Information Technology, Human Resources Management Systems and Firm Performance: An Empirical Analysis from Spain

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ABSTRACT

This research paper uses survey data on 1.518 Catalan firms (in Spain, with capital in Barcelona) to examine the relationship between IT use, innovative human resources management systems (IHRMS) and firm's performance. Using factor and cluster analysis, we find that only one-third of Catalan firms use IHRMS. Using association analysis we find that firms that adopt IHMRS are more internationalised; show grater ability to adapt to the change environment, to innovate and to collaborate; focuses product/service differentiation strategy enhancing quality; apply a greater degree of new forms of work organization; use IT more intensively; and invest more in training their employees Using regression analysis, we find that features which are structural, technological, strategic, organisational and result-related explain the adoption of IHRMS.

Keywords: Innovative Human Resources Management Systems (IHRMS), Information Technology (IT), New forms of work organization, Firm's performance.

1. INTRODUCTION

In the transition process towards a global knowledge economy human resources management (HRM) is shaping up as a determining element in the firms' competitiveness (Castells, 1996, Carnoy, 2000; Lindley, 2002; Pettigrew *et al.*, 2003; Svetlik and Stavrou-Costea, 2007). Since the mid 90's, the consolidation and productive use of information technology (IT), improved human resources competences and organisational redesign have developed in parallel, and together require workers who are better trained and more highly motivated (Murphy, 2002). It has been demonstrated that the delegation of responsibility and decreased hierarchical levels, together with: a) intensive use of IT and the flow of information and knowledge; and b) HRM which increases workers' commitment, ultimately promote business process innovation (Lundvall and Nielsen, 2007) and improve the firm's productivity and competitiveness (Torrent-Sellens and Vilaseca-Requena, 2007). Thus, and considering the symbiotic relationship between IT, organisational change and HRM practices, this paper will analyse innovative human resources management systems (IHRMS) for the specific case of the Catalan firm. The aim of the paper is to find and characterize which types of HRM practices adopted by Catalan firms, and to establish determinants of implementation of IHRMS.

2. RESEARCH HYPOTHESES

The term HRM practices is defined as the pattern of planned human resource deployment and activities that help organisations attract, evaluate, motivate, and develop people with the appropriate behaviours and competencies to meet current and future needs (Huselid, 1995). Literature on HRM provides us with a noteworthy body of empirical evidence centring on the appearance of IHRM practices and their effects on the organisation's results (Ichniowski, 1990; Osterman, 1994). This empirical evidence suggests that firms able to transform their workers' basic competences, flexibly organise production and labour, and establish labour relations that increase the commitment of the workforce, have a greater competitive advantage at their disposal than do those firms with more traditional HRM (Carayannis and Sagi, 2001; Child and McGrath, 2001; Gant *et al.*, 2002).

IHRM practices are often referred to as high involvement or high performance work system (Appelbaum and Kallerberg, 2000). The literature has identified a set of HRM practices in various ways that would assure the adoption of flexible work systems (Lawler *et al.*, 1998), but generally they include three dimensions that are related to: 1) skills and competency requirements; 2) developmental approach to enhance continuous learning and performance as well as; and 3) innovative remuneration and labour relations programmes based on performance-related pay that drive motivation and commitment (Huselid, 1995; MacDuffie, 1995).

Within this context, we will begin with the premise that the results of an innovativeness HRM system do not depend, solely, on how each of the practices is managed separately. The final result also depends on how these practices interact with one other. There is no doubt that having more qualified workers who have been selected with greater care, and who work in a system that allows and encourages them to use their skills provides higher levels of organisational performance (Pfeffer, 1997). As the empirical literature shows, organisations gains from the internal consistency of their HRM, obtained through the suitable coordination between the different management practices and the high involvement of the workers (MacDuffie, 1995; Pil and MacDuffie, 1996; Ichniowski *et al.*, 1997). Empirical evidence also confirms

the existence of important relationships of interdependence between certain internal and external aspects of structure of firms and the intensity with which IHRMS are adopted (Foss, 2005). As these practices become more sophisticated, they progressively form part of an overall system which, in turn, interrelates with other relevant aspects of business activity.

From a technological perspective, it has been demonstrated that digital investment is greater in those firms which delegate decision-making to their employees, more is invested in skills training, and organisational structures that are less vertical are adopted (Brynjolfsson and Hitt, 2000). Within this context, the complementary nature between IHRM practices and IT use determines: a) an important increase in the competences required from the workforce (Bresnahan *et al.*, 2002; Bartel *et al.*, 2004); and b) if combined with reorganisation of the organisational architecture, ultimately, an improvement of the firm's productivity (Black and Lynch, 2001, 2004; Brynjolfsson and Hitt, 2003; Arvanitis, 2005; Torrent-Sellens and Vilaseca-Requena, 2007) as are the workers' salaries (Caroli and Van Reenen, 2001; Shaw, 2002; Osterman, 2005).

By IHRMS we mean that group of practices which, acting as a complete system, is characterised by: a) a higher level of competence of their employees; b) the effort made in selecting and training them; c) a set of practices related to the transfer of power; d) the quality of labour relations; and e) remuneration which is managed through a system of setting objectives and performance review. In this sense, we formulate three research hypotheses:

- Hypothesis 1: *HRM practices operate as a system where they are mutually reinforcing.*
- Hypothesis 2: *The adoption of IHRMS is linked with firms that they: a) are more internationalised and show greater ability to adapt to the changing environment, to innovate and to collaborate; b) focuses product/service differentiation strategy enhancing quality c) apply a greater degree of new forms of work organization; d) have more technological equipment and use IT more intensively; and e) invest more in training their employees.*
- Hypothesis 3: *Firm structure, new forms of work organisation, IT use level, interaction with international suppliers, collaboration networks for innovation, and business efficiency, are determinants in the adoption of an innovative system of HRM.*

3. RESEARCH DESING AND DATA

The data used in the empirical analysis was collected in the course of the research *The Network Firm: ICTs, Productivity and Competitiveness in Catalan Firms* (Torrent-Sellens and Vilaseca-Requena, 2007) using a questionnaire which included questions on the incidence of IT use in the transformation of elements of value and business results in Catalan firms. The survey was based on a representative sample of 2,038 firms (confidence interval: 95%, p=q=0.5, and sampling error +/- 2.2 percent). Sample firms were contacted through telephone calls to confirm a contact person in each firm, followed by survey questionnaires that were answered by managers by means of a face-to-face, hour-long interview. The questionnaire consisted of 128 items. The study takes a cross-sectional approach. Follow-up data collection took place between January and May 2003. A careful examination of the data of these 2,038 firms led to the exclusion of 520 cases with contradictory or non-plausible answers; 1,518 valid answers remained which were used for this analysis. Therefore, we re-weighted the reduced sample of firms based on a factor which gives each company the real weight it should have according to its size. Table I illustrates the survey items and values which serve as the basis for collecting data pertaining to HRM practices.

Table I. Practices of HRM adopted by frequency in Catalan firms

		Frequency	Valid percentage
EDMAN	- Most frequently finished level of studies among managers: university level	845	55.7
	- Secondary/primary level/no studies among managers	673	44.3
EDNONMAN	- Most frequently finished level of studies among non-management employees: university level	325	21.4
	- Secondary/primary level/no studies in non-managerial workers	1,193	78.6
ATTMAN	- Most valued attributes for managers: Experience, leadership, and initiative and innovation ability	416	27,4
	- Previous attributes not mentioned in the first place	1,102	72.6
ATTNONMAN	- Most valued attributes for non-managerial employees: Initiative and innovation ability, work capacity, and technical knowledge	264	17.4
	- Previous attributes not mentioned in the first place	1,254	82.6
CTMAN	- Continuous and/or in company training for managers paid by the firm	599	39.5
	- No additional training for management	917	60.5
CTNONMAN	- Continuous and/or in company training for non-managerial employees paid by the firm	614	40.8
	- No additional training for non-management	890	59.2
REMMAN	- Type of remuneration: mixed, profit sharing, stock options, bonuses or deferred compensation for managers	966	63.6
	- Fixed remuneration	552	36.4
REMNONMAN	- Type of remuneration: mixed, profit sharing, stock options, bonuses or deferred compensation for non-managerial employees	326	21.5
	- Fixed remuneration	1,192	78.5
SALHR	- Amount of above-average remuneration	400	35.2
	- Salary less than or equal to the Catalan average	735	64.8
CONST	- Indefinite contract	1,034	68.1
	- Other types of contracting	484	31.9

4. FACTOR, CLUSTER AND ASSOCIATION ANALYSIS

Although the implementation of HRM practices is not equal in the Catalan firm, we observe several internal complementarities that suggest the existence of an overall system of IHRM practices. An analysis of the means for the components and their correlations, confirms that several elements in the matrix have a very positive (coefficients over 0.30) and significant correlation.

Factor analysis is used to assess item correlations and identify common relationships between similar items, allowing the items to be categorized into various themes or factors. Analysis of the correlation matrix: KMO (0.573) and Bartlett's test of sphericity (p=0.000) suggested that the correlation matrix was factorable. Data reduction was undertaken by principal components analysis using the Varimax option to identify possible underlying dimensions of HRM practices. From the analysis, five factors emerged that explained 66.9 per cent of total variance (table II). Five factors were labelled: 1) *Flexible remuneration*; 2) *Job training*; 3) *Qualifications*; 4) *Employment security*; and 5) *Managerial Competences*.

Non Hierarchical Cluster Analysis of K-means was applied to the five factors obtained in the Factor Analysis plus a new variable HRMSUM, that indicates the number of IHRM practices (from 0 to 10) that each firm fulfils. Two clusters or behavioural patterns were found in Catalan firms, according to the degree to which firms adopted IHRMS (table III).

Cluster 1 is comprised by the firms that display or favour greater importance towards (managerial and non-managerial) employees' qualifications and the non-managerial workers' skills (0.606), that provide more extensive professional and on-the-job training in terms of number of employees involved (0.532), and that have established mechanisms for flexible remuneration (0.518). Additionally, they are unlike the second group in terms of contractual stability (0.328) and the relevance given to new managerial competences (0.324). It is represented by firms that adopt IHRMS. Cluster 2 is characterised by HRM practices completely different from the previous ones and where all the factors identified are negative. It is represented by firms that adopt more traditional HRM practices or do not adopt any at all. Thus, and depending on the HRM systems adoption, we can characterise the Catalan firm in two clusters: 1) cluster 1, that uses all five of the HRM practices, can be considered to be the type of firm that uses the innovative system of HRM (37.6% of the firms); and 2) cluster 2 that contains groups of companies, most of Catalonia's private productive network (62.4% of the firms), that can be considered to use much more traditional practices or use none of the new HRM systems.

Table II. Varimax Rotated Factor Matrix of HRM practices

	Factor 1 Flexible remuneration	Factor 2 Job training	Factor 3 Qualifications	Factor 4 Employment security	Factor 5 Managerial competences	Commonalities
EDMAN	0.014	0.054	*0.791*	-0.193	-0.044	0.668
EDNONMAN	0.264	-0.062	*0.641*	0.246	-0.173	0.575
ATTMAN	-0.047	0.060	-0.131	-0.052	*0.911*	0.856
ATTNONMAN	-0.273	0.204	*0.450*	0.065	0.239	0.634
CTMAN	0.125	*0.794*	-0.068	0.032	0.030	0.653
CTNONMAN	0.084	*0.801*	0.101	0.028	0.031	0.661
REMMAN	*0.687*	0.194	0.231	-0.223	0.141	0.632
REMNONMAN	*0.676*	0.281	0.093	0.096	-0.107	0.565
CONST	-0.088	0.101	-0.046	*0.901*	-0.058	0.836
SALHR	*0.432*	-0.280	0.322	0.380	0.317	0.614
Autovalues	1.932	1.440	1.192	1.111	1.019	
% variance explained	19.316	14.400	11.917	11.106	10.195	

Notes: Rotated components matrix; Sampling method: factor analysis by main components; Rotation method: Varimax with Kaiser normalisation; convergence in 11 iterations.

Table III. IHRMS in Catalan firms. Results of k-means (quick cluster) analysis

	Clusters	
	1 n=571	2 n=947
Flexible remuneration	0.518	-0.312
Job training	0.532	-0.321
Qualifications	0.606	-0.366
Employment security	0.328	-0.198
Managerial competences	0.324	-0.195
HRMSUM	5.87	2.71

Notes: Method of analysis: non-hierarchical cluster, final cluster centroids;

Finally, we carried out statistical analysis of the relationships between the IHRMS and several measurements of structure and firm results, as a first step towards the later formulation of a model that establishes the determinants for an innovative system of HRM practices. This analysis can be summarised on the basis of the following results (table IV):

- *Structure of the firm*. IHRMS is evidenced, in percentages that are higher than expected, in: a) the services sector; b) firms that form part of a business group; c) firms which have foreign capital, primarily from the European Union; d) the most internationalised firms; e) firms with a differential presence of clients and suppliers from outside Catalonia (Spain, the European Union, and the rest of the world); and f) firms with a high degree of collaboration with their competitors.
- *Competitive strategy*. IHRMS is demonstrated, in a greater percentage, in the firms that: a) opt for a strategy of product differentiation or specialised service; and b) have carried out improvements in

their productive process through quality control of products or services.
- *Work organisation practices*. Firms with IHRMS opt, in a greater percentage, for: a) delegation of authority in decision making; b) using flexible and adaptable work teams; c) a greater flow of communication among workers; d) coordination systems based on work supervision by objectives; and e) a significantly greater percentage of externalised or subcontracted operations.
- *Technological and innovation perspective*. Catalan firms with IHRMS have at their disposal, in a greater percentage than those firms with traditional system: a) more digital technological equipment; b) a better level of internet equipment; c) more advanced IT use; d) a dynamic of greater innovation in the productive process through IT; and e) superior development of organisational innovation.

Table IV. IHRMS and structure of Catalan firms

	IHRMS	Traditional HRMS	Sign.		IHRMS	Traditional HRMS	Sign.
Sector of activity			0.000	*Work organisation practices*			
Information industry	5.0	9.0		- Organisational innovations in the last 2 years	46.4	32.5	0.000
Low tech industry	6.4	24.2		- Workers at operational level make decisions	37.8	33.1	0.076
Mid tech industry	1.2	4.4		- Existence of flexible and adaptable work teams	53.3	44.8	0.003
High tech industry	2.6	1.4		- Workers can share and exchange information	97.6	95.1	0.025
Low knowledge intensive services	60.0	41.2		-Supervision by objectives	71.6	62.9	0.002
Knowledge intensive services	24.9	19.7					
Property structure				*ICT equipments and uses*			
Forms part of a business group	19.2	7.5	0.000	Webpage	57.6	40.9	0.000
Internationalisation of sales and origin of capital				E-mail	96.7	85.0	0.000
Percentage of sales in Catalonia	73.3	79.9	0.001	Intranet (LAN/WAN)	67.6	52.3	0.000
Percentage of sales in the EU	6.7	4.2	0.006	Internet equipment:			0.000
Percentage of sales in the rest of the world	4.2	1.2	0.000	- Very low (no connection)	3.2	7.5	
% of Catalan capital	92.3	96.8	0.000	- Low: connection with narrowband	40.8	52.9	
% of capital from the rest of Spain	0.3	2.4	0.000	- Normal: connection with narrowband and webpage	52.1	37.4	
% of capital from the EU	6.9	0.7	0.000	- Advanced: connection with broadband and			
% of capital from the rest of the world	0.5	0.0	0.070	webpage	3.9	2.2	
Agents immediately external to the firm				Payroll payment systems by means of IT	45.7	22.5	0.000
Suppliers from Spain	72.0	61.9	0.000	Internal communications systems	21.3	12.3	0.000
Suppliers from the EU	52.5	27.5	0.000	Information management systems	16.6	6.2	0.000
Suppliers from the rest of the world	29.5	15.5	0.000	Executive information systems (EIS)	11.6	4.0	0.000
The firm carries out activities with the competitors	40.4	19.6	0.000	Integrated management systems (ERP)	11.1	1.7	0.000
Competitive strategy				Utilisation of IT in the covering vacant positions	22.7	16.3	0.000
Competitive strategy of the firm based on:			0.000	Level of IT use:			0.000
- Differentiation of product/specialised service	40.7	24.0		- Low IT use	55.7	81.1	
- Flexibility and rapid response	4.5	15.9		- Medium IT use	39.3	16.7	
- Quality control of products and services	92.2	80.3		Advanced IT use	5.0	2.1	
Strategic redesigning of objectives				*Innovation in IT use*			
- Due to changes in demand	71.6	62.3	0.001	IT innovation in the last two years	59.7	49.1	0.000
- Due to improvements in the offer	63.6	54.0	0.001	Process innovation based on IT	47.4	34.9	0.000
- To adapt to changes in environment	58.2	46.2	0.000				

Notes: percentages of firms and chi-squared significance

5. ESTIMATION

With the aim of estimating the overall effect of individual variables on the adoption of IHRMS, we applied a binomial logit model. The parameters for the binary logistic regression model are described in equation:

$$IHRMS_i = \beta_0 + \beta_1 \cdot SIZE_i + \beta_2 \cdot STPROP_i + \beta_3 \cdot SECT_i + \beta_4 \cdot ADVIT_i + \beta_5 \cdot INTSUP_i + \beta_6 \cdot COOPNET_i + \beta_7 \cdot DECPROC_i + \beta_8 \cdot SALEWKR_i + \varepsilon_i$$

Where, IHRMS= a dichotomous dependent variable (1 if IHRMS adoption takes place, 0 otherwise); β = parameters to be estimated; and ε_i= error term of the model. The interpretation of standardized regression coefficients determines the probability that the independent variables represented in the model explain the adoption of IHRMS in the Catalan firms.

Regarding the independent variables, we contemplated a first group of business structure variables: a) size (SIZE); b)

structure of the property (STPROP); and c) the sector of activity (SECT). We shall presume that large firms, which form part of a business group and whose activity is intensive in technology and knowledge use, are more likely to adopt IHRMS. The SIZE variable takes the value of 1 when the firm has more than 20 employees; and the value of 0 when it has fewer than 20 employees. The STPROP variable takes the value of 1 if the firm forms part of a group of companies; and the value of 0 if it does not belong to a business group. The SECT variable takes the value of 1 when the firm belongs to the sectors in the sample identified as intensive in the use of technology or knowledge: information industry, high tech industry and knowledge-intensive services; and the value of 0 when it is located in low or medium tech industry and in less knowledge-intensive services.

From the technological perspective, it has been proven that more intensive use of information technology is decisive in the adoption of more IHRMS. With the aim of measuring this effect, we considered the ADVIT variable, which takes the

value of 1 when IT use is advanced and the value of 0 when use is low or mid-level. To determine advanced IT use, we generated an indicator for IT use which gathers the sufficiency of use in five elements of value in business activity: 1) production; 2) supplies and distribution; 3) marketing; 4) organisation and basic human resources (accounting and invoicing, payroll payment and internal communication); and 5) organisation and complex human resources (data management and/or information exploitation, information systems for management and integrated management systems). This sufficiency, which is collected through the arrangement of digital technology systems in each of the five elements of value, determines the three levels of the indicator: a) low use of IT, when the firm does not have technological systems in any or has in just one, of the five defined elements of value; b) mid-level use of IT, when the firm has technological systems for two or three of the five defined elements of value; and c) advanced use of IT, when the firm has technological systems in four or five of the defined elements of value.

Another set of independent variables is determined by the firm's strategic and organisational resources. Regarding strategy, we considered a quality management variable. Quality management means greater sophistication in the utilisation of productive processes and a greater emphasis on employee's development. To measure this effect, we used a variable that measures the implementation of quality certification in the firm (QUAL), and which takes the value of 1, when the firm has an accredited system to guarantee quality; and 0 if it does not.

In terms of workplace practices, we incorporated autonomy and decision-making capacity when workers carrying out their labour tasks, as well as labour control and supervision systems. We shall presume that the movement of the decision-making process towards operational level is linked with HRM practices that involve workers more. The DECPROC variable, takes the value of 1 when the firm's workers at operational level make decisions at operational level, and the value of 0 when there is no delegation of responsibility towards them. Additionally, the management by objectives, instead of the traditional hierarchical structure, involves establishing mechanisms for arranging HRM activities. In this regard, we considered the variable of control and supervision by objectives and results (SUPOBJ), which takes its values depending on their application: yes, value of

1; and no, value of 0. HRM has also been involved in the nature of existing labour relations in the firm, and particularly in the role played by trade unions. Trade unions should be interested in those organisational changes which give the workers a greater presence and larger role in internal decision-making. Nonetheless, they can also consider the incorporation of more flexible systems of HRM as a threat to employment security. To measure the trade unions' capacity regarding the generation of innovation in HRM, the variable TRADUNI takes the value of 1 and indicates the presence of trade unions in the firm; and the value of 0 when there are not.

The literature also confirms that ties outside the company are very relevant for innovation. In this regard, businesses that have established cooperation networks with other companies or institutions should be more willing to facilitate internal innovation through more IHRMS. The COOPNET variable takes the value of 1 when the firm's cooperation (present or past) with other firms and/or institutions has led to innovation. If the firm does not or has not cooperated in innovation with other firms and institutions, this variable takes the value of 0. Additionally, we included a variable that measures the firm's interaction with international suppliers (INTSUP). This variable takes the value of 1 when the firm has suppliers that are from the European Union or the rest of the world; and the value of 0, in the opposite case (Catalonia and the rest of Spain).

Lastly, and as we have pointed out, other research finds a significant correlation between IHRMS and several business efficiency measures. We presuppose that efficient businesses are characterised by a greater concern for their competitive advantage in general and the innovative management of their human resources in particular. Based on the sales quotient per worker in the firm, we generate the SALEWKR variable, which takes the value of 1 when the average is greater than the Catalan average (135.6 thousand euros) and takes the value of 0 when it is less than or equal to the Catalan average. After running the model and applying the Wald Statistic and the Likelihood-Ratio Statistic, the TRADUNI, QUAL and SUPOBJ variables were not statistically significant (p values>0.10) and therefore they were disesteemed or rejected. To increase the goodness of fit and explanatory power, they were eliminated from the model. The estimated coefficients are presented in Table V.

Table V. Determinants for the adoption of IHRMS

	Estimated coefficient	Standard error	Wald	Significance	Marginal effects Exp (β)
SIZE	0.453	0.152	8.817	0.003	1.572
STPROP	0.758	0.168	20.241	0.000	2.134
SECT	0.839	0.140	35.768	0.000	2.314
ADVIT	0.692	0.205	11.369	0.001	1.999
INTSUP	0.387	0.144	7.191	0.000	1.472
COOPNET	0.556	0.140	15.788	0.000	1.743
DECPROC	0.579	0.155	13.909	0.000	1.785
SALEWKR	0.568	0.160	12.540	0.000	1.765
Constant	-1.715	0.152	127.552	0.000	0.180

Notes: Method of regression: binomial logit analysis; dependent variable: Advanced HRM Practices (value 1, adopted; value 0, not adopted); standardised coefficients. Statistics: - 2 Log-likelihood=1.245.113; R^2 Cox-Snell= 0.178; R^2 Nagelkerke= 0.238; Hosmer-Lemeshow test= 0.957; p=0.000.

The model correctly classified 69.1% of firms (75.8% of those that do not use IHRMS and 61.5% of those that use IHRMS). The Nagelkerke's R^2 equals to 0.238. The improvement in the likelihood function is significant (from 1381.9 to 1245.1). It accepts the goodness-of-fit of the predictive capacity and the variables as a whole have an outstanding explanatory power (Hosmer-Lemeshow test=0.957; p=0000). From the estimation of the model, it is found that all the variables included have a very significant

explanatory power regarding the decision to incorporate IHRMS in the Catalan firm (p<0.01). The relationships of influence found have a plus sign. It is observed that the structural variables of the firm (size, technology and knowledge intensive sector, and membership in a business group), relationship with international suppliers and firms, networks for cooperation with other institutions and firms, decentralisation in decision making and business efficiency play a positive and significant role in the IHRMS adoption.

6. CONTRIBUTIONS

In this research paper, we have contemplated on IHRMS, its characteristics and determinants, for the specific case of the Catalan firms. On the basis of the four basic dimensions of HRM (selection, training, hiring and remuneration), we obtained five factors: flexible remuneration, job training, qualifications, employment security, and managerial competences, which have allowed us to identify a system of IHRM practices.

The empirical evidence that was obtained demonstrates that most of Catalan firms (about two thirds) have traditional forms of HRM, and that those firms incorporating innovative system of HRM practices (slightly more than a third of the total) have a considerably differentiated profile. Using association analysis we find that firms that adopt IHMRS are more internationalised; show grater ability to adapt to the change environment, to innovate and to collaborate; focuses product/service differentiation strategy enhancing quality; apply a greater degree of new forms of work organization; use IT more intensively; and invest more in training their employees.

Medium-sized and large firms (more than 20 workers), that form part of a business group, belong to a knowledge-intensive sector, with advanced IT use, establish collaboration networks with firms and institutions in order to innovate, whose suppliers are geographically international, that favour more decentralised decision-making and are efficient are the firms with greater probability of incorporating IHRMS.

Despite the limitations of the research, particularly the lack of a time series and the restrictions imposed by the indicators and the methodologies used, the results obtained are consistent with other studies carried out at firm level as well, in other regions and sectors (Foss, 2005; García-Olaverri *et al.*, 2006). However, the specific characteristics of the overall productive system in Catalonia (very small firms, low intensity in technology and knowledge, with low levels of training and, and serious problems of productivity and competitiveness) allow the results obtained to be extrapolated to other regions and groups of firms.

7. REFERENCES

E. Appelbaum and A.L. Kallerberg, **Measuring the Components of a High-Performance Work System,** Ithaca: Cornell University Press, 2000.

S. Arvanitis, "Computerization, workplace organization, skilled labour and firm productivity: Evidence from the Swiss business sector", **Economics of Innovation and New Technologies**, Vo. 14, No. 4, 2005, pp. 225-249, 2005.

A.P. Bartel, C. Ichniowski and K. Shaw. **The strategic investment in information technologies and new human resource practices and their effects on productivity: An –insider- econometric analysis,** Cambridge (MA): National Bureau of Economic Research Summer Institute, 2004.

S.E. Black and L.M. Lynch, "How to compete: The impact of workplace practices and information technology on productivity", **Review of Economics and Statistics**, Vol. 83, No. 3, 2001, pp. 434-445.

S.E. Black and L.M. Lynch, "What's driving the new economy? The benefits of workplace innovation", **The Economic Journal,** Vol. 114, No. 493, 2004, pp. 97-116.

T.F. Bresnahan, E. Brynjolfsson and L.M. Hitt, "Information technology, workplace organization and the demand for skilled labor: A firm-level evidence", **Quarterly Journal of Economics**, Vol. 117, No. 1, 2002, pp. 339-376.

E. Brynjolfsson and L.M. Hitt, "Beyond computation: Information technology, organizational transformation, and business performance", **Journal of Economic Perspectives**, Vol. 14, No. 4, 2000, pp. 23-48.

E. Brynjolfsson and L.M. Hitt, "Computing productivity: Firm level evidence", **Review of Economics and Statistics**, Vol. 85, No. 4, 2003, pp. 793-808.

E. Carayannis and J. Sagi, "New vs. old economy: Insights on competitiveness in the global IT industry", **Technovation**, Vol. 21, No. 8, 2001, pp. 501-514.

M. Carnoy, **Sustaining the new economy: Work, family, and community in the information age,** New York: Russell Sage Foundation/Harvard University Press, 2000.

E. Caroli and J. Van Reenen, "Skill biased organizational change? Evidence from a panel of British and French establishments", **Quarterly Journal of Economics**, Vol. 116, No. 4, 2001, pp. 1449-1492.

M. Castells, **The Rise of the Network Society,** Oxford: Blackwell, 1996.

J. Child and R.G. McGrath, "The organizations unfettered: Organizational form in an information-intensive economy", **Academy of Management Journal**, Vol. 44, No. 6, 2001, pp. 1135-1149.

N.J. Foss, **Strategy, economic organization, and the knowledge economy. The coordination of firms and resources,** Oxford and New York: Oxford University Press, 2005.

J. Gant, C. Ichniowski and K. Shaw, "Social capital and organizational change in high-involvement and traditional work organizations", **Journal of Economics & Management Strategy**, Vol. 11, No. 2, 2002, pp. 289-328.

C. García-Olaverri, E. Huerta-Arribas and M. Larraza-Kintana, "Human and organizational capital: Typologies among Spanish firms", **International Journal of Human Resource Management**, Vol. 17, No. 2, 2006, pp. 316-330.

M.A. Huselid, "The impact of human resources management practices on turnover, productivity and corporate financial performance", **Academy of Management Journal**, Vol. 38, 1995, pp. 635-672.

C. Ichniowski, **Human resources management systems and the performance of U.S. manufacturing business,** Cambridge (MA): *NBER working paper* 3449, 1990.

C. Ichniowski, K. Shaw and G. Prennushi, "The effects of human resources management practices on productivity: A study of steel finishing Lines", **American Economic Review**, Vol. 87, No. 3, 1997, pp. 291-313.

E. Lawler, S.A. Mohrman and G.E. Ledford, **Strategies for high performance organizations, the CEO report: Employee involvement, TQM and reengineering programs in Fortune 1000 corporations,** San Francisco (CA): Jossey-Bass, 1998.

R.M. Lindley, "Knowledge-based economies: the European employment debate in a new context", In M.J. Rodrigues (ed.), **The New Knowledge Economy in Europe. A Strategy for International Competitiveness and Social Cohesion,** Cheltenham (UK) and Northampton (MA): Edwar Elgar, pp. 95-145, 2002.

B-A. Lundvall and P. Nielsen, "Knowledge management and innovation performance", **International Journal of Manpower**, Vol. 28, No. 3/4, 2007, pp. 207-223.

J.P. MacDuffie, "Human resource bundles and manufacturing performance: Organizational logic and flexible production systems in the world auto industry", **Industrial and Labor Relations Review**, Vol. 48, 1995, pp. 197-221.

M. Murphy, **Organisational changes and firm Performance,** Paris: OECD *STI working Papers* 14, 2002.

P. Osterman, "How common is workplace transformations and who adopts it?", **Industrial and Labour Relations Review**, Vol. 47, No. 2, 1994, pp. 173-187.

P. Osterman, **The wage effects of high performance work organization in manufacturing**, Cambridge (MA): MIT working paper, 2005.

A. Pettigrew, R. Whittington, L. Melin, C. Sanchez-Runde, F.A.J. Van den Bosch, W. Ruigrok and T. Numagami, **Innovative forms of organising,** London: Sage, 2003.

J. Pfeffer, **New directions for organization theory: Problems and prospects**, New York: Oxford University Press, 1997.

F.K. Pil and J.P. McDuffie, "The adoption of high-involvement work practices", **Industrial Relations**, Vol. 35, 1996, pp. 423-455.

K. Shaw, "By what means does information technology affect employment and wages?", In N. Greenan, Y. L'Horty and J. Mairesse (eds.), **Productivity, inequality, and the digital economy. A transatlantic perspective**. Cambridge (MA): The MIT Press, 2002.

J. Svetlik and E. Stavrou-Costea, "Connecting human resources management and knowledge management", **International Journal of Manpower**, Vol. 28, No. 3/4, 2007, pp. 197-206.

J. Torrent-Sellens and J. Vilaseca-Requena, **The network company in Catalonia: ICT, productivity, competitiveness, wages and returns in Catalonia's firms**, Barcelona (Spain): Open University of Catalonia, 2007.
Available at:
http://www.uoc.edu/in3/pic/eng/network_company.html.