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Human Resource Management, Strategy and Operational Performance in the Spanish Manufacturing Industry

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In recent years companies have begun to implement a series of human resource management (HRM) practices that are referred to in the literature as high-performance or high-commitment. Among others these practices include employee involvement, training and organisational incentive plans. In this study we attempt to determine how and to what extent the adoption of this type of practices affects the firm's performance record. We focus specifically on the impact HRM has on operational performance. Moreover, we test if the impact of high-commitment practices on firm performance is contingent on the strategy followed by the firm. We try to detect possible differences in the relationship between HRM and the different kinds of operational results (efficiency, quality, and time). For this aim we use a database covering an initial sample of 965 factories each with a workforce of over 50 employees. We begin with a review of the literature before going on to present the descriptive statistics for the variables to be used and, finally, testing the relationship between HRM and operational performance through the estimation of several ordered probit models. Our results reveal the presence of a positive, statistically significant correlation between the adoption of high-commitment practices and improvements in quality and time-based performance. We also find that this effect is universal and not dependent on the strategy used by the firm.

It is commonly accepted that the people working for a firm are one of its main assets and one of the factors in determining its progress. Workers' qualities, attitudes and behaviour in the workplace, together with other factors, play an important role in determining a company's success or lack of it.

Although this type of resource is one over which companies do not have complete control, there do exist certain instruments to enable them to exert their influence on the quality and performance of the human capital on which they rely. The human resource management (HRM) practices that they adopt will have a vital influence in this area and thereby on the performance achieved by the firm.

In recent years references have begun to appear in the literature regarding a series of HRM practices that are named high-performance, high-commitment or innovative, and are said to help firms to achieve significant improvements in performance. The aim of these practices is to achieve a more valuable workforce, by selecting and retaining the

more highly skilled individuals, and to increase motivation in the existing workforce by getting its members to adopt the firm's objectives as their own. This is accompanied by structuring and organising tasks in such a way as to obtain the maximum benefit from the increased capacity and motivation thus achieved among the workers. These practices include, for example, the provision of training for the workers, broader job definitions and meticulous personnel selection processes. At the same time it is stated that these practices may not have the same effect in all firms. Potential benefits may depend on the type of strategy being employed in the firm; a particular strategy may enable a firm to draw more benefit from the behaviour and abilities generated by high-commitment practices.

This study attempts to test the hypothesis that a firm's style of personnel management influences its operational performance. Thus it will be that firms implementing high-performance practices will register more outstanding improvements in results. We will also analyse the effect of HRM on firm performance to determine whether this is universal or contingent on the strategy of the firm.

The environment in which we intend to test this hypothesis is the Spanish industrial sector. Using an initial sample of close to 1,000 Spanish manufacturing plants we will try to discover whether findings in similar sectors in other parts of the world are also applicable to Spain.

This study aims to offer an analysis of the relationship between HRM practices in the operational context and various performance measurements (efficiency, quality and time-based measures) both from the universal and the contingency perspective. We consider this to be a significant contribution of the article, in view of the general scarcity of empirical studies with this sort of focus, the few that exist applying mainly to the US context.

In the next section we carry out a review of existing empirical findings regarding the connection between combinations of HRM practices and business results, while in the following one we explore the role of strategy in moderating the relationship between HRM and performance. We then devote a section to a brief explanation of the importance of operational results in factory management. We then define the research objectives of the article. The following section begins with a few remarks regarding data collection methods, before going on to define the variables to be used in our subsequent empirical analysis and defining the estimating framework. We then estimate the effect of personnel management on a plant's performance and analyse the results obtained. We finish with a discussion of the main conclusions to be drawn from our study.

HRM AND ITS IMPACT ON RESULTS

Workers are key elements in the running of a firm and as such play an important part in the firm's success in reaching its objectives. Human resources, taken to be «the pool of human capital under the firm's control in a direct employment relationship» (Wright, McMahan and

McWilliams, 1994: 304), can provide the firm with a source of competitive advantage with respect to its rivals.

This is possible because of the series of requirements that the workers fulfil (Wright and McMahan, 1992; Wright et al., 1994). The first of these is the value added to the company's production processes, the contribution made by each individual having its effect on the results obtained by the organisation as a whole. Also, since individuals are not all the same, their characteristics are in limited supply in the market. In addition, these resources are difficult to imitate, since it is not easy to identify the exact source of the competitive advantage and reproduce the basic conditions necessary for it to occur. Finally, this type of resource is not easily replaced; though short-term substitutes may be found, it is unlikely that they result in a sustainable competitive advantage anything like that provided by human resources.

For a firm to find the human capital to provide it with a sustained competitive advantage is not just a matter of luck. It depends rather on the action the firm is prepared to undertake towards that end. It is through personnel management practices that firms try to obtain the human resources that will give them the advantage when it comes to holding their own against other companies. It is the human resources themselves, however, and not the practices, that make up the source of competitive advantage. Personnel management practices do not qualify as sources of sustainable competitive advantage, since they are perfectly replaceable and quite likely to be copied by other firms. They are, nevertheless, necessary, not only for the firm's human capital to develop but also to enable it to be employed in such a way as to ensure improvements in the company's performance.

If HRM practices help to create better human capital in the firm and, thereby, a sustained competitive advantage, it is reasonable to assume some sort of connection between the way in which personnel is managed and the results obtained by the firm. There are numerous empirical studies that deal with the influence of individual personnel management practices on different performance measurements. Among these we would find quality circles (Katz, Kochan and Gobeille, 1983), recruitment (Holzer, 1987), worker training (Bartel, 1994), profit-sharing schemes (Weitzman and Kruse, 1990) and information sharing (Morishima, 1991).

Other investigations have attempted to examine the individual impact of not one but several of these practices. These would include investigations carried out by Kalleberg and Moody (1994), Delaney and Huselid (1996), Black and Lynch (2000; 2001), Cappelli and Neumark (2001), Harel and Tzafrir (1999) and Fey, Björkman and Pavlovskaya (2000). Finally, there are some studies that take a global perspective on the relationship between personnel management and performance, taking the view that practices are not applied separately but in conjunction with one another. Instead of looking at the impact of one specific practice, they study the total joint effect of the way in which the different aspects of personnel management are dealt with, particularly the adoption of high-performance practices. Studies such as those of Huselid (1995) and MacDuffie (1995) are among these. There are sev-

eral articles that offer an in-depth critical review of this literature. Among them we must mention those of Dyer and Reeves (1995), Becker and Gerhart (1996), Huselid and Becker (1996), Ichniowski , Kochan, Levine, Olson and Strauss (1996), Guest (1997), Whitfield and Poole (1997), and Becker and Huselid (1998).

This last type of empirical studies, and here we would include our own, analyse a wide range of measurements. Among them we find, for example, such measurements of HRM performance as the ability to attract and retain employees (Kalleberg and Moody, 1994), management-worker relations (Wood and de Menezes, 1998), turnover (Huselid, 1995; Becker and Huselid, 1998; Wood and de Menezes, 1998), absenteeism (Wood and de Menezes, 1998; Hoque, 1999), workers' commitment to the company (Hoque, 1999), job satisfaction among workers (Hoque, 1999) and indices that capture several of these outcomes (Liouville and Bayad, 1998).

In addition to these, we also see measurements of financial results, which are an indication of the firm's overall performance. Among others we might mention productivity (Ichniowski, 1990; Huselid, 1995), profitability (Huselid and Becker, 1996), customer satisfaction (Kalleberg and Moody, 1994), Tobin's q (Ichniowski, 1990; Huselid, 1995) or the firm's market value (Becker and Huselid, 1998).

Finally, we find studies which, like ours, are concerned with analysing the effect of HRM on aspects of operational performance, such as the hours of labour required to manufacture a particular product (Arthur, 1994; MacDuffie, 1995), the percentage of programmed time that the production line is in operation (Ichniowski and Shaw, 1999; Ichniowski, Shaw and Prennushi, 1997), the defects rate (Arthur, 1994; MacDuffie, 1995) or the percentage of production that meets the required quality standards (Ichniowski and Shaw, 1999; Ichniowski et al., 1997). There are also works that take as their dependent variable indices that capture the firm's overall performance in this area. These would include Liouville and Bayad (1998), who incorporate aspects such as defects costs, and Youndt, Snell, Dean and Lepak (1996), who include the degree of utilisation of equipment, minimisation of waste, product quality and in-time delivery. Broadly speaking, all the studies that address this issue, irrespective of the type of operational result on which they are focused, show the introduction of high-commitment HRM practices to have an impact not only on the plant's productive system performance but also on business performance.

THE MODERATING ROLE OF STRATEGY

It has been underlined in the literature that, when adopting their HRM practices, firms must take into account the desirability of fit between these practices and firm strategy (Baird and Meshoulam, 1988). As a consequence, one of the main goals of strategic human resource management is to ensure that HRM is integrated with the strategy and the strategic needs of the firm in order to gain competitive advantage (Wright and Sherman, 1999). Different ways of competing in the mar-

ket require different characteristics, behaviour and attitudes on the part of workers, and these differences are fundamentally the result of applying different HRM policies (Schuler and Jackson, 1987; Wright and McMahan, 1992). This contingency perspective leads to the expectation that the competitive strategy the firm pursues in the market moderates the relationship between HRM and performance (Tichy, Fombrun and Devanna, 1982; Miles and Snow, 1984; Schuler and Jackson, 1987).

The literature, however, does not make it quite clear in what direction this mediation actually works. Miles and Snow (1984) argue that defender firms may, in their effort to achieve stability through efficiency, find it better to establish a long term relationship with their workers, by offering them job security, establishing internal labour markets and investing in their training. This would reduce the turnover of employees, thereby making reactions on the part of the workforce easier to predict. In contrast to this, prospector firms have difficulty in investing in their workforce, since they can not be sure what type of demands they will have to make on them in the future, so they would not benefit from a high-commitment HRM approach.

Schuler and Jackson (1987), Arthur (1992) and Youndt et al. (1996), using the categories established by Porter (1980) in as far as these can be compared to those of Miles and Snow, suggest the opposite relationship. Arthur (1992) claims that a cost leadership strategy is hardly likely to benefit from the introduction of innovative schemes in HRM. Firms attempting to compete on the market in this way will do everything they can to keep their costs to a minimum, a feat that is easier to achieve via a traditional style of management. This enables standardised goods to be produced through strict division of labour, thereby keeping costs low, since, by not requiring highly qualified personnel, it reduces the need for worker training. This makes employees easily replaceable, thereby eliminating the need for the firm to increase wages in order to keep them on. Nor, of course, can we ignore the savings to be made from avoiding the costs involved in setting up and running high-performance programmes.

Those firms that choose to adopt a strategy of differentiation, on the other hand, must be flexible enough to adapt in order to meet the various demands their clients may make on them (Arthur, 1992). In this state of affairs, rather than being responsible for a limited number of tasks, workers will be required to carry out a variety of activities and they are likely to find themselves in situations in which they must decide, of their own accord, how to proceed (Youndt et al., 1996). Adequate training is essential, if workers are to live up to this challenge. They must also be sufficiently motivated to make the choices that will serve the best interests of the firm. There is no question but that this can be better achieved via high-commitment HRM than through traditional methods.

Regarding the empirical evidence, Huselid (1995) finds limited evidence for the impact of HRM on performance contingent on competitive strategy. However, Hoque (1999) finds that the best-performing hotels are those that practise high-commitment management coupled

with a quality strategy. Similar results are reached by Youndt et al. (1996): human capital-enhancing systems have stronger effects when adopted together with a quality manufacturing strategy.

OPERATIONAL PERFORMANCE

The subject of the measurement, evaluation and conceptualisation of operational performance in a company is a recurrent theme in the different areas of the academic literature. One of the first general classifications, and one that has been widely used, is that of Venkatraman and Ramanujam (1986). They adopt a strategic management perspective and focus on the measurement to establish a division between financial and operational performance, with the emphasis on the latter. Following a similar line, Kaplan and Norton (1992) believe that the traditional measurements of financial performance are no longer valid for today's business demands. Therefore, they consider that operational measurements of management are needed when dealing with customer satisfaction, internal processes and activities directed at improvement and innovation in the organisation, which lead to future financial returns.

Manufacturing performance, which encompasses part of the operational performance previously mentioned, is commonly used in the field of operations management. This type of result takes into account the company's performance in reaching its basic objectives, that is, productivity, quality and service. There are several studies which aim to establish a classification of this kind of results (Corbett and Van Wassenhove, 1993; Neely, Gregory and Platts, 1995; Filippini, Forza and Vinelli, 1998). For example, Corbett and Van Wassenhove's model considers three dimensions of performance: cost or efficiency, quality and time.

Efficiency refers to the best possible use of all available resources in order to maximise output. This results in low cost products thanks to the reduction of waste and enables the factory to give value to customers.

Traditionally quality has been defined in terms of conformance to specification and hence quality-based measures of performance have focused on issues such as the number of defects produced and the cost of quality. With the advent of total quality management (TQM) the emphasis has shifted away from conformance to specification and moved towards customer satisfaction. In either case, firms must obtain high levels of quality performance in order to improve or, at least, maintain their level of competitiveness.

The first dimension of time-based performance is reliability. This means fulfilling delivery commitments. On-time deliveries may have a significant impact on customer satisfaction, which makes it an issue to be taken seriously in operations management. The second time-related dimension refers to the speed of production processes, which is frequently measured as the time elapsing between materials reception and delivery of product to the customer. One of the main goals of just-

in-time (JIT) and other production planning and control systems (e.g., Optimised Production Technology) is to improve the flow of production processes, in order to respond more rapidly to customer demands.

RESEARCH OBJECTIVES

As we have explained above, both the theoretical and empirical literature suggest that the way in which the employees of a plant are managed has a significant impact on its performance. Organisational success can be largely explained by the HRM practices that have been applied. Companies that have implemented a bundle of high-performance work practices, in other words, a HRM system aimed at improving people's capabilities and motivation, outperform rivals that have not done so. It has also been indicated that some literature additionally emphasises the mediating role of strategy in the link between HRM and performance.

We have also stated that operational performance measures are the most effective means of assessing how a factory has been managed. In this article we intend to analyse the impact of high-commitment practices on operational results. We understand that, according to the literature quoted earlier, the most immediate and direct effects of HRM in a factory should be on manufacturing performance, as financial results can be affected by other variables that cannot be controlled from an operations management point of view.

This article aims to contribute to the literature in several ways. First of all, it attempts to ascertain whether the impact that high-commitment management is found to have on firm performance in other countries also holds in Spain. We investigate whether high-performance work practices lead to better performance. Secondly, we also test the contingency hypothesis of the relationship between HRM and performance in the Spanish context. Thirdly, we focus specifically on the impact HRM has on operational performance, using a large sample of manufacturing establishments. Finally, we examine data to discover whether there is any difference in the relationship between HRM and the different types of operational results. We try to assess whether high-performance work practices are a useful means for factory managers to achieve all of their various manufacturing goals or if their effect varies for each individual measure of operational results.

METHODOLOGY

DATA

The Spanish manufacturing industry constitutes the scope of our study. The concept of manufacturing industry is clearly defined in the National Classification of Economic Activity (NACE), which includes all the manufacturing industries (from code 15 to code 37) with the exception of oil refining and the treatment of nuclear fuel (code 23).

Fixing the unit of analysis was an important matter to settle. Two possibilities were initially open to us: we could choose either the company or the plant as the focus of our study. We opted for the latter, basing our choice on the fact that in the industrial sector, the plant is the business unit of most strategic importance for the implementation of the practices that would be considered in our study. These practices are adopted in the plant, and therefore, it is at this level where problems arise and where the results must be analysed. Moreover, the answers to the different questions raised are expected to be more reliable when taken from the plant; since the knowledge of these issues is greater even if only because of greater proximity.

Another aspect of the field of application to be determined was the size of the plants. The industrial plants included in our sample employ 50 or more workers. This limit has been used in other studies relating to this area (see Osterman, 1994). It serves to cover a wide spectrum of the population employed in Spanish industry. It also simplifies the fieldwork. Following these criteria, the population consisted of 6,013 plants. The aim was to achieve a sample of 1,000 units, stratified according to sector and size. The larger-size stratum was represented at 50% in the sample design. For the two remaining size strata, a fixed number of 30 interviews was allocated to each sector; the rest of the interviews being allocated among sectors proportionally. The sample allocated to each of the strata within a sector was also distributed proportionally. A random selection of plants was taken from each stratum for interview. The survey was based on a questionnaire that was made up, pre-tested, and then modified in different ways to form the final questionnaire. The questions on HRM refer to blue-collar workers. The fact that we refer to a specific group of workers creates problems, as far as the generalisation of the results to other professions is concerned. However, by limiting the type of job considered, we are better able to compare the different units we have studied, as there can be several significantly different internal labour markets within a given company.

As we had foreseen from the start, most of the questionnaires (more than three quarter, in fact) were filled in by either the plant manager or the production manager. The questionnaire covered different issues, all linked to production. It was meant to be answered by someone with a broad understanding of both the organisational aspects of the plant and the technical side, though knowledge of the latter was less crucial. Nevertheless, the complexity of the questionnaire did not mean it could not be understood by any of the plant managers with knowledge of the areas under study.

After making 3,246 telephone calls to make the necessary appointments, 965 valid interviews were conducted. This represents a response rate of 29.72% and constitutes the initial sample for which we have information.

MEASURES OF VARIABLES

MEASURING HIGH-COMMITMENT HRM PRACTICES

A look at the different empirical studies to be found in the literature dealing with high-commitment HRM practices soon reveals a lack of unanimity surrounding the practices that ought to be included under this general heading. It sometimes even happens that practices considered by some authors to be synonymous with high-performance HRM systems, are taken by others to be more closely related to traditional personnel management systems.

For the purpose of the present study, the choice of practices to be included in the category of high-commitment management was made with various points in mind. We first turned our attention to those practices most often included in investigations into innovations in HRM. A second consideration involved the restrictions imposed upon us by the questionnaire we were using; we could obviously only include in our study those practices about which we had data. Taking these details into account, we included the practices that were most often mentioned in the literature and that also figured in our database. We then added a number of other variables which, though absent from other studies, appeared to us to fit into the management philosophy we wished to investigate.

The use of employees already working for the organisation to fill vacancies further up in the hierarchy is a variable common to all the different studies of high-performance HRM practices. Respondents were asked to show on a scale of one to five how many of their current supervisors and skilled technicians had previously had jobs on the shop floor. This scale has been transformed into a scale from 0 to 1 to create the variable *Promotion.*

Another factor that encourages workers' identification with the firm is their confidence in being able to keep their jobs. The *Security* variable equals the percentage of permanent employees.

The criteria applied in the selection and recruitment of new workers give some indication of how the firm is being run, since they reveal what type of qualities and behaviour is being sought after in candidates for jobs in the firm. The binary variable *Selection* tells us whether one of the two main factors considered when selecting and taking on new workers gives priority to personality characteristics or the ability to work as part of a team and learn new skills, rather than focusing on higher qualifications and a closer match between the technical requirements of the job and the abilities and technical skills possessed by the candidate.

The effort made by the firm to train its workers also serves as an indication of its concern for the future of its workforce. *Training* is equal to 1 if some workers have received any formal training within the past year. As for the content of that training, *Grouptrain* equals the percentage of hours of training provided by the firm devoted to teamwork and problem solving techniques.

There are several issues relating to wage systems that must be included. *Wagelevel* is a binary variable that indicates whether the workers'

average wage is above the average for the same type of workers in the same sector and the same region. *Plantinc* shows whether or not the plant uses for the majority of its workers incentive schemes based in any way on its operations or financial performance. *Knowpay* indicates whether the main factor in determining the majority of workers' wages is their level of professional skill, as opposed to other criteria, such as the nature of their job or their length of service in the firm.

Several of the aspects included refer to the nature of the job. On the one hand, there is the existence of autonomous work teams, which is measured by the variable *Team.* The use of job rotation among shop-floor workers is captured by the variable *Rotation,* which takes values from a scale of 0 to 1 (the initial values obtained from the questionnaire were based on a scale of 1 to 4). Self-inspection by the majority of workers as a quality management technique is represented by the *Selfins* dichotomous variable. Respondents were asked in the interview to indicate on a scale of 0 to 10 the degree to which their workers were allowed to plan and organise their own work. The variable *Autonomy* is the outcome of dividing these initial values by 10 and therefore assumes values between 0 and 1.

Specific action designed to increase the participation of workers in the running of the firm may take the form of schemes to collect individual suggestions or the creation of groups of workers to meet periodically in order to identify problems related with their work and propose possible solutions. These two instruments are reflected in the binary variables *Suggestion* and *Groups,* respectively.

The use of methods to allow communication to take place between workers and company management is an issue that needs to be taken into account when dealing with the attempt to get workers to identify with the firm. While periodic meetings with employees in order to inform them about company issues creates a downward flow of communication, conducting surveys in which employees are asked about their degree of job satisfaction sets up a flow of communication in the opposite direction. This type of action is captured by the variables *Meetings* and *Surveys. Opendoor,* meanwhile, indicates whether or not the firm has organised open-days in an attempt to involve employees and the surrounding community and to create links between the workers' private environment and the firm that employs them.

Table 1 contains the most relevant descriptive statistics for the seventeen HRM practices that we have defined as high-performance. This table shows that the adoption of the different practices in Spanish industry varies considerably. As far as diffusion is concerned, at one extreme we find training in teamwork and problem solving techniques and plant incentives, in which application is the least intense. Two further practices, with a diffusion limited to around 20%, and both contributing to increasing worker involvement, are, first of all, surveys to detect job satisfaction and, second, the organisation of open days. Meanwhile, only a quarter of the plants interviewed included workers' level of knowledge and skills when fixing the basis for their wages. Moreover, workers are given very little autonomy in their jobs.

Table 1. Mean, standard deviation, and correlation matrix for HRM practices (N = 758)

Variable	Mean	S.D.†	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Promotion	.67	.30																
2. Training	.80	.40	.03															
3. Grouptrain	.07	.13	.01	.29***														
4. Wagelevel	.42	.49	.05	.05	.12***													
5. Plantinc	.12	.32	.01	.08**	.10***	.04												
6. Knowpay	.25	.43	.03	.09***	.02	.03	-.05											
7. Team	.47	.50	-.07*	.11***	.11***	-.01	.02	-.04										
8. Rotation	.47	.29	.06	.15***	.12***	.07*	.08**	.03	.06*									
9. Selfins	.90	.31	-.01	.06*	.02	-.05	.07*	.01	.05	.03								
10. Autonomy	.25	.29	-.02	.08**	.04	.00	.07*	-.02	.22***	.05	.04							
11. Groups	.39	.49	.01	.28***	.20***	.09**	.11***	.03	.18***	.11***	.03	.19***						
12. Suggestion	.57	.50	.03	.29***	.10***	.01	.05	.01	.09***	.01	.10***	.15***	.29***					
13. Meeting	.59	.49	.04	.33***	.12***	.10***	.10***	.10***	.14***	.13***	.09***	.12***	.34***	.34***				
14. Survey	.21	.41	.02	.17***	.15***	.09**	.12***	.05	.15***	.07*	.10***	.15***	.32***	.24***	.28***			
15. Opendoor	.19	.39	.04	.15***	.10***	.03	.06*	.01	.14***	.08**	.07**	.09**	.23***	.17***	.22***	.28***		
16. Selection	.67	.47	.04	.07**	.11***	.01	.01	-.04	.03	.01	-.01	.02	.03	.07**	.09***	.10***	.04	
17. Security	.80	.21	.05	.15***	.08**	.08**	.00	.04	.00	.05	.02	.01	.03	.07*	.07*	-.01	.05	.07*

†: standard deviation; ***: p<.01; **: p<.05; *: p<.10.

At the other extreme, we have self-inspection by the workers of the quality of the products they manufacture. This is common practice in 90% of the plants interviewed. There is also very widespread provision of some kind of formal training for production workers (80% of the sample) and a high proportion of permanent employees. Though to a more moderate extent, we should also mention the widespread application of personality-based criteria in personnel selection processes, as well as frequent use of internal promotion in order to fill posts as job vacancies occur within the organisation.

Highly relevant observations can be made from the associations between the different practices and how they interrelate. A close look at the correlation table will provide some very interesting information in this respect. As was to be expected, the correlation coefficients are overwhelmingly positive, and among the negative only one is significantly distinct from 0. In all, of the 136 coefficients that make up the matrix, only eleven are negative.

It can be seen how some of the practices considered possess an individual diffusion profile that falls far wide of the trend followed by most of the rest. This casts serious doubts on the theory that high-commitment practices are implemented in such a way as to remain consistent with one another. However, this phenomenon may also be interpreted as an indication of error in the theoretical definition of the practices that make up the subject of our investigation. In other words, it may be that some of the practices included fail to complement the rest.

In relation to this issue, there is evidence to suggest that paying workers above the going rate, providing them with job security, rewarding them for their knowledge and offering them internal promotion are practices that have very little connection with other aspects of high-commitment management. The case of the *Promotion* variable is particularly remarkable, in that it fails to register even a single positive correlation significantly distinct from 0 with any of the remaining sixteen practices analysed. This echoes the results obtained in Becker and Huselid (1998) and points to the need for further theoretical investigation into the relationship of this feature of internal labour markets and the rest of the HRM system.

When there is a great number of practices to be analysed, as in the case in hand, the investigator is faced with two possible ways of evaluating the degree to which HRM can be considered to be based on high-commitment. The first of these involves taking the variables refering to the use of individual practices and creating an index that measures the extent to which high-performance employment practices are being applied (e.g., Wood and Albanese, 1995; Pil and MacDuffie, 1996; McNabb and Whitfield, 1999). The second option is to classify firms according to their level of application of the whole set of practices under consideration (Arthur, 1992). It is thus possible to opt for a more or less continuous measurement or for using a nominal variable. For the purposes of the present study, we will apply both options, since this will help in ascertaining whether the results obtained are robust in relation to the procedure used to evaluate the way in which human resources are managed.

The index we intend to use for the present study is the sum of the seventeen variables defining high-commitment practices taking place in the establishment; this will be labelled *HRMindex.*

In order to group the plants according to the degree to which they have introduced high-commitment practices into their management of human resources, we classify them by means of cluster analysis. We begin by carrying out an agglomerative analysis using a Ward hierarchical procedure and the square of the Euclidean distance. From this we are able to deduce that the optimum number of groups to be formed is 2. Taking the results of this first analysis as our initial centroids, we then perform a non-hierarchical cluster analysis using two groups.

This process gives two groups. **Table 2** shows the number of plants in each group, the mean value in each group for the variables and the statistical significance of the chi-squared statistic. Judging from the frequencies of the different HRM practices examined, the first of the groups is the one that can be classed as containing the firms where high-performance HRM practices have been introduced. The second group, meanwhile, is made up of plants that continue to practise traditional methods of personnel management, placing the emphasis on strict control of workers' actions. *HRMgroup* is a binary variable that takes a value of 1 when the plant belongs to the first group taken from the cluster analysis, that is, plants that include high-commitment practices in their HRM, and a value of 0 otherwise.

Table 2. Association between HRM practices and groups resulting from cluster analysis

Variable	Mean	Mean Group 1	Mean Group 2	Chi-2 p-value
1. Promotion	.67	.69	.65	.042
2. Training	.80	.96	.60	.000
3. Grouptrain	.07	.10	.05	.000
4. Wagelevel	.42	.46	.37	.016
5. Plantinc	.12	.31	.07	.000
6. Knowpay	.25	.28	.20	.010
7. Team	.47	.58	.33	.000
8. Rotation	.47	.50	.43	.000
9. Selfins	.90	.93	.85	.000
10. Autonomy	.25	.31	.18	.000
11. Groups	.39	.65	.07	.000
12. Suggestion	.57	.83	.25	.000
13. Meeting	.59	.91	.21	.000
14. Survey	.21	.36	.04	.000
15. Opendoor	.19	.30	.06	.000
16. Selection	.67	.72	.62	.002
17. Security	.80	.81	.78	.044
N	758	415	343	

It can be clearly seen how the first group includes most of the plants where the adoption of the seventeen practices considered is most intense. Moreover, it must also be emphasised that differences between the two groups are always significant, although on two of the variables, *Promotion* and *Security,* the difference is not quite as marked as on the rest. These findings coincide reasonably closely with the conclusions drawn from our previous analysis of correlation in the implementation of these practices.

OPERATIONAL PERFORMANCE MEASURES

It is important to explain the two characteristics of the measurements of performance we have used in this study. First of all, they measure the degree of improvement in the different performance indicators of the plant in the last three years. The different manufacturing performance dimensions, which are measured in absolute terms, depend largely on the technology being used and type of process being undertaken at the plant. Therefore, it becomes difficult to establish comparisons when the data are obtained from a group of heterogeneous plants, even when the sector is introduced as a control variable. The other noteworthy characteristic is the subjectivity of the information used. Results of a subjective nature are often used in research on organisations. Some studies have demonstrated a strong relationship between objective and subjective measures of financial performance. This may serve as a justification for the use of this kind of performance (Dess and Robinson, 1984; Venkatraman and Ramanujam, 1987; Powell, 1995).

The indicator for efficiency (cost performance) used here is *Efficiency;* this refers to improvement in the percentage of productive hours in relation to the total number of hours of direct presence of the workforce. It reflects waste and inefficiency in the productive system and identifies unproductive time resulting from organisational problems (lack of material, breakdowns, problems with quality, etc.).

The two indicators of improvement in quality performance correspond to a definition of product quality as conformance with specifications and they are defined as the percentage of defective products. *Quality1* measures improvement in the percentage of defective finished products, that is, the number of defective finished units divided by the total number of finished units manufactured in the plant. *Quality2* measures improvement in the percentage of defective unfinished products, that is, it refers to the percentage of defective units that have been detected in the intermediate stages of the manufacturing process, and not at the end of it.

We also use two indicators for time performance. *Time1* indicates the improvement in the percentage of delivery dates fulfilled, which is a typical measurement of punctuality, and considered a basic aspect of customer service. *Time2* indicates improvement in the reduction of the time taken from the moment the material is received to the moment the product is delivered to the customer. This serves as an indicator of process speed (lead time).

The five performance variables are discrete variables. They take a value of 0 for plants whose manufacturing results have not improved

in the last three years, 1 for those whose results have improved slightly and 2 for those whose results have improved greatly.

CONTROL VARIABLES

The first control variable is the size of the plant, measured by the natural logarithm of the number of employees that work in the factory *(Lnsize).* This is a common means of measuring establishment size.

Technology has great significance in any attempt to explain the operational results achieved by the plant. Technical features are measured by the variable *Automation,* which aims to capture the degree of automation in the plant. The questionnaire enquired after four technical features that were felt to be directly related to the degree of automation: namely, robots or programmable automatons, automatic materials storage and retrieval systems, computer integrated manufacturing and computer networks for the processing of the plant's production data. By applying factor analysis to these four variables, a single factor is obtained with an eigenvalue greater than 1, which accounts for just over 47% of the variance. The factor loadings on these variables are greater than .44. *Automation* is defined as the average of the four variables mentioned.

Competitive pressure can force firms into striving to improve operational performance if they wish to survive in the market or maintain and improve their financial results. The level of competition being faced by the firm is captured by the variable *Competition.* This uses a scale of 1 to 5 to assess the evolution of competition levels over the last three years in the sector in which the plant operates. A score of 1 on this scale indicates a large decrease, whereas a score of 5 represents a large increase.

Qualassur is a binary variable that assesses whether the plant has set up a quality assurance system. It reveals whether the factory is following a quality strategy by establishing organisational routines aimed at preventing defective products from reaching the customer.

Finally, *Strategy* is a variable defining the relative importance attached by the management of the plant to the question of quality in comparison to cost; when both quality and cost are given the same importance *Strategy* takes a value of 100.

Table 3 shows the average and standard deviation of the dependent variables, control variables and *HRMgroup* and *HRMindex.* It also shows the correlation between *HRMgroup, HRMindex,* performance variables and control variables.

This table enables us to see how the plants included in the sample remain at intermediate levels of automation, though slightly below the exact mid-point. However, the plants that participated in the study claimed that the competition they had to face had increased over the three years previous to the interview. It is also worth mentioning the effort that is going into increasing quality assurance at the plants, since 71% of the manufacturers claim to have set up systems to deal with this.

As was to be expected, the vast majority of the plants report improvements in the different plant performance areas considered, that is, efficiency in the use of resources, quality, and the speed at which they

complete the different stages in the productive cycle. Analysis of the correlation matrix brings us to the conclusion that no incompatibilities are present in the performance attaining processes in the different areas of operations management at the plant. Plants that have improved their performance in one of the three areas considered are more likely also to have improved in the remaining areas.

Table 3 also offers a simple profile of the plants that have opted to introduce high-commitment. The larger the size of the plant, the greater the likelihood of its introducing this type of practices. Likewise, in the area of technology, there is clear evidence to show that these tend to be plants with more highly automated processes, and where it will be more usual to find quality assurance schemes in progress.

ESTIMATION FRAMEWORK

Given the nature of our dependent variables, the question of whether HRM leads to differences in operational results will be tested by estimating ordered probit models (Maddala, 1983). For each dependent variable three different models are constructed. The first of these includes only control variables, the second incorporates the *HRMgroup* variable and its interaction with *Strategy* and the third substitutes *HRMgroup* with the *HRMindex* variable, which is our other measurement of the prevalence of high-performance HRM practices, also including the interaction term. To deal with the multicollinearity problems of the multiplicative interaction terms we have made a linear transformation known as "centering", in which the mean value for a variable is subtracted from each score (MacDuffie, 1995). By using two variables to measure the adoption of high-performance practices, we aim to obtain a clearer picture of the impact that such practices have on plant performance. Although in our estimations we control by activity sector through eleven dummy variables, the coefficients do not appear in the corresponding tables.

Table 3. Mean, standard deviation, and correlations between results variables, control variables, *HRMgroup* and *HRMindex* (N = 758)

Variable	Mean	S.D.†	1	2	3	4	5	6	7	8	9	10	11
1. Lnsize	4.88	.85											
2. Automation	4.18	2.36	.318***										
3. Competition	3.48	.89	-.036	.041									
4. Qualassur	.71	.45	.280***	.296***	.011								
5. Strategy	161.79	85.59	.012	.081**	-.004	.059							
6. Efficiency	.81	.71	.103**	.138***	.027	.141***	-.028						
7. Quality1	.82	.70	.095**	.164***	.053	.217***	.006	.405***					
8. Quality2	.83	.70	.109***	.211***	.016	.208***	.006	.457***	.797***				
9. Time1	.90	.72	.065	.126***	-.007	.138***	-.005	.506***	.491***	.540***			
10. Time2	1.01	.75	.110***	.255***	.061	.193***	-.002	.288***	.286***	.372***	.356***		
11. HRMgroup	.44	.50	.226***	.293***	.004	.314***	.045	.114***	.197***	.183***	.200***	.207***	
12. HRMindex	7.86	2.48	.287***	.350***	-.033	.347***	-.034	.127***	.208***	.214***	.150***	.217***	.747***

†: standard deviation; ***: p<.01; **: p<.05; *: p<.10.

RESULTS

Tables 4, 5 and 6 show results for the ordered probit models estimated to examine the determinants of plant performance. Table 4 is an analysis of the efficiency of the production system, Table 5 deals with quality and Table 6 with time-related performance.

EFFICIENCY

Table 4 shows the results of the ordered probit models estimated for improvement in efficiency, measured in terms of changes in the proportion of productive hours over the total number of hours of direct labour. Though the model proves significant, results are not entirely satisfactory, owing to the low pseudo-R^2 value.

Out of all the control variables included, both the level of automation and the installation of quality assurance systems register coefficients significantly distinct from 0. These, therefore, are factors that enhance the capacity of a manufacturing plant to improve the efficiency of its production processes. The decrease in significance of the *Qualassur* variable in the second and third models was to be expected, in view of its strong correlation with *HRMgroup* and *HRMindex.* In the second model it can be seen how the fact of belonging to the high-commitment HRM practitioners group enhances a factory's efficiency results, though not to a significant degree. Results obtained on model 3, in contrast, show that if the level of application is measured in terms of the intensity of practices adopted *(HRMindex)* we see the emergence

Table 4. Ordered probit analysis for efficiency performance

	Model 1		Model 2		Model 3	
	b†	s.e.‡	b	s.e.	b	s.e.
Constant	-.8279**	.403	-.8152**	.4034	-.9993**	.409
Lnsize	.0989	.064	.0860	.065	.0829	.066
Automation	.0489**	.020	.0448**	.020	.0432**	.020
Competition	.0235	.051	.0217	.051	.0255	.051
Qualassur	.2324**	.109	.2106*	.113	.1955*	.113
Strategy	-.0244	.056	-.0131	.057	-.0149	.058
HRMgroup			.1338	.099		
HRMgroup × Strategy			-.0021*	.001		
HRMindex					.0357*	.021
HRMindex × Strategy					.0004	.001
Pseudo-R2	6.7		7.7		7.7	
Chi-square	40.16***		45.97***		45.87***	
Log L	-661.27		-658.36		-658.41	
N	662		662		662	

†: parameter estimate; ‡: standard error; ***: p<.01; **: p<.05; *: p<.10.

of a positive and significant impact on improvements in efficiency. The interaction term is significant only in model 2, although not with the expected sign. For the case in hand, therefore, we are unable to draw any definite conclusions regarding the relationships analysed.

QUALITY

Table 5 shows the results of the ordered probit models estimated for the two variables that capture the plants' quality performance. The first three models refer to *Quality1,* i.e., changes in the percentage of product defects, while the remaining three refer to *Quality2,* i.e., changes in the percentage of processing defects. All six models are statistically significant and give a substantially better overall impression than those obtained when attempting to explain manufacturing efficiency.

As in the previous table, both the level of automation and the installation of quality systems have a strong influence on the firm's progress in the pursuit of quality. The two factors have a similar type of effect on the firm's capacity to improve the quality of its products. In the case of *Quality1,* however, a significant impact is also brought about by the evolution of the firm's competitive position in the market. It would appear that plants feeling themselves exposed to increasing competition are forced to improve the quality of the final products that they take to market.

For both product and processing defect rates, it is apparent that HRM practices being implemented help to explain the evolution of the plant's quality performance. In the case in hand, results remain conclusive whatever method is used to measure the implementation of high-commitment practices. The explanatory capacity of the two models increases by introducing the *HRMgroup* variable; a similar effect also takes place with the *HRMindex* variable. The implementation of high-commitment HRM practices in a factory has a beneficial effect on reducing the defect rate. However, the interaction terms are significant in none of the models; therefore, the existence of complementarities between strategy and the adoption of HRM practices is disregarded in explaining quality performance.

TIME-BASED PERFORMANCE

Table 6 shows the results of the ordered probit models estimated to explain trends over the last three years in the two indicators used to evaluate speed of action, which are the percentage of on-time deliveries and the time that elapses between receiving the materials and delivering to the client. It can be seen that all six models are significant and help to explain the variables being analysed.

Once again we find that quality assurance systems and high levels of automation in product processing help firms to achieve improvements in time-based performances. In the case of *Time2* it is also possible to see the effect of competition on the results obtained by the firms in this respect. Plants that come under higher levels of competitive pressure make a greater effort to reduce the time that elapses between receiv-

Table 5. Ordered probit analysis for quality performance

	Quality1						*Quality2*					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	b†	s.e.‡	b	s.e.	b	s.e.	b	s.e.	b	s.e.	b	s.e.
Constant	-.5381	.357	-.5924*	.357	-.8779**	.359	-.5147	.364	-.5348	.365	-.8267**	.368
Lnsize	.0068	.059	-.0196	.060	-.0316	.060	.0538	.061	.04299	.061	.0300	.061
Automation	.0614***	.021	.0511**	.021	.0458**	.021	.0870***	.021	.0799***	.021	.0729***	.021
Competition	.0989*	.051	.1036*	.051	.1082**	.051	.0400	.050	.0425	.050	.0492	.050
Qualassur	.4761***	.108	.4182***	.111	.4124***	.111	.4309***	.109	.3855***	.111	.3662***	.111
Strategy	-.0276	.054	-.0154	.055	-.0172	.054	-.0238	.056	-.0137	.057	-.0143	.056
HRMgroup			.3023***	.099					.2230**	.099		
HRMgroup × Strategy			-.0001	.001					-.0002	.001		
HRMindex					.0694***	.021					.0665***	.021
HRMindex × Strategy					-.0001	.001					-.0001	.001
Pseudo-R2	12.7		14.1		14.4		12.6		13.4		14.2	
Chi-square	76.43***		85.83***		87.83***		76.81***		82.05***		87.32***	
Log L	-625.50		-620.80		-619.80		-631.05		-628.43		-635.06	
N	654		654		654		659		659		659	

†: parameter estimate; ‡: standard error; ***: p<.01; **: p<.05; *: p<.10.

Table 6. Ordered probit analysis for time-based performance

	Time1						*Time2*					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	b†	s.e.‡	b	s.e.	b	s.e.	b	s.e.	b	s.e.	b	s.e.
Constant	-.2066	.366	-.2487	.371	-.4813	.378	-.4540	.353	-.4990	.355	-.7442**	.366
Lnsize	.0356	.060	-.0146	.061	-.0105	.061	-.0029	.057	.0149	.057	-.0219	.058
Automation	.0592***	.020	.04636**	.020	.0478**	.020	.1188***	.021	.1084***	.021	.1054***	.021
Competition	.0232	.049	.0287	.050	.0291	.050	.0927*	.049	.0967*	.050	.1002**	.050
Qualassur	.3112***	.105	.2379**	.106	.2554**	.106	.3406***	.102	.2743***	.103	.2807***	.103
Strategy	.0047	.053	.0184	.055	.0183	.055	-.0135	.049	-.0008	.050	-.0092	.050
HRMgroup			.3860***	.096					.3187***	.094		
HRMgroup × Strategy			-.0008	.001					.0001	.001		
HRMindex					.0578***	.020					.0608***	.020
HRMindex × Strategy					.0002	.0002					-.0001	.0002
Pseudo-R2	9.3		10.7		11.8		11.8		12.9		13.1	
Chi-square	57.60***		74.30***		66.83***		100.26***		111.74***		109.85***	
Log L	-680.62		-672.27		-676.00		-701.90		-696.16		-697.10	
N	675		675		675		702		702		702	

†: parameter estimate; ‡: standard error; ***: p<.01; **: p<.05; *: p<.10.

ing materials at the start of the production cycle and the moment when the product finally reaches the client, irrespective of whether or not they accompany this with action in the technological area.

The conclusion that emerges yet again is that the way workers are managed has its effect on a plant's performance. The impact of *HRMgroup* and *HRMindex* on both dependent variables is highly significant and, as with the quality results, the explanatory capacity of the models increases noticeably with the introduction of these variables. The implementation of innovative practices in the area of HRM leads not only to an increase in the percentage of on-time deliveries but also to a reduction of the amount of time the firm takes to manufacture the product and deliver it to the client. Again, the interaction terms do not show any significant coefficient in the different models estimated.

CONCLUSIONS

This study enables us to confirm that the way in which human resources are managed influences a company's performance. Generally speaking, our findings support the hypothesis that by using high-performance HRM systems, organisations can improve their chances of reaching objectives as long as they do not lose sight of other aspects, mainly of a technological nature, the explanatory capacity of which is considerable. These findings coincide largely with those of researchers into this issue in other contexts.

It can not be said, however, that the impact of high-commitment HRM practices used is significant in all of the three measurements of manufacturing performance analysed. When it comes to efficiency, for example, we can not be absolutely certain that the development of high-performance HRM practices in the plant noticeably increases the likelihood of improvements, since results differ depending on how the implementation of such practices is measured. In the case of quality and time-based performance, however, there is conclusive evidence that high-commitment work practices can bring about substantial improvements in company performance.

Our findings also show that the strategy of the firm does not play any intermediate role between high-commitment management and performance. The positive effects of adopting high-performance practices for companies are equally significant both for firms that base their strategy on cost and for companies that give priority to quality in managing the factory.

The recommendations for managers that derive from our results are straightforward. Our findings encourage managers strongly to implement in their firms high-commitment practices in their management of human resources. These practices elicit behaviours and develop competencies in employees in such a way that they give rise to a series of benefits in terms of better outcomes, both in quality and time.

One of the limitations of this study is a result of the context in which the empirical analysis was carried out. The fact that we have focused on the manufacturing industry, with the wide range of activities which that

implies, and have concentrated on only one group of employees, albeit the largest, means that our conclusions can not be made applicable to all professions and sectors.

One of the shortcomings of this study is that cross section analysis, whilst revealing the type of association that exists between variables, does not provide any clear account of the causal relationships. It is not absolutely clear from the results of the study whether there is a causal relationship or a concomitant one. This issue might, therefore, be worthwhile exploring in any possible future investigation using panel data.

In subsequent studies we intend to look further other issues that have not been dealt with in this one. One of these is the possibility of a complementary relationship between the practices comprised in high-commitment management. Although we have looked on the system as a whole and not on individual practices, it is worth looking into the question of how these practices are interrelated and in what way this affects company performance. This analysis could reveal the importance of internal consistency in the field of personnel management.

We also consider interesting to be able to analyse more deeply the use of other operational indicators different from those used in this article. In this effort a balanced scorecard approach would be extremely useful in determining the effect of high-commitment management on the performance of the factory.

It will also be necessary to ascertain how far HRM practices complement other areas of plant management different from strategy. While our findings support the theory of the universal impact of these practices and rejects the contingency hypothesis on strategy, it remains to be seen whether the extent of the positive effect of high-commitment management depends on other decisions taken in the factory. The degree to which HRM complements strategy and technology will require special attention.

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