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**ORGANISATIONAL AND TECHNOLOGICAL INNOVATIONS
IN MANUFACTURING FIRMS: DIFFUSION AND DETERMINANTS**

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Davide Antonioli, Massimiliano Mazzanti, Paolo Pini, Ermanno Tortia
University of Ferrara, Faculty of Economics, Via del Gregorio 13, 44100 Ferrara

corresponding author: Paolo Pini
phone 0532-293000, fax 0532-293012
e-mail pini@economia.unife.it

Abstract

This paper presents some results of the project carried out by the research team of the University of Ferrara on *Organisational Innovations, Industrial Relations, and Economic Performances.* The core of the program is the analysis of the interactions between various forms of flexibility that characterise both managerial styles and industrial relations within a large sample of manufacturing firms, with 50 employees and more, located in the province of Reggio Emilia, Emilia-Romagna.

The main objective of the study is to highlight the organisational features and the models of human resources management accompanying direct and indirect worker participation and leading to improved economic performances. Within this framework, the aim is to investigate the role of industrial relations in affecting the organisational configuration of the firm. Moreover, the work enquires the relationship between quality of industrial relations, particularly in the field of worker and representative participation, and innovative processes within the firm.

The econometric section focuses on the determinants of techno-organisational innovations. Past firm performance indicators, industrial relations indexes, labour flexibility and structural features of the firms are used as regressors to determine what factors favour different kind of innovation processes. A set of variables emerge with distinctive and significant effects: firm size, flat hierarchical structure, flexibility of labour contracts for new hiring, quality of industrial relations, past profitability of the firm and access to capital markets, low level of labour productivity, are key factors associated to innovation intensity, with different significance and robustness with respect to the various kinds of techno-organizational innovations.

Key words: human resources management, industrial relations, competitiveness.
J.E.L.: J51, L60, M54

Introduction[*]

The economic and managerial literature[1], no more than the operators' positions, emphasise the role of innovative managerial models coupled with innovative technological paths in improving firm performance. Both aspects of innovations have been widely studied often in distinct theoretical and empirical streams. Since technology and organisation, as it will be more extensively explained below, are likely to co-evolve and to mutually influence each other, the empirical analysis should consider together these aspects, though the work addresses primarily organisational themes in the field of labour participation and human resources management (HRM hereafter) practices.

The core of the paper examines the innovations adopted by management, their characteristics in terms of organisational change *versus* technological innovation, and the related degree of employee involvement. Of course, the theme of worker participation in organisational models evokes the role of worker representatives and unions and the distinction between direct and indirect participation in the domain of industrial relations.

The analysis is based on the information collected with a structured questionnaire addressed, with the method of direct interview, to managers for a sample of about 200 manufacturing firms with at least 50 employees, located in the province of Reggio Emilia, Emilia-Romagna[2].

The structure of the paper is as follows. The theoretical background underpinning the empirical analysis is presented in section 1. After a brief description of the methodical features of the survey, with the related response rates (section 2), a closer attention is paid to the firm economic performance between 1998 and 2001 reported by managers (section 3) and to the organisational structure of the firm: the general macro-structure in terms of hierarchy, production organization, and working hours is described in section 4. Section 5 constitutes the core of the paper and deal with technological and organisational innovations, focussing on types and proponents of innovations. Section 6 presents some relevant results of the analysis based on simple correlation coefficients between structural features of the firms, various aspects of innovation processes, and firm performance. Sections 7 and 8 are devoted to a closer look to industrial relations and worker participation. The former describes the way in which firm managers, union delegates, and workers interact with each other, while the latter explores the dilemma of complementarity versus substitution of direct and indirect participation within the firm. The econometric analysis focussing on the determinants of techno-organisational innovations is performed in section 9. The main factors introduced as regressors are the structural features of firms, indexes representing labour flexibility, employee involvement practices, quality of industrial relations, finally performance indicators. Some final remarks conclude the paper.

1. Theoretical background

The European Commission (E.C., 1997) underlines the role of changes in firm organisation in developed countries. An evolutionary process characterised by the transformation of the Fordist-Taylorist organisation in knowledge economy has taken place in the last decades. Firms can be described as *learning organisations*, characterised by a flat and decentralised organisational structure

[1] Some of the most relevant articles in this wide and populated research field are Fernie-Metcalf (1995), Machin-Stewart (1996), Addison-Belfield (2001), Black-Lynch (2001), Ichiniowski-Shaw (2003). See Section 1 of this paper for a discussion of the theoretical framework. For a comprehensive survey dealing with payment systems, the reader can consult European Parliament (2003).

[2] The interviews were carried out directly during the first half of the year 2002 by the research group coordinated by prof. Paolo Pini at the University of Ferrara, Department of Economics Institutions Territory. This paper will present only part of the results emerging from the information collected during the interviews.

(Lundvall-Nielsen, 2002). Organisational decentralisation is necessarily connected with some degree of decisional decentralisation. Individual workers, groups of workers, and their representatives participate in decisional processes, at least at the operative and, to a lesser extent, organisational level. Such kind of participation can be mutually advantageous for firms and workers. While the former are able to exploit workers' competencies, that can be generated and developed at the workplace through *empowerment and job enrichment* (Foss-Foss, 2002; Foss-Laursen, 2002; Ichiniowski-Shaw, 2003; Leoni *et al.* 2003), the latter benefit of a more involving and participatory working environment, and at the same time obtain a credit with the management at the bargaining table and an economic reward trough negotiations.

Recent studies (Black-Lynch, 2001) show that worker participation has a crucial role in making new technologies work within new organisational settings. New practices (often labelled "best work practices") are often introduced by the initiative of managers. However, they appear to be more efficacious the more they actively involve employees in the production process, even if only at the operative level, with or without worker representatives' intervention. On the other hand, the introduction of new work practices is related to the utilisation of "knowledge intensive" technologies.

The mere introduction of new technologies, without organisational innovation and new human resources management practices, does not seem to support better performances (Arnal *et al.* 2001). On the other hand, knowledge intensive practices, which appear to be adopted in bundles (OECD, 1998), are likely to require new and more flexible technologies, able to trespass the old Fordist-Taylorist scheme and to underpin a more integrated and inclusive working environment. It should be noticed that the direction of innovation *(technology driven* or *organisational driven)* is not easy to enquire. At any rate, it seems fair to state that (as, for example, in Leoni *et al.,* 2001) the two components (organisational and technological innovation) are likely to co-evolve, and, when separated, do not lead to remarkable results.

The European Commission (E.C., 1997) underlines the impact of organisational innovation and new work practices on industrial relations too. In turn, industrial relations can have an active role in favouring or halting innovation. New organisational models necessarily influence information, consultation and bargaining procedures between managements and worker representatives, at times in a way similar to the model of partnership (Appelbaum-Hunter, 2003). The old scheme requiring the definition and measurement of simplified and predetermined tasks is progressively overcome. Union intervention cannot be limited any more to the mere control over the measurements carried of by supervisors. It needs to become wider and more complex. Bi-directional information sharing, consultation, and negotiation concerning organisational settings and economic results are added to traditional bargaining procedures at the local level. In a context where it becomes impossible to precisely measures workers' output, it is necessary to device new patterns of interaction between managers and worker representatives. The sharing of procedures seems to be a particularly promising direction to follow, for example in the field of worker formal evaluation. Just the management of internal labour markets would constitute an especially promising field of interaction for social parties (managers, union delegates, and workers). The presence of largely diverging opinions on the issue notwithstanding, an active role of union guaranteeing the respect of procedures and supporting the development of workers' competencies would represent a privileged field of increased participation and involvement.

The contributions present in the literature, which address the description and assessment of unions' role in the new economy in a milieu where new organisational schemes are adopted, highlight the fact that the impact of unions' presence cannot be predicted in advance. It crucially depends on the attitudes of both worker representatives and firm managers. The result is confirmed by the non- unequivocal empirical results concerning union impact on worker productivity and firm performance (Deery *et al.,* 1999; Addison et al., 2000; Addison-Belfield, 2001). Given the clear distinction between differing roles, the presence of unions devoted to collaboration and non-antagonistic participation seems to favour both organisational innovation and better economic performance (Black-Lynch, 2001; Leoni *et al.,* 2001; Pini, 2002).

Participation becomes the area where firm modernisation and development possibilities intersect. Right choices are not granted and the risk to follow wrong directions is always present. While many firms choose a more conservative attitude and retain traditional organisational settings, the connection

between participation, that can take the form of collaborative industrial relations, and organisational innovation, for example in the field of human resources management, constitutes a new frontier characterised by opportunities and risks. At the level of scientific enquire there is no doubt about the interest created by the exploration of the potentialities of participation. However, it should not be forgotten that participation cannot interfere with fundamental institutional barriers. For example, property rights and the connected governance structure of the firm keep on being underpinned by managerial initiative that, in turn, is accountable to the firm owners (Godard, 2001).

2. Firm population and response rate to the survey

The firms included in the universe are drawn from national[3] and local[4] databases and are classified on the basis of the codex ISTAT-ATECO 91. They are all the manufacturing firms (257) with at least 50 employees located in the province of Reggio Emilia in the year 2001. The survey is made up of a questionnaire addressed to the management, on three main topics: (a) organisational innovations and human resources management practices; (b) industrial relations; (c) payment systems. The firms responding to the survey are 199, with a reply ratio of 77,4% of the entire population[5]. Firm distribution by sector and dimension is characterised by limited bias. The textile sector and small firms (50 to 99 employees) are under-represented. However, no significant distortion emerges in all other sectors and dimensions, with the number of interviewed firms approaching or reaching 100% of the total in many of them *(tables 1.1-1.2)*.

After a first phone contact, the introductory part of the questionnaires was sent by fax directly to each firm in February 2002, asking to answer the questions concerning the structural features of the firm and ascertaining the willingness to answer the whole questionnaire during a direct interview. Interviewers were sent to accepting firms between May and July 2002. Interviewees are generally top managers and human resources directors. Where necessary, firms were contacted again to solve problems pertaining their answers or to complete the questionnaire (autumn 2002).

Balance sheet data are available for 146 firm out of the 257 total population, for the period 1991-1996. Both balance sheet data and questionnaires addressed to the management are available for 113 firms (44% of the total population)[6]. The availability of balance sheet data does not vary significantly by dimension being near to 50% of firms for all dimensional classes, with the exception of medium sized firms (employees 50-99 and 250-499) which show higher percentages. By sector, the chemical and the textile are under-represented, while all the other sector are close to the average. As for the availability of balance sheet data and firm managers' interviews, quite the same picture as in the previous paragraph is found, though by size only class 250-499 shows a degree of representation significantly higher than the average *(tables 1.3-1.4)*.

Comparing performance indicators of the 146 firms with balance sheet available and the 113 firms with also managers' interviewed, we note slight differences in performance among the two groups of firms: in particular the subset of 113 firms presents relatively higher labour productivity and investment per employee and a lower labour cost per employee *(table 1.5)*.

3. Economic performance between 1998 and 2001

On the basis of firm managers' subjective evaluation, the economic performances accomplished between 1998 and 2001 are positive (*table 2)*.

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[3] Intermediate census 1996 of the National Institute of Statistics (ISTAT, 1999).

[4] *Camera di Commercio* in Reggio Emilia (Infocamere, 2001).

[5] For details on the structures of the database see Antonioli *et al.* (2003a).

[6] The source of balance sheet dataset is *Camera di Commercio* in Reggio Emilia; the balance sheets have been reclassified by the balance sheets division operating at the *Camera del Lavoro di Reggio Emilia*, under the direction of Anna Ruozi.

Six dimensions of performance were taken into consideration (production, sales, investments, employment, profitability, and liabilities). Respondents indicated for all six dimensions if their firm had improved or worsened its results over the past four years. An additive index varying between -1 and +1 was build over the six dimensions. Its total value is 0,52, indicating a clear tendency toward positive results.

The individual values for each of the six dimensions highlight a notable degree of variation. The index values for production, sales and investments are near to 0,7, indicating that the greatest part of firms had improved over these dimensions. The value of the index for employment is equal to 0,51, while for profitability it is equal to 0,3. It is clear that increase in sales and production do not entail increased profitability, though firms' results are positive in the latter respect too. Finally, the level of debts decreased in 28% of the enquired firms, and increased in 15%. Hence a slight tendency to liability reduction is detected.

4. Macrostructure of the firms: hierarchy, production organization, and working hours

The core of the survey is constituted by the enquiry on technological and organisational innovation. Besides, some more general organisational futures, to be intended as structural variables, are enquired. Among these, the hierarchical structure, the number of functional divisions within the firm, the organisation of production in terms of flexibility of the production process and of labour services, and the management of working hours constitute part of the framework within which techno-organisational innovation is expected to flourish.

As long as formalised divisions and hierarchical structure are concerned, the results emerging from the research describe firms that do not show a particularly hierarchical structure. While the number of formalised divisions[7] is quite high, they are distributed over a reduced number of hierarchical ladders. The result is that the hierarchical intensity[8] is not particularly high (the overall value is 0,29, in the range 0-1). This is mainly true just in firms where a more complex and articulated organisational structure is present. Furthermore, there is a tendency to increase the number of formalised functions without strengthening the pyramidal structure of the firm. Important differences are found by sector and dimension. In particular, little and medium sized firms, though they are characterised by a simpler organisational structure, show a higher hierarchical intensity, while in larger firms, due to the presence of many distinct functions with horizontal relations, hierarchy is less pronounced *(tables 3-3.3)*.

The organisation of production is characterised by a high level of flexibility both in the utilisation of the plants technologies, and in the utilisation of labour services. In more than a half (55%) of the total number of enterprises the two features are coupled together, though it must be said that 30% of enterprises show both rigid plant technologies and rigid labour services[9].

Working hours are a third general organisational feature that received close inspection by the survey. Since 1998, 36% of the firms introduced innovations in working time regimes. The accomplishment of innovations in working hours regimes is likely to be connected to the preceding organisational item, i.e. the degree of flexibility of plant technologies and labour services. Changes in working time regimes are more widespread in firms showing lower levels of flexibility. The reason may be that firms characterised by low flexibility are prone to introduce flexibility in working hours in order to recoup the underlying rigidities.

Innovations introduced in working hours regimes constitute a first field where to compare managerial initiatives with the initiatives taken by worker representatives, joint committees and workers themselves. As it will become evident in the following sections, managerial leadership in steering the innovation process emerge as a clear feature with respect to both technology and organisation. However,

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[7] The questionnaire identified fifteen distinct formalised divisions. The average number of divisions is 10,5, and the standard deviation is 2,9.

[8] Hierarchical intensity is defined as the ratio of number of hierarchical ladders to the number formalised divisions.

[9] See for details Antonioli *et al.* (2003b).

throughout the analysis of innovative processes, a significant role of worker representatives, unions, and workers is found. These results are well aligned with the theoretical viewpoint of authors like Aoki (1980, 1984, 1988). A complex picture of the firm emerges, where a hierarchical structure which is fundamentally top-down is completed by initiatives and information flows which run in the opposite direction. These systemic features may allow the firm to exploit the disperse operative knowledge formed at lower hierarchical layers *(tables 4.1-4.2)*.

5. Technological and organisational innovations

The core of the paper concerns technological and organisational innovation carried out at the plant level. The first step is to examine the presence of some organisational practices (*total quality management, job rotation, team work, quality circles, and just in time*), often labelled "high performance" (Godard, 2001) or "best work organizational practices" (OECD, 1998) because they imply employee involvement at the operative and organisational level. Particular attention will be devoted to the characteristics of team work. The second step is the analysis of other innovations introduced at the organisational level and in the field of new technologies and product quality, with special focus on its employee involvement content and on proponents (management, union delegates, joint committees or workers themselves).

The analysis depicts an entrepreneurial reality which is dynamic and open to change at the organisational and technological level.

However, decisional decentralisation intervenes at a slow pace. While standard innovations are widespread, the ones implying employee involvement and pattern of decisional decentralisation characterise a restricted set of firms. In this group of firms, the relevance of proposals by union delegates, production workers, and joint committee emerges - in relative terms - with respect to managerial proposals.

Though the decisions taken by management remain dominant, worker representatives accomplish an important role just in the adoption of participatory innovations.

At least one out of the five organisational practices studied by the literature on human resources management *(total quality management, job rotation, team work, quality circles, and just in time)* is present in 67,3% of the total firms[10]. Among these five practices, total quality management, job rotation, and team work are the most widespread, being present in a percentage of firms equal or superior to 30%. The remaining two practices (quality circles and job rotation) are not common since they were found in slightly more than 10% of firms. The percentage of workers involved, in firms where such practices are present, is superior to 50% in the case of just in time, total quality management, and team work, whilst it is inferior to 50% in the other cases *(tables 5.1-5.2)*.

Among the various human resources management practices (HRM practices hereafter) particular attention was given to the organisational features of team work, as it potentially implies a high degree of worker involvement at the operative level. Team work is found in 30% of the firms. In the vast majority of these firms (85%), workers in team are responsible for specific product and/or services. This result is confirmed by the fact that in 60% of total firms where teamwork is found, team members decide together how operations should be performed, even if workers generally do not decide the group leader. Team work activity is rewarded in some way in 83% of the firms adopting it; the main typologies of reward are career advancement and economic rewards[11].

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[10] Their introduction usually occurred during the nineties, though in some cases it took place during the eighties, and, in rare cases, during the seventies.

[11] Beyond teamwork and decisional decentralisation at the operative level, another channel of worker involvement is employee suggestions to the management on problem solving, a practice that is recorded in 77% of total firms. These workers need not be members of team and they are economically rewarded in 38% of cases.

5.1. Organisational and technological innovations introduced since 1998

Since 1998 the most part of firms decided to introduce organisational and technological innovations. It is possible to distinguish five main categories of changes:
a) new products and services;
b) new technologies at the plant level;
c) changes in remuneration systems;
d) standard innovation in work organisation;
e) various typologies of organisational innovations which imply worker involvement and participation with possible sharing of procedures.

The most frequent changes (recorded in a percentage of enterprises equal or superior to 70%) are the ones comprehended in categories (a), (b) e (d): new product and services, new technologies, and standard innovations in work organisation. *Table* 6.2 highlights the strong incidence of both product and process innovations that, even separately, are recorded in a percentage of firms near to 70%. Innovations in quality control are less diffused, but still present in more than 50% of firms. Innovations in category (e) (participatory work organisational innovations) are present in a percentage of firms near to 50%: job rotation, total quality management, life-long training processes connected with new organisational requirements *(table 6.1)*.

Other changes were recorded in a percentage of enterprises comprehended between 20% and 40% of the total. They are changes in remuneration systems (category c), and other innovations concerning the participation of employees, hence to be enclosed in category (e). This group comprehends higher levels of employee autonomy in problem solving, and creation of structured channels for employee suggestions to the management about organisation and product quality[12].

Worker training deserves a special place in the analysis of techno-organisational innovation. In 85,4% of firms techno-organisational change entailed interventions on worker skills within the firm, while 61,3% of firms employed new workers for the same reason. In the latter case, 54% of firms employed workers with new competencies. The upgrading of employee skills associated with innovation depends primarily on the introduction of new technologies (77% of cases), but also on new competencies (58% of cases). Finally, it is interesting to note that in 46% of firms processes of life-long worker training were detected, and in 35% of firms a formalised function concerning worker training is *present (table 6.2)*.

5.2. The proponents of technological and organisational innovations

A precise knowledge concerning who took the initiative in the introduction of technological and organisational innovations is important for the study of industrial relations and worker participation within the firm. Various models can be envisaged in this field, ranging from purely uni-directional and hierarchical ones, to more democratic models where initiatives for changes come from all hierarchical ladders, or from worker representatives and joint committees *(table 6.1)*.

The evidence concerning manufacturing firms in the local system of Reggio Emilia highlights a clear prevalence of managerial initiatives[13] over the initiatives of workers or their representatives. This broad result is not at all surprising and it is in line with many theoretical streams, ranging from the property rights school, to the principal-agent model, to the managerial theories of the firm. The interesting aspect that comes into light concerns the role of the social parties other than management.

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[12] One of the least adopted innovation is the introduction of innovations in working hours systems (about 30% of firms), that were already dealt with.

[13] The management takes the initiative for the introduction of innovations in at least 85% of firms for the vast majority of innovation typologies.

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The exceptions to this rule are constituted most of all by changes enclosed in category (e), innovations in worker participation at the operative and organisational level. For example, the introduction of structured channels for employee suggestions concerning product quality and organisational settings are proposed by management only in 50% of cases. Other changes comprised in category (e), together with changes in remuneration systems, are characterised by the active intervention of management in a percentage of firms ranging from 65% to 80%. It seems that organisational changes implying worker involvement are characterised by the lowest degree of managerial intervention.

Conversely, the same category of changes, plus the introduction of remuneration system, is characterised by the active intervention of actors other than managers at times in more than 50% of the total number of firms. For example, the proposals of union delegates, joint committees and workers happened to be relevant for the introduction of job rotation, team work, life-long training programmes, and for greater employee autonomy in problem solving.

Overall, it seems that the data recorded highlight a polarisation of the typologies of innovation on the basis of the proposing actors. The management intervenes actively in the vast majority of cases as far as the realisation of changes addressed to improve internal efficiency and firm performance, such as product and process innovation, product quality and innovations in work organisation of a more traditional kind are concerned. On the other hand, worker representatives, joint committees and workers perform an active role in organisational fields which implies some kind of worker involvement.

5.3. Synthetic indexes for technological and organisational innovations

With the aim of synthesising and sorting off the diffusion of various typologies of technological and organisational innovations, a series of additive indexes able to incorporate all the information collected were built[14]. As long as the topics just dealt with are concerned, two groups of indexes were built, the former representing innovation intensity and the latter representing the proponents of innovations *(table 6.4)*.

The first group of indexes comprises 5 items, ranging between 0 and 1. The first index (INNO_1) synthesises all innovation categories, both technological and organisational, in terms of dimension and intensity. Its value (0,461) represents a benchmark for the other indexes. The second index (INNO_2) represents product and process innovation (new technologies and new products/services introduced). Its value (0,744) is the highest and testimony the fact the technological innovations are, on average, realised at a higher pace than organisational ones. An alternative synthetic index of technological innovation (labelled INNO_TECH) comprises product, process and quality control innovation: it is worth 0,625, hence it has a value a bit lower than the previous one due mainly to the diffusion of quality control practices (t*able 6.3*).

The third index (INNO_3) represents the commonest organisational innovations (e.g. total quality management, job rotation, team work). Its value is 0,468. The fourth index (INNO_4) is again related to organisation, but it comprises all innovations, not only the commonest, but also the participatory ones (e.g. employee autonomy in problem solving, structured channels for employee suggestions to the management, life-long training). Its value is 0,409. The fifth index (INNO_5) encloses only the innovations that have a more pronounced participatory characterisation and its value is 0,362. The value of the three organisational indexes shows a clear tendency toward a more cautious implementation of participatory schemes than common schemes. Putting it differently, it seems that the enquired firms assume a quite bold attitude in innovating at the technological and organisational level, though em-

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[14] The most part of the indexes built in the study are additive as average value of dichotomous (0-1) variables representing the various typologies of technological and organisational innovations. Hence they vary between 0 and 1. Alternatively, they can be standardised to the interval 0-1. There are exceptions: not all questions have dichotomous answers (e.g.: "yes/no", "present/absent" etc…). However, in such case, variables are most often categorical and their value ranges over a limited scale like the corresponding indexes. In other cases, the indexes can be termed "qualitative" insofar as different weights were assigned to different answers on the basis of a subjective evaluation of their significance. Since the most part of indexes are of the first kind, only the qualitative nature of indexes will be specified in the text.

ployee participation finds more difficulties and obstacles and would require stronger effort.

The second group of indexes (from INNO_7 to INNO_11) represents the intensity of initiatives taken by the social actors. As it may have been easily predicted, the index representing the intensity of managerial initiatives is much higher than the one representing the initiatives taken by the other social parties (union delegates, joint committees, and workers)[15]. The former scores 0,338, while the latter scores 0,134. The intensity of initiatives by union delegates, joint committees, and workers is less than a half of managerial intensity. However, it should be noted that it is not irrelevant. Quite the contrary, it appears to be important in specific field of organisational innovation, as it will be underlined in the following sections.

5.4. Innovations in compensation systems

Part of the literature[16] points out that a balanced introduction of organisational innovations (e.g. best work practices) and innovative payment systems is likely to support higher level of performance indicators.

The study of payment systems constitutes the focus of a whole part of the questionnaire to firm managers in the province of Reggio Emilia. Though it is not the main objective of the present work, the most qualifying aspects of worker remuneration have been introduced as a separate typology of innovation. In the econometric part of the work (section 9) its determinants are enquired using the variable already selected for the other typologies of innovation.

The system of worker evaluations and rewards is constituted by three main elements: (a) formal evaluation of workers; (b) individual bonuses and incentives; (c) flexible wages negotiated with worker representatives[17]. Whilst the former two typologies can be independent of industrial relations, the latter one is not, since negotiation with unions delegates on flexible collective pay system at the firm level is mandatory in Italy since the reform of the bargaining procedures in 1993.

Formal evaluation is widespread in the case of executives (present in 50% of firms), while it is less common, though present in at least 30% of firms, for top managers, clerks, skilled and unskilled manual workers. The main objective of formal evaluation is the determination of wage increases and bonuses (in 80% of firms), though incentive to workers' productivity is a very important aim as well (present in 60% of firms) *(table 6.5)*.

Individual bonuses and incentives are present in 3/4 of firms. On average they cover 44% of employees, though the percentage of employees covered steadily decreases down the hierarchy. While 77% of top managers and 69% of executives are involved in bonus schemes, the percentage lowers down to 27% and 18% in the case of skilled and unskilled manual workers respectively. Finally, collective wage flexibility negotiated with workers representatives is recorded in 71,4% of firms[18].

On the basis of all the listed typologies of incentives, economic and non economic rewards, and payment systems an additive index was build synthesising the intensity of introduction and presence of rewarding mechanisms (INNO_REWARDS). The results are displayed in *table 6.6*. Intensity of incentive mechanisms increases steadily with firm size. It is almost double in large firms with respect to small firms. There can be scale economies and cost reasons explaining differences in the introduction of personnel evaluation and incentives schemes. Alternatively, the weakening of incentives connected

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[15] See INNO_7 vs. INNO_8-9-10-11.

[16] Coriat (1995), Ichiniowski-Shaw (1995), Del Boca-Kruse-Pendleton (1999), Poutsma-Huijgen (1999), Foss-Laursen (2000, 2002), Black-Lynch (2001), Cainelli-Fabbri-Pini (eds., 2001), Pini (2001), Cainelli-Fabbri-Pini (2002).

[17] For the sake of precision, there is a fourth element, namely financial participation, i.e. distribution of stocks and bonds, stock options etc… This element will not be considered in the treatment below since the diffusion of financial participation is marginal in the firms of Reggio Emilia province, and, indeed all around Italy where legislation and the fiscal system does not strongly support its diffusion.

[18] Though the structure of negotiation between firms and worker representatives is complex and concerns many aspects of worker remuneration, such as the indicators chosen to calculate flexible wages, the possibility of renegotiation and change in parameters and indicators, all these issues will not be enquired in the present work. As already stated, they are enclosed in a separate section of the questionnaire and will be dealt with in future work.

to the bureaucratisation that characterises larger firms may advice the introduction of such mechanisms.

6. Some relationship between innovations and firm characteristics

A first test to identify some relationships emerging out the set of data collected and illustrated so far is constituted by a simple statistical correlation analysis. Though the empirical analysis cannot be limited to the exploration of simple correlation coefficients this description is a first useful step highlighting possible structures of linkages between variables.

On the basis of this first exploration of the data, the analysis reveals important relationships that often are quite strong from a statistical point of view. Such connections will be summarised in the present section[19] *(tables 6.4, 7.1-7.4).*

A first result that clearly emerges from data exploration is the strongly complementary character of the introduction and presence of innovations. Technological and organisational innovations are seldom introduced alone. Most often, they appear in clusters and are introduced following a path that calls to mind increasing returns to innovations, at least up to a minimum number of innovations necessary to accomplish sufficient cost reduction and productivity increasing effects. This result is underlined by various works, and it is confirmed by the present analysis.

Second, innovative intensity seems to be a growing function of dimension, mainly in terms of plant dimension more than in terms of firm dimension. Innovative processes are particularly intense in medium and medium-large firms (between 250 and 999 employees), while it is less pronounced in firms below 250 employees.

Third, hierarchy does not seem to help innovation. Innovation is more intense in firms characterised by a low ratio of hierarchical ladders to the number of formalised functions existing within the organisation. Among the others, the presence of formalised functions addressing industrial relations, training, and human resources management seems to be more conducive to innovative processes.

Fourth, the flexibility of labour relations is associated with the intensity of innovative processes. The utilisation of short term contracts[20] is positively correlated with innovation. One of the main functions performed by the utilisation of short term contracts is screening. Such contracts are interpreted by firms as trial periods during which managers have the possibility to assess worker fitness for the tasks assigned and to select personnel with adequate characteristics. The analysis of this result in terms of worker functional position within the firm adds further important information. *Skilled craft workers* seem to constitute integral part of core business and are only marginally influenced by the diffusion of short term contract. Furthermore, the percentage of skilled workers on short term contract is *negatively* associated with the intensity of innovation processes. One of the main functions of the presence of *unskilled craft workers* seems to be to increase the flexibility of the production process and to easy innovation processes without being an integral part of it. In fact, the percentage of unskilled worker on short term contracts is *positively* associated with the intensity of innovation[21].

Fifth, economic performances, mainly in terms of liability position and profitability, but also in terms of other performance indicators, are strictly associated with innovative processes. Liabilities, in absolute terms, are lower in more innovative firms, though it seems that the rate of growth of liabilities is *positively associated* with innovative processes. This apparently contrasting results can be ex-

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[19] In this section not all the tables are included. However, they can be requested from the authors.

[20] Labelled "atypical" contract in the Italian jargon.

[21] An indirect confirmation of these results comes from the association between innovation processes and the degree of education of the workforce. Indexes of correlation between education and the degree of innovation are positive and significant in the field of innovation in labour organisation and they grow as the degree of participation incorporated in organisational innovation increases. Hence education seems to favour participation, while it is negatively related (though not strongly) to process and product innovation. Overall, a picture of the role of labour in innovative processes is obtained where innovation in labour organisations is favoured by higher educational levels, long term employment of skilled workers and short term employment of unskilled workers.

plained, on the one hand, by the necessity of innovative firms to expand investments and, consequently, financial exposition, and, on the other hand, by the better ability of innovative firms to self-finance themselves and reduce financial exposition in relative terms by means of increased profitability.

Sixth, in the domain of labour organisation, innovations that show the strongest statistical association with profitability are what were defined as participatory arrangements (e.g. increased autonomy in problem solving, life-long training, and structured channels for employee suggestions to management). The introduction of such typologies of organisational innovations is characterised by a more intense initiative by non managerial actors (mainly worker representatives). An increased interaction between management and other social parties (*social dialogue*) is associated with a growing intensity of innovative processes and with improved economic performances.

Finally, internationalisation of the firm is positively related to innovation. Though the elements to test causality are insufficient, it is clear that firms operating more intensely on foreign markets are more innovative. The percentage of foreign sales is positively associated with innovation, whilst the contrary is true for the percentage of domestic sales. Competition on international markets seems to require (and maybe favour) more intense techno-organisational innovations. Firms adopting a defensive policy may be able to survive on domestic markets, while innovation is likely to be a necessary condition for survival on international markets[22].

7. Information, consultation and bargaining between management and worker representatives on technological and organisational innovations

Different schools of thought tend to see in the presence of unions at the firm level a danger for the efficiency of production processes, or an element of stimulus, pressure, and active interaction with the management. At the empirical level, contrasting results have been reached about the role of unions (see, for example, Fernie-Metcalf, 1995; Machin-Stewart, 1996; Addison-Belfield, 2001) and their generalisation would not be granted.

In our survey, on the basis of the answers provided by managers it results that unions and firms interact first of all on the basis of information flows: this is so in the 64% of total firms. In the 29% of the firms consultive procedures between managers and unions were recorded, while processes of negotiation concerning innovations are present in the 11,3% of the firms *(tables 8.1-8.2)*.

In the following paragraphs the general result of the analysis will be highlighted without going into the detail of all the empirical elaborations. In broad terms, firm policies aiming at discussion and bi-directional interaction between managers and worker representatives are not in contrast with innovation processes. Quite the contrary, it seems that an interaction characterised by high information flows is able to support the introduction and management of innovative practices. This result emerges also from the analysis of correlation coefficients between indexes of techno-organisational innovations and indexes representing the interaction between managers and worker representatives.

It should be noted that mainly information flows and, to a lesser extent, consultive interaction do

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[22] A further extension of the analysis takes into consideration the categorisation introduced by Pavitt, and employed in OECD (1994) which distinguishes firms on the basis of their productive orientation. Firms are sorted in five categories: (a) labour intensive; (b) resources intensive; (c) scale intensive; (d) specialised suppliers; (e) science based. In the present study concerning Reggio Emilia, the number of categories reduces to four since firms characterised as science based were not detected. The summary results in the fields of innovation intensity, performance, and industrial relations concerning the various groups of firms highlight clear and distinctive results. Labour intensive firms show a poor record in all three fields: weak performance, weak innovation intensity, and weak interaction between managers and worker representatives. At the other end of the spectrum, specialised suppliers are found: they associate good performance, high innovation pace, and close interaction between managers and unions at various levels. Resources intensive and scale intensive firms show a more articulated position. The former are characterised by low innovation pace, though good industrial relations seem to result in good performances connected with the limited innovative processes. On the other hand, scale intensive firms show high innovation pace and good performance, though industrial relations are not as good as in the other categories.

appear to support innovation[23]. Consultation appears significant in the field of labour organisation and employee participation, while it is less so as long as product/process innovation and product quality are concerned.

The interesting result is that social interaction, though mainly at the level of information flows and consultation, is most relevant just in the areas of participatory practices. The initiative for the introduction of new practices is taken by managers in the most part of cases, but this attitude does not foreclose a more open interaction with worker representatives.

8. Complementarity and antagonism of direct versus indirect participation

The analysis of the relationship between management, union delegates and workers is of crucial importance in the study of industrial relations. A topic much debated in the literature (Addison *et al.,* 2000) concerns the comparison between *direct* and *indirect* interaction between managers and workers. Some authors (Fenton-O'Creevy *et al.,* 1998) maintain that the two typologies of interaction exclude each other. Where direct interaction prevails, the role of unions necessarily fades away, as it can be observed, for example, in important parts of the American and British industrial systems. On the other hand, a strong diffusion and relevance of unions induces firm managers to interact with worker representatives, penalising if not excluding direct interaction with individual or group of workers (in this case the German industrial system can be recalled). The co-presence of the two typologies of interaction is sometimes considered superfluous, or inefficient, or likely to favour overlapping and contrasts between social parties.

The results of this study on manufacturing firms in Reggio Emilia point to a different direction *(tables 9.1-9.4)*.

Two indexes synthesising industrial relations were used: the first describes the interaction between managers, workers and union delegates in terms of information, consultation and negotiation in the field of techno-organisational innovation[24]. The second describes the complex of industrial relations enclosing other aspects of the interaction between social parties[25]. The analysis clearly highlights the fact that the interaction between managers and worker representatives is more intense where more practices of direct employee involvement are found[26]. There is no evidence of some form of antagonism or substitution between direct and indirect participation. Quite the contrary, the two phenomena are likely to coexist and reinforce each other.

In other words, more participatory firms are characterised by various practices of worker involvement in terms of consultation and delegation (Coriat, 2002)[27] at the individual and team work level. In

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[23] Correlation coefficients between information flows and innovation processes are almost always positive and statistically significant.

[24] The interaction between management and unions in Reggio Emilia was studied on the basis of a list of 22 discussion themes. Some examples of themes enclosed in the list are "product quality", "market evolution", "production", "decentralisation of non-core activities", "labour contracts", "career advancements", etc… The same list was used for the study of industrial relations both in the survey addressed to management and in a second the survey addressed to worker representatives that is not considered in this work. Various additive indexes (both quantitative and qualitative) of the type described in footnote 14 were built. The results illustrated in the following sections are based on this technique for empirical analysis.

[25] For example, it takes into consideration elements such as the organisation of joint work groups comprising both managers and workers, employee participation in formal organisms with decisional powers at the operative and organisational level, etc.

[26] See *tables* 9.1-9.4 and Antonioli *et al.* (2003b) for details. There, it emerges a strongly positive relation between the intensity of the interaction between managers and worker representatives on the one hand, and the various modalities and intensity of direct involvement (consultation and delegation) of workers by the management. The most striking feature of the results is that both the indexes of industrial relations and interactions between managers and union delegates grow monotonically with the number of practices of direct involvement of workers.

[27] A more in depth analysis, in line with what is presented in Coriat (2002), distinguishes between individual and group delegation and consultation. Very briefly, the results of the analysis highlight that the most effective forms of decisional decentralisation are individual consultation and group delegation. In other words, managers testimony better results in cases

this group of firms the interaction between managers and union delegates is likely to be more intense in terms of information, consultation, and negotiation concerning the various themes under discussion and the various typologies of techno-organisational innovation.

On the basis of all the listed typologies of consultation and delegation practices (individual/group) an additive index was build synthesising the intensity of introduction and presence of participation mechanisms in work organization (INNO_PART) (*table 9.5*). These practices increase steadily with firm size, and in particular are higher in firms with at least 250 employees. In this case too, there can be scale economies and cost reasons explaining differences in the introduction of worker involvement through consultation and delegation.

9. An investigation on the determinants of organisational and technological innovations

The main purpose of this section is to present the results of the econometric analysis, which is aimed at investigating the nature of the relationship, if any, between the intensity of innovation (measured by specific indexes of organisational and technological innovations), taken as dependent variable, and a set of explanatory variables. In modelling the relationship, we follow the economic and managerial oriented literature on technological and organizational innovations as reported in section 1, referring to the following explanatory variables:

(A) a set of *firm typology variables* such as: dummies for firm size, processes and market orientation (sectors), industrial group membership, cooperative-like firm, firm governance, in/outsourcing strategies, firm hierarchical structure, structures of workforce (shares of top managers, executives, clerks, blue collars -specialized and not- on total employees, the ratio of skilled/unskilled workers) and its education level;

(B) variables concerning *flexibility in productions process and labour services;*

(C) indexes referring to the quality of *industrial relations* among management, employees and worker representatives (and their interactions);

(D) *performance indicators* deriving from balance sheets dataset available for 113 firms over the period 1991-1996[28].

The availability of performance indicators defines the sample of firms we use in the present section. The analysis is then implemented in a cross section environment, where variables from (A) to (C) refer to the period 1998-2001[29]. Performance variables (D) instead refer, as stressed, to the period 1991-1996[30]; the aim is thus to capture the dynamic effect of (lagged) performances on different specifications of innovations[31].

We now present more in detail what kind of variables are selected as potential factors which drive the innovative content of productive activities. First of all, innovation (the trend on the adoption of in-

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where they have consulted individual workers about operational and organisational issues. Good results are also recorded in firms where a certain degree of delegation of responsibilities and decision making power was conceded to groups of employees, often working in teams. Individual delegation and group consultation are less widespread and do not seem to be associated with improved performance and good effects on innovation processes. See Antonioli *et al.* (2003b) for details.

[28] Thus, at the present stage the analysis is bounded to 113 firms out of 199 which fill the final survey questionnaire.

[29] Generally, values represent the observed (surveyed) trend over the 4 years period; in some case they refers to the end of year 2002 (as for structure of workforce).

[30] Both mean indicators and growth indicators were included. Growth indicators are calculated as the 1991-1996 changes on the 1991 level.

[31] The availability of performance indexes over 1991-1996 allows to introduce a sort of "lagged effect". This in part resolves the problem of determining the direction of causality between innovation and performances, which characterises many analyses in the field of innovation. In that case, methods like two stage least squares; two equations model and IV analysis are feasible ways of tackling the problem. It is worth noting, however, that the main empirical problem is the difficulty of collecting panel data for complex organisational and technological innovation indicators as here intended, thus moving away from usual input and output proxies as R&D and number of patents, which allows an easier econometric analysis.

novative practices and strategies over the period 1998-2001) is proxied by 7 different index measures[32, 33]:

1. index of all innovation categories, both technological and organisational, in terms of dimension and intensity (INNO_1);
2. index of technological innovations concerning product, process and quality control innovations (INNO_TECH)[34];
3. index representing the commonest innovations in work organisation (INNO_3) (e.g. total quality management, job rotation, teamwork, quality circle);
4. index enclosing only the innovations that have a more pronounced participatory characterisation (INNO_5);
5. innovation practices involving both consultation of individual workers and group delegation about operational and organisational issues (INNO_PART), referring to the work practices discussed in previous section 8;
6. innovations related to flexible non economic rewards and compensation systems, thus including information on: flexibility of payment schemes, individual incentives, bonuses, pay-for-performance schemes, and practices of formal evaluation on workers. Both bargained and non-bargained economic incentives and payment schemes discussed in previous section 5.4 are taken into account (INNO_REWARDS);
7. *extended* index of innovations, including *not only the previous organizational and technological innovations*, *but also innovations in management of internal labour market and human resources* (INNO_EXT)[35].

All innovation indicator variables vary between zero and one. Some indexes present limit observations, some others do not. This point is relevant for the treatment of such "fractional variables", being thus continuous but ranging from zero and one, as it will be clearer below. As far as covariates are concerned, we sum up in *table 10* the full set of variables used as explanatory factors.

This sub-set of variables constitutes the outcome of a pre-selection of relevant variables carried out by analysing the full correlation matrix of all available variables, both deriving from the survey study and from the balance sheet dataset. As a rule, given a set of variables showing an index of correlation higher than 0.50, the ones associated to the highest number of significant correlation overall were dropped[36]. This is a first step to deal with collinearity and misspecification problems in a cross section environment. This pre-selection was also a method to reduce the set of explanatory variables to a manageable number, given the large amount of qualitative and quantitative information arising from the survey questionnaire.

In particular, we estimate the following reduced form equation, which synthesises a conceptual model of innovation determinants:

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[32] The synthetic indexes for innovation were commented in section 5. We here focus on those used for the specific aim of econometric analysis. Thus, indexes are labelled following section 5.

[33] As already said, the analysis will be based on a sub-sample of the 199 firms with manager interviews (113 firms). *Table* 11 presents mean values and standard deviations for the 7 depend variables of innovations, distinctly for the 199 and 113 firm samples, showing no significant differences among the two samples.

[34] INNO_TECH is used instead of INNO_2, which captures similar factors of innovation, as it presents more variability for estimation purposes. In addition, INNO_TECH includes also innovations in methods of quality control in production processes and products.

[35] This index includes also variables concerning hiring policy, career advancements, on the job and out of the job training, layoff policy, employees involvement policy, individual and group rewards (monetary and not), pay for performance schemes, etc. Not all these aspects are discussed in this paper; they are considered in other works of the research group (see for some preliminary analysis *MRP* entry in www.economia.unife.it).

[36] We are aware that any defined threshold of correlation between variables is arbitrary. No theoretically grounded rule exists for assessing what the correct level of correlation across independent variables is.

$$\text{INNOVATION\_INDEXES}_{1998\text{-}2001ji} = \alpha_i + \beta_{1i}(\text{FIRM\_TYPOLOGY\_Variables}_{1998\text{-}2001}) +$$

$$\beta_{2i}(\text{FLEXIBILITY\_Variables}_{1998\text{-}2001}) +$$

$$\beta_{3i}(\text{INDUSTRIAL\_RELATIONS\_Variables}_{1998\text{-}2001}) +$$

$$\beta_{4i}(\text{FIRM\_PERFORMANCES\_Variables}_{1991\text{-}1996}) + \varepsilon_i$$

The seven innovation indexes presented above are used as dependant variables[37]. The β_j, ranging from 1 to 4, obviously stand for vectors of coefficients associated to the set of explanatory variables listed in *table* 10.

The aim of the analysis is twofold: first, we want to assess what determinants appear significant across innovation indexes more often; second, the analysis aims at highlighting what the specific determinants for each specific innovation index are. Both economic theory and previous empirical studies may drive ex ante expectations concerning the signs of coefficients.

The theoretical framework and the empirical literature highlights the significant role, as innovation determinants, of the following firm-specific features: firm size, share of revenue on foreign markets, membership in industrial groups, cooperative-like firm with positive association to better innovative performances, while more pronounced hierarchical structure of the firm could be negative associated to innovation. As far as industrial sectors are concerned, the literature also emphasises sector effects that we try to capture with the Pavitt synthetic dummies for firm industrial orientation (specialised suppliers, scale intensive, resources intensive, labour intensive), method we prefers to the simple list of *n* industrial sectors. Other control variables were used as regressors, such as firm governance, in/out-sourcing, workforce structures, education level, etc., without "a priori" hypotheses.

As far as flexibility is concerned, on the one hand we may expect that innovation is affected by the adoption of labour flexibility in work organizations and labour contracts, that is by the need to acquire this flexibility given relative rigidity in work organizations and in labour utilizations, but on the other hand the management of complex organisational and technological innovations could require stable and long run oriented relationships with workers within the firm. Thus, the expected sign on the set of labour flexibility indexes should be detected on empirical ground. In addition, with reference to the long run flexibility and human capital formation in the firm, we considers indexes of on the job training for employees and newly recruited workers, assuming complementarity between training activities its variety in items, and innovation intensity.

For industrial relations, no univocal suggestion derives from the literature, that on this topic is controversial both on theoretical as well empirical level, though many scientific contributions stress the positive link with innovation practices. In fact, the sole presence of unions is not sufficient as a determinant for innovation: unions with conflictual attitudes may undermine the possibility of adopting innovative strategies, while participative-like unions may favour the adoption. In many cases, moreover, the mere existence of unions may turn out in a stimulus for firms to innovate, given the limited possibility of reducing labour costs for increasing firm competitiveness. Instead, concerning the indexes related to the relationships between management and employees, we expect a clear positive sign, as the literature suggests.

Finally, we also expect firms associated to higher profit performance and firms with high levels of capital market resources to show higher innovation indicators, while lower productivity levels may be directly linked to innovation (innovation is triggered by the need of increasing a low productivity level). A positive sign on the level of investments would suggest a certain degree of complementarity

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[37] The analysis on innovation determinants is different from that presented by Black-Lynch (2001) and Leoni *et al.*, (2003), since it develops on a specific set of innovation indexes, rather that on an index of innovation derived as the residual part from an estimated production function. The two approaches are not comparable, but alternative ways of assessing innovation determinants. Using synthetic indexes of innovation is also an alternative route to the established procedure of using input-based or output based indexes for innovation, like respectively R&D expenses and number of patents. In our framework it is not possible to use a count data model (i.e. counting patents or innovations), given the nature of data on innovation elicited by the survey. We note also that there are problems in using a count index: some patents/innovations, for example, may be worth more than others, thus the relation could not be assumed as linear.

between organisational innovation and physical capital. In addition, these effects could be captured by labour cost variables, (labour cost per employee or labour cost per unit of output).

In all cases a general to specific modelling strategy is used, thus starting with all explanatory variables and reducing the number of relevant parameters by removing the least significant ones at each consequential step (backward stepwise method)[38]. Regression results are shown in *table* 12.1[39]. We now present and comment the outcome of econometric analysis.

9.1 Econometric results

Starting with the first and all-inclusive techno-organization innovation index, INNO_1, we observe the following results. First, the dummy concerning firm size is significant and positive, while only the resource intensive dummy is significant with negative sign (which mirrors and confirms the positive and significant impact of the other three Pavitt dummies, when used). Firm hierarchical structure has instead a negative impact on innovation, as shown by the sign and significance on the associated coefficient. The covariate named outsourcing 1 (outsourcing concerning auxiliary activities) is negatively related to innovation but not significant. The regression is controlled for workforce structure, in terms of blue collar workers, with significant positive sign. Second, among the flexibility variables, the atypical/temporary employment contracts index and the more general synthetic index of labour flexibility are significant at 10% and 1% with a positive coefficient. Plant flexibility is significant at 10% showing a positive sign, and finally the variable associated to the on the job training for employees and newly recruited workers is also positively related at 10% level of significance. Among the industrial relations variables, the indexes of attitudes of management vs. employees, the synthetic index of industrial relations and the index of interactions of management vs. worker representatives concerning innovation are significant at 5%, 10% and 10%, all with a positive coefficient attached. As far as performance indexes are concerned, the ratios net profit/revenue and revenue/employees are positively associated with innovation (5% and 1% levels), while the growth of investment on revenue is significant at 1%, with positive sign.

Finally, we observe that both the Breusch Pagan test and the more general White test show that that heteroskedasticity is not a serious problem which may affect the analysis (this is confirmed for all innovation indexes). Thus, regressions introducing a weighting variable of scale (i.e. number of employee, revenue) correcting for heteroskedasticity are not attempted in this case. The regression is robust referring to both F test, heteroskedasticity tests, R-squared and correlations between covariates.

The literature underlines that fractional variables ranging from zero to one *may* suffer from biases similar to those associated with using OLS procedures in dealing with latent variables (binary)[40]. Thus, a further specification (not reported in *table* 12) was estimated, transforming the dependant variable. Two limit observations were dropped, in order to transform INNO_1 (ranging from 0 to 1) in log terms (INNO_1/1-INNO_1), a variable, which varies over a potential non, limited space. The main outcome is that some coefficients slightly change the associated t ratio, but the ranking of significances is unchanged. When fractional variables are used and limit observations do not constitute a

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[38] As already said, before starting the regression analysis, a preliminary selection was carried out by studying the full correlation matrix concerning covariates. A threshold was fixed at 0.50: above this value of correlation, variables were discarded, keeping the one with the least serious correlation problem overall. The first selection was aimed at reducing the collinearity problem. Then, variables showing a coefficient with associated a t ratio below the value of 1.282 (20%) were dropped at each stage of the econometric analysis. The backward stepwise method may result more consistent with the different biases arising when relevant variables are omitted or irrelevant ones are included: in the former case coefficient are biased, in the second case variances are inflated by using too much information and estimates are less efficient. Thus, the second problem, which we may encounter here in over fitting specifications starting from a conceptual model, is less severe and can be resolved by deleting non-significant variables.

[39] Due to the backward stepwise methodology used, we decided to emphasise mainly coefficients which arise significant at 10%, 5% and 1% (see *, ** and *** in *table* 12.1, and t-statistics in *table* 12.2).

[40] Long (1997), Papke - Woolridge (1996).

large share of observations, the above transformation is nevertheless a useful method for comparing and checking different specifications[41].

The second specification we analyse concerns INNO_TECH, the index that captures the technological innovation content: process, product and quality control. The significance, with positive sign of the coefficient, is confirmed for the dummy concerning firm size. The index named Outsourcing 3 (productive activities out) shows a positive and 5% significant coefficient. The shares of skilled and unskilled blue collars on total employees both show a strongly significant and positive coefficient. The change in hierarchical layers/structure emerges with a positive sign, suggesting that technological innovation intensity is higher just in firms increasing the hierarchical macro-structure. No variables related to short-run and lung-run flexibility arise here significant instead. Labour flexibility, short-term contracts for workers, training activities, emerge as not relevant factors affecting technological innovations. Among the industrial relations variables, we note that the index of interactions of management vs. worker representatives specifically concerning innovations and the index of initiatives of management vs. employees on work organizations are significant at 1 and 5% levels. Five performance variables emerge instead significant: net profit/revenue (positive sign) and value added per employee, both in growth term and mean levels, with negative sign (all at 1% level). The growths of exports and of debt/revenue are both significant at 5%, with positive sign. We might note that the specification, referring to F test, R-squared, and constant term significance, is less robust compared to other specifications.

The third index we analyse, INNO_3, is explained by the following determinants. Establishment size in terms of employees and Pavitt specialise suppliers dummy are both significant (positive, at 10% and 5%). Also the firm hierarchical structure is significant, at 1%, with negative sign. As for INNO_TECH, both the share of specialized blue collars and the share of not specialized blue collars on total employees show a significant positive coefficient (1%). Concerning flexibility and industrial relations determinants, we observe the synthetic index of labour flexibility (positive sign, 5%) and the index of interactions of management vs. worker representatives specifically concerning innovations (positive, 10%). Among performances, the growth of investment per employee, the level of net profit/revenue and revenue per employee are associated to positive signs, while the growth of financial capital index shows a negative sign (this result is more counterintuitive, although no assessed theoretical element could assign an ex ante expectation on the sign). The outcome of INNO_3 confirms what found with INNO_1, adding new marginal information on driving elements, specific to this narrower index of innovation.

The fourth index we have drawn out for the econometric analysis is interesting since it partially changes the perspective. In fact, INNO_5 is an index enclosing only organizational innovations that have a more pronounced participatory characterisation. This means that a sub sample of firms is associated to a zero limit observation (16 out of 113 without any participatory characterisations). For this reason, it could be relevant to compare different methods of specifying the model specification: standard OLS procedure (linear regression), Tobit analysis, and the two-stage Heckman model. The latter model is crucial for assessing whether or not innovation dynamics may be explained by hybrid discrete/continuous phenomenon: first firms take a discrete decision concerning the choice of innovating (a 1/0 choice, examined by a probit analysis), then firms associated to 1 in the first stage decide the amount and degree of innovation content they want to pursue.

The linear regression shows this outcome. The three dummies concerning Pavitt indicators show all positive coefficients, but only LI and SI show statistical significant levels; the share of revenue on national markets, as expected, emerge for the first time here, with negative sign, although only significant at 10%; then, the outsourcing of auxiliary activities is negative with a 5% significance level. In addition, the indexes of firm hierarchical structure and the change in hierarchical layers are both significant with expected negative sign. In this regression, also the presence of the ratio of skilled on unskilled employees[42] is significant, with negative sign, at 10% level. Among the flexibility variables,

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[41] A two limits Tobit analysis was also attempted, without any significant results.

[42] This variable concerns all the workforce: we considers top managers, executives and specialized workers as *skilled*, clerks and not specialized workers as *unskilled*.

we note that atypical/temporary employment contracts index (positive) and on the job training (positive) are also significant explanatory factors. In addition, the indicator of attitudes of management vs. employees and that of interactions between managers and worker representatives on innovation are positively correlated with innovation (the first is more significant nonetheless). As far as performance indicators are concerned, both the growth and the mean level of investment per employee emerge as highly significant, added to the role of net profit growth and of financial capital level, both also positively significant. The role of net investments thus emerges here with stronger relevancy.

As far as the Tobit analysis is concerned, we do not report results. The specification seemed at a first sight less robust: this was proved by a LR test which tested the restriction building on the fact that the Tobit log-likelihood is the sum of the log-likelihood's for the truncated regression and the probit models. The LR test is λ= -2[logTobit –(logProbit + logTrunc)], dof =K parameters (Greene, 2000, p.915). The chi-squared value shows that the null hypothesis is largely rejected: this is a sign of a potential mis-specification due to the Tobit restriction.

Building on that result, we move to the alternative two-stage analysis, as said above. We thus first estimate a probit specification, associating the value 1 to firms with a positive participatory characterisation linked to innovation. Then, the sub-sample of "1" firms are used as sample for the second step, which consists in a OLS specification adding the inverted Mill's ratio as covariate.

Results show that the most significant explanatory factors of innovations are the share of revenue in foreign markets (1% significant and positive, which thus increases its significance with respect to OLS), the cooperative-like nature of the firm (negative), the change in hierarchical layers (negative, 5%), the attitudes of management vs. worker representatives (positive), the index of management initiatives vs. employees in work organizations (positive), the atypical/temporary employment contracts (positive), and on the job training (positive). Significant among performances are instead the mean level of financial capital and net profit growth. Overall, the two-stage procedure leads to a final specification showing a reduced number of explanatory factors. As far as the Mill's ratio is concerned, the final specification shows a t ratio associated to the Mill's ratio coefficient which is significant at 5% level. A sample selection is thus occurring by the participatory characterisation of firms toward innovation; the two-stage model could be performed on a larger dataset of firms, depending on future data availability, to confirm this outcome.

The fifth index of innovation investigated is INNO_PART, which takes into account worker involvement in terms of consultation and delegation in work organizations, that is direct participation. Three highly significant variables are: the index of in-sourcing of productive activities (positive), the share of executives on total employees (negative) and the firm hierarchical structure (negative). No size or sector variables prove to be significant in this regression. Two new determinants, as "individual flexible pay systems and individual evaluation (no necessarily negotiated with trade unions)" and "variety and intensity of on the job training for employees and newly recruited workers", show also a positive and high significant coefficient. These variable prove to be highly associated with procedures of consultation and delegation by management towards employees. In addition, the two indexes of management initiatives vs. employees and interactions with trade unions delegates specifically concerning innovation present robust coefficients and positive signs. It is worth noting that for all mentioned terms the level of significance is 1%. It seems that there is no conflict between direct participations and unions representative involvement in firms where individual and group consultations and delegations procedures are implemented by managers. The two most significant performance indicators are revenue per employee and labour cost per employee (appearing for the first time), respectively associated to positive and negative signs. The growth of net investment and net profit are significant at 5% with positive signs. Summing up, new determinants emerge when considering INNO_PART, and coefficients show very significant t ratios.

The determinants of INNO_REWARDS are, among the first set of variables, the shares of top managers and clerks on total employees (positive and negative signs, 5% and 1%), outsourcing productive activities (positive, 5%), firm hierarchical structure (negative, 10%). Being a resource intensive firm confirms to be detrimental for innovation (1% level). Concerning flexibility and industrial relations, labour service flexibility in work organizations is highly significant with expected negative sign, while management initiatives index and attitudes of management vs. worker representatives in-

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dex are less significant with positive signs. Among performance indicators, we note that the growth of net profit and net investment per employee, and the mean levels of revenue per employee and labour cost/labour productivity ratio are all significant with positive sign, a negative sign is linked instead to the level of net debt.

We finally focus on specifications using as dependant variable the extended index of innovation (INNO_EXT), which incorporates information on a large set of human resource management practices. The index is transformed using the logarithmic procedure discussed for INNO_1 (we do not have limit observations here). Results show that, considering the most exhaustive index of innovative practices, all Pavitt indicators are significant, with positive sign on coefficients. The firm size dummy is also positive and significant. A positive sign associated to statistical significance is also the case for: the index named outsourcing 3 (productive activities out), the shares of both specialized and not specialized blue collars on total employees, and, only case among specifications, education level (the coefficients relating to skills and education are all significant at 1%). All afore mentioned variables are significant at least at 5%. The general index of short run labour flexibility and the labour services flexibility in work organization show expected signs, respectively positive and negative (1% both). The two indexes of attitudes and initiatives of management vs. employees are related to positive and highly significant coefficients, as the index of interactions between management and unions delegates concerning innovations is. The level of net profit/revenue (the most significant), the level of revenue per employee, the growth of net investment per employee, and the level of net debt/revenue are significant performance indicators, respectively associated to positive, negative, positive and positive signs, thus confirming ex ante expectations.

9.2 Summing up

To conclude the section, we may want to sum up what econometric analysis draws out concerning the determinants of innovation activities.

As a general comment, correlations concerning regressors in final specifications never overcome the 0.30 thresholds. Then, as stressed, both the Breusch Pagan test and the more general White test lead to the conclusion that heteroskedasticity is not a problem seriously affecting the data.

The analysis highlights that different specification of innovative practices may present different determinants. Some of those determinants emerge more often across regressions. In absence of a sound analytical model, the theoretical model which links innovation and its determinants should rely first on the quantity and quality of data collected and, then, on an appropriated and robust statistical analysis, which has to adapt to the way innovation is measured.

With regards the four group (A)-(D) variable identify as regressors we stress the following results.

First, the firm size[43] and the Pavitt indicators characterising the productive orientation of the firm emerge as significant elements among the firm typology indicators. The membership to industrial groups emerges once across specifications, as cooperative-like firm, the first with positive sign, and the second with negative sign. Also the share of revenue on national markets proves to be significant, with negative effects on innovation intensity. We note also that the hierarchal structure of the firm and the change in hierarchical layers in the organization macro-structure of the firm seems to negatively affect all kind of innovation, except strictly technological innovations. All coefficients show expected signs, but the last. The outsourcing of auxiliary activities emerge with negative sign, while the other two in/outsourcing indexes, when significant, have a positive sign. As far as skill and education levels are concerned, we note that generally the presence of blue collars seems to be positively associated to innovation, while the presence of large shares of top managers, executives, clerks are a weaker element, and in some cases an adverse factors for innovations.

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[43] Different estimations were realized using a) establishment employees level and b) firm employees level as regressors for firm size. The results show positive effects of these variables on different innovation indexes, in particular in the case of establishment employees level. The relative tables are non reported here. Thus, using level variables instead of size dummies, the dimension emerges as a factor positively affecting the intensity of techno-organizational innovations.

Second, general labour flexibility in terms of employment contracts and the specific atypical/temporary content of employment relations are determinants which seem to enhance innovations. Plant flexibility only once emerges significant; instead the labour services flexibility in work organizations affects innovations, with negative sign: it seems that firms with more rigid labour utilizations in work organizations tend to compensate it with a larger use of flexibility in employment contracts and an higher intensity of organizational innovations to reduce that rigidity in labour utilizations. In addition, the econometric results stresses the relevance of long run flexibility captured by the on the job-training variables: training appears as important as flexibility in employment contracts with respect to innovation intensity.

Third, as far as industrial relations are concerned, regressions show that both the synthetic index of industrial relations and the more specific indexes of attitudes of management vs. employees and vs. worker representatives are significant, as the interactions of management vs. worker representatives on innovations. In addition, the index capturing management initiatives vs. employees on work organizations is also potential determinant of innovations. The effect is not homogenous: depending on the innovation indexes considered, different proxies of industrial relation quality are significant[44]. The econometric results are anyway highly robust in showing a positive and complementary effects on innovation intensity of different modes of interactions between direct and indirect participation within the firm, and of the degree of social dialogue between management and unions delegates.

Finally, performance indicators also affect innovation and depict different linkages. The most common significant indicator across innovation specifications is net profit and net investment per employee (in growth terms). The ratio of revenue/employee and the profit/revenue indexes also positively affect innovation. Instead, the value added per employee is negatively related to innovation both in growth and level terms, in one case. The labour cost per employee and the labour cost per unit of output are also relevant, with negative and positive sign, as expected. The role of financial capital, and net debt on revenue (looking at *table* 12.1), are probably weaker and slightly more ambiguous (although the level of financial capital is highly significant with positive sign in two cases).

Summing up, the distinctive characteristics of innovative firms from the techno-organizational point of view are the following.

1) Innovation processes are associated with firm size: medium and large enterprises show higher indexes of innovations. Dimension gains an important role both in terms of strictly technological innovations (process and product innovations, synthesised by the indexes INNO_1 and INNO_TECH) and, to a greater extent, in terms of organisational innovations and human resources management practices widely conceived (INNO_EXT).

2) Productive and market orientation of the firm is associated with innovative intensity: following the Pavitt categories, specialised suppliers, scale intensive and labour intensive firms show higher indexes of innovation mainly in labour organisation and practices requiring participation and advanced human resources management (INNO_5 and INNO_EXT).

3) Among in/outsourcing indicators, the one concerning *out*-sourcing of productive activities is the most often significant, with positive sign (3 cases): firms with subcontracting for specific productive activities have an higher probability to be innovative in particular in technology (INNO_TECH), flexible systems of compensations (INNO_REWARDS), and in general on organizational innovations (INNO_EXT). In addition we note that in order to be innovative in consultation and delegations procedure toward employees (INNO_PART), *in*-sourcing proves to be relevant instead that *out*-sourcing.

4) International openness of firms, indexed by the ratio of foreign sales over total sales, is connected with organisational innovations of a participatory kind (INNO_5).

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[44] In addition, we note also that a variable of interactions between the index of attitude of management vs. employees and the index of attitude of management vs. worker representatives shows to be significant for INNO_1, INNO_5, INNO_PART, INNO_EXT in particular: this suggests that not only the two different attitudes of management vs. direct and indirect participation in industrial relations are important for innovations, but that these attitudes are characterized by complementary, with respect to innovations. The estimates are not reported here.

5) The most innovative firms are characterised by a low hierarchical macro-structure and also by a reduction of hierarchical layers (INNO_1, INNO_3, INNO_5, INNO_PART, INNO_REWARDS).

6) The share of blue collars workers on total employees seems to affect innovative activities (INNO_1, INNO_TECH, INNO_3, INNO_EXT). The most innovative firms are those with a large share of production workers, as the presence of specialised and non-specialised blue collars seems to be linked to higher innovative practices. At the same time, skills embodied into workers, measured by education level of the workforce, are positive associated to human resource management and organizational innovation in a broader sense (INNO_EXT).

7) Labour flexibility and in particular the degree of flexibility of labour contracts, indexed by the flow of "atypical"[45] contract for new hiring, is positively connected with innovative processes mainly in the organisational realm (INNO_3, INNO_5), and in two cases in conjunction with a relative low labour services flexibility in work organizations (INNO_REWARDS, INNO_EXT). The survey also shows a limited stock of atypical contracts and a marked propensity in the province of Reggio Emilia to transform short term contracts in long term, "typical" contracts. At the same time, the degree of contractual labour flexibility in the employment *stock* is not significant in affecting innovation decision[46]. In the light of these further results, the linkage emerging between short term contracts and innovation processes can be interpreted in two ways. Innovative firms may use short term contracts to increase a relatively low degree of labour services flexibility in work organizations. However, the same kind of contracts is likely to have a second aim, perhaps more important, namely the screening and selection of newcomers' skills and competencies. The importance of the development of skills and competencies for the firm is confirmed by the results obtained for training variable: on the job training for employees and newly recruited workers appears strongly associated to organizational innovations requiring employment involvement and human resources management. Long run flexibility captured by training effort and variety of items in training activity prove to be strongly associated to organizational innovation, employees involvement and participation to work organizations (INNO_1, INNO_5, INNO_PART). Labour flexibility seems to be unimportant only for strictly technological innovations and innovation in compensation systems (INNO_TECH, INNO_REWARDS).

8) The quality of industrial relations, concerning the interactions between management, on one hand, and both union delegates and employees, on the other, are strongly associated with techno-organisational innovations of any kind. Firms aiming at initiating innovative paths realise policies favouring employee participation at the operative, organisational and macro-organisational level. At the same time, they also implement information flows, consultation and negotiation procedures with worker representatives on work organizations, process and product innovations. In the enquired firms, the quality of industrial relations emerges as a key factor supporting techno-organisational innovations and human resources management practices, first and foremost in the areas requiring or allowing worker participation and influence.

9) As far as performance indicators are concerned, various interesting elements emerge.
    1) *First*, innovation processes of all kinds are associated to previous positive results in terms of profitability. The implementation of innovations requires a relevant amount of resources that only better performing firms may be able to afford.
    2) *Second*, access to the credit market seems to be a second key element favouring the introduction of techno-organisational innovations. The level of liabilities and financial market resources are associated to the intensity of organisational (INNO_3, INNO_5) and, to a lesser extent, technological innovations (INNO_TECH).
    3) *Third*, past flow of investments per employee in physical capital is positively associated with innovation requiring employees involvement (INNO_5, INNO_PART), and generally to innovation in organization and compensation systems (INNO_1, INNO_EXT,

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[45] For the sake of understanding, "atypical" contracts can be equated to short term contracts in the most part of instances.

[46] The introduction of this variable does never prove to pass statistical test of significance, in any regression.

INNO_REWARDS): firms with high past investments have an higher propensity to innovate in the organizational realm with worker participation. In this respect, organisational innovations may be complementary with respect to the introduction of new technologies in process and product.

4) *Forth*, past level of productivity is *negatively* associated with innovation processes at least for two modes of innovation, one specific and one general (INNO_TECH and INNO_EXT): the introduction of innovation seems to respond to the necessity to increase productivity levels by upgrading technologies and labour organisation instead of resorting to lay-offs.

5) *Finally*, past labour cost per employee and past labour cost per unit of output prove to be relevant factors affecting firms' decision to innovate. In the first case, an high level of labour cost per unit of output stimulates management to introduce innovations in compensation systems to increase the share of flexible pay (INNO_REWARDS). In the second case, an high rate of growth of labour cost per employee refrains management to introduce work practices involving employees in decision process (through consultation and delegation), which are in the short run usually costly in organizational and financial terms (INNO_PART).

10. Concluding remarks

The analysis highlights a series of interesting results concerning the relationships between techno-organisational innovations on the one hand, industrial relations and firm performance on the other hand.

Though these results, needing deeper future enquire, should not be overstated, it seems reasonable to state that an high level and quality of social dialogue is an important condition for the implementation of new technologies and organisational practices.

The industrial local system of Reggio Emilia emerged as a complex one, primarily characterised by a high degree of dynamics of the system, with important variations and exceptions to this general feature. Innovation intensity is high, driven by managerial initiatives, with an important role played by union delegates and workers in the field of innovative labour organisation. Just the organisational realm is likely to constitute the most suitable field for further fruitful experimentation in the field of worker participation.

The role of industrial relations, together with worker training and other relevant features of the workforce, do have a relevant impact on the organisational structure of the firm, the intensity of its innovative efforts, its ability to benefit from the flexibility of labour services and labour contracts, and, eventually, to accomplish better economic performance.

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APPENDIX

Table 1.1: Total firms

SECTOR	SIZE: no. of employees						
	A 50-99	B 100-249	C 250-499	D 500-999	E > 999	Total (%)	*Total* *(absolute value)*
FOOD (DA)	0,78	1,95	1,17	0,78	0,78	5,45	*14*
OTHER INDUSTRIES (DN)	0,78	0,00	0,00	0,00	0,00	0,78	*2*
PAPER-PUBLISHING (DE)	1,56	0,00	1,17	0,00	0,00	2,72	*7*
CHEMICAL (DG-DH)	3,11	2,72	0,78	0,00	0,39	7,00	*18*
WOOD (DD)	0,00	0,78	0,00	0,00	0,00	0,78	*2*
MACHINERIES (DJ-DM)	28,02	15,95	5,06	2,72	3,50	55,25	*142*
NON-METAL MINERALS (DI)	9,73	6,61	1,95	2,72	0,78	21,79	*56*
TEXTILE (DB-DC)	1,56	1,56	2,72	0,00	0,39	6,23	*16*
Total (%)	45,53	29,57	12,84	6,23	5,84	100,00	
Total (absolute value.)	*117*	*76*	*33*	*16*	*15*		*257*

Table 1.2: Interviewed firms

SECTOR	SIZE: no. of employees						
	A 50-99	B 100-249	C 250-499	D 500-999	E > 999	Total (%)	*Total* *(absolute value)*
FOOD (DA)	0,00	60,00	100,00	100,00	100,00	71,43	10
OTHER INDUSTRIES (DN)	100,00	-	-	-	-	100,00	2
PAPER-PUBLISHING (DE)	75,00	-	100,00	-	-	85,71	6
CHEMICAL (DG-DH)	100,00	71,43	100,00	-	100,00	88,89	16
WOOD (DD)	-	50,00	-	-	-	50,00	1
MACHINERIES (DJ-DM)	73,61	73,17	84,62	85,71	100,00	76,76	109
NON-METAL MINERALS (DI)	68,00	88,24	100,00	100,00	100,00	82,14	46
TEXTILE (DB-DC)	75,00	75,00	28,57	-	100,00	56,25	9
Total (%)	73,50	75,00	78,79	93,75	100,00	77,43	
Total (absolute value.)	86	57	26	15	15		199

Table 1.3: Balance sheet data 1991-1996 on total firms

| SECTOR | SIZE: no. of employees | | | | | | |
	A 50-99	B 100-249	C 250-499	D 500-999	E > 999	Total (%)	Total (absolute value)
FOOD (DA)	0,00	60,00	100,00	50,00	50,00	57,14	8
OTHER INDUSTRIES (DN)	0,00	-	-	-	-	0,00	0
PAPER-PUBLISHING (DE)	50,00	-	100,00	-	-	71,43	5
CHEMICAL (DG-DH)	50,00	28,57	0,00	-	0,00	33,33	6
WOOD (DD)	-	100,00	-	-	-	100,00	2
MACHINERIES (DJ-DM)	51,39	73,17	84,62	57,14	55,56	61,27	87
NON-METAL MINERALS (DI)	52,00	64,71	80,00	42,86	50,00	57,14	32
TEXTILE (DB-DC)	50,00	25,00	28,57	-	100,00	37,50	6
Total (%)	49,57	64,47	69,70	50,00	53,33	56,81	
Total (absolute value.)	58	49	23	8	8		146

Table 1.4: Balance sheet data 1991-1996 and interviews to firm managers on total firms

| SECTOR | SIZE: no. of employees | | | | | | |
	A 50-99	B 100-249	C 250-499	D 500-999	E > 999	Total (%)	Total (absolute value)
FOOD (DA)	0,00	40,00	100,00	50,00	50,00	50,00	7
OTHER INDUSTRIES (DN)	0,00	-	-	-	-	0,00	0
PAPER-PUBLISHING (DE)	25,00	-	100,00	-	-	57,14	4
CHEMICAL (DG-DH)	50,00	14,29	0,00	-	0,00	27,78	5
WOOD (DD)	-	50,00	-	-	-	50,00	1
MACHINERIES (DJ-DM)	34,72	56,10	69,23	42,86	55,56	45,77	65
NON-METAL MINERALS (DI)	36,00	52,94	80,00	42,86	50,00	46,43	26
TEXTILE (DB-DC)	50,00	25,00	14,29	-	100,00	31,25	5
Total (%)	35,04	48,68	60,61	43,75	53,33	43,97	
Total (absolute value.)	41	37	20	7	8		113

Table 1.5: Firm performance, 1991-1996, annual average

Firms	All firms	Only firm with management interviews
Number of firms	146	113
Firm performance		
ROE Return on equity	0,093	0,092
ROI Return on investment	0,082	0,081
Leverage	4,923	4,820
Gross operative margin / revenue	0,120	0,121
Labour cost per employee	58,478	58,148
Net profits / revenue	0,021	0,020
Net capital per employee	92,231	99,822
Gross investments per employees	141,597	148,815
Value added per employee	97,848	99,854
Revenue per employee	342,468	353,696
Net debt / Revenue	0,187	0,189
Net investment per employees	105,600	118,282
Net investment / revenue	0,297	0,315
Export share on revenue	0,306	0,300

Table 2: Economic performance since 1998

Indicators	Percent				Synthetic Index
	decrease	stable	increase	Na	[-1, +1]
- Production	7,54	17,09	75,38	0,00	0,678
- Sales	8,54	11,06	79,40	1,01	0,716
- Investments	3,02	17,09	79,40	0,50	0,768
- Employment	14,57	19,60	65,33	0,50	0,510
- Profits	14,57	40,20	43,72	1,51	0,296
- Liabilities	27,64	55,28	14,57	2,51	0,134
Total	*10,05*	*7,54*	*81,91*	*0,50*	*0,518*

Table 3: Formalised division and hierarchical structure

Firm structure		average		st. dev.	
Formalised firm divisions		10,49		2,894	
Hierarchic structure	decrease	stable		increase	index
Changes in the number of divisions since 1998	3,02	38,69		58,29	0,553
	no			yes	
Hierarchy among division (firm direction excluded)	51,76			48,24	
	average			st. dev.	
No. of hierarchical layers	2,834			1,077	
No. of hierarchical layers (only firms with at least three layers)	3,729			0,923	
Ratio of number of hierarchical layers to number of formalised divisions (hierarchy ratio)	0,289			0,137	
	decrease	stable		increase	index
Change in the no. of hierarchical layers	4,02	79,40		16,58	0,126
Change in hierarchy ratio	12,56	66,83		20,60	0,080

Table 3.1: No. of formalised divisions and hierarchic layers (%)

Change in the no. of hierarchical layers	Change in the no. of divisions				
	Decrease	Stable	Increase	Total	*No of firms*
Decrease	1,01	2,51	0,50	4,02	*8*
Stable	2,01	36,18	41,27	79,40	*158*
Increase	0,00	0,00	16,58	16,58	*33*
Total	3,02	38,69	58,29	100,00	
No of firms	*6*	*77*	*116*		*199*

Table 3.2: Hierarchic structure and hierarchic kevel (%)

Change in the no. of hierarchical layers	Change in hierarchic structure				
	Decrease	Stable	Increase	Total	*No of firms*
Decrease	3,52	0,50	0,00	4,02	*8*
Stable	8,04	65,32	6,03	79,40	*158*
Increase	1,01	1,01	14,57	16,58	*33*
Total	12,56	66,83	20,60	100,00	
No of firms	*25*	*133*	*41*		*199*

Table 3.3: Number of divisions and hierarchic structure (%)

Change in the no. of divisions	Change in hierarchic structure				
	Decrease	Stable	Increase	Total	*No. of firms*
Decrease	1,51	1,51	0,00	3,02	*7*
Stable	4,02	33,67	1,01	38,69	*77*
Increase	7,04	31,66	19,60	58,29	*116*
Total	12,56	66,83	20,60	100,000	
No. of firms	*25*	*133*	*41*		*199*

Table 4.1: Innovations in working hours regimes

Flexibility in working hours regimes	Yes	No
Innovations since 1998	36,18	63,82
Innovative modalities	Yes	No
Work shift (double, triple, etc…)	70,83	29,17
Annual "bank" of work hours	20,83	79,17
Working time reduction	34,72	65,28
Flexibility regimes (weekly, annual, etc…)	23,61	76,39
Work on Saturday and Sunday	23,61	76,39
Time entry/exit flexibility	31,94	68,06
Worker availability on request	26,39	73,61
Horizontal and/or vertical part time	29,17	70,83
Other	1,39	98,61
	index (0-1)	stand. dev.
Index, introduction of work hours flexibility	0,106	0,171
Index, introduction of work hours flexibility (only innovative firms)	0,292	0,164
Proposing party	Yes	no
Firm managers	86,11	13,89
Worker representatives	31,94	68,06
Joint committees	11,11	88,89
Groups of workers	11,11	88,89
Total of non managerial parties	50,00	50,00

Table 4.2: Innovation in working hours regimes and flexibility

Indexes	Index of flexibility		*Total of firms (abs. val.)*
Innovations in working hours regimes	Plant technologies	Labour services	
No	0,382	0,413	*127*
Yes	0,326	0,403	*72*
Total of firms	0,362	0,410	*199*

Table 5.1: Organisational practices

Organisational practices: present or adopted	Yes	No	Year of introductions (average)	% of involved workers in firms with organisational practices	Stand. Dev.
Team work	29,65	70,35	1993	50,85	33,375
Quality circles	12,06	87,94	1994	35,68	34,630
Just in time	13,07	86,93	1991	63,46	34,548
Job rotation	32,16	67,84	1991	35,70	23,798
Total quality management	45,73	54,27	1995	59,74	40,976
Other	1,52	98,48	2001	26,67	16,073
No organisational practices present or adopted	32,66	67,34			

Table 5.2: Modalities of team work

Operative modalities of teams	Yes	No
Team members appoint their chief	8,47	91,53
Team members decide together how their tasks should be performed	57,63	42,37
Teams are responsible for specific products or services	84,75	15,25
Individual team members are responsible for specific products or services	59,32	40,68
Index: operative modalities of team work (index, stand. dev.)	*0,525*	*0,231*
Team work rewards	Yes	No
No reward	16,67	83,33
Economic reward	53,33	46,67
Career advancement	55,00	45,00
Training	23,33	76,67
Other	1,67	98,33
Index: team work reward (index, stand. dev.)	*0,439*	*0,285*
Employee suggestions	Yes	No
The existence of team work notwithstanding, are there channels tapping suggestions concerning work methods?	76,88	23,12
If the answer is yes, are there economic rewards?	37,91	62,09

Table 6.1: Changes since 1998 and their proponents

Changes introduced	Introduced	Top management	Worker representatives	Joint committes	Employees	Total non managerial
1. Remuneration systems	41,71	66,27	24,10	16,87	7,23	48,19
2. New technologies	73,37	94,52	2,05	4,79	7,53	13,01
3. Innovation in work hours regimes	36,18	86,11	31,94	11,11	11,11	50,00
4. Work organisation	69,35	89,13	5,80	13,77	16,67	34,78
5. New products and services	75,38	94,67	1,33	5,33	6,00	12,67
6. Introduction of team work	28,64	77,19	5,26	19,30	14,04	36,84
7. Total quality management	50,00	94,95	7,07	6,06	5,05	18,18
8. Job rotation	50,25	73,00	16,00	15,00	14,00	45,00
9.Increased individual and group autonomy in problem solving	39,20	75,64	6,41	12,82	26,92	44,87
10. Structured channel for suggestions from workers to managers on organisational themes	23,62	57,45	23,40	23,40	23,40	65,96
11. Structured channel for suggestions from workers to managers on product quality	30,15	55,00	10,00	26,67	26,67	58,33
12. Life-long training programmes	45,73	82,42	8,79	14,29	14,29	35,16
13. Definition of objectives for teams of workers and individual workers	35,68	90,14	8,45	7,04	11,27	26,76
14. Increase in the number of and distance between hierarchical ladders	9,55	100,00	0,00	0,00	5,26	5,26
15. Other	1,01	100,00	0,00	50,00	0,00	50,00
Total	97,99	97,95	32,31	31,79	33,85	68,21

Table 6.2: Worker training and techno-organisational change

As a consequence of techno-organisational change, did you need to intervene on workers' skills by means of training or new enrolment?	Yes	No
Training		
Realised training activity	85,43	14,57
Work side by side	47,74	52,26
On-the-job training	66,33	33,67
Off-the-job training	47,74	52,26
Hiring of new personnel		
Hiring	61,31	38,69
Hiring of personnel with new competencies	53,77	46,23
If training level for employees increased since 1998, what have been the reasons ?	Technical reasons (technological change)	Functional reasons (change in required competencies)
Top managers	24,20	31,21
Executives	34,72	39,58
Clerks	58,29	41,71
Skilled workers	66,30	28,80
Unskilled workers	49,43	22,16
Total	76,88	57,79

Table 6.3: Technological innovations, in product, process and quality control

Typologies	Yes	No
Technological innovations, in product, process and quality control	*95,48*	*4,52*
Product innovations	67,84	32,16
Process innovations	66,83	33,17
Quality control innovations in process and/or product	52,76	47,24
	Index	*Stand. Dev.*
Synthetic index INNO_TECH	*0,625*	*0,292*

Table 6.4: Innovation indexes

Innovation vs. firm size	50-99	100-249	250-499	500-999	>999	Total	% firms without innovations
INNO Team work	0,326	0,246	0,269	0,267	0,400	0,296	70,35
INNO Quality circles	0,093	0,105	0,192	0,067	0,267	0,121	87,94
INNO Just in time	0,105	0,105	0,192	0,200	0,200	0,131	86,93
INNO Job rotation	0,267	0,316	0,423	0,400	0,400	0,322	67,84
INNO Total quality management	0,442	0,456	0,500	0,467	0,467	0,457	54,27
INNO NO organisational practices	0,291	0,368	0,346	0,333	0,333	0,327	32,66
INNO_1 Total innovations	0,393	0,463	0,586	0,513	0,574	0,461	2,01
INNO_2 New technologies and product/services	0,680	0,763	0,904	0,667	0,833	0,744	11,06
INNO_3 Work organisation	0,412	0,456	0,577	0,533	0,587	0,468	6,53
INNO_4 Work organisation and worker participation	0,343	0,398	0,535	0,500	0,513	0,409	4,02
INNO_5 Innovations only with worker participation	0,292	0,341	0,489	0,495	0,486	0,362	18,09
INNO_6 Payment systems	0,314	0,509	0,462	0,333	0,667	0,417	58,29
INNO_7 (managerial proposals)	0,286	0,352	0,472	0,316	0,382	0,338	4,02
INNO_8 (worker representatives proposals)	0,022	0,049	0,056	0,071	0,044	0,040	63,34
INNO_9 (joint committees proposals)	0,034	0,028	0,064	0,120	0,102	0,048	68,84
INNO_10 (worker proposals)	0,065	0,043	0,059	0,031	0,031	0,052	66,83
INNO_11 (proposals without managerial intervention)	0,112	0,117	0,172	0,218	0,173	0,134	33,17
INNO_TECH (process, product, quality)	0,593	0,626	0,718	0,711	0,556	0,625	4,52

Table 6.5: Employee formal evaluation and flexible pay systems

Presence of formal evaluation	Yes	No
Top managers	40,65	59,35
Executives	49,30	50,70
Clerks	39,09	60,91
Skilled manual workers	31,87	68,13
Unskilled manual workers	31,61	68,39
Total	54,31	45,69
Objectives for formal evaluation (if present)	Yes	No
1. Job promotions and transfers	44,86	55,14
2. Information on worker results and competencies	31,78	68,22
3. Determination of wage increases and bonuses	81,31	18,69
4. Setting of training procedures and competences development	38,32	61,68
5. Evaluation of the gap between realised and programmed results	43,93	56,07
6. Stimulate work effort	59,81	40,19
7. Other objectives	1,87	98,13
Presence of bonuses/individual incentives	Yes	No
	74,87	25,13
Involved employees (%)	Involved in % of firms	% of employees in the case of "Yes"
Top managers	85,12	76,55
Executives	89,47	68,82
Clerks	85,71	38,04
Skilled manual workers	59,26	26,56
Unskilled manual workers	36,15	17,54
Total	54,31	43,94
Introduction of financial participation (distribution of stocks and bonds, stock options, etc…)	Present or to be introduced in the near future	No
	4,05	95,95
Introduction of collective variable compensation negotiated with unions delegates (Performance Related Pay, PRP)	Yes	No
	71,36	28,64

Table 6.6: Worker evaluation and bonuses by firm size (index 0-1)

Forms of evaluation and flexible compensations / Firm size	50-99	100-249	250-499	500-999	> 999	Total
Involved employees in formal evaluation (0-6)*	1,791	1,877	2,040	3,714	2,533	2,041
Objectives of formal evaluation: organisational	0,434	0,383	0,500	0,455	0,458	0,435
Objectives of formal evaluation: non-economic rewards	0,395	0,400	0,500	0,636	0,500	0,449
Objectives of formal evaluation: economic rewards	0,737	0,800	0,875	0,909	0,917	0,813
Objectives of formal evaluation: mix of incentives	0,596	0,611	0,604	0,667	0,694	0,620
Presence of individual bonuses and rewards	0,651	0,807	0,846	0,667	1,000	0,749
Individual bonuses and rewards: employees involved (%)	44,12	39,81	47,35	40,49	53,17	43,94
Bonus/rewards determined in a discretional manner	0,214	0,283	0,217	0,200	0,333	0,247
Introduction of financial participation (shares, bonds, stock options)	0,023	0,018	0,077	0,071	0,333	0,056
Negotiation of flexible wages (Performance Related Pay, PRP)	0,628	0,737	0,769	0,733	1,000	0,714
Index INNO_REWARDS	0,287	0,324	0,373	0,400	0,511	0,334

Note: * index varying from 6 to 0 as % of total employees: 6) 100%; 5) 80-99%; 4) 60-79%; 3) 40-59%; 2) 20-39%; 1) 1-19%; 0) none.

Table 7.1: Correlations, innovation indexes and firm characteristics

	Index formal division HRM	Index formal division HRM (qualitative)	No. Hierarchical levels	Ratio hierarchical levels to no. of divisions	Change in hierarchic structure	Index: flexibility of plant technology	Index: flexibility of labour services
INNO Team work	0,156	0,168	-0,233	-0,070	-0,020	0,063	0,048
INNO Quality circles	0,132	0,128	0,063	-0,139	-0,216	0,097	-0,016
INNO Just in time	0,147	0,163	-0,233	-0,082	-0,058	0,134	-0,031
INNO Job rotation	0,188	0,174	-0,128	-0,132	-0,140	0,050	-0,007
INNO Total quality management	0,143	0,127	-0,203	-0,111	-0,031	0,125	0,040
INNO NO organisational practices	-0,112	-0,111	0,285	0,147	0,083	-0,075	-0,022
INNO_1 Total innovations	0,315	0,298	-0,152	-0,167	-0,002	0,162	0,024
INNO_2 New technologies and product/services	0,005	-0,010	-0,039	-0,164	0,035	0,099	0,030
INNO_3 Work organisation	0,268	0,276	-0,263	-0,161	-0,035	0,177	0,085
INNO_4 Work organisation and worker participation	0,316	0,304	-0,149	-0,137	-0,108	0,212	0,074
INNO_5 Innovations only with worker participation	0,329	0,316	-0,127	-0,118	-0,118	0,164	0,061
INNO_6 Payment systems	0,175	0,164	-0,122	-0,130	0,123	-0,001	-0,198
INNO_7 (managerial proposal proposals s)	0,278	0,256	-0,079	-0,171	0,041	0,177	0,005
INNO_8 (worker representatives proposals)	0,169	0,149	-0,079	0,050	-0,036	0,032	0,074
INNO_9 (joint committees proposals)	0,106	0,126	-0,070	-0,070	-0,167	-0,009	0,056
INNO_10 (worker proposals)	-0,059	-0,068	-0,044	-0,046	0,030	0,074	0,124
INNO_11 (proposals without managerial intervention)	0,124	0,119	-0,102	-0,053	-0,113	0,068	0,181
INNO_TECH (process, product, quality)	0,207	0,194	0,197	0,008	-0,039	0,181	0,089

Table 7.2: Correlations, innovation indexes

	INNO teamwork	INNO quality circles	INNO just in time	INNO job rotation	INNO total quality management	INNO NO innovation	INNO_1 Total innovations	INNO_2 New technologies and product/services	INNO_3 Work organisation	INNO_4 Work organisation and worker participation	INNO_5 Innovations only with worker participation	INNO_6 Payment systems	INNO_7 (managerial proposals)	INNO_8 (worker representatives proposals)	INNO_9 (joint committees proposals)	INNO_10 (worker proposals)	INNO_11 (proposals without managerial intervention)	INNO_TECH (process, product, quality)
INNO Teamwork	1,000	0,131	0,173	0,236	0,133	-0,452	0,356	0,148	0,534	0,416	0,382	0,031	0,278	0,202	0,151	0,117	0,269	0,068
INNO Quality circles		1,000	0,085	0,208	0,218	-0,258	0,209	0,074	0,177	0,242	0,198	0,062	0,253	0,108	0,008	-0,039	0,053	0,124
INNO Just in time			1,000	0,244	0,273	-0,270	0,191	-0,015	0,197	0,163	0,144	0,126	0,213	0,138	0,003	-0,089	0,025	0,073
INNO Job rotation				1,000	0,318	-0,480	0,343	0,122	0,450	0,381	0,326	0,029	0,318	0,155	0,060	0,155	0,244	0,161
INNO Total quality management					1,000	-0,639	0,345	0,201	0,427	0,320	0,199	0,062	0,367	0,129	-0,059	0,042	0,081	0,294
INNO NO organisational practices						1,000	-0,284	-0,136	-0,525	-0,335	-0,228	0,019	-0,278	-0,073	-0,043	-0,137	-0,159	-0,182
INNO_1 Total innovations							1,000	0,533	0,752	0,893	0,782	0,472	0,867	0,327	0,224	0,233	0,481	0,348
INNO_2 New technologies and product/services								1,000	0,410	0,311	0,169	0,112	0,557	0,073	0,002	0,123	0,149	0,412
INNO_3 Work organisation									1,000	0,779	0,598	0,188	0,669	0,178	0,185	0,170	0,337	0,354
INNO_4 Work organisation and worker participation										1,000	0,924	0,267	0,733	0,324	0,269	0,273	0,524	0,291
INNO_5 Innovations only with worker participation											1,000	0,227	0,587	0,340	0,318	0,253	0,545	0,173
INNO_6 Payment systems												1,000	0,418	0,251	0,053	-0,037	0,145	-0,030
INNO_7 (managerial proposals)													1,000	0,259	-0,138	0,189	0,206	0,374
INNO_8 (worker representatives proposals)														1,000	-0,036	-0,091	0,452	0,022
INNO_9 (joint committees proposals)															1,000	0,025	0,579	0,060
INNO_10 (worker proposals)																1,000	0,615	0,149
INNO_11 (proposals without managerial intervention)																	1,000	0,166
INNO_TECH (process, product, quality)																		1,000

Table 7.3: Correlations, innovation indexes and some firm features

	Employees, firm	Employees, plant	Sales	Percent national sales	Percent foreign sales	Firm typology	Performance production 98-01	Performance sales 98-01	Performance investments 98-01	Performance employment 98-01	Performance profits 98-01	Performance liabilities 98-01
INNO Teamwork	-0,036	0,096	0,024	-0,201	0,189	0,126	-0,019	-0,046	-0,007	-0,031	0,045	-0,138
INNO Quality circles	0,123	0,172	0,155	-0,004	0,014	0,216	0,120	0,117	0,082	-0,026	0,042	-0,127
INNO Just in time	0,049	0,148	0,016	-0,011	0,021	0,083	0,033	0,034	0,062	0,015	0,112	-0,176
INNO Job rotation	0,003	0,164	0,072	-0,098	0,084	0,143	0,046	0,047	0,058	-0,046	0,041	-0,108
INNO Total quality management	-0,025	0,131	0,024	-0,047	0,045	0,008	-0,012	0,010	0,148	0,091	0,077	-0,129
INNO NO Organisational practices	0,028	-0,040	0,033	0,160	-0,166	-0,066	0,034	0,008	-0,042	-0,017	-0,034	0,183
INNO_1 Total innovations	0,178	0,352	0,245	-0,101	0,103	0,168	0,089	0,031	0,104	0,024	0,191	-0,107
INNO_2 New technologies and product/services	0,076	0,190	0,001	-0,109	0,125	0,110	0,014	-0,038	0,088	0,020	0,066	-0,209
INNO_3 Work organisation	0,083	0,268	0,160	-0,154	0,150	0,143	0,019	-0,020	-0,022	-0,047	0,083	-0,115
INNO_4 Work organisation and worker participation	0,158	0,332	0,257	-0,125	0,117	0,190	0,073	0,015	0,061	-0,036	0,161	-0,086
INNO_5 Innovations only with worker participation	0,273	0,315	0,285	-0,131	0,121	0,212	0,031	-0,029	0,045	-0,072	0,108	-0,034
INNO_6 Payment systems	0,170	0,182	0,073	-0,023	0,019	-0,009	-0,005	0,039	0,069	-0,019	0,108	0,030
INNO_7 (managerial proposals)	0,078	0,306	0,073	-0,101	0,099	0,173	0,108	0,103	0,148	0,038	0,204	-0,115
INNO_8 (worker representatives proposals)	0,100	0,164	0,086	-0,155	0,156	0,081	0,039	-0,043	0,069	-0,072	0,025	-0,024
INNO_9 (joint committees proposals)	0,215	0,247	0,393	-0,019	0,032	0,101	0,041	-0,043	0,002	0,053	0,039	0,027
INNO_10 (worker proposals)	-0,043	-0,027	-0,037	0,005	-0,003	-0,049	0,076	0,056	0,043	0,146	0,113	-0,040
INNO_11 (proposals without managerial intervention)	0,162	0,231	0,275	-0,074	0,083	0,073	0,097	-0,005	0,077	0,091	0,108	-0,016
INNO_TECH (process, product, quality)	-0,101	0,207	0,095	-0,069	0,078	0,067	0,009	-0,005	0,171	0,057	0,028	-0,219

Table 7.4: Correlations, innovation indexes and some features of employment

	Employment and labour contracts, index	Employment and education level, index	Change in total employment	Change in 'atypical' employment
INNO Teamwork	0,034	0,085	-0,037	0,042
INNO Quality circles	-0,191	0,093	0,015	0,081
INNO Just in time	-0,091	0,190	0,030	0,022
INNO Job rotation	-0,084	-0,089	0,011	0,160
INNO Total quality management	-0,223	0,028	0,061	0,143
INNO NO Organisational practices	0,158	-0,037	0,008	-0,144
INNO_1 Total innovations	-0,044	0,108	0,043	0,262
INNO_2 New technologies and product/services	0,041	-0,109	0,100	0,047
INNO_3 Work organisation	-0,023	-0,004	0,018	0,174
INNO_4 Work organisation and worker participation	0,007	0,125	-0,007	0,271
INNO_5 Innovations only with worker participation	0,046	0,126	-0,059	0,252
INNO_6 Payment systems	-0,092	0,122	-0,050	0,183
INNO_7 (managerial proposals)	-0,054	0,050	0,086	0,152
INNO_8 (worker representatives proposals)	0,053	0,068	0,017	0,142
INNO_9 (joint committees proposals)	-0,022	0,075	-0,012	0,130
INNO_10 (worker proposals)	-0,011	0,027	0,127	-0,004
INNO_11 (proposals without managerial intervention)	0,004	0,100	0,102	0,131
INNO_TECH (process, product, quality)	-0,129	-0,036	0,067	0,018

Table 8.1: Correlations, innovation indexes and industrial relations

Innovations vs. Information, consultation and negotiation on organizational innovations	Index interaction management/ worker representatives	Management / worker representatives (qualitative)	Information	Consultation	Negotiation
INNO Team work	0,138	0,141	0,108	0,091	0,128
INNO Quality circles	0,036	0,029	0,065	-0,013	0,028
INNO Just in time	-0,002	0,000	-0,003	-0,007	0,009
INNO Job rotation	0,069	0,055	0,100	0,023	0,026
INNO Total quality management	0,050	0,035	0,107	-0,023	0,022
INNO NO Organisational practices	-0,045	-0,047	-0,094	0,069	-0,093
INNO_1 Total innovations	0,279	0,232	0,330	0,183	0,090
INNO_2 New technologies and product/services	0,094	0,075	0,141	0,027	0,036
INNO_3 Work organisation	0,229	0,202	0,263	0,125	0,122
INNO_4 Work organisation and worker participation	0,280	0,229	0,336	0,190	0,075
INNO_5 Innovations only with worker participation	0,289	0,241	0,324	0,215	0,085
INNO_6 Payment systems	0,076	0,056	0,113	0,038	0,007
INNO_7 (managerial proposals)	0,224	0,184	0,264	0,158	0,060
INNO_8 (worker representatives proposals)	0,106	0,095	0,063	0,143	0,023
INNO_9 (joint committees proposals)	0,120	0,105	0,156	0,039	0,074
INNO_10 (worker proposals)	-0,107	-0,106	-0,063	-0,114	-0,067
INNO_11 (proposals without managerial intervention)	0,093	0,074	0,119	0,056	0,022
INNO_TECH (process, product, quality)	0,227	0,201	0,218	0,190	0,092

Table 8.2: Interaction between management and worker representatives on techno-organisational innovation, and indexes of techno-organisational innovation

Indexes: techno-organisational innovations	Index industrial relations less than the average	Index industrial relations more than the average
INNO_1 Total innovations	0,432	0,534
INNO_2 New technologies and product/services	0,734	0,755
INNO_3 Work organisation	0,430	0,541
INNO_4 Work organisation and worker participation	0,372	0,496
INNO_5 Innovations only with worker participation	0,321	0,471
INNO_6 Payment systems	0,429	0,471
INNO_7 Innovation introduced by managerial initiative	0,319	0,384
INNO_11 Innovation introduced by initiative of subjects different from management	0,122	0,153
INNO_TECH (process, product, quality)	0,585	0,725

Table 9.1: Forms of consultation and delegation in production

	CONSULTATION IN DECISIONAL PROCESSES	DECISIONAL DELEGATION
INDIVIDUAL LEVEL	*6 ITEMS*	*4 ITEMS*
	Channels for employee suggestions	
	Structured modalities of suggestions on production	Non-hierarchical characteristics in team work
	Structured modalities of suggestions on quality	Presence of job rotation
	Initiatives of individual involvement	Introduction of job rotation
	Enquires on organisational climate	Non-hierarchical employee evaluation
	Formal evaluation of employees	
GROUP LEVEL	*5 ITEMS*	*10 ITEMS*
		Subject involved in quality control
		Presence of team work
	Initiatives for involvement of teams	Non-hierarchical features of team work
	Presence of quality circles	Presence of total quality management
	Presence of team work	Introduction of team work
	Hierarchical features of team work	Introduction of total quality management
	Introduction of team work	Increased autonomy for work teams
		Objectives of team work
		Certification of quality control
		Initiatives of work teams involvement

Table 9.2: Consultation and delegation in decisional processes: employee direct participation

Typologies of direct participation	Yes	No	No. of practices	Maximum no. of adopted practices	Maximum percentage of practices	Synthetic index of diffusion (0-1)	Stand. Dev.
Individual consultation	92,46	7,54	6	4	66,67	0,289	0,162
Group consultation	53,77	46,23	5	4	80,00	0,201	0,223
Individual delegation	59,80	40,20	4	3	75,00	0,232	0,233
Group delegation	95,98	4,02	10	6	60,00	0,303	0,155

Table 9.3: Interaction between management and worker representatives on innovation versus consultation and delegation practices

Index	Consultation		Delegation	
Item	individual	group	individual	group
0	0,231	0,296	0,306	0,333
1	0,323	0,376	0,389	0,333
2	0,367	0,352	0,365	0,333
3	0,368	0,467	0,361	0,314
4	0,542	0,667	Absent	0,357
5	Absent	Absent		0,406
6	Absent			0,400
7				Absent
8				Absent
9				Absent
10				Absent
Average	0,348	0,348	0,348	0,348

Table 9.4: Index of industrial relations versus consultation and delegation practices

Index	Consultation		Delegation	
Item	individual	group	individual	group
0	0,274	0,348	0,323	0,306
1	0,361	0,361	0,391	0,357
2	0,353	0,353	0,397	0,335
3	0,393	0,428	0,412	0,335
4	0,540	0,727	Absent	0,391
5	Absent	Absent		0,407
6	Absent			0,440
7				Absent
8				Absent
9				Absent
10				Absent
Average	0,365	0,365	0,365	0,365

Table 9.5: Worker consultation and delegation practices in work organization, by firm size *(index 0-1)*

Consultation and delegation in work organizations	50-99	100-249	250-499	500-999	> 999	Total
Index INNO_PART	0,243	0,244	0,286	0,296	0,283	0,256
Individual consultation	0,267	0,269	0,346	0,367	0,311	0,289
Group consultation	0,195	0,186	0,215	0,227	0,240	0,201
Individual delegation	0,215	0,228	0,260	0,250	0,267	0,231
Group delegation	0,295	0,293	0,323	0,340	0,313	0,303

Table 10: The set of explanatory variables used in regressions

	Variables	Type
A	*Firm typology*	
A.1	Firm size	Dummy (1=more than 249 employees, 0 otherwise)
A.2	Establishment size	Dummy (1=more than 249 employees, 0 otherwise)
A.3	Firm employees level	Continuos
A.4	Establishment employees level	Continuos
A.5	Revenue	Continuos
A.6	Productive orientation à la Pavitt (labour intensive LI, resource intensive RI, specialized suppliers SS, scale intensive SI)	4 Dummies
A.7	Sectoral codes (two digits)	Dummy
A.8	Industrial group membership; cooperative firms/cooperative group	2 Dummies
A.9	Firm governances (owner, owner-managers, managers)	Dummy
A.10	Share of revenue on domestic markets, on foreign market	Continuos 0 1
A.11	Share of revenue from market, from subcontracting	Continuos 0 1
A.12	Firm hierarchical structure	Continuos 0 1
A.13	Change in hierarchical layers / structures	Continuos –1 +1
A.14	In/Out-sourcing 1 (auxiliary activities out), 2 (productive in), 3 (productive out)	Continuos 0 1
A.15	Share top managers / total employees	Continuos 0 1
A.16	Share executives / total employees	Continuos 0 1
A.17	Share clerks / total employees	Continuos 0 1
A.18	Share specialized blue collars / total employees	Continuos 0 1
A.19	Share not specialized blue collars / total employees	Continuos 0 1
A.20	Share skilled / unskilled employees	Continuos 0 1
A.21	Employees education level	Continuos 0 1
B	*Flexibility in production process and labour services*	
B.1	Plant flexibility	Continuos 0 1
B.2	Labour services flexibility in work organizations	Continuos 0 1
B.3	Flexibility of employment contracts for the stock of employees	Continuos 0 1
B.4	Trend in atypical/temporary employment contracts for hiring	Continuos 0 1
B.5	Synthetic index of labour relation flexibility	Continuos 0 1
B.6	Synthetic index of labour flexibility	Continuos 0 1
B.7	Individual flexible pay systems and individual evaluation	Continuos 0 1
B.8	On the job training for employees and newly recruited workers	Continuos 0 1
B.9	Variety and intensity of on the job training for employees and newly recruited workers	Continuos 0 1

C	Industrial relations	
C.1	Attitudes of management vs. employees [1]	Continuos 0 1
C.2	Management initiatives vs. employees in work organizations	Continuos 0 1
C.3	Attitudes of management vs. worker representatives [2]	Continuos 0 1
C.4	Interactions of management vs. worker representatives [2] concerning innovations (information, consultation, negotiation)	Continuos 0 1
C.5	Interactions of attitudes of management vs. employees and of management vs. worker representatives	Continuos 0 1
C.6	Synthetic index of industrial relations (management vs. unions' delegates)	Continuos 0 1
D	Performance variables [3]	
D.1	Net profit (g)	Continuos
D.2	Net profit / revenue (g,m)	Continuos
D.3	Value added per employee (g,m)	Continuos
D.4	Revenue per employee (g,m)	Continuos
D.5	Export goods and services (g)	Continuos
D.6	Labour cost per employee (m)	Continuos
D.7	Labour cost per unit of output (m): (Labour cost / labour productivity)	Continuos
D.8	Net Investments per employee (g,m)	Continuos
D.9	Financial capital (market resources) [4] (g,m)	Continuos
D.10	Net debt/revenue (g,m)	Continuos

Note to table 10:

1) *No involvement, information, consultation;*
2) *No involvement, information, consultation, negotiation;*
3) *We recall that performance indicators were introduced both as mean indicators of absolute levels (labelled m) and as growth of performance indexes (labelled g), both calculated over the period 1991-1996. Those listed in table A are the ones used for econometric analysis. The analysis of the correlation matrix was used as a preliminary step to select the subset of performance indexes drawn out of the full available set.;*
4) *We introduced only one index of capital out of the many available, given the high degree of correlation observed among capital indexes (financial capital indexes).*

Table 11: Dependent variables, basic statistics

DEPENDENT VARIABLES	INNO_1 (tech.-org.) (1)	INNO_TECH (1)	INNO_3 (labour org.) (1)	INNO_5 (labour org. with worker part.) (1)	INNO_PART (worker cons.-deleg.) (1)	INNO_REWARDS (1)	INNO_EXT (gru-tech.-org.) (1)
Total sample, 199 firms, mean value	0,461	0,625	0,468	0,362	0,256	0,334	0,490
Total sample, 199 firms, stand. dev.	*0,214108*	*0,291922*	*0,254560*	*0,264263*	*0,144578*	*0,190080*	*0,123934*
Partial sample, 113 firms, mean value	0.474	0.628	0.478	0.373	0.253	0.353	0.497
Partial sample, 113 firms, stand. dev.	*0.196090*	*0.291249*	*0.244122*	*0.244795*	*0.139402*	*0.171922*	*0.121065*

Table 12.1: Regression results: coefficients

DEPVAR	INNO_1 (tech.-org.) (1)	INNO_TECH (1)	INNO_3 (labour org.) (1)	INNO_5 (labour org. with worker part.) (1)	INNO_5 (labour org. with worker part.) (2)	INNO_PART (worker cons.-deleg.) (1)	INNO_REWARDS (1)	INNO_EXT (gru-tech.-org.) (1)
Constant	-0,0996	-0,2294	-0,1846*	0,0071	0,1870**	0,0804	0,3911***	-0,2255**
Firm size (d) [employees]	0,0556*	0,1070*		0,0711			0,0419	0,0506**
Establishment size (d) [employees]			0,0814*			0,0178		
Sectoral codes (d) (two digits)		0,0093				0,0014		
Pavitt Scale Intensive SI firms (d)				0,1276*				0,0604**
Pavitt Labour Intensive LI firms (d)				0,2339**	0,1098**			0,0638**
Pavitt Specialised Suppliers SS firms (d)			0,0754**	0,0802				0,0631***
Pavitt Resources Intensive RI firms (d)	-0,0960**							-0,1091***
Industrial group (d)			0,0669					
Cooperative (d)					-0,1341*			
Share of revenue on domestic markets				-0,0014*	-0,0019***			
Outsourcing 1 (auxiliary activities out)	-0,1417			-0,2631**				
Outsourcing 2 (productive in)						0,1949***		
Outsourcing 3 (productive out)		0,3312**					0,1543**	0,0856**
Share top managers / total employees							0,0134**	
Share executives / total employees						-0,0104***		
Share clerks / total employees							-0,0052***	
Share specialized blue collars / total employees	0,0012*	0,0072**	0,0046***			-0,0008		0,0022***
Share not specialized blue collars / total employees	0,0024***	0,0065***	0,0059***					0,0032***
Share skilled / unskilled employees				-0,0003**				
Employees education level								0,5156***
Firm hierarchical structure	-0,3230***		-0,4291***	-0,2341*		-0,2379***	-0,2037*	
Change in hierarchical layers/structure		0,0971**		-0,0729*	-0,0617**			
Plant flexibility	0,0933*							
Labour service flexibility in work organizations	-0,0909						-0,1446***	-0,1207***
Trend in atypical/temporary employment contracts for hiring	0,0777*			0,1959***	0,1208***			
Synthetic index of labour flexibility	0,7618***		0,6041**					0,6070***
Individual flexible pay systems and individual evaluation						0,1645***		
Variety and intensity of on the job training for employees and newly recruited workers						0,1531***		
On the job training for employees and newly recruited workers	0,1742*			0,2127**	0,1199**			
Attitudes of management vs. employees	0,2266**			0,4423***				0,1636***
Management initiatives vs. employees in work organizations		0,4143***			0,1323*	0,1692***	0,1590**	0,1970***
Attitudes of management vs. work representatives					0,3125**		0,2114*	
Interactions of management vs. worker representatives concerning innovation (information, consultation, negotiation)	0,0704*	0,1737**	0,1216*	0,0927**		0,0572***		0,0337*
Synthetic index of industrial relations	0,1346*		0,1593					
Net profit/revenue (m)		2,0143***	1,0435*					0,5508***
Net profit/revenue (g)	0,0006**							
Net profit (g)				0,0005**	0,0009**	0,0004*	0,0005*	
Revenue per employee (m)	0,0002***		0,0003***			0,0002***	0,0002***	
Revenue per employee (g)								-0,0004*
Value added per employee (m)		-0,0018***						
Value added per employee (g)		-0,0017***						
Net Investment per employee (m)				0,0001***	0,8 E-4			
Net Investment per employee (g)	0,8 E-5***		0,0002***	0,9 E-5***		0,0002**	0,0002***	0,00006**
Export goods and services (g)		0, 9 E-5**						
Labour cost per employee (g)						-0,0010***		
Labour cost per unit of output (m)							0,0005**	
Net debt/revenue (m)							-0,1480***	0,0689**
Net debt/revenue (g)		0,0004**						
Financial capital (market resources) (m)				0,8 E-6***	0,9 E-6***			
Financial capital (market resources) (g)			-0,0029***					
Inverted Mill's Ratio					-0,1220**			
Adj R²	0,5133	0,3114	0,3998	0,5194	0,4425	0,4593	0,3146	0,6039
F test	7,9487***	4,8969***	6,7395***	8,1191***	7,2800***	7,7946***	4,6713***	11,0431***
Breusch Pagan test (dof)	21.95 (17)	14.31 (13)	9.31 (13)	18.07 (17)		12.31 (14)	8.6 (17)	18.06 (14)
White test (dof)	15.72 (17)	18.48 (13)	6.8 (13)	18.13 (17)		15.72 (14)	9.14 (17)	21.06 (14)

*Note: 1) Least squares; 2) Two stages; coefficients * significant at 10% level, ** significant at 5% level, *** significant at 1% level.*

Table 12.2: Regression results: t-statistic

DEPVAR	INNO_1 (tech.-org.) (1)	INNO_TECH (1)	INNO_3 (labour org.) (1)	INNO_5 (labour org. with worker part.) (1)	INNO_5 (labour org. with worker part.) (2)	INNO_PART (worker cons.-deleg.) (1)	INNO_REWARDS (1)	INNO_EXT (gru-tech.-org.) (1)
Constant	-0,9414	-0,8435	-1,9186	0,0691	2,5260	1,1378	6,1459	-2,3236
Firm size (d) [employees]	1,9655	1,8633		1,6102			1,1973	2,6327
Establishment size (d) [employees]			1,7054			0,7180		
Sectoral codes (d) (two digits)		1,3733				0,6720		
Pavitt Scale Intensive SI firms (d)				1,8957				2,0306
Pavitt Labour Intensive LI firms (d)				3,7944	2,4420			2,1016
Pavitt Specialised Suppliers SS firms (d)			1,9992	1,4857				3,6533
Pavitt Resources Intensive RI firms (d)	-2,5616						-3,5027	
Industrial group (d)			1,5910					
Cooperative (d)					-1,6530			
Share of revenue on domestic markets				-1,7616	-2,8270			
Outsourcing 1 (auxiliary activities out)	-1,6063			-2,4578				
Outsourcing 2 (productive in)						2,9520		
Outsourcing 3 (productive out)		2,9087					2,6112	2,5053
Share top managers / total employees							2,2509	
Share executives / total employees						-2,7896		
Share clerks / total employees							-4,2334	
Share specialized blue collars / total employees	1,7130	3,3444	4,6083			-1,6095		2,8270
Share not specialized blue collars / total employees	3,1167	3,5224	6,0608					4,4092
Share skilled / unskilled employees				-2,6610				
Employees education level								2,7930
Firm hierarchical structure	-3,6326		-3,4018	-1,7650		-3,5597	-1,8765	
Change in hierarchical layers/structure		2,2194		-1,8150	-2,0610			
Plant flexibility	1,6931							
Labour service flexibility in work organizations	-1,5803						-3,2815	-4,5127
Trend in atypical/temporary employment contracts for hiring	1,9613			3,9838	2,7320			
Synthetic index of labour flexibility	3,5709		2,3840					4,4842
Individual flexible pay systems and individual evaluation						2,7520		
Variety and intensity of on the job training for employees and newly recruited workers						2,1004		
On the job training for employees and newly recruited workers	1,8308			2,3157	2,2890			
Attitudes of management vs. employees	2,2644			3,2149				3,1771
Management initiatives vs. employees in work organizations		3,8194			1,6880	3,3753	2,0875	5,3066
Attitudes of management vs. work representatives					2,4710		1,8857	
Interactions of management vs. worker representatives concerning innovation (information, consultation, negotiation)	1,8623	2,0735	1,7440	2,3528		2,6877		1,9065
Synthetic index of industrial relations	1,8203		1,5092					
Net profit/revenue (m)		2,9007	1,8933					2,8579
Net profit/revenue (g)	2,1328							
Net profit (g)				1,9889	2,4150	1,7813	1,6939	
Revenue per employee (m)	3,8831		3,2827			3,3199	2,9808	
Revenue per employee (g)								-1,7398
Value added per employee (m)		-2,9098						
Value added per employee (g)		-4,6838						
Net Investment per employee (m)				4,5814	1,2720			
Net Investment per employee (g)	4,1115		6,6439	3,2890		2,5275	7,0556	2,6395
Export goods and services (g)		2,3260						
Labour cost per employee (g)						-3,2817		
Labour cost per unit of output (m)							2,2823	
Net debt/revenue (m)							-2,6826	2,4833
Net debt/revenue (g)		2,5898						
Financial capital (market resources) (m)				3,0994	3,0190			
Financial capital (market resources) (g)			-3,1552					
Inverted Mill's Ratio					-2,1510			
Observations	113	113	113	113	96	113	113	113
F test prob value	0,000000	0,000001	0,000000	0,000000	0,000000	0,000000	0,000002	0,000000
Breusch Pagan test (dof)	21.95 (17)	14.31 (13)	9.31 (13)	18.07 (17)		12.31 (14)	8.6 (17)	18.06 (14)
White test (dof)	15.72 (17)	18.48 (13)	6.8 (13)	18.13 (17)		15.72 (14)	9.14 (17)	21.06 (14)

Note: 1) Least squares; 2) Two stages.