR indicators, their measurement scale and references to previous contributions in which these practices were also used as distinguishing HR features. Except for the presence of cooperation with schools, all the HR practices used can be found in the extant literature (for general overviews see Becker and Gerhart 1996; Boselie et al. 2001; Ulrich 1997).

In relating HR practices to organizational performance several techniques have been used, ranging from reliability analysis (Guthrie 2001), cluster analysis (Arthur 1994; Ichniowski et al. 1997) and factor or principal components analysis (Huselid et al. 1997; Huselid 1995). The rationale for the use of these techniques is the possibility that some HR practices may be complementary. Performing a principal components analysis on these 12 HR items results in a four-factor solution (based on the eigenvalue >1 criterion) where the first seven items cluster together and task rotation, job autonomy, % flexible working hours, percentage standby contracts and performance-based pay do not have a

Table 1 Strategic Human Resource Practices

Human resource practices	Scale	Sources[a]
Presence of training policies	dummy, 0–1	DH96, H95, LF03, GCD04, PB00, M95
Cooperation with schools	dummy, 0–1	-
Do employees follow internal training?	dummy, 0–1	DH96, LF03, GCD04
Do employees follow external training?	dummy, 0–1	DH96, LF03, GCD04, ISP97
Procedures for quality maintenance?	dummy, 0–1	HJS97, H95, LF03
Procedures for recruitment?	dummy, 0–1	HJS97, H95, PB00, KG96, ISP97, DH96, GCD04
Procedures for education of employees?	dummy, 0–1	HJS97, H95, G01, B02, ISP97, DH96
Task rotation	dummy, 0–1	HJS97, MS99, LF03, G01, B02, ISP97, M95
Job autonomy	dummy, 0–1	DH96, MS99, LF03, GCD04, B02, PB00
% Flexible working hours	0–100	MS99
% Standby contracts	0–100	MS99
Performance-based pay	dummy, 0–1	DH96, H95, MS99, LF03, G01, PB00, CC03, M95

[a] H95 = Huselid 1995; DH96 = Delaney and Huselid 1996; KG96 = Koch and McGrath 1996; HJS 97 = Huselid, et al., 1997; GCD04 = Guest, et al., 2004; MS99 = Michie and Sheehan 1999; LF03 = Laursen and Foss 2003; G01 = Guthrie 2001; B02 = Batt 2002; B99 = Bloom 1999; PB00 = Perry-Smith and Blum 2000; CC03 = Collins and Clark 2003; ISP97 = Ichniowski et al., 1997; M95 = Macduffie 1995.

Table 2 Principal Components Analysis

	Factor 1 eigenvalue 2.4	Factor 2 eigenvalue 1.2	Factor 3 eigenvalue 1.1	Factor 4 eigenvalue 1.0
Presence of training policies	**.50**	.14	.12	–.01
Cooperation with schools	**.50**	.07	.00	–.31
Do employees follow internal training?	**.61**	.04	–.13	.02
Do employees follow external training?	**.49**	–.08	.00	–.01
Procedures for quality maintenance?	**.57**	–.18	.26	.01
Procedures for recruitment?	**.66**	.00	–.26	–.09
Procedures for education of employees?	**.70**	–.07	.09	–.01
Task rotation	–.01	.46	**.62**	–.23
Job autonomy	–.04	**.72**	.18	**.06**
% Flexible working hours	.18	**.57**	–.33	.13
% Standby contracts	–.04	.28	**–.64**	–.07
Performance-based pay	.20	.03	.11	**.91**

Note: Highest factor loadings are depicted in bold.

latent factor explaining their variance. The results of the principal components analysis are shown in Table 2.

Scale purification by performing additional factor analyses and calculation of reliability measures (Cronbach's alpha) indicates that, except for the items in bold included in factor 1, the remaining items should be included as separate variables. This implies that there is one composite factor including seven items (Cronbach's alpha = .67) related to training and schooling practices, three dummy variables indicating the presence of task rotation, job autonomy and performance-based pay systems, and two continuous measures of the fraction of employees with flexible working hours and standby contracts. These six variables are directly related to the hypotheses and are included in the regression analyses explaining the fraction of radically or incrementally new products in total sales.

Control Variables

We control for both firm-specific characteristics and environment-specific or external factors that may either influence the innovativeness of a firm directly (e.g. a firm's R&D intensity), or may lead to an over- or underestimation of the relationship between HR practices and a firm's innovativeness. In total, we include 20 control variables.

Firm-Specific Controls

First we include each firm's *R&D intensity*, measured by the quotient of the R&D expenditures and sales. Following Batt (2002), and Perry-Smith and Blum (2000) we also include a dummy variable if the firm is part of a larger organizational entity (e.g. a holding, or a business unit). Firms that form a *unit* in a larger entity may have access to more resources affecting their ability to innovate (Hansen 2002; Tsai 2001; Tsai and Ghoshal 1998). In a similar vein we control for *size* of the firm, measured on a 1–6 scale reflecting different size categories (Jackson and Schuler 1995; Camison-Zornoza et al. 2004). The *number of hierarchical levels* is measured on a scale of 0–7 and is a reflection of a firm's organizational structure (Macduffie 1995; Delaney and Huselid 1996; Perry-Smith and Blum 2000).

As firms that are more export-oriented may be more innovative due to competitive pressures, we control for *export intensity*, measured as the quotient of the foreign sales in total sales. Similar to Guthrie (2001), we include a measure for *age* of the firm. Age is measured in years since foundation. Following Hoskisson et al. (2002), we control for the *ownership* of the firm, by including a dummy reflecting whether the directors of the firm are also (part) owners. We also include a dummy taking the value of 1 if respondent perceives his/her firm to be active in a market characterized by *competition* (Perry-Smith and Blum 2000). Average *adjustment period* reflects the average time needed for new employees to function properly and get used to the new working environment (Macduffie 1995). It is measured on a 1–4 scale where 1 = less than one week, and 4 = more than a year.

Another aspect of a firm's organizational structure concerns the gender structure of its employees (Perry-Smith and Blum 2000; Batt 2002). Gender diversity is measured by the fraction of male (or female) employees and its squared term to allow for nonlinearities. Finally, we control for a firm's wage structure. Similar to Batt (2002), pay was measured as median monthly pay of the workforce. However, wage levels as such do not indicate whether a firm is paying high or low wages, as obviously the wage paid in a firm depends on its type of activities and the associated labour demand and supply in the industry. Therefore, an additional variable is included, reflecting a firm's median wage level relative to the industry median wage level (at SIC1 level). Hence, we include both *wage level* and *relative wage level*. The dispersion in wages is also included, (*wage concentration*), by including a dummy taking the value 1 if more than 70 percent of a firm's employees fall in the same wage category[4] (Bloom 1999; Shipton et al. 2006b). In the analysis we experiment with cutoff levels of 50 and 60 percent, and this does not change the results.

Product-Specific Controls

We control for a number of product-related characteristics. First we control for the degree of *product diversification*, measured by the fraction of sales of the main product in the total sales, and its squared term to allow for potential nonlinearities. A high value reflects a low diversified firm. Product diversification can both be negatively and positively related to innovation (Katila 2002). On the one hand economies of scope may enhance the innovativeness through increased opportunities to use new knowledge. On the other hand, the management of a highly diversified firm may show less commitment to long-term innovation (Hoskisson and Hitt 1988). Second, we include *type of product*, by including dummies for investment good, a consumer good and a semi-manufactured good. The default category is consumer good. Finally we control for *type of main clients* by including dummies reflecting whether the main clients are consumers (business to consumer), other firms (business to business) or a larger organizational entity (Batt 2002).

Industry- and Region-Specific Effects

Following Geroski's (1990) argument that firms may face different technological opportunities in different sectors, we control for industry-specific effects by including sectoral dummies on SIC 1 level. We control for location-specific effects that may affect a firm's innovative output (Audretsch and Feldman 1996; Jaffe et al. 1993). The *regional* dummies are based on the 12 Dutch provinces, corresponding with the generally accepted classification as used by the European Statistical Office (Eurostat).

Common Method and Rater Bias

In order to check for common method bias, we performed a Harmon one-factor test was performed, as described by Podsakoff and Organ (1986). The factor analysis on all the HR practice variables and the dependent innovation measures yields five factors with an eigenvalue larger than 1 with the first factor explaining only 15 percent. No single factor accounted for the majority of the covariance, suggesting that common method variance is not responsible for the findings.

As our data are based on single respondents and it has been suggested that there may be differences between respondents with different functional backgrounds regarding HR practices (Batt 2002), we have tested the reliability of the responses. For the full sample of 988 firms we have information on the background of the respondent. Including dummies for the different types of respondents (director, head of HR unit, employee HR unit, administrative staff, other) in our main regression in Table 4 does not yield significant results, suggesting that a rater bias is not present in our sample (results not shown but available on request).

Analysis and Results

Estimation Technique

The choice to include both innovators and non-innovators in our sample determines the estimation technique. As a significant portion of the firms does not

Table 3. Mean, Standard Deviation and Correlations

Variable	Mean	St. dev.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Total innovation	22.3	29.7	1														
2. Incremental innovation	12.8	19.7	.70*	1													
3. Radical innovation	9.5	17.7	.66*	.19*	1												
4. Size	2.96	1.5	.11*	.11*	.06	1											
5. Age of the firm	23.25	26.1	–.04	–.01	–.09*	.21*	1										
6. Unit	.31	.46	.04	.04	.07	.32*	–.01	1									
7. Export intensity	11.41	25.69	.09*	.04	.05	.29*	.06	.22*	1								
8. R&D intensity	3.42	10.12	.21*	.15*	.22*	.00	–.02	.00	.04	1							
9. Ownership	.48	.50	–.10*	–.09*	–.11*	–.35*	.05	–.15*	–.01	–.13*	1						
10. Competition	.87	.34	–.03	.01	–.08	.12*	.04	.15*	.15*	–.11*	.25*	1					
11. No. of hierarchical levels	2.29	.81	.04	.04	.02	.58*	.10*	.27*	.24*	.00	–.19*	.15*	1				
12. Adjustment period	2.62	.70	.06	.04	.06	–.04	–.01	.03	.02	.09*	–.01	–.01	.00	1			
13. % male	58.7	33.7	–.04	–.02	–.07	.19*	.14*	.23*	.29*	–.01	.31*	.31*	.18*	–.01	1		
14. Wage concentration	.12	.33	–.05	–.07	.02	–.10*	–.05	–.09*	–.05	–.03	.10*	.01	–.09*	.11*	–.04	1	
15. Wage level	3926	1390	.08	.12*	.08	.13*	.04	.05	.03	.14*	–.21*	–.07	.03	.16*	.17*	–.07	1
16. Relative wage level	1.01	.35	.08	.12*	.08	.11*	.05	.05	.06	.13*	–.18*	–.06	.02	.16*	.17*	–.07	.98*
17. Product diversification (inverse)	86.6	21.1	.08	–.10*	–.03	–.03	–.02	–.04	–.00	–.06	.05	.01	–.04	–.09*	–.02	.08	–.09*
18. Investment good	.21	.41	.05	.04	.03	.06	.06	.04	.01	.11*	.04	.06	.06	.08	.22*	–.05	.09*
19. Semi-manufacture	.16	.37	.01	–.01	.04	.13*	–.00	.06	.18*	.01	–.03	.06	.08	.01	.14*	–.01	.14*
20. Business to consumer	.52	.50	–.01	–.01	–.01	–.18*	.12*	–.18*	–.25*	.09*	–.08	–.14*	–.09*	–.02	–.42*	.03	–.21*
21. Intrafirm business	.02	.15	.03	.08	–.03	.00	.00	.11*	–.01	.02	–.01	–.05	.06	–.04	.04	–.01	.05
22. Training and schooling	.00	1.00	.16*	.15*	.09*	.56*	.08	.25*	.13*	.06	–.34*	–.01	.38*	.07	–.03	–.10*	.11*
23. Task rotation	.63	.48	.04	.02	.07	–.03	–.02	.00	.09*	.04	.09*	.06	.00	.02	.00	–.00	–.03
24. Job autonomy	.63	.48	.08	.08	.10*	–.12*	–.14*	–.11*	–.11*	.05	–.07	–.08	–.10*	.04	–.19*	–.05	.06
25. % Flexible working hours	22.9	36.1	.13*	.09*	.13*	.07	–.03	–.01	–.02	.15*	–.22*	–.10*	.06	.08	–.11*	–.03	.21*
26. % Standby contracts	3.5	10.5	–.09*	–.08	–.04	.01	–.03	.07	–.10*	–.05	–.06	.01	–.01	–.11*	–.16*	.12*	–.19*
27. Performance-based pay	.12	.32	.05	.08*	–.01	.10*	.04	.18*	.04	.02	.02	.09*	.13*	.03	.09*	–.01	.00

Continued

Table 3 (continued)

Variable	16	17	18	19	20	21	22	23	24	25	26
16. Relative wage level	1										
17. Product diversification (inverse)	–.09*	1									
18. Investment good	.06	–.01	1								
19. Semi-manufacture	.14*	–.03	–.23*	1							
20. Business to consumer	–.20*	.05	–.13*	–.28*	1						
21. Intrafirm business	.04	–.02	.01	.03	–.15*	1					
22. Training and schooling	.09*	–.06	.03	.03	–.01	.04	1				
23. Task rotation	–.03	–.02	–.04	.03	.01	–.05	–.00	1			
24. Autonomy	.04	–.05	.01	–.13*	.11*	–.09*	–.03	.14*	1		
25. % Flexible working hours	.19*	–.09*	–.05	.10*	–.06	.01	.11*	.01	.12*	1	
26. % Standby contracts	–.19*	–.02	–.11*	–.06	.17*	–.01	–.01	–.05	.05	.05	1
27. Performance-based pay	–.00	.02	–.01	–.03	–.01	.01	.12*	–.01	.02	.03	–.03

Note: Industry and regional dummies not included. $N = 988$ observations. *Significant correlations (at 1% level).

innovate (355 of the 988 firms reporting no innovation at all), the dependent variable takes the value of zero in a number of cases. In this case, the nonlinear Tobit procedure is required (Greene 1993; Maddala 1983). The appendix contains the technical details.

Results

Other than the logical correlations between, for example, firm size and number of hierarchical levels (.58) and firm size and the fact that the firm is part of a larger organization (.32), all correlations between the set of control variables are below .3. As expected the correlation between size of the firm and training and schooling practices is relatively strong (.56). However, as was already shown by the principal components analysis, the correlations between the HR practices are low (all below .14), suggesting that these variables measure different aspects of the overall set of HR practices.

To estimate the impact of HR practices on a firm's innovativeness, different models were used. As shown in Table 4, a regression is estimated including only the control variables (model 1), an equation including only the set of HR practices (model 2), a full model including controls and HR practices (model 3), a model in which each *individual* HR practice is regressed on innovative output including all control variables (model 4) and full models for incremental (model 5) and radical innovation (model 6).

Training and schooling is significantly positive ($p < .01$) in all models except when explaining radical innovation. Task rotation has a positive sign but is never significantly related to innovativeness. Job autonomy is positive and significant (at $p < .05$) in all models. The fraction of employees with flexible working hours is significantly positive for radical innovation but is not significantly related to incremental innovation. For performance-based pay we find the opposite result: performance-based pay is positively and significantly associated with incremental innovation, but not with radical innovation. We find strong negative and significant effects of the use of standby contracts ($p < .01$ except for radical innovation where $p < .1$). The picture that emerges from these regressions is the following: increased incremental innovation is associated with training and schooling, job autonomy, performance-based pay and a limited use of standby contracts. Radical innovation is associated with standby contracts (negatively) and job autonomy and employees' flexibility regarding working hours (both positively). In other words, where incremental innovation can be organized by incentive systems and training programmes, the best one can do to promote radical innovation is to give employees autonomy in terms of tasks and the planning of these tasks. However, to test whether these results are robust, a number of additional analyses were performed.

Robustness

We have tested the robustness of the main results in Table 4 along four dimensions. First we explore the interactions between the HR practices to test for potential complementarities (see Parker and Van Witteloostuijn 2007). Second,

Table 4. Main Regression Results

	Model 1 Innovation Controls only	Model 2 Innovation HR practices only	Model 3 Innovation Full model	Model 4 Innovation Full model (individual practices)[a]	Model 5 Incremental innovation	Model 6 Radical innovation
Firm characteristics						
1. Size	4.00 (1.22)**	—	3.01 (1.31)*	—	2.00 (.96)*	2.47(1.12)*
2. Age	–.09 (.05) †	—	–.07 (.05)	—	–.02 (.04)	–.10 (.04)*
3. Unit	5.53 (3.24) †	—	3.53 (3.25)	—	2.43 (2.38)	8.24 (2.76)**
4. Export intensity	.15 (.06)*	—	.14 (.06)*	—	.06 (.04)	.03 (.05)
5. R&D intensity	.74 (.13)**	—	.68 (.13)**	—	.33 (.10)**	.52 (.10)**
6. Ownership	2.04 (3.61)	—	1.67 (3.6)	—	1.81 (2.62)	1.73 (3.04)
7. Competition	3.44 (4.39)	—	4.62 (4.36)	—	5.21 (3.21)	–1.05 (3.61)
8. No. of hierarchical levels	–1.89 (2.06)	—	–2.91 (2.04)	—	–1.62 (1.51)	–1.84 (1.76)
9. Adjustment period	.69 (2.01)	—	–.83 (2.01)	—	–1.24 (1.48)	.76 (1.74)
10. % Male employees	.57 (.19)**	—	.61 (.19)**	—	.31 (.14)*	.87 (.16)**
11. (% Male employees)^2	–.004 (.002)**	—	–.005 (.02)**	—	–.002 (.001) †	–.01 (.002)**
12. Wage concentration	–3.93 (4.37)	—	–1.04 (4.34)	—	2.11 (3.21)	2.14 (3.74)
13. Wage level	.02 (.01) †	—	.02 (.01)	—	.02 (.008)*	.001 (.01)
14. Relative wage level	–81.4 (43.9) †	—	–73.3 (43.5) †	—	–63.8 (31.9)*	–5.39 (36.3)
Product characteristics						
1. Product diversification (inverse)	.76 (.38)*	—	.89 (.37)*	—	.58 (.28)*	.61 (.31) †
2. Product diversification (squared)	–.007 (.003)*	—	–.007 (.003)**	—	–.005 (.002)**	–.004 (.002)*
3. Investment good	8.21 (3.63)*	—	—	—	—	8.23 (3.04)**
4. Semi-manufacture	2.88 (3.96)	—	8.15 (3.59)*	—	3.09 (2.63)	5.14 (3.32)
5. Business to consumer	2.71 (3.21)	—	4.12 (3.93)	—	–.28 (2.91)	2.19 (2.72)
6. Intrafirm business	13.16 (9.61)	—	3.66 (3.20)	—	1.99 (2.35)	–11.2 (9.05)
(Industry and regional dummies not shown)			14.8 (9.52)		18.3 (6.85)**	

(Continued)

Table 4 (Continued)

	Model 1 Innovation Controls only	Model 2 Innovation HR practices only	Model 3 Innovation Full model	Model 4 Innovation Full model (individual practices)[a]	Model 5 Incremental innovation	Model 6 Radical innovation
HR practices						
1. Training and schooling	—	7.81 (1.42)**	4.53 (1.71)**	5.28 (1.72)**	3.53 (1.26)**	1.82 (1.47)
2. Task rotation	—	.75 (2.89)	1.35 (2.83)	3.29 (2.82)	.20 (2.02)	3.95 (2.44)
3. Job autonomy	—	6.26 (2.92)*	7.03 (2.95)*	7.43 (2.93)*	5.43 (2.17)*	5.75 (2.52)*
4. Flexible working hours	—	.15 (.04)**	.07 (.039) †	.08 (.04)*	.03 (.03)	.07 (.03)*
5. Standby contracts	—	–.51 (.15)**	–.60 (.16)**	–.60 (.16)**	–.32 (.11)**	–.21 (.13) †
6. Performance-based pay	—	3.49 (4.22)	6.59 (4.17)	8.78 (4.20)*	7.81 (3.03)**	1.14 (3.54)
N		988	988	988	988	988
Log L		–3517.85	–3457.79	—	– 2953.94	– 2329.19
No. of left-censored obs. at 0		355	355	355	422	564

Notes: ** p <.01, * p < .05, † p < .10. Standard error in parentheses.

[a] In this model we run the full model including all controls and subsequently include each HR practice separately. As such we have 6 individual regressions. We do not report the results on the control variables and the log likelihood as these are based on 6 separate models.

Table 5. Robustness Test for Total Innovation as Dependent Variable, Unless Specified Otherwise

	Training & schooling	Task rotation	Job autonomy	% Flexible working hours	% Standby contracts	Performance-based pay	Interactions/ nonlinear terms
Main model of Table 4 (model 3)	4.53 (1.71)**	1.35 (2.89)	7.03 (2.95)*	.07 (.039) †	–.60 (.16)**	6.59 (4.17)	—
I. Interactions[a] (Interactions presented in last column)							
Total innovation							
Size * Performance-based pay	4.40 (1.71)**	1.33 (2.82)	7.10 (2.94)*	.08 (.04)*	–.60 (.16)**	21.39 (9.45)*	–4.36 (2.54) †
R&D intensity * Training and schooling	3.14 (1.78) †	.65 (2.81)	6.88 (2.93)*	.07 (.04) †	–.57 (.16)**	6.50 (4.14)	.36 (.13)**
R&D intensity * Task rotation	4.42 (1.72)**	–.31 (2.94)	6.95 (2.94)*	.07 (.04) †	–.60 (.16)**	6.77 (4.15)	.46 (.27) †
Incremental innovation							
Training and schooling * % Standby contracts	4.29 (1.32)**	.31 (2.08)	5.28 (2.17)*	.03 (.03)	–.35 (.11)**	7.67 (3.02)*	–.17 (.09) †
Training and schooling * R&D intensity	2.16 (1.31)	–.25 (2.07)	5.32 (2.16)*	.03 (.03)	–.30 (.11)**	7.56 (3.01)*	.35 (.11)**
Radical innovation							
Size * Training and schooling	7.23 (2.74)**	4.41 (2.43) †	5.58 (2.51)*	.07 (.03)*	–.21 (.13) †	1.33 (3.52)	–2.0 (.85)*
Size * % Flexible working hours	1.82 (1.46)	4.04 (2.43) †	5.59 (2.51)*	.20 (.07)**	–.20 (.13)	1.66 (3.53)	–.04 (.02)*
Size * Performance-based pay	1.60 (1.46)	4.22 (2.43) †	5.86 (2.51)*	.07 (.03)*	–.21 (.13) †	19.7 (8.03)*	–5.5 (2.17)*
Task rotation * Performance-based pay	1.73 (1.47)	5.62 (2.61)*	5.51 (2.51)*	.07 (.03)*	–.20 (.12)	8.83 (5.56)	–12.6 (7.1) †
% Flexible working hours * Performance-based pay	1.90 (1.46)	3.97 (2.43)	5.76 (2.51)*	.09 (.03)*	–.21 (.13) †	5.36 (4.31)	–.16 (.09) †
II. Nonlinearities (squared terms presented in last column)							
- Training and schooling	–.59 (.15)**	—	—	—	—	—	–.93 (1.31)
- % Flexible working hours	—	—	—	.26 (.17)	—	—	.002 (.002)
- % Standby contracts	—	—	—	—	–.85 (.32)**	—	.005 (.005)
III. Sample selection of only innovating firms ($N = 633$)							
- Without Heckman selection (OLS)	1.99 (1.59)	2.29 (2.56)	4.48 (2.66)†	.03 (.04)	–.21 (.16)	3.41 (3.67)	—
- With Heckman selection (1st stage on $N = 988$)[b]	2.23 (1.61)	2.43 (2.56)	4.67 (2.67)†	.03 (.04)	–.22 (.16)	3.22 (3.64)	—
IV. Stepwise regression (starting from an empty model)[c]							
Total innovation (12 variables total, R&D intensity 1st)	5.15 (1.6)**[2]	Not included	6.64 (2.83)*[8]	.09 (.04)*[6]	–.52 (.15)**[4]	Not included	—
Incremental innovation (13 variables total)	3.81 (1.21)**[1]	Not included	6.49 (2.09)**[7]	Not included	–.31 (.11)**[5]	7.12 (2.99)*[6]	—
Radical innovation (18 variables total, R&D intensity 1st)	1.69 (1.43)[d]	Not included	5.19 (2.47)*[6]	.07 (.03)*[4]	–.21 (.12) †[18]	Not included	—

** $p < .01$, * $p < .05$, † $p < .10$. Standard error in parentheses.

[a] We have tested for all interactions between HR practices, size of the firm and HR practices and R&D intensity and HR practices, but only significant interactions are shown.

[b] The inverse Mills ratio is insignificant in all models explaining total, radical and incremental innovation. The selection variables in the first equation are presence of R&D (dummy significant at $p < .001$), the dummy measuring the presence of competition (insignificant) and the ownership dummy ($p < .001$). Inclusion of the HR practices as selection variables does not yield significant inverse Mills ratios.

[c] The number in superscript represents the rank order in which the variable was included when starting from an empty model with a limited p value of .1.

[d] Training and schooling is added as 3rd variable but turns insignificant once Size is added in step 16. This corresponds with the finding on the interaction effect between Size and Training and Schooling for Radical Innovation (see under 'I interactions').

we test for potential nonlinearities. Third, we take issue with the zeros in the dataset, and finally, we perform a stepwise regression.

The first robustness test consists of a test of potential interaction effects between HR practices. As suggested by proponents of the configurational approach, there may be potential complementarities of certain HR practices or the effect of HR practices may be moderated by other firm characteristics. Alternatively, certain combinations of HR practices may predict innovation above and beyond their direct effects (see Shipton et al. 2006a). Therefore, we also test whether the HR practices are moderated by size of the firm and whether the effect of R&D intensity is moderated by certain HR practices. Though we have tested for all potential interactions between the HR practices, we only report the significant ones in Table 5 for reasons of space. For incremental innovation we find that the impact of R&D intensity is positively affected by the presence of training and schooling. The interaction effect of 'training and schooling x R&D intensity' is positive and significant ($p < .01$), suggesting that the effectiveness of R&D can be improved by combining it with training and schooling. We also find a negative and significant (though at $p < .1$) interaction effect of the use of standby contracts with training and schooling, implying that the positive effect of training and schooling is negatively affected when combined with an increasing fraction of employees with standby contracts. For radical innovation we find interaction effects for size with certain HR practices and for performance-based pay with task rotation and fraction of employees with flexible working hours. More specifically, we find that — in addition to the nonsignificant effect of training and schooling in the main regression — training and schooling has a positive main effect but that its effect on radical innovation becomes smaller when firms are larger. Size also moderates the positive effects of training and schooling and the fraction of employees with flexible working hours in a negative way.

Second, we explore whether the relationship between HR practices and innovativeness contains nonlinearities. As we are limited to continuous measures, we include only the squared terms of training and schooling, percentage of employees with flexible working hours and percentage of employees with standby contracts. We find no indications of nonlinearities.

Third, we take the specific sample structure into account by taking a closer look at the zeros (the non-innovators) in the sample. Although the Tobit regression explicitly controls for this, it is useful to further explore the effect of this specific data structure. We perform an OLS on only the innovating firms (hence excluding the zeros), and second we treat the zeros as missing variables by applying a Heckman sample selection correction. Whereas one might expect the OLS to yield biased results (because we exclude the zeros), the Heckman procedure is a way to control for this. Acknowledging that the zeros are actual reported zeros and not missing observations, the Heckman procedure is nevertheless a useful complementary technique to the Tobit procedure we applied in the main regression. The OLS regression does not yield a significant effect of HR practices. To see whether this gives reasons to question our main findings or if this is the result of a biased estimation, we also perform the Heckman sample selection correction (see appendix for technical details). We find similar results for the OLS with and without Heckman correction. More importantly, we find no

indication of a sample selection bias because the inverse Mills ratio is insignificant (results not shown but available on request). In sum, the results suggest no sample selection problem exists and that our main findings presented in Table 4 are correct.

Finally, we perform a stepwise regression in which we start from an empty model and add variables based on their explanatory power. The results we obtain are in line with the ones reported in Table 4, corroborating the main findings. Overall, we find full support for hypotheses 2, 3a and 4 and partial support for hypothesis 1 (no significant effect of job rotation but a positive effect for training and schooling). It should, however, be noted that differences exist between types of innovation.

Discussion and Conclusion

Towards a Theoretically Informed HR–Performance Link

This paper is exploratory in the sense that as far as we know, no well-developed theoretical framework exists linking HR practices to innovation. This is remarkable as it is widely acknowledged that proper management of a firm's human resources is important for a sustained competitive advantage. The relevant literature has not answered the questions of how and which HR practices affect the capability of firms to generate innovations in a satisfactory way. In this light our finding that certain HR practices affect a firm's innovativeness is highly relevant. The results confirm the theoretical prediction that HR practices can indeed be a valuable resource for firms that wish to innovate. This paper thus extends and enhances the resource-based view of the firm and the literature on human resource management which has not adequately explained how firms can effectively use HR practices to increase their innovative output.

The field of SHRM has been criticized for its lack of a clear theoretical framework and the ad hoc measures of HR practices. In this paper we have taken issue with the criticism that the link between HR practices and performance lacks theory and is often perceived as a black box. We have selected our relevant HR practices by combining insights from creativity theory and HR literature. This is an improvement, but by doing so we have not only narrowed down the size of this black box, but also changed its nature. It is not the selection of HR practices, but the associated process of (organizational) learning, that remains implicit in this paper. As Crossan et al. (1999: 535) argue: 'It requires the capability to link human resources management, strategic management, and the management of information technology as a means to facilitate the flow of learning.' We believe that the results of this paper may provide additional building blocks to theorize on the relationship between HR practices, organizational (and individual) learning, and a firm's ability to generate new products. Recent work by Kang et al. (2007) complements this plea by embedding HR architectures in organizational learning theory: 'HRM plays a pivotal role in facilitating knowledge flows and organizational learning, mediated by social relations' (Kang et al. 2007: 5).

Practical Implications

In general, our findings suggest that, in contrast to radical innovation, incremental innovations are relatively easier to 'organize' in the sense that, by implementing certain HR practices, managers can increase a firm's incremental innovative output. The ability to organize and manage radical innovations is much more limited to the extent that one can only offer job autonomy and flexibility in terms of working hours to promote radical innovations. Incremental innovations on the other hand are positively associated with a number of HR practices in our study. For both types of innovation we find that the use of standby contracts has a negative effect. Hence, whereas standby contracts may result in allocative efficiency and positively affect a firm's financial performance, it may at the same time negatively affect a firm's innovativeness (Arulampalam and Booth 1998).

We find that training and schooling is positively associated with incremental and radical innovation, but that its effect on radical innovation is smaller for larger organizations. Moreover, training and schooling will have an upward effect on the impact of R&D intensity on a firm's innovativeness, suggesting that every euro spent on R&D (relative to the size of the firm) will have a larger impact on a firm's innovative output when combined with training and schooling.

We also find that performance-based pay works only for incremental innovation, and that when combined with task rotation or flexible working hours it may even have a negative effect on radical innovation. This implies that performance-based pay should be applied only by those firms pursuing incremental innovations. Moreover, given the negative moderating effect of size on performance-based pay, this implies that performance-based pay should be applied only when it is possible to measure the individual performance of employees. Flexible working hours, task rotation or large firms may complicate the ability to apply performance-based pay systems in an effective way.

Limitations and Future Research

Building on creativity research is attractive for the reasons explained above. However, acknowledging that both personal (Barron and Harrington 1981) and contextual factors drive employee creativity (Amabile 1988; Drazin et al. 1999; Oldham and Cummings 1996), inserting creativity theory in relating HRM to innovation implies we have concentrated on the contextual factors. It was implicitly assumed that the effect of contextual variables (HRM) is homogeneous for all individuals. Recent literature on interest alignment may provide a useful route for future research in this area. In organizing creativity, the challenge is to structure the incentive system and the job routines in such a way that individual creativity transforms into organizational innovation. This process of interest alignment closely relates to motivation drivers, which are embedded in HRM systems (Gottschalg and Zollo 2007). Moreover, the empirical results also suggest that important differences exist between HR practices and *types* of innovation. Hence, we think it is important to push the research frontier on types of innovation, HR practices and creativity by more elaborate theorizing. In line with Shipton et al. (2006a) it may, for example, be interesting to conceptualize HR systems in terms of their orientation towards exploration or exploitation.

Empirically, there is (always) room for improvement in terms of increasing the internal validity of the measures used, especially to get 'inside' some of the categorical variables. In this case, there are three aspects of a firm's HR system that demand closer scrutiny because the data do not allow us to measure the exact character of these practices. First is job rotation. Whereas theory suggests this may promote creativity and innovation, we obtain an insignificant finding. One reason for this may be that our measure does not distinguish the *nature* of job rotation. Job rotation may take two forms; rotation according to functional areas allowing employees to build up ties with people with very different knowledge and perspectives from their own, or just rotation between otherwise disconnected people (e.g. Macduffie 1995). A similar problem holds for our variable measuring task rotation. What is the nature of the rotation? In scope (i.e. how much multi-skilling?), or in degree of diversity of roles rotated? The third data problem holds for our measure of performance-based pay. Data do not allow us to distinguish between types of performance-based pay. Is it only individual, or is there a collective component? Theory suggests that different types of performance-based pay have different effects on types of creativity. Future research on the nature of output-based pay and the type of creativity is required to shed light on this important issue.

In conclusion, this article has demonstrated the importance of the use of certain HR practices for improving the innovative performance of firms, yielding important insights and practical tools for HR managers confronted with market pressure to organize innovation.

Appendix. Tobit and Heckman Sample Selection Model

Left-Censored Tobit Model

Because we have a number of firms that report no innovation at all, we have censored data. In this case a Tobit estimation is required. Algebraically, the likelihood function of a left-sided Tobit procedure looks as follows (see Greene 1993: 696):

$$\ln L = \sum_{y_i>0} -\frac{1}{2}\left[\ln(2\pi) + \ln\sigma^2 + \frac{(y_i - \beta' x_i)^2}{\sigma^2}\right] + \sum_{y_i=0} \ln\left[1 - \Phi\left(\frac{\beta' x_i}{\sigma}\right)\right]$$

Maximizing $L(\beta,\alpha \mid y_i \ldots y_n, x_i \ldots x_n)$ with respect to β and α yields maximum likelihood (ML) estimates of the impact of the explanatory and control variables on the (latent) dependent variable, and an estimate of the variance of the error term. Hence, given the characteristics x of firm i and given (the ML estimates of) the parameters β and α, the model gives us a probability distribution of the innovative performance y of firm i. For values between zero and one, this distribution mimics the normal distribution. For zero performance we have an atom in the distribution that is equal to the mass in the left tail of the normal distribution, censored at zero. The parameters β and α should be interpreted as

the contribution of the explanatory variables to the variance in the endogenous variable. These parameters report the change in the share of innovative products in sales that is to be associated with a change in the explanatory variables. Thus, a change in x_i has two effects: it affects the conditional mean of innovative output and the probability that the innovative output will be positive at all. Following the ML estimates of the Tobit regression, we obtain log likelihoods for each model specification. As a consequence, there is no traditional goodness-of-fit measure such as R-squared (Greene 1993).

Heckman Selection Model

The Heckman selection procedure is a method to control for a sample selection bias. Assuming that the zeros in our sample are not zeros but missing observations, the OLS regression on only innovators may produce biased results. The problem in this case may be that the missing innovation data (the zeros) are not completely missing at random. The decision to innovate or not is made by individual firms. Hence, in theory the non-innovators may at least to some extent constitute a self-selected sample and not a random sample. For some firms it may be attractive not to produce innovations for a number of strategic reasons (see for example Greve 2005 on this strategic buffering). If we exclude the non-innovators, we may overestimate the innovative output of the firms in the sample. Somehow we need to take the non-innovators into account. Although this discussion does not directly apply to our sample, as we have actual zero observations and not missing observations (and therefore the Tobit technique is the proper method), it is nevertheless important to put the OLS result on the innovators into the proper perspective. The Heckman selection model takes this into account by estimating two equations. First there is the regression model,

$$y = v\beta + u_1$$

And second there is the selection model,

$$Z_Y + u_2 > 0$$

Where the following holds

$$u_1 \sim N(0,\delta)$$

$$u_2 \sim N(0,1)$$

$$\text{corr}(u_1, u_2) = \rho \text{ (only if } \rho = 0 \text{ OLS produces unbiased results)}$$

As the HR practice variables are both included in the selection equation and the regression equation, strictly speaking the effect size and the estimated coefficients of the HR practice variables cannot be interpreted in the usual way. The marginal effect of an HR practice variable on innovation is composed of the effect on the selection equation and the outcome equation. Using Mills ratio one can calculate the correct coefficients and effect size. Results are available on request. For more information on the Heckman selection model we refer to Verbeek (2005: 218–236 on Tobit and p. 237–240 on Heckman) and Heckman's original paper (1979).

Difference between Tobit and Heckman

Without going into technical details on the difference between Tobit models and Heckman sample selection models, it is useful to be aware of the difference between the two estimation techniques at the intuitive level. The difference boils down to the question of how to deal with zeros in the dataset. A Tobit model is used when the dataset is censored. The assumption when using a Tobit model is that the zeros in the dataset are actually observed outcomes. A Heckman sample selection correction is applied when it is a self-selected dataset and the positive values (and the zeros for the 'missing observations') are the result of a self-selection process. The implication is that there should be theoretical reasons to predict this selection process and one should be able to articulate a well-specified choice model. In other words, in deciding between Tobit and Heckman, one should concentrate on the question of why the zeros arise. In this paper, we have chosen Tobit because the zeros are actual observations. However for reasons of robustness we have also regressed our HR practice variables on the innovativeness of only innovating firms, excluding the zeros. In this case we should apply the Heckman selection procedure. The results indicate there is no selection bias present (the inverse Mills ratio is insignificant), reflected in similar findings for the OLS regression both with and without the Heckman control. In other words, these tests indicate that our sample does not suffer from a selectivity bias, and provide further support for our choice to apply a Tobit model.

Notes

The author thanks Andre van Hoorn, Willem Schramade, the two reviewers and the associate editor for their useful suggestions and comments, and Alain de Beuckelaer for sharing his insights on latent structure analysis. This research was made possible by the financial support of The Netherlands Organization for Scientific Research (NWO).

1 We do not wish to provide an extensive overview of the literature on creativity. We refer to Amabile (1988), Oldham and Cummings (1996) and Unsworth (2001) for literature overviews.
2 www.tilburguniversity.nl/osa
3 For example, one typical variable included in most HR research is the degree of unionization (e.g. Guthrie 2001; Huselid 1995; Huselid et al. 1997). Although the degree of unionization in The Netherlands is slightly lower than in the United Kingdom (25 percent versus 30 percent in 1997), there is a major difference with respect to the collective bargaining agreement coverage (CBA) in The Netherlands (over 80 percent of all employees in 1998) compared to the UK (about 30 percent in 1998).
4 We have eight wage categories in our sample: < 1900 guilders; 1901–2400; 2401–2900; 2901–3500; 3501–4400; 4401–6900; 6901–10,000; >10,000. 100 guilders equal 45 euros. The overall distribution of wages over the different categories for all firms in the sample reflects a normal distribution and is as follows: 5.38 percent, 5.32 percent, 11.53 percent, 21.93 percent, 27.35 percent, 20.48 percent, 6.43 percent and 1.4 percent. As this corresponds with the figures for the overall Dutch economy, we have no reason to believe there is a bias in our sample.

References

Amabile, Teresa M.
1983 *The social psychology of creativity.* New York: Springer.

Amabile, Teresa M.
1988 'A model of creativity and innovation in organisations' in *Research in organisational behavior*, vol. 10. B. M. Staw and L. L. Cummings (eds), 123–167. Greenwich CT: JAI Press.

Amabile, Teresa M., Regina Conti, H. Coon, J. Lazenby, and M. Herron
1996 'Assessing the work environment for creativity'. *Academy of Management Journal* 39/5: 1154–1184.

Argyres, Nicholas S., and Brian Silverman
2004 'R&D, organizational structure, and the development of corporate technical knowledge'. *Strategic Management Journal* 25: 929–958.

Arthur, Jeffrey
1994 'Effects of human resource systems on manufacturing performance and turnover'. *Academy of Management Journal* 37: 670–687.

Arulampalam, Wiji, and Alison L. Booth
1998 'Training and labour market flexibility: Is there a trade-off?' *British Journal of Industrial Relations* 36/4: 521–536.

Audretsch, David, and Marian Feldman
1996 'R&D spillovers and the geography of innovation and production'. *American Economic Review* 86: 630–640.

Barney, Jay
1991 'Firm resources and sustained competitive advantage'. *Journal of Management* 17: 99–120.

Barney, Jay
1995 'Looking inside for competitive advantage'. *Academy of Management Executive* 9/4: 49–61.

Barron, Frank B., and David M. Harrington
1981 'Creativity, intelligence, and personality'. *Annual Review of Psychology* 32: 439–476.

Batt, Rosemary
2002 'Managing customer services: Human resource practices, quit rates, and sales growth'. *Academy of Management Journal* 45: 587–597.

Baumol, William
2004 'Entrepreneurial cultures and countercultures'. *Academy of Management Learning and Education* 3/3: 316–326.

Becker, Brian, and Barry Gerhart
1996 'The impact of human resource management on organizational performance: Progress and prospects'. *Academy of Management Journal* 39/4: 779–801.

Benson, Georg S., David Finegold, and Susan A. Mohrman
2004 'You paid for the skills, now keep them: Tuition reimbursement and voluntary turnover'. *Academy of Management Journal* 47/3: 315–331.

Bloom, Matt
1999 'The performance effects of pay dispersion on individuals and organizations'. *Academy of Management Journal* 42: 25–40.

Boselie, Paul, Jaap Paauwe, and Paul Jansen
2001 'Human resource management and performance: Lessons from the Netherlands'. *International Journal of Human Resource Management* 12/7: 1107–1125.

Camison-Zornoza, Cesar, Rafael Lapiedra-Alcami, Mercedes Segarra-Cipres, and Montserrat Boronat-Navarro
2004 'A meta-analysis of innovation and organizational size'. *Organization Studies* 25/3: 331–361.

Colbert, Barry A.
2004 'The complex resource based view: Implications for theory and practice in strategic human resource management'. *Academy of Management Review* 29/3: 341–358.

Collins, Christopher J., and David Clark
2003 'Strategic human resource practices, top management team social networks, and firm performance: The role of human resource practices in creating organizational competitive advantage'. *Academy of Management Journal* 46: 740–751.

Crossan, Mary M., Henry W. Lane, and Roderick E. White
1999 'An organizational learning framework: From intuition to institution'. *Academy of Management Review* 24/3: 522–537.

Danneels, Erwin
2002 'The dynamics of product innovation and firm competences'. *Strategic Management Journal* 23: 1095–1121.

Datta, Deepak, James P. Guthrie, and Patrick M. Wright
2005 'Human resource management and labor productivity: Does industry matter?' *Academy of Management Journal* 48/1: 135–145.

Davis-Blake, Alison, Joseph P. Broschak, and Elizabeth George
2003 'Happy together? How using nonstandard workers affects exit, voice and loyalty among standard employees'. *Academy of Management Journal* 46/4: 475–485.

Delaney, John T., and Mark Huselid
1996 'The impact of human resource management practices on perceptions of organizational performance'. *Academy of Management Journal* 39: 949–969.

Delery, John E., and D. Harold Doty
1996 'Modes of theorizing in Strategic Human Resource Management: Tests of universalistic, contingency, and configurational performance predictions'. *Academy of Management Journal* 39/4: 802–835.

Drazin, Robert, Mary Ann Glynn, and Robert K. Kazanjian
1999 'Multilevel theorizing about creativity in organizations: A sensemaking perspective'. *Academy of Management Review* 24: 286–307.

Drucker, Peter
1999 'Knowledge-worker productivity: The biggest challenge'. *California Management Review* 41/2: 79–94.

Geroski, Paul
1990 'Innovation, technological opportunity, and market structure'. *Oxford Economic Papers* 42: 586–602.

Gilson, Lucy L., John E. Mathieau, Christina E. Shalley, and Thomas M. Ruddy
2005 'Creativity and standardization: Complementary or conflicting drivers of team effectiveness'. *Academy of Management Journal* 48/3: 521–531.

Gottschalg, Olivier, and Maurizio Zollo
2007 'Interest alignment and competitive advantage'. *Academy of Management Review* 32: 418–437.

Greene, William
1993 *Econometric analysis*, 2nd edition. Englewood Cliffs, NJ: Prentice Hall.

Greve, Heinrich R.
2003 'A behavioral theory of R&D expenditures and innovations: Evidence from shipbuilding'. *Academy of Management Journal* 46: 685–702.

Griffin, Mark A., Andrew Neal, and Sharon K. Parker
2007 'A new model of work role performance: Positive behaviour in uncertain and interdependent contexts'. *Academy of Management Journal* 50: 327–347.

Guest, David, Neil Conway, and P. Dewe
2004 'Using sequential tree analysis to search for "bundles" of HR practices'. *Human Resource Management Journal* 14: 79–96.

Guthrie, James P.
2001 'High involvement work practices, turnover, and productivity: Evidence from New Zealand'. *Academy of Management Journal* 44: 180–190.

Hansen, Morten
2002 'Knowledge networks: Explaining effective knowledge sharing in multi unit companies'. *Organization Science* 13/3: 232–248.

Hatch, Nile W., and Jeffrey Dyer
2004 'Human capital and learning as a source of sustainable competitive advantage'. *Strategic Management Journal* 25: 1155–1178.

Heckman, James
1979 'Sample selection bias as a specification error'. *Econometrica* 7: 153–161.

Hoskisson, Robert, and Michael Hitt
1988 'Strategic control systems and relative R&D investment in large multi-product firms'. *Strategic Management Journal* 9: 605–621.

Hoskisson, Robert E., Michael Hitt, Richard A. Johnson, and Wayne Grossman
2002 'Conflicting voices: The effects of institutional ownership heterogeneity and internal governance on corporate innovation strategies'. *Academy of Management Journal* 45: 697–716.

Huselid, Mark A.
1995 'The impact of human resource management practices on turnover, productivity, and corporate financial performance'. *Academy of Management Journal* 38: 635–672.

Huselid, Mark A., Susan E. Jackson, and Randall Schuler
1997 'Technical and strategic human resource management effectiveness as determinants of firm performance'. *Academy of Management Journal* 40/1: 171–188.

Ichniowski, Casey, Kathryn Shaw, and Giovanna Prennuschi
1997 'The effects of human resource management practices on productivity: A study of steel finishing lines'. *American Economic Review* 87: 291–313.

Jackson, Susan E., and Randall S. Schuler
1995 'Understanding human resource management in the context of organizations and their environments' in *Annual review of psychology*, vol. 46. J. T. Spence, J. Darley and D. Foss (eds), 237–264. Palo Alto, CA.

Jaffe, Adam, Manuel Trajtenberg, and Rebecca Henderson
1993 'Geographic localization of knowledge spillovers as evidenced by patent citations'. *Quarterly Journal of Economics* 108: 577–598.

Kang, Sung-Choon, Shad Morris, and Scott Snell
2007 'Relational archetypes, organizational learning, and value creation: Extending the human resource architecture'. *Academy of Management Review* 32/1: 236–256.

Kanter, Rosabeth M.
1988 'When a thousand flowers bloom: Structural, collective, and social conditions for innovation in organization' in *Research in organizational behavior*, vol. 10. B. M. Staw and L. L. Cummings (eds), 169–211 Greenwich, CT: JAI Press.

Katila, Riitta
2002 'New product search over time: Past ideas in their prime?' *Academy of Management Journal* 45: 995–1010.

Kleinknecht, Alfred
1998 'Is labour market flexibility harmful for innovation?' *Cambridge Journal of Economics* 22/3: 387–396.

Koch, Marianne J., and Rita Gunther McGrath
1996 'Improving labor productivity: Human resource management policies do matter'. *Strategic Management Journal* 17: 335–354.

Lau, Chung-Ming, and Hang-Yue Ngo
2004 'The HR system, organizational culture and product innovation'. *International Business Review* 13: 685–703.

Laursen, Kjeld, and Nicolai Foss
2003 'New human resource management practices, complementarities and the impact on innovation performance'. *Cambridge Journal of Economics* 27: 243–263.

Lengnick-Hall, Cynthia A., and Mark L. Lengnick-Hall
1988 'Strategic human resources management: A review of the literature and a proposed typology'. *Academy of Management Review* 13/3: 454–470.

Lepak, Dave P., and Scott A. Snell
1999 'The human resource architecture: Toward a theory of human capital allocation and development'. *Academy of Management Review* 24: 31–48.

Macduffie, John Paul
1995 'Human resource bundles and manufacturing performance: Organizational logic and flexible production systems in the world auto industry'. *Industrial and Labor Relations Review* 48: 197–221.

Maddala, G. S.
1983 *Limited-dependent and qualitative variables in econometrics*. Cambridge, MA: Cambridge University Press.

Mairesse, Jacques, and Pierre Mohnen
2002 'Accounting for innovation and measuring innovativeness: An illustrative framework and an application'. *American Economic Review* 92/2: 226–230.

Marchington, Mick, and Irena Grugalis
2000 '"Best practice" human resource management: Perfect opportunity or dangerous illusion'. *International Journal of Human Resource Management* 11: 1104–1124.

Michie, Jonathan, and Michie Sheehan
1999 'HRM practices, R&D expenditures and innovative investment: Evidence from the 1990s workplace industrial

relations survey'. *Industrial and Corporate Change* 8: 211–234.

Michie, Jonathan, and Michie Sheehan
2003 'Labour market deregulation, 'flexibility' and innovation'. *Cambridge Journal of Economics* 27: 123–143.

Michie, Jonathan, and Michie Sheehan
2005 'Business strategy, human resources, labour market flexibility and competitive advantage'. *International Journal of Human Resource Management* 16/3: 445–464.

Miles, Ray, and Charles C. Snow
1984 'Designing strategic human resource systems'. *Organizational Dynamics* 13/1: 36–52.

Nonaka, Ikujiro, and Hirotaka Takeuchi
1995 *The knowledge creating company: How Japanese companies create the dynamics of innovation*. New York: Oxford University Press.

Nonaka, Ikujiro, Georg von Krogh, and Sven Voelpel
2006 'Organizational knowledge creation theory: Evolutionary paths and future advances'. *Organization Studies* 27: 1179–1208.

Oldham, Greg R., and Anne Cummings
1996 'Employee creativity: Personal and contextual factors at work'. *Academy of Management Journal* 39/3: 607–634.

Oliver, Christine
1997 'Sustainable competitive advantage: Combining institutional and resource based views'. *Strategic Management Journal* 18/9: 697–713.

Parker, Simon, and Arjen van Witteloostuijn
2007 'A general framework for estimating multidimensional fit'. Working paper, Faculty of Applied Economics, University of Antwerp.

Perry-Smith, Jill E.
2006 'Social yet creative: The role of social relationships in facilitating individual creativity'. *Academy of Management Journal* 49/1, 85–101.

Perry-Smith, Jill E., and Terry C. Blum
2000 'Work-family human resource bundles and perceived organizational performance'. *Academy of Management Journal* 43: 1107–1117.

Pfeffer, Jeffrey
1994 *Competitive advantage through people*. Boston, MA: Harvard Business School Press.

Pfeffer, Jeffrey
1998 *The human equation: Building profits by putting people first*. Boston, MA: Harvard Business School Press.

Podsakoff, Phillip, and Dennis Organ
1986 'Self reports in organizational research: Problems and prospects'. *Journal of Management* 12/4: 531–544.

Postrel, Steven
2002 'Islands of shared knowledge: Specialization and mutual understanding in problem solving teams'. *Organization Science* 13/3: 303–320.

Richard, Orlando C.
2000 'Racial diversity, business strategy, and firm performance: A resource based view'. *Academy of Management Journal* 43/2: 164–177.

Sanchez, Ron
1995 'Strategic flexibility in product competition'. *Strategic Management Journal* 16: 135–159.

Shipton, Helen, Doris Fay, Michael West, Malcolm Patterson, and Kamal Birdi
2005 'Managing people to promote innovation'. *Creativity and Innovation Management* 14/2: 118–128.

Shipton, Helen, Michael West, Jeremy Dawson, Kamal Birdi, and Malcolm Patterson
2006a 'HRM as a predictor of innovation'. *Human Resource Management Journal* 16/1: 3–27.

Shipton, Helen, Michael West, C. Parles, and Jeremy Dawson
2006b 'When promoting positive feelings pays: Aggregate job satisfaction, work design features and innovation in manufacturing organizations'. *European Journal of Work and Organizational Psychology* 15/4: 404–430.

Tansky, Judith W., and Robert Heneman
2003 'Guest editor's note: Introduction to the special issue on human resource management in SMEs, a call for more research'. *Human Resource Management* 42: 299–302.

Tsai, Wenpin
2001 'Knowledge transfer in interorganizational networks: Effects of network positions and absorptive capacity on business unit innovation and performance'. *Academy of Management Journal* 44: 996–1004.

Tsai, Wenpin, and Sumantra Ghoshal
1998 'Social capital and value creation: The role of intrafirm networks'. *Academy of Management Journal* 41: 464–476.

Ulrich, Dave
1997 'Measuring human resources: An overview of practice and a prescription for results'. *Human Resource Management* 36: 303–320.

Unsworth, Kerrie L.
2001 'Unpacking creativity'. *Academy of Management Review* 26/2: 289–297.

van Dijk, Christiaan, and Jan van den Ende
2002 'Suggestion systems: Transferring employee creativity into practicable ideas'. *R&D Management* 32/5: 387–395.

Verbeek, Marno
2005 *A guide to modern econometrics*, 2nd edition. Chichester, UK: John Wiley & Sons.

Wiklund, Johan, and Dean Shepherd
2003 'Knowledge based resources, entrepreneurial orientation, and the performance of small and medium sized businesses'. *Strategic Management Journal* 24: 1307–1314.

Youndt, Mark A., Scott Snell, James W. Dean Jr., and David Lepak
1996 'Human resource management, manufacturing strategy and firm performance'. *Academy of Management Journal* 39: 836–866.

Zollo, Maurizio, and Sidney Winter
2002 'Deliberate learning and the evolution of dynamic capabilities'. *Organization Science* 13/3: 339–351.

Sjoerd Beugelsdijk

Sjoerd Beugelsdijk is Associate Professor at the Nijmegen School of Management of the Radboud University Nijmegen, The Netherlands. He completed his PhD at Tilburg University in 2003. His research interests are in the field of institutional economics. Since the start of his PhD his research is aimed at combining the premise of economic rationality with the principles of social behaviour.
Address: Nijmegen School of Management, Radboud University Nijmegen, Thomas van Aquinostraat 5.0.65, PO Box 9108, The Netherlands.
Email: S.Beugelsdijk@fm.ru.nl