# HRM practices and innovation performance: a panel-data approach

**Article** *in* International Journal of Manpower · June 2017

DOI: 10.1108/IJM-02-2015-0028



3 authors:

Mirta Diaz-Fernandez
Universidad Pablo de Olavide


Mar Bornay-Barrachina
Universidad de Cádiz


Alvaro Lopez Cabrales
Universidad Pablo de Olavide

International Journal of Manpower

# HRM practices and innovation performance: a panel-data approach

Mirta Diaz-Fernandez, Mar Bornay-Barrachina, Alvaro Lopez-Cabrales,

# HRM practices and innovation performance: a panel-data approach

Mirta Diaz-Fernandez, Mar Bornay-Barrachina and Alvaro Lopez-Cabrales
*Business Administration Department, Pablo de Olavide University, Seville, Spain*

Received 11 February 2015
Revised 2 October 2015
10 February 2016
19 May 2016
Accepted 26 June 2016

## Abstract

**Purpose** – The purpose of this paper is to study the relationship between human resource management (HRM) practices and innovation performance in Spanish manufacturing firms. The paper focuses on the number of existing patents, analyzing the extent to which this variable is favored by HRM practices. It will also assess the extent to which patents explain the firm performance and mediate in the relationship between the latter and HRM practices.

**Design/methodology/approach** – The objective is to assess these relationships using the Spanish Survey of Industrial Strategic Behavior. The longitudinal analysis focuses on the years between 2001 and 2008, a period of great economic growth in Spain.

**Findings** – The findings show that the most innovative firms were also the most competitive ones. Furthermore, employment security positively affects innovations over time and training on new technologies is associated with the number of patents, when overall compensation practices are high.

**Practical implications** – This study demonstrated the existence of two objectives that HR managers should be aiming at. On the one hand, the development of patents should be a priority for obtaining better results over time. On the other hand, management should invest in HRM practices because they favor innovation and are neither a waste of time nor resources.

**Originality/value** – This study contributes to the literature, surpassing the limitations of previous research, by assessing the role of HRM practices in innovation and company outcomes and by using a longitudinal study design.

**Keywords** Training, Innovation performance, Compensation, Longitudinal studies, Employment security, ESEE, Firm Performance

**Paper type** Research paper

## 1. Introduction

The study of leveraging innovation has recently generated theoretical and empirical contributions. Advances in data analysis and panel data at corporate level have allowed researchers to pinpoint the specific relationships between innovation and industrial dynamics. Several studies have addressed the propensity of firms to innovate (López Cabrales *et al.*, 2009; Teece, 2007), and it is acknowledged that individuals and the way they are managed play an important role in developing corporate innovation (Kang and Snell, 2009; Subramaniam and Youndt, 2005).

Nevertheless, there is a certain amount of debate about the potential benefits of investing in employees. Some authors recommend applying human resource management (HRM) practices, such as employment security, training initiatives and compensation policies, which both encourage people's commitment to the firm as well as updating HR skills and knowledge to prevent obsolescence (Lepak *et al.*, 2006). However, investment in employees, be it in their employment, skills or salaries, is under discussion because organizations are looking to achieve maximum efficiency in their budgets while at the same time seeking to cut costs (Mohrman and Worley, 2009). Consequently, more research is needed to show how

The financial support for this paper was provided by the Ministerio de Economia y Competitividad, Plan Nacional de I + D + I (ECO2010-14939).

International Journal of Manpower
Vol. 38 No. 3, 2017
pp. 354-372

0143-7720
DOI 10.1108/IJM-02-2015-0028

investing in HRM eventually contributes to corporate competitiveness and success. A great deal of research which analyzes the role of HRM practices in the firm performance, using ROI, profits and turnover as the dependent variables has been carried out (Arthur, 1994; Ichniowski *et al.*, 1997). However, this research measured the contribution of HRM practices through financial metrics. It did not assess the role of HRM practices in other outcomes, which would explain firm performance. This has led to there being a call for research into intermediating mechanisms which would explain the nexus between HRM and performance (Paauwe, 2009).

As the literature has suggested (e.g. Zhou, 2006), innovation has been viewed as a key contributor to competitive advantage in firms. Research into HRM has analyzed the effects of employees' knowledge and HRM practices on facilitating innovation (López Cabrales *et al.*, 2009). Moreover, although much is known about the individual effects of HRM practices on innovation performance in companies, little is known about their interaction. This is a critical gap to be filled from an HRM approach, as HR managers are constantly faced with a myriad of HRM practices, but have limited resources to implement them simultaneously. An understanding of which HRM practices interact with each other would be invaluable to innovation management research.

Another gap, and potential opportunity, emerges in the cross-sectional nature of the data analyzed in previous HRM-innovation research. Innovation performance is an evolving, dynamic process that requires a longitudinal study design. The previous cross-sectional studies (e.g. Chen and Huang, 2009; López Cabrales *et al.*, 2009) lack an effective way of measuring causality between HRM and dependent variables, and this missing link has been considered a shortcoming when analyzing the consequences of HRM designs (Combs *et al.*, 2006; Paauwe, 2009). Laursen and Foss (2003) analyzed the contribution of HRM systems to innovation performance using an extensive Danish data set, but measuring only one year's data of HRM practices. Wang *et al.* (2003) also conducted a longitudinal analysis of HRM effectiveness on innovation performance and labor productivity (LP), but their measurement of innovation was based on corporate research intensity. The novelty of this paper is that it assesses and combines three different panel data for an entire period (2001-2008): patents, firm performance (measured in terms of added value (AV) and employee productivity) and HRM practices. Then, a longitudinal analysis is conducted on their relationship, with a view to evaluating the contribution of several HRM practices to innovation performance over time, while looking at the effect of individual practices, interactions among them and the measurement of innovation in the relationship between HRM and firm performance.

To fill the research gaps mentioned above, this paper sets out first to analyze whether the number of patents produced depends on HRM practices such as employment security, training and compensation by studying their individual effects on innovation performance. Second, it will assess the extent to which the contribution of these HRM practices to firm performance (AV and productivity) is a direct effect or whether it is mediated by the innovations being developed. In doing so, this study examines a sample of Spanish enterprises using data from 2001 to 2008, a period of major growth in both the global and the Spanish economies, using a longitudinal design, so that causality may be derived from the analyses.

This paper aims to contribute to the existing literature in several ways. First, it measures both the individual and the interactional effect of certain HRM practices on patents. It also studies the mediating effect of patents in the relationship between HRM and firm performance. In studying HRM, innovation and performance together, this paper studies how HRM impacts on firm innovation (Chen and Huang, 2009) and also contributes to the debate about the "black box" in HRM (Paauwe, 2009), as it considers innovation from the perspective of the generation of patents (an objective variable that can be measured and controlled) as a mediator explaining the positive effect of investment in employees on firm performance (López Cabrales *et al.*, 2009). This is considered to be critical for the future of HRM, since it shows firms the positive consequences of investing in people in terms of AV and productivity.

Another positive contribution of this paper is how it uses panel data (2001-2008) to assess these relationships. This is noteworthy because it is consistent with the idea of evolving, long-term processes associated with innovation and because causality might be inferred with this study design (Combs *et al.*, 2006). Hence, this paper overcomes empirical challenges of HRM research, especially in so far as researchers are recommended to examine how HRM practices, processes and interactions evolve over time. The data analysis provided here suggests that certain HRM investments have a positive effect on patents over time, that patents positively influence firm performance and that they explain the contribution of HRM practices to firms' results. Explanations for the evolving processes can, as mentioned previously, be more detailed by taking into account a longitudinal data set.

The theoretical reasoning that underlies the hypothesis of this study is explained below, drawing on HRM and innovation literature. The empirical research, which tests the hypothesis using a longitudinal sample of Spanish industrial companies, is then presented. Finally, important findings and directions for further study are discussed.

## 2. HRM practices, innovation performance and firm performance: hypotheses

### *2.1 Individual HRM practices, interaction HRM practices and innovation performance*

Innovation has become fundamental in achieving a competitive advantage (Zhou, 2006) and is one of the principal topics of debate in management literature. In defining innovation from an organizational point of view, Damanpour *et al.* (2009) focus on the development and/or use of new ideas or behaviors. They define innovation as new to the adopting organization and consider that the process of innovation involves two main stages: generation and adoption. The generation process includes recognition of opportunity, research, design, commercial development and marketing and distribution, while the adoption process is conceived to include two main sub-processes: initiation and implementation. The initiation process consists of all activities leading to the decision to adopt the innovation and the implementation process consists of all events and actions initially using the innovation and continuing to do so until it becomes a routine feature of the organization. While the term "innovation" is broadly debated, this paper will focus only on the result of innovation or innovation performance, understood as a broad term that defines the ability of a firm to launch new products or lines (ranges) onto the market (Chen and Huang, 2009).

It is accepted that a company's ability to obtain new products and other aspects of performance is inextricably linked to the management of its human resources (Laursen and Foss, 2003). This perspective has important implications in the application of HRM practices, which are, in turn, coherent with the innovative strategies. According to Boxall (1996), firms can generate human capital advantages by retaining outstanding people; that is, by attracting people of exceptional human talent, developing their knowledge and skills and rewarding their contributions. These three broad HRM practices can be considered part of the ability, motivation and opportunity theory (AMO model) (Paauwe, 2009). Therefore, in spite of the variety of HRM practices we could apply (see Perdomo-Ortiz *et al.* 2009 for a review), we shall focus our analyses on HRM practices that can enhance the employees' skills (such as training) and motivate them to perform (such as employment security and compensation). The "opportunity" part of the equation may be secondary if employees lack the necessary skills and knowledge to perform (Bos-Nehles *et al.*, 2013). Ability and motivation are prerequisites for innovation.

It has been stated that employees who possess the required knowledge for innovation demand stable employment conditions and should not be offered short-term contracts because their contributions to the firm are expected to be important (Tsui and Wu, 2005).

Therefore, the first practice to be considered is employment security, because the more employees perceive that the organization values their potential for bringing new knowledge to the workplace, the more they will become involved in and committed to the organization (Shafer *et al.*, 2001). According to Lepak *et al.* (2006), employment security is one of the motivation-enhancing practices that encourage employees to work toward the firms' strategic objectives. A consequence of such practices will be the development of knowledge-sharing processes, where talented employees are willing to share their individual experiences and experiment with new solutions, and where personnel retention – by means of permanent contracts and participation in long-term projects – has been shown to be a driving force toward knowledge sharing (Ax and Marton, 2008). Such a proposition has been confirmed because it has been empirically demonstrated that a certain level of employment security generates greater innovation results and even higher returns (López Cabrales *et al.*, 2009; Subramaniam and Youndt, 2005), as we propose the following hypothesis:

*H1a.* The HRM practice of employment security is positively related to the innovation performance.

As previously mentioned, employment security is a prerequisite for innovation performance, but it should go hand-in-hand with other initiatives. High-value human capital is unlikely to reach its potential if these employees do not perceive support from the organization. Different HRM practices reflect different types of investment in employees. Human resource practices are used by managers to maintain and elicit their employees' knowledge. Following the AMO theory (Paauwe, 2009), investment in employee training is a skill-enhancing practice enabling talented employees to produce creative ideas (Chen and Huang, 2009). Moreover, a broad application of training is necessary in order to develop the employees' skills and knowledge needed for innovation ( Jiménez-Jiménez and Sanz-Valle, 2008). In that sense, Laursen and Foss (2003) found that internal and external training practices had a positive effect on innovation performance. Specifically, training in new technologies is necessary because it improves technical abilities for solving problems. Training to acquire technological knowledge enables both the identification and exploitation of opportunities, as it can lead to technological breakthrough (Bojica *et al.*, 2011). Investment in language training is another orientation of training that can provide employees with the opportunity to share knowledge with external partners and generate new understanding and ideas. This training practice will positively impact the employees' abilities to participate in external networks, facilitating the assimilation and later implementation of new ideas and projects. Therefore, one would expect that investment in different training initiatives within firms will favor innovation performance, as we propose the following hypotheses:

*H1b.* Investment in language training in the firm is positively related to innovation performance.

*H1c.* Investment in training in new technologies in the firm is positively related to innovation performance.

Finally, compensation practices are also needed for innovation purposes as these practices influence the innovation behavior of individuals. As AMO theorists suggest, compensation is part of the motivation-enhancing HR practices that influence the employees' attitudes at work (Lepak *et al.*, 2006). Specifically, innovative companies should design attractive compensation packages in order to attract the best skilled employees (Laursen and Foss, 2003). Additionally, the positive impact of employees' salary scales on innovation has been empirically demonstrated (Van Reenen, 1996). In this regard, we agree with Chen and Huang (2009) who explicitly recognized that overall compensation is an effective way of recognizing individual and collective achievements and that it also encourages innovation. High intrinsic and extrinsic rewards motivate employees to take risks at work, generate new ideas and develop new products (Mumford, 2000). The positive effect of compensation on innovation performance is depicted in the following hypothesis:

*H1d.* Overall compensation and benefits are positively related to the innovation performance.

The above arguments seem to recognize the positive effects on innovation performance of individual practices such as employment security, training and compensation. Nevertheless, as Laursen and Foss (2003, p. 249) explicitly state, "HRM practices (will) be more conducive to innovation performance when adopted, not in isolation, but as a system of mutually reinforcing practices."

Given that intrinsic and extrinsic rewards are considered essential to motivate employees to innovate (Mumford, 2000) and that they have been stated to be effective inducements in any working relationship (Wang *et al.*, 2003), it is easy to imagine that the positive effects of employment security and/or training investment on innovation performance would diminish in the case of providing low compensation and benefits. We are explicitly assuming that any investment in training or the retention of valuable employees is in vain in the absence of a high and generous compensation package for innovative purposes. In other words, managers could expect their trained, permanent employees to behave in an innovative manner if there is also an attractive monetary compensation package. To some extent, compensation and benefits are taking on a more prevalent role in our study of HRM practices and innovation, as they are considered an irreplaceable part of an HRM system which facilitates innovation. In summary, the following hypotheses reflect this reasoning:

*H2a.* The relationship between employment security and innovation performance will be moderated by overall compensation and benefits.

*H2b.* The relationship between language training and innovation performance will be moderated by overall compensation and benefits.

*H2c.* The relationship between training in new technologies and innovation performance will be moderated by overall compensation and benefits.

### *2.2 Innovation performance and firm performance: direct and mediated effects*

The previous hypotheses proposed that certain HRM investments have positive effects on innovation, but this begs the question of the extent to which being innovative is important. According to the RBV literature (Li and Atuahene-Gima, 2001), innovation is one of the main sources of competitive advantage. Firms that offer products tailored to the needs of target customers and market them faster and more efficiently than their competitors are in a better position to achieve higher performance and to create sustainable competitive advantages (Alegre *et al.*, 2006). Furthermore, given that organizational capabilities such as innovativeness can be seen as a proxy for a competitive edge (López Cabrales *et al.*, 2009), there is a very close link between innovation performance, competitive advantage and firm performance.

It has been suggested that the development of innovation contributes to a company's performance. That is to say, innovative firms have the potential to create markets, shape customer preferences and even change the basic behavior of consumers (Zhou, 2006), which, in turn, leads to more profits. Additionally, it is expected that innovative success positively affects innovations in subsequent years, creating a cycle that produces continuous profits (Flaig and Stadler, 1994). Given these factors, we would argue that innovation performance enhances the company's performance. This leads to the third hypothesis:

*H3.* Innovation performance is positively related to the firm performance.

Finally, as mentioned in the introduction, traditional research into HRM, and more specifically into high performance work systems (Becker *et al.*, 1997), has associated certain HRM practices with performance, including employment security, training and compensation, among others. Nevertheless, the assumption is that the outcome of such practices is the development of innovation, as argued in the above hypotheses. One might expect that innovation itself should exert some influence on the relationship between the HRM practices and firm performance.

At this point, it can be assumed that the goal of HRM investments is to promote the necessary behavior among employees to make firms more competitive and consistently profitable. If HRM practices support innovation performance, and innovation affects the firm performance, then innovation can be seen as a link or nexus between the HRM practices and firm performance. In others words, employment security, compensation practices and training investment would not improve the firm performance unless they increase the amount of innovation being developed by the organization, in accordance with our theoretical model. This proposition calls for a study of the "black box" or intermediating mechanisms that explain the contribution of HRM to performance (Paauwe, 2009). Therefore, it is posited here that the generation of new products is the mediating variable in such a relationship. The last hypothesis is as follows:

*H4.* Innovation performance mediates in the relationship between the HRM practices and firm performance.

## 3. Methodology

### *3.1 Sample*

The data used in this study consisted of a longitudinal survey of Spanish manufacturing firms called the *Encuesta sobre Estrategia Empresarial* (ESEE, Survey of Industrial Strategic Behavior). The data were collected by the Fundación Empresa Pública (SEPI Foundation) through its Economics Research Program (*Programa de Investigaciones Económicas*) and sponsored by the Spanish Ministry of Industry. The database is representative of the manufacturing firms in the Spanish economy.

The reference population of the ESEE consists of firms with at least ten employees dedicated to one of the activities corresponding to divisions 15 to 37 of the NACE-93. ESEE surveyed firms with more than 200 workers. Participation was compulsory for all of these companies (70 percent of which actually did). Firms with less than 200 employees (ranging from 10 to 200 employees) were sampled randomly by industry, retaining approximately 5 percent in the database, so that representativeness for every industry and firm size was guaranteed (Fariñas and Jaumandreu, 1999).

Within this population, 1,363 firms were selected as a sample that offered data on innovation, performance, staffing, training and compensation policies, from 2001 to 2008, a time of great economic development in Spain. All missing data of the selected variables were eliminated; as a result, 6,887 firm-year observations were obtained.

The sample included innovative and non-innovative firms so that light could be shed on all nuances that explain the innovation performance. The Organization for Economic Cooperation and Development (OECD) classification stresses the low-medium tech character of the sample. Following the OECD classification of companies according to technology intensity, there were 689 firms in the low-tech category (50.6 percent), 301 in the medium-tech category (22.1 percent) and 373 firms in the high-tech category (27.4 percent). The distribution by technology intensity is shown in Table I.

### *3.2 Measures*

*Control variables*. Firm size was measured by the natural logarithm of the number of total employees, as in previous research (Cardinal, 2001). Technology intensity is a dummy variable used to control the effect of different activities (Wall *et al.*, 2004). For technology intensity, the OECD classification was adopted, distinguishing three groups of industries. Since this is a categorical variable, it is necessary to identify a reference category, which will not be included in the regression analysis. For this study, low-tech industries were chosen (OECD1). The other categories in the industrial sector are introduced as dummy variables, taking the value of one when the firms belong to the corresponding sector and 0 otherwise.

*Independent variables*. In this study, there are several independent variables, employment security, training expenses and overall compensation and benefits (HRM practices). Thus, employment security is calculated as the ratio of permanent employees divided by the total number of employees in the firm, which is intended as a proxy of stable, permanent employment. By permanent workers we meant those employees who have an employment contract of indefinite duration. Training practices are calculated using two training approaches: as the ratio of total expenditure on training in new technology divided by the total number of employees in the firm; and the ratio of total expenditure on language training divided by the total number of employees in the firm. Finally, overall compensation and benefits is calculated as the ratio between labor cost and the total number of employees in the firm, where labor cost includes salaries, innovation incentives and social benefits.

The evolution of these HRM practices during the period studied (2001-2008) is shown in the Figure A1.

*Dependent variables*. Two dependent variables have been considered: innovation performance and firm performance. Following previous research, innovation performance was measured by the number of firm patents. Patents are probably the most commonly used objective measurement of innovation and, given that patent applications are usually filed early in the research process, not only are they a measurement of innovative output, but also an indicator of the level of innovative activity itself (Popp, 2005). In our case, innovation was measured by the use of a proxy as the number of firm patents. Patent data provide a useful indicator of a firm's research (Ahuja and Katila, 2004; Narin *et al.*, 1997). And patent records are likely to be good indicators of the underlying innovative behavior of the firm in our sample (Ahuja and Katila, 2004). Firm performance was measured using three indicators: hourly productivity (HP) (Wall *et al.*, 2004), LP (Freeman, 2008) and AV (Komnenic and Pokrajcic, 2012). To be specific, HP is calculated as the ratio of AV to hours worked. This ratio is considered to be a thousand euros for every 1,000 hours worked. LP is calculated as the ratio of a measurement of the volume of goods and services to the total number of employees. LP provides a measurement of the efficiency with which workers are used to produce goods and services. Finally, AV is a financial performance measurement which is calculated as the difference between output (total sales) and input (cost of bought-in materials, components and services) (Komnenic and Pokrajcic, 2012).

**Table I.** OECD's industry classification and number of firms in the sample

| | Industry classification | Number of firms | % of the sample |
|---|---|---|---|
| Low-tech OECD1 | Meat industry; food products, tobacco; beverages; textiles; footwear; wood industry; paper printing and publishing; non-metallic mineral products; iron and non-iron metallic products; metallic products; furniture; other manufacturing | 689 | 50.6 |
| Medium-tech OECD2 | Rubber and plastics; industrial and agricultural machinery; motor vehicles; other transport material | 301 | 22.1 |
| High-tech OECD3 | Chemistry; office machines and computers; electrical material and machinery | 373 | 27.4 |

Since this study focuses on data collected over an eight-year period, Figure A1 provides a graph showing the evolution of the main variables during this period: innovation performance and HRM practices.

Definition and descriptive statistics of variables used in this study are shown in Table II.

### *3.3 Statistical analysis*

The hypotheses are tested by means of panel data regressions using STATA software (Hair *et al.*, 1999). The panel was constructed taking into account the information about available variables for each year of the target period (2001-2008). The use of panel data makes it possible to achieve an increased sample size and degrees of freedom with improved efficiency of estimation. Estimation bias is lower than with either times-series or cross-sectional data, and multi-collinearity is less of a problem. One of the key strengths of panel data methods is that they have the potential to remove confounding impacts of any omitted variables correlated with variables in the model. The use of panel data also helps reduce error in model specification and in parameter estimation. We used an estimation process that is appropriate for our theoretical arguments and robust enough to support the usual problems associated with panel data analysis, it is Arellano-Bond system generalized method of moments (GMM) estimation model (Arellano and Bond, 1991). In a dynamic panel data model, specifically when there is a small number of time periods (2001-2008) but a large number of cross-sectional observations (6,887 firms/year) the implied manipulations required to implement a "fixed effects" approach could create a correlation between the regressor and error (Nickell, 1981). The use of an Arellano-Bond model overcomes these

| Variable | Definition | Mean | SD |
|---|---|---|---|
| *Control variables* | | | |
| Size | Logarithm of the number of employees | 0.25 | 0.162 |
| *Intensity of Technology* | | | |
| OECD1 | Low-tech industry (reference category) | 0.51 | 0.500 |
| OECD2 | 1 if medium-tech industry; 0 for any other category | 0.22 | 0.415 |
| OECD3 | 1 if high-tech industry; 0 for any other category | 0.27 | 0.445 |
| Innovation performance | Number of patents | 0.50 | 5.965 |
| *HRM practices* | | | |
| Employment security | Ratio of permanent employees divided by the number of total employees in the firm | 0.826 | 0.192 |
| Training new technologies | Ratio of total of expenditures on training on new technology divided by the number of total employees in the firm | 37.25 | 287.11 |
| Training on Languages | Ratio of total expenditures on training on languages divided by the number of total employees in the firm | 33.39 | 279.28 |
| Overall compensation and benefits | It is calculated as the ratio between laboral cost and the number of total employees in the firm. Laboral cost included salaries, innovation incentives and contributions (thousand euros) | 53.75 | 226.60 |
| *Performance* | | | |
| Added value | The difference between the output and input (millions of euros) | 20.09 | 65.10 |
| Hourly productivity | Ratio of added value between worked hours | 27.40 | 22.97 |
| Labor productivity | Labor productivity is calculated as the ratio between a volume measure of goods and services and the number of total employees. Labor productivity provides a measure of the efficiency with which workers are used to produce goods and services | 180.67 | 220.85 |

**Note:** Mean and SD were calculated considered data from the eight-year period

**Table II.** Definition and descriptive statistics of variables concerns and it is appropriate to our situation where there exist a dynamic variable (innovation performance), fixed individual effects and human resource variables which are not strictly exogenous.

We also use the GMM with lagged variables as instruments to resolve a potential problem for endogeneity. From a theoretical point of view, we assume that there is a relationship between innovation performance and firm performance (Alegre *et al.*, 2006; Flaig and Stadler, 1994; Zhou, 2006), but other authors have linked the firm performance as an input of innovation performance (Añón-Higón and Driffield, 2010; Klomp and Leeuwen, 2001). Because the potential endogeneity due to the problem of simultaneity or inverse causality we have included the innovation performance and firm performance as sources of endogeneity lagging the variables. Therefore, we consider our model to be autoregressive, so we have included the lagged dependents variables (innovation performance$_{(t-1)}$ and firm performance$_{(t-1)}$, respectively) as instruments.

To test the validity of the model specification when using GMM, the Hansen Statistic of over identifying restrictions was applied to evaluate the lack of correlation between the instruments and the terminal error in all of our models. The acceptance of the $H_0$ Hansen statistic implies the absence of any correlation between the instruments used and the terminal error in all of our models. The Hansen test of over identifying restrictions and the AR(2) test were performed and, in all cases, a $p$-value of more than 0.05 was obtained. The Arellano and Bond methodology is therefore adequate. The GMM methodology has two main advantages in the context of our data since it is suitable for a short panel such as the one used in this study (eight years) and it is adequate with a highly persistent dependent variable such as innovation performance. The resultant model is as follows:

$$\begin{aligned}\text{Innovation performance}_t &= \alpha\text{Innovation performance}_{(t-1)} + \beta_1\text{E.Security}_t \\ &\quad + \beta_2\text{T.Languages}_t + \beta_3\text{T.NewTech}_t + \beta_4\text{Compensation}_t + \upsilon_t \\ \text{Firm performance}_t &= \alpha\text{ Firm performance}_{t-1} + \text{Innovation performance}_t + \upsilon_t \end{aligned} \tag{1}$$

Nevertheless, this is an univariate analysis and it does not establish a causal link between the innovation performance (patents) and HRM practices nor firm performance and innovation performance, since the revealed evidence may be driven by unobserved heterogeneity and be affected by direct and crossover effects of other possible determinants of innovation performance. So, we turn to the econometric test of (1) for firms ($i$) over time ($t$):

$$\begin{aligned}\text{Innovation performance}_{i,t} &= \alpha\text{Innovation performance}_{i,\ t-1} + \beta_1\text{E.Security}_{i,t} \\ &\quad + \beta_2\text{T.Languages}_{i,t} + \beta_3\text{T.NewTech}_{i,t} + \beta_4\text{Compensation}_{i,t} \\ &\quad + (n_i + \upsilon_t)\text{ Firm performance}_{i,t} = \alpha\text{ Firm performance}_{i,t-1} \\ &\quad + \text{Innovation performance}_{i,t} + (n_i + \upsilon_t)\end{aligned} \tag{2}$$

## 4. Results

Table III provides the correlations between the variables included in the analysis.

Regression analysis for innovation performance as a dependent variable and human resource practices were supported by employment security and overall compensation and benefits (Table IV; Model 1). The coefficients were statistically significant, supporting *H1a* and *H1d*. The relationship between language training and training in new technologies and innovation performance were not significant in this sample. None of the control variables were significant in this regression.

Table IV (Model 2) shows that the results support *H2a* and *H2c*. We first introduce control variables, then, in a second step, the main effects and finally we introduce interaction

**Table III.** Correlations (standardized solution)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Employment security | 1 | | | | | | | | | | | |
| 2. Training new technologies | 0.025** | 1 | | | | | | | | | | |
| 3. Training on languages | 0.042*** | 0.362*** | 1 | | | | | | | | | |
| 4. Overall compensation and benefits | 0.039*** | 0.481*** | 0.696*** | 1 | | | | | | | | |
| 5. Innovation performance | 0.029*** | 0.063*** | 0.011 | 0.000 | 1 | | | | | | | |
| 6. Productivity per worker | 0.172*** | 0.022** | 0.013 | −0.010 | 0.038*** | 1 | | | | | | |
| 7. Hourly productivity | 0.223*** | 0.025** | 0.022** | −0.002 | 0.082*** | 0.604*** | 1 | | | | | |
| 8. Added value | 0.106*** | 0.012 | 0.006 | −0.014 | 0.104*** | 0.299*** | 0.371*** | 1 | | | | |
| 9. Size | 0.213*** | −0.012 | −0.043*** | −0.106*** | 0.096*** | 0.326*** | 0.358*** | 0.438*** | 1 | | | |
| 10. OECD1 | −0.050*** | −0.026** | −0.008 | 0.011 | −0.053*** | 0.004 | −0.048*** | −0.050*** | −0.084*** | 1 | | |
| 11. OECD2 | −0.053*** | −0.015 | −0.020 | −0.046*** | −0.012 | −0.055*** | −0.065*** | 0.041*** | 0.016 | −0.540*** | 1 | |
| 12. OECD3 | 0.105*** | 0.043*** | 0.027*** | 0.031*** | 0.071*** | 0.046*** | 0.115*** | 0.018 | 0.079*** | −0.619*** | −0.327*** | 1 |

**Notes:** $n =$ 1,363. The dummy variables corresponding to the eight-year period are not included. $*p < 0.01$; $**p < 0.05$ and $***p < 0.001$

**Table IV.** Regression results HRM practices and innovation performance (*H1* and *H2*)

| Innovation performance | Model 1 Coefficient | Model 1 SE | Model 2 Coefficient | Model 2 SE |
|---|---|---|---|---|
| *Control variables* | | | | |
| Size | 0.004 | 0.019 | 0.004 | 0.025 |
| OECD2 | 0.008 | 0.079 | 0.018 | 0.081 |
| OECD3 | 0.036 | 0.069 | 0.049 | 0.074 |
| *Main effects* | | | | |
| Innovation performance (*t*−1) | 0.047 | 0.013 | 0.048 | 0.139 |
| Employment security | 0.001* | 0.002 | 0.016* | 0.041 |
| Training on languages | 0.002 | 0.001 | 0.002 | 0.004 |
| Training on new technologies | 0.003 | 0.019 | 0.002 | 0.039 |
| Overall compensation and benefits | 0.002* | 0.008 | 0.013* | 0.041 |
| *Interaction terms* | | | | |
| Employment security × compensation | | | 0.021** | 0.003 |
| Training languages × compensation | | | 0.009 | 0.014 |
| Training new tech × compensation | | | 0.022* | 0.047 |
| Model fit statistics | Wald $\chi^2(8) = 1.45$ Prob $\chi^2 = 0.003$ | | Wald $\chi^2(11) = 2.04$ Prob $\chi^2 = 0.008$ | |
| Hansen test | $\chi^2(20) = 17.418$; $p = 0.625$ | | $\chi^2(20) = 35.925$; $p = 0.105$ | |
| AR(1) test | 1.31 $p = 0.189$ | | 1.31 $p = 0.187$ | |
| AR(2) test | 0.415 $p = 0.678$ | | 0.431 $p = 0.666$ | |
| *n* | 6,887 | | 6,887 | |
| Groups | 1,363 | | 1,363 | |
| Instruments | 28 | | 31 | |

**Notes:** $^*p < 0.01$; $^{**}p < 0.05$ and $^{***}p < 0.001$

terms once they have been centered. The results specifically show that the interaction term for overall compensation and benefits and employment security is statistically significant ($\beta = 0.021$**), making the direct effect of employment security statistically significant ($\beta = 0.016$*) for innovation performance. The results also give support to the moderator role of overall compensation and benefits in the relationship between training in new technologies and innovation performance since it has been found to be a statistically significant coefficient for the interaction term ($\beta = 0.022$*) at the same time that the direct effects are reinforced ($\beta = 0.013$*). In these regressions, none of the control variables were significant.

Overall compensation and benefits were plotted in relation to innovation performance at high and low levels of employment security. For departments with low employment security, overall compensation and benefits and innovation performance were not related, whereas in departments with high employment security, overall compensation and benefits and innovation performance were positively related. The same is observed when overall compensation and benefits are plotted in relation to innovation performance at high and low levels of training in new technologies (see Figures 1 and 2).

To test the theoretical relationship between innovation performance and firm performance (*H3*), three models were created based on the dependent variable. Model 1 considered AV as a dependent variable, Model 2 considered LP and Model 3 considered HP. Table V shows the results of the regressions. Innovation performance was positive and significant for AV and HP, but not significant in the case of LP. These results support *H3* when the firm performance is taken as AV and HP.

Finally, in relation to *H4*, this study followed the traditional perspective provided by Baron and Kenny (1986), which states that three equations and four conditions must be given in order to demonstrate a mediation effect. In the first equation, the independent variable (in our case, language training, training in new technologies, employment security and overall compensation and benefits) must have a significant relationship with the dependent variable (firm performance, it is, AV, LP and HP). In the second equation, the independent variable (language training, training in new technologies, employment security and overall compensation and benefits) must have a significant relationship with the mediator (innovation performance). Finally, in the third equation, the mediator variable must have a significant relationship with firm performance after the independent variables are controlled. Additionally, in the third equation, the relationship of the independent variables with the dependent variables should decrease when the mediator variable is included in the equation.

It is worth noting, then, that even though Condition one (which establishes that the dependent variable should be significant for the independent variable regardless of the mediator variable in Equation (1)) is needed to demonstrate a mediating effect several authors do not support this assertion (Lawrence *et al.*, 2006). For the purpose of this study, Condition 1 will be taken into consideration, but whether it is fulfilled will not be taken as decisive in order to prove a mediating effect.

Since we have three variables for the firm performance (AV, labor and HP) we performed three models with three equations to each. We named the model as Model 1 when AV is presented as a dependent variable for Equations (1) and (3), Model 2 when labor productivity is presented as a dependent variable for Equations (1) and (3), and Model 3 for the case of HP.

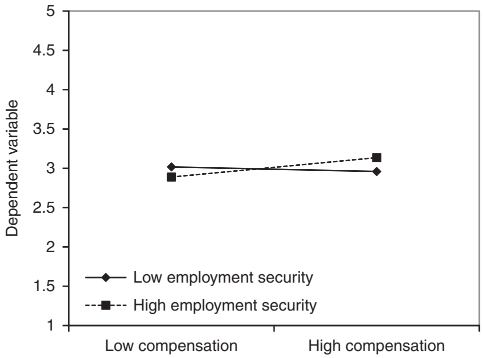


**Figure 1.** Interaction plot for moderator effect of overall compensation and benefits and employment security

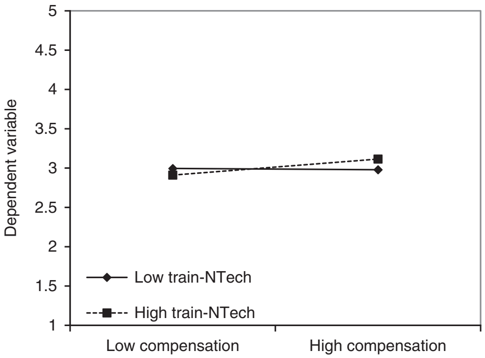


**Figure 2.** Interaction plot for moderator effect of Overall compensation and benefits and training on new technology

**Table V.** Regressions results for innovation performance and firm performance (*H3*)

| | Model 1 DV: added value | | Model 2 DV: labor productivity | | Model 3 DV: hourly productivity | |
|---|---|---|---|---|---|---|
| | Coefficient | SE | Coefficient | SE | Coefficient | SE |
| *Control variables* | | | | | | |
| Size | 0.088*** | 0.019 | 0.153*** | 0.037 | 0.119 | 0.082 |
| OECD2 | 0.031 | 0.053 | 0.095 | 0.054 | 0.079 | 0.165 |
| OECD3 | 0.020 | 0.050 | 0.079 | 0.047 | 0.080 | 0.122 |
| *Main effects* | | | | | | |
| Firm performance ($t$−1) | 0.010 | 0.282 | 0.921*** | 0.225 | 0.065 | 0.250 |
| Innovation performance | 0.017* | 0.020 | 0.001 | 0.003 | 0.017 | 0.023 |
| Model fit statistics | Wald $\chi^2(8) = 28.07$ Prob $\chi^2 = 0.000$ | | Wald $\chi^2(5) = 34.09$ Prob $\chi^2 = 0.000$ | | Wald $\chi^2(5) = 5.12$ Prob $\chi^2 = 0.001$ | |
| Hansen test | $\chi^2(20) = 26.318$; $p = 0.155$ | | $\chi^2(20) = 53.201$; $p = 0.062$ | | $\chi^2(20) = 27.486$; $p = 0.122$ | |
| AR(1) test | 1.48; $p = 0.138$ | | 2.705; $p = 0.006$ | | 3.450; $p = 0.000$ | |
| AR(2) test | 0.330; $p = 0.741$ | | 0.019; $p = 0.849$ | | 0.431; $p = 0.513$ | |
| $n$ | 6,887 | | 6,887 | | 6,887 | |
| Groups | 1,363 | | 1,363 | | 1,363 | |
| Instruments | 25 | | 25 | | 31 | |

**Notes:** *$p < 0.01$; **$p < 0.05$ and ***$p < 0.001$

Table VI shows the results for regressions. The pattern for different coefficients related to language training and overall compensation and benefits fulfill the proposed conditions (Baron and Kenny, 1986). Specifically, for language training and overall compensation and benefits, the pattern fulfills all the conditions established in Equations (2) and (3) to show that innovation performance has a mediator role. Therefore, the results support the mediating effect of innovation performance (*H4*) in relation to both human resource practices.

## 5. Implications and conclusions

The purpose of this paper was to analyze the contribution of specific HRM practices – employment security, training investment and compensation, individually, and their interactions with innovation performance (measured by the number of patents) – and the firm performance (in terms of AV and productivity) using a longitudinal data design. It focused on innovation performance as one of the most relevant sources for gaining a sustainable competitive advantage (López Cabrales *et al.*, 2009; Zhou, 2006). As previous research has noted, innovative results emerge from the way employees are managed, that is to say, the extent to which having a permanent, stable job, an attractive salary and continued training bears on their level of commitment to the company. Also, the study analyzed the direct effect of innovation performance on firm performance and the extent to which innovation performance mediates in the relationship between the HRM practices and firm performance, in an attempt to disentangle the so-called "black box" between investment in employees and organizational profits. Data panel regressions were conducted to infer causality from a longitudinal design. The implications derived from the results obtained are as follows.

First, it was interesting to observe that not all HRM practices, studied individually, contribute to the innovation performance over time. Employment security and compensation did impact separately on innovation, while training did not exert any impact on the number of patents. These results are opposed to some research findings that claim labor market flexibility is a stronger mechanism for producing innovation. For example, Gong *et al.* (2009) stated that employees who have job security add experience to their work and are more strongly associated with minor and short-term improvements in

**Table VI.** Results for mediation role of innovation performance (*H4*)

| | Equation (1) (DV: added value) | Model 1 Equation (2) (DV: innovation performance) | Equation (3) (DV: added value) | Equation (4) (DV: labor productivity) | Model 2 Equation (5) (DV: innovation performance) | Equation (6) (DV: labor productivity) | Equation (7) (DV: hourly productivity) | Model 3 Equation (8) (DV: innovation performance) | Equation (9) (DV: hourly productivity) |
|---|---|---|---|---|---|---|---|---|---|
| *Control variables* | | | | | | | | | |
| Size | 0.098*** | 0.004 | 0.099*** | 0.170*** | 0.004 | 0.169*** | 0.017 | 0.004 | 0.017 |
| OECD2 | 0.032 | 0.008 | 0.029 | 0.095 | 0.008 | 0.094 | 0.071 | 0.008 | 0.017 |
| OECD3 | 0.012 | 0.036 | 0.015 | 0.083 | 0.036 | 0.082 | 0.054 | 0.036 | 0.071 |
| Firm performance$_{(t-1)}$ | 0.056 | | 0.231 | 0.004 | | 0.032 | 0.013 | | 0.01 |
| Innovation performance$_{(t-1)}$ | | 0.047 | | | 0.047 | | | 0.047 | |
| Employment security | 0.004 | 0.001 | 0.002 | 0.021** | 0.001 | 0.021** | 0.058*** | 0.001 | 0.059*** |
| Training on languages | 0.002 | 0.002** | 0.002 | 0.001 | 0.002** | 0.001 | 0.004 | 0.002** | 0.045 |
| Training on new technologies | 0.008 | 0.003 | 0.008 | 0.006 | 0.003 | 0.006 | 0.002 | 0.003 | 0.002 |
| Overall compensation and benefits | 0.025** | 0.002* | 0.022** | 0.006 | 0.002* | 0.004 | 0.127*** | 0.002* | 0.132** |
| Innovation performance | | | 0.017*** | | | 0.001** | | | 0.016*** |
| Model fit statistics | Wald $\chi^2(8) = 38.41$ Prob. $\chi^2 = 0.000$ | Wald $\chi^2(8) = 1.45$ Prob. $\chi^2 = 0.000$ | Wald $\chi^2(9) = 38.07$ Prob. $\chi^2 = 0.000$ | Wald $\chi^2(8) = 36.63$ Prob. $\chi^2 = 0.000$ | Wald $\chi^2(8) = 1.45$ Prob. $\chi^2 = 0.000$ | Wald $\chi^2(9) = 37.05$ Prob. $\chi^2 = 0.000$ | Wald $\chi^2(8) = 48.16$ Prob. $\chi^2 = 0.000$ | Wald $\chi^2(8) = 1.45$ Prob. $\chi^2 = 0.000$ | Wald $\chi^2(9) = 50.13$ Prob. $\chi^2 = 0.000$ |
| Hansen test | $\chi^2(20) = 25.67$; $p = 0.166$ | $\chi^2(20) = 17.41$; $p = 0.625$ | $\chi^2(20) = 38.4$; $p = 0.154$ | $\chi^2(20) = 53.15$; $p = 0.085$ | $\chi^2(20) = 17.418$; $p = 0.625$ | $\chi^2(20) = 52.38$; $p = 0.185$ | $\chi^2(20) = 28.82$; $p = 0.091$ | $\chi^2(20) = 17.418$; $p = 0.625$ | $\chi^2(20) = 28.93$; $p = 0.089$ |
| AR(1) test | 1.48; $p = 0.137$ | 1.31; $p = 0.189$ | 1.48; $p = 0.137$ | 2.69; $p = 0.007$ | 1.31; $p = 0.189$ | 2.67; $p = 0.007$ | 3.46; $p = 0.000$ | 1.31; $p = 0.189$ | 3.46; $p = 0.000$ |
| AR(2) test | 0.368; $p = 0.713$ | 0.415; $p = 0.677$ | 0.326; $p = 0.744$ | 0.192; $p = 0.847$ | 0.415; $p = 0.677$ | 0.193; $p = 0.846$ | 0.641; $p = 0.521$ | 0.415; $p = 0.677$ | 0.626; $p = 0.530$ |
| *n* | 6,887 | 6,887 | 6,887 | 6,887 | 6,887 | 6,887 | 6,887 | 6,887 | 6,887 |
| Groups | 1,363 | 1,363 | 1,363 | 1,363 | 1,363 | 1,363 | 1,363 | 1,363 | 1,363 |
| Instruments | 28 | 28 | 29 | 28 | 28 | 29 | 28 | 28 | 29 |

**Notes:** $^*p < 0.01$; $^{**}p < 0.05$ and $^{***}p < 0.001$

products and processes, as opposed to large radical innovations, which are supposedly measured by the number of patents. Nevertheless, our finding needs to be explored further. For example, it would be interesting to ascertain the desired trade-off index between contingent and permanent workers as there is no information about the optimal proportion of temporary workers in a firm's workforce.

Our results also confirm an absence of any direct effect of training in new technologies and languages on innovation. A possible explanation for this unexpected result would be that the training orientation we studied was not appropriate for our innovative purposes. Unfortunately, these are the only measurable training investments in our sample, as our research is based on a longitudinal survey, whose measurements we cannot change.

Interestingly, the level of compensation positively affects the number of patents. This result seems to indicate that employees value high salaries as leverage to produce more patents and, as such, is coherent with previous research, such as Jiménez-Jiménez and Sanz-Valle (2008) or Van Reenen (1996). Taken as a whole and considering the AMO framework, our results regarding individual HRM practices seem to confirm that motivation-enhancing practices (employment security and compensation) are more important than ability-enhancing practices (training) for increasing innovation.

However, some results change when interactions among practices are introduced. Specifically, we observed a tendency over time which indicates that employment security and investment in training in new technologies produce more patents when such practices are moderated by high salaries. This result is even more interesting with respect to training practices. When it comes to explaining patenting, and considering our previous results, this means that training investments fail when standing alone. They must coexist and interact with high salaries in order to make any significant contribution to innovation. This result is an example of the importance of measuring interactions between practices, as one HR practice could alter the effect of other HR practices.

Moreover, we observed a strong, positive impact of innovation performance as a predictor of AV and HP as performance metrics. This is important because it supports the well-accepted idea in innovation literature that innovation paves the road to firm performance and competitiveness (Zhou, 2006). Control variables also played a relevant role in this relationship as AV is sensitive to the size of a company, highlighting the need to differentiate between large enterprises and SMEs. However, the measurement of innovative performance used here has certain limitations. It would be interesting to enhance these results by assessing not just the number of patents but the value added by each patent, as the quality of innovative content of patented innovations may differ greatly (Beneito, 2006; Narin *et al.*, 1997).

Our study also showed that training and higher salaries positively impact on firm performance when such HRM practices bring more patents to the firm. This is a way of looking inside the black box to explain HRM and performance; the extent to which high compensation levels and investment in training contribute to the development of patents partly explains company performance. Therefore, what is relevant here is the suggestion that innovation performance mediates in the relationship between HR practices and firm performance. In other words, HRM practices such as training and compensation have an indirect effect on firm performance through innovation performance.

Despite the above-mentioned contributions, this study does have certain limitations and these limitations have implications for future studies. In the first place, the weaknesses associated with some proxy variables of innovation performance, HRM practices and firm performance provide grounds for searching for new variables or even ratios in the database. These limitations are important in the case of our compensation measurements which do not allow us to differentiate between different pay policies. It is difficult to solve this pitfall when the study is based on panel data since researchers are not allowed to create new variables "ad hoc." Particularly in the field of innovation performance, future research should enhance the measurement of the number of patents, assessing the value of these patents and adding other measurements of incremental innovations. Second, this research focused only on staffing, training and compensation practices. It would be of great interest to add new HRM practices to the analysis, in order to reinforce the idea of an HRM system and finding a way of measuring the "opportunity" part of the AMO model. The difficulties in finding objective data in the database for measuring new HRM practices were a limitation here. We were also unable to include additional measurements of firm profitability in our data set, such as the ROA and ROE, as they were not available in our database. Finally, this paper explored data from a healthy economic period (2001-2008). Future research should compare these results with those obtained in times of recession, as a way of enriching our knowledge of the effects of HRM investment over time.

In conclusion, this study demonstrated the existence of two objectives that HR managers should be aiming at. On the one hand, the development of patents should be a priority in order to obtain better results over time. On the other hand, management should invest in HRM practices (specifically, mostly in training and compensation) because they favor innovation and are neither a waste of time nor resources. On the contrary, they can be a means of enhancing corporate competitiveness by providing innovative results.

**References**

Ahuja, G. and Katila, R. (2004), "Where do resources come from? The role of idiosyncratic situations", *Strategic Management Journal*, Vol. 25 Nos 8/9, pp. 887-907.

Alegre, J., Lapiedra, R. and Chiva, R. (2006), "A measurement scale for product innovation performance", *European Journal of Innovation Management*, Vol. 9 No. 4, pp. 333-346.

Añón-Higón, D. and Driffield, N. (2010), "Exporting and innovation performance: analysis of the annual small business survey in the UK", *International Small Business Journal*, Vol. 29 No. 1, pp. 4-24.

Arellano, M. and Bond, S. (1991), "Some test of specification for panel data: Monte Carlo evidence and an application to employment equations", *Review of Economics Studies*, Vol. 58 No. 2, pp. 277-297.

Arthur, J.B. (1994), "Effects of human resources systems on manufacturing performance and turnover", *Academy of Management Journal*, Vol. 37 No. 3, pp. 670-687.

Ax, C. and Marton, J. (2008), "Human capital disclosures and management practices", *Journal of Intellectual Capital*, Vol. 9 No. 3, pp. 433-455.

Baron, R.M. and Kenny, D.A. (1986), "The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations", *Journal of Personality and Social Psychology*, Vol. 51 No. 6, pp. 1173-1182.

Becker, B., Huselid, M., Pickus, P. and Spratt, M. (1997), "Human resource as a source of shareholder value: research and recommendations", *Human Resource Management*, Vol. 36 No. 9, pp. 39-47.

Beneito, P. (2006), "The innovative performance of in-house and contracted R&D in terms of patents and utility models", *Research Policy*, Vol. 35 No. 4, pp. 502-517.

Bojica, A., Fuentes, M. and Gomez-Gras, J. (2011), "Radical and incremental entrepreneurial orientation: the effect of knowledge acquisition", *Journal of Management and Organization*, Vol. 17 No. 3, pp. 326-343.

Bos-Nehles, A., Riemsdijk, M. and Looise, J. (2013), "Employee perceptions of line management performance: applying the AMO theory to explain the effectiveness of line managers' HRM implementation", *Human Resource Management*, Vol. 52 No. 6, pp. 861-877.

Boxall, P. (1996), "The strategic HRM debate and the resource-based view of the firm", *Human Resource Management Journal*, Vol. 6 No. 3, pp. 59-75.

Cardinal, L. (2001), "Technological innovation in the pharmaceutical industry: the use of organizational control in managing research and development", *Organization Science*, Vol. 12 No. 1, pp. 19-36.

Chen, C. and Huang, J.W. (2009), "Strategic human resource practices and innovation performance – the mediating role of knowledge management capacity", *Journal of Business Research*, Vol. 62 No. 1, pp. 104-114.

Combs, J., Liu, Y., Hall, A. and Ketchen, D. (2006), "How much do high-performance work practices matter? A meta-analysis of their effects on organizational performance", *Personnel Psychology*, Vol. 59 No. 3, pp. 501-529.

Damanpour, F., Walker, R.M. and Avellaneda, C.N. (2009), "Combinative effects of innovation types and organizational performance: a longitudinal study of service organizations", *Journal of Management Studies*, Vol. 46 No. 4, pp. 650-675.

Fariñas, J.C. and Jaumandreu, J. (1999), "Diez Años de Encuesta Sobre Estrategias Empresariales (ESEE)", *Economía Industrial*, Vol. 329 No. 5, pp. 29-42.

Flaig, G. and Stadler, M. (1994), "Success breeds success. The dynamics of the innovation process", *Empirical Economics*, Vol. 19 No. 1, pp. 55-68.

Freeman, R. (2008), *Labour Productivity Indicators*, OECD, Paris.

Gong, Y., Huang, J. and Farh, J. (2009), "Employee learning orientation, transformational leadership, and employee creativity: the mediating role of employee creative self-efficacy", *Academy of Management Journal*, Vol. 52 No. 4, pp. 765-778.

Hair, F.J., Anderson, R.E., Totham, R.L. and Black, W.C. (1999), *Análisis Multivariante*, 5ª edición, Prentice Hall, Madrid.

Ichniowski, C., Shaw, K. and Pennushy, J. (1997), "The effects of HRM practices on productivity: a study of steel finishing lines", *The American Economic Review*, Vol. 87 No. 3, pp. 291-313.

Jiménez-Jiménez, D. and Sanz-Valle, R. (2008), "Could HRM support organizational innovation?", *The International Journal of Human Resource Management*, Vol. 19 No. 7, pp. 1208-1221.

Kang, S. and Snell, S. (2009), "Intellectual capital architecture and ambidextrous learning: a framework for human resource management", *Journal of Management Studies*, Vol. 46 No. 1, pp. 66-92.

Klomp, L. and Leeuwen, G.V. (2001), "Linking innovation and firm performance: a new approach", *International Journal of the Economics of Business*, Vol. 8 No. 3, pp. 343-364.

Komnenic, B. and Pokrajcic, D. (2012), "Intellectual capital and corporate performance of MNCs in Serbia", *Journal of Intellectual Capital*, Vol. 13 No. 1, pp. 106-119.

Laursen, K. and Foss, N. (2003), "New HRM practices, complementarities and the impact on innovation performance", *Cambridge Journal of Economics*, Vol. 27 No. 2, pp. 243-263.

Lawrence, R.J., Stanley, A.M. and Brett, J.M. (2006), "A tale of two methods", *Organizational Research Methods*, Vol. 9 No. 2, pp. 233-244.

Lepak, D.P., Liao, H., Chung, Y. and Harden, E. (2006), "A conceptual review of human resource management systems in strategic human resource management research", in Martocchio, J. (Ed.), *Research in Personnel and Human Resources Management*, Vol. 25, Elsevier, Oxford, pp. 217-271.

Li, H. and Atuahene-Gima, K. (2001), "Product innovation strategy and the performance of new technology ventures in China", *Academy of Management Journal*, Vol. 44 No. 6, pp. 1123-1134.

López Cabrales, A., Pérez Luño, A. and Valle Cabrera, R. (2009), "Knowledge as a mediator between HRM practices and innovative activity", *Human Resource Management*, Vol. 48 No. 4, pp. 485-503.

Mohrman, S.A. and Worley, C. (2009), "Dealing with rough times: a capabilities development approach to surviving and thriving", *Human Resource Management*, Vol. 48 No. 3, pp. 433-445.

Mumford, M. (2000), "Managing creative people: strategies and tactics for innovation", *Human Resource Management Review*, Vol. 10 No. 1, pp. 313-351.

Narin, F., Hamilton, K.S. and Olivastro, D. (1997), "The increasing linkage between US technology and public science", *Research Policy*, Vol. 26 No. 3, pp. 317-330.

Nickell, S.J. (1981), "Biases in dynamic models with fixed effects", *Econometrica*, Vol. 49 No. 6, pp. 1417-1426.

Paauwe, J. (2009), "HRM and performance: achievements, methodological issues and prospects", *Journal of Management Studies*, Vol. 46 No. 1, pp. 130-142.

Perdomo-Ortiz, J., González-Benito, J. and Galende, J. (2009), "An analysis of the relationship between total quality management-based human resource management practices and innovation", *International Journal of Human Resource Management*, Vol. 20 No. 5, pp. 1191-1218.

Popp, D. (2005), "Uncertain R&D and the Porter hypothesis", *Contributions to Economic Analysis and Policy*, Vol. 4 No. 1, pp. 1-14.

Shafer, R., Dyer, L., Kilty, J., Amos, J. and Ericksen, J. (2001), "Crafting a human resource strategy to foster organizational agility: a case study", *Human Resource Management*, Vol. 40 No. 3, pp. 197-211.

Subramaniam, M. and Youndt, M.A. (2005), "The influence of intellectual capital on the types of innovative capabilities", *Academy of Management Journal*, Vol. 48 No. 3, pp. 450-464.

Teece, D.J. (2007), "Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance", *Strategic Management Journal*, Vol. 28 No. 13, pp. 1319-1350.

Tsui, A.S. and Wu, J.B. (2005), "The new employment relationship versus the mutual investment approach: implications for human resource management", *Human Resource Management*, Vol. 44 No. 2, pp. 115-121.

Van Reenen, J. (1996), "The creation and capture of rents: wages and innovation in a panel of UK companies", *The Quarterly Journal of Economics*, Vol. 111 No. 1, pp. 195-226.

Wall, T.D., Michie, M., Patterson, S., Wood, M., Sheehan, C., Clegg, C. and West, M. (2004), "On the validity of subjective measures of company performance", *Personnel Psychology*, Vol. 57 No. 3, pp. 95-118.

Wang, D., Tsui, A., Zhang, Y. and Li, M. (2003), "Employment relationships and firm performance: evidence from an emerging economy", *Journal of Organizational Behavior*, Vol. 24 No. 5, pp. 511-535.

Zhou, K.Z. (2006), "Innovation, imitation, and new product performance: the case of China", *Industrial Marketing Management*, Vol. 35 No. 3, pp. 394-402.

(The Appendix follows overleaf.)

## Appendix

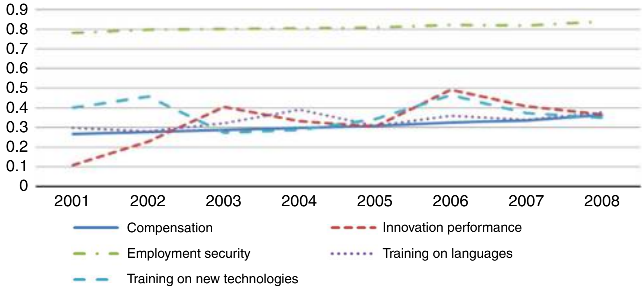


**Figure A1.** Evolution of innovation and HRM practices 2001-2008

## About the authors

Mirta Diaz-Fernandez is an Assistant Professor of Business Administration in the Business Administration Department, Pablo de Olavide University (Seville). She received a PhD Degree in Business Administration from the Pablo de Olavide University in 2007. She has been a Visiting Scholar at the Texas A&M University, in the USA. Her research interests include strategic human resource management, compensation, individual competencies and intellectual capital. She has published in journals like *International Journal of Human Resource Management* and *European Journal of International Management*. Mirta Diaz-Fernandez is the corresponding author and can be contacted at: mdiafer@upo.es

Mar Bornay-Barrachina is an Assistant Professor of Business Administration in the Business Administration Department, Pablo de Olavide University (Seville). She obtained her Doctorate in 2007 at the Pablo de Olavide University. She is teaching on Human Resource Management and her research area is focused on human resource management, strategic leadership, team creativity and team innovation. She is publishing her research in international journals as *British Journal of Management*, *International Career Development*, *International Journal of Human Resource Management* and *Personnel Review*, among others.

Alvaro Lopez-Cabrales is an Associate Professor of Human Resource Management in the Business Administration Department, Pablo de Olavide University (Seville), where he obtained his Doctorate in 2003. He has been a Visiting Scholar at the Texas A&M University, in the USA. His current work focuses on research in human capital, employment relationships, organizational capabilities and innovation. He is publishing his research in international journals as *Human Resource Management*, *R&D Management*, *Personnel Review*, *British Journal of Management* or *The International Journal of Human Resource Management*.