



Knowledge Strategies, Firm Types, and Complementarity in Human-Resource Practices

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Abstract. This paper argues that complementary human resource practices play an important role in the development of a knowledge based theory of firm. In general, such a theory might be advanced through investigating complementary coordination mechanisms as components of governance structures. In particular, human resource practice combinations contribute as coordination mechanisms to organise knowledge creation and exploitation in complex social relations. Yet, little is known about why and how innovation strategies and activity systems of different firm types relate to combinations of human resource practices. We address this gap by investigating the impact of firm types and knowledge strategies pursued on the application of human resource practices in a multisectoral sample of 684 manufacturing and 1,200 non-manufacturing firms. We find that the adoption of practices applied differ with the characteristics of knowledge strategies and with firm types. In addition, after controlling for these differences, we find that complementarity effects among practices are present in varying degrees. The implications of our findings include that there are fewer restrictions to combinations of coordination mechanisms than widely assumed.

Key words: complementarities, human resource practices, innovation, knowledge coordination

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1. Introduction

Recent contributions in the economic and management literature seek to develop a knowledge based theory of firm, and as such they see the primary reason for the existence of firms in the creation, integration, and utilisation of knowledge (Nelson and Winter, 1982; Demsetz, 1988; Kogut and Zander, 1992; Nonaka, 1994; Conner and Prahalad, 1996). In general, such a theory might be best advanced by investigating complementary coordination mechanisms as components of governance structures (Grandori, 1997). In particular, because there is “close connection between knowledge possessed by the personnel of the firm and the services obtainable from its material resources” (Penrose, 1959: 77), human resource management (HRM) practice combinations help as coordination mechanisms to organise know-

ledge creation and exploitation in complex social relations. In this paper we take HRM practices to be observable regularities which act as coordination mechanisms in the governance of people. As such, they are concerned with the coordination of knowledge in the interplay between the employee, the job and the organisation (cf. Legge, 1995). This empirical paper is concerned with identifying the characteristics of firms (firm type and knowledge strategies), which adopt different human resource management practices, and moreover, it is concerned with gauging organisational complementarities between the adoption of various such practices. We follow Milgrom and Roberts (1995: 181) in defining complementarities, since they suggest that "... activities are Edgeworth complements if doing more of one thing increases the returns to doing (more of) the others." Hence, in this paper, human resource practices are regarded as complements if applying more of one practice increases the effectiveness in terms of knowledge creation, integration, and utilisation to applying (more of) another practice.

Several authors suggest that human resources are not only important, but that they are among the most strategically relevant resources (Itami and Roehl, 1987; Castanias and Helfat, 1991; Mahoney, 1995; Ulrich, 1996). Consequently, scholars propose that "new" human resource management contributes to firm performance through applying both individual and systems of human resource practices (e.g. Lado and Wilson, 1994; Mahoney, 1995; Huselid, 1995). Several individual practices have been distinguished in the literature (e.g. Ichniowski, Shaw and Prenzushi, 1997; Baron and Kreps, 1999), including the practices we have chosen to analyse in the empirical part of this paper, namely "the application of interdisciplinary work groups", "collection of employee proposals", "planned job rotation", "delegation of responsibility", "integration of functions", "performance related pay", "firm internal and external training". Given that these practices have been in the focus in the recent literature, we have chosen the overall label "new HRM practices".¹ At the same time, it should be noted that we disregard other practices such as e.g. recruiting or career paths.

A growing empirical literature stream (McDuffie, 1995; Koch and McGrath, 1996; Becker and Gerhard, 1996; Pennings, Lee and van Witteloostuijn, 1998) confirms performance effects of human resources management practices. But only the most recent studies (Baron and Kreps, 1999; Ichniowski, Shaw and Prenzushi, 1997; Mendelson and Pillai, 1999) start to unpack the observation that several human resource practices used simultaneously and in particular combinations, increase productivity beyond what individual human resource practices achieve in isolation. While preliminary evidence is encouraging as it shows that human resource practices matter for performance in general, little is known, in particular, about how and why combinations of human resource management practices matter, for example, when they are employed in different types of firms, or in order to support different knowledge strategies. The current study adds to the studies mentioned above, but it is also different in focus. We attempt to contribute to the empirical literature by focussing on the impact of firm type and knowledge

strategies pursued on the deployment of combinations of complementary human resource practices.²

The paper is organised as follows. In Section 2 we unfold the theoretical arguments. First, we suggest that firm types and knowledge strategies differ and that these differences may be reflected in the human resource practices used. Second, we argue that the application of the work practices looked at in this paper, all add to the same underlying process of knowledge creation, integration, and utilisation, and moreover, that these practices are complementary to a varying degree. Section 3 contains the empirical analysis. Using a multisectoral sample of 1884 Danish firms we regress nine human resource practices on a set of observables (“the first step”). This analysis suggests significant effects of firm types and knowledge strategies. A subsequent correlation analysis of the error terms from the first step suggests pair-wise complementarity of work practice combinations, thus, providing further support for the existence of complementarity among work practices. Finally, in the concluding section (Section 4), we summarise our results and in continuation thereof, we consider theoretical implications for advancing research on the relation between human resource practices, knowledge strategies, and complementarity among work practices.

2. Theoretical Background and Hypotheses

2.1. THE IMPACT OF KNOWLEDGE STRATEGIES AND FIRM TYPES ON THE APPLICATION OF HUMAN RESOURCE PRACTICES

2.1.1. *Firm types*

Given the fact that different firm types are engaged in different activities involving different types of learning (Pavitt, 1984), one should expect the organisational structure, coordination mechanisms utilised, and human resource practices employed to vary with the firm types and their activities. However, while economic activities differ in nature, it is not evident which organisational form suits each of the activities. Nevertheless, the so-called contingency theories from the organisational literature can be helpful in this context. One line of research using such an approach is the work of Paul Lawrence and colleagues (see e.g. Lawrence, 1981), within the Harvard Programme. In this line of research the organisational form emerges as a function of two variables, namely resource scarcity (“*resource tensions*”) on the one hand, and *strategic uncertainty* on the other hand. In this context strategic uncertainty refers to the number of different types of competitors the firm has to face, and stability or turbulence regarding sources of knowledge, including suppliers, universities and government research etc. In contrast, resource tensions refer to the fact that organisations require scarce resources (raw material, capital and human resources) and favourable resource exchanges.

In this framework different organisational forms emerge as an adaptation to these two types of pressure from the external environment. In other words,

depending on whether resource tensions and strategic uncertainties are relatively high or low respectively, certain types of organisations appear as the “best fit” for each combination. In this framework, if firms face high uncertainty due to a high rate of technological change – as it is often the case for firms active in knowledge intensive industries (Lawrence, 1981: 328–329) – the best fit organisational arrangement can be characterised as being an “organic form” (Burns and Stalker, 1961). That is, activities are organised in a flexible, decentralised, informal and highly integrated organisational structure. When we talk about knowledge intensive firm types in this context, we mean firm types that have a strong internal capacity to develop new services or products (for an operationalisation of knowledge intensive firm types, see Section 3.1 below).

Another contingency approach has been proposed by William Ouchi (e.g. 1980), which yields similar prediction, albeit for different reasons. The starting point is to identify conditions that give rise to the cost of exchanges between individuals, namely goal incongruence and performance ambiguity. Performance ambiguity has to do with how easily inputs and outputs of the production process are measured. This, in turn depends on whether input, processes, and output can be standardised in any meaningful way. If inputs and outputs are not easily measured – for instance if both factors of production as well as outputs are intangible – performance ambiguity will be high. Therefore, the theory predicts, *inter alia*, that pecuniary incentives for employees will only be effective when inputs and outputs can be reliably measured. Goal incongruence refers to the fact that individuals (members of the organisation) have only partly overlapping goals in many cases. Hence in these cases, when left on their own, the individuals would pursue incongruent objectives and their efforts would be uncoordinated. However, Ouchi (1980) argues that – when a group within a firm has been socialised in a certain way – goal incongruence can in fact be reduced to a low level.

Different sizes of parameters with respect to the two variables (goal incongruence and performance ambiguity) then help in distinguishing three basic mechanisms of control as the efficient response to problems of economic coordination: markets, bureaucracies, and clans. Markets are seen to be the efficient form of organisation, when performance ambiguity is low and goal incongruence is high, while bureaucracies are argued to be the efficient form when both goal incongruence as well as performance ambiguity are moderately high. But just as markets can fail (Williamson, 1995) so can bureaucracies: “when the ambiguity of performance evaluation becomes significantly greater than that which brings about market failure” (Ouchi, 1980: 134). A bureaucracy relies typically on standardisation of input, processes, jobs and behaviour to approximate contributions to output. Yet, bureaucracies can fail when uncertainty reaches extreme levels. Job definitions become unclear or highly unique, and standardisation as a necessary condition for performance control is rendered meaningless. Thus, in instances of uncertainty and complexity, “where organisations become an invertebrate process rather than a structure” (Grandori,

1987: 93) clans are seen to be the most efficient form of organisation because they reduce goal incongruence through socialisation to a low level, while tolerating high levels of performance ambiguity. Firms applying a clan organisation are typically active in technologically advanced or closely integrated industries (Ouchi, 1980: 136), where teamwork is common and where complexity in interactions often renders individual performance highly ambiguous.³ In this respect the predictions on the best fit organisational type for knowledge intensive activities parallel that of the Harvard approach. Given the properties of the “organic” form of organisation (the flexible, decentralised, informal and highly integrated structure), the HRM practices, included in this analysis and typically associated with this organisational structure include “interdisciplinary workgroups”, “systems for collection of employee proposals”, “delegation of responsibility”, and “integration of functions”. Furthermore, “performance related pay” seems suitable only for those firm types where standardisation of input, jobs, processes, or output is feasible and meaningful. As a consequence of the arguments and findings presented above, we expect the human resource practices employed to vary with firm types. In particular:

- H1a:** Firm types which can rely on standardisation of job description and processes (e.g. manufacturing firms) are expected to apply quality circles and planned job rotation more often than other firms.
- H1b:** Firm types which can rely on standardisation of input, behaviour, jobs and output (e.g. wholesale, traditional services, low- to medium-tech manufacturing firms) are expected to apply performance pay more often than other firms.
- H1c:** Firm types that cannot rely on standardisation of input, behaviour, jobs and output (e.g. knowledge intensive firms) are expected to apply work practices associated with “organic organisations” more often than other firms.

2.1.2. *The impact of knowledge strategies on the application of human resource practices*

While firms play different roles in the economy and engage in different principal activities, they may additionally follow different knowledge strategies. By “knowledge strategy” we mean the link between a firm’s competitive orientation (innovation vs. imitation) and its means to create and assimilate knowledge (Zack, 1999; Bierly and Chakrabarti, 1996). For example, based on an empirical study of knowledge strategies in the pharmaceutical industry, Bierly and Chakrabarti (1996) suggest that a firm’s knowledge strategy involves choices about (a) the degree of external and internal learning (b) radical or incremental learning, (c) fast vs. low learning speed, and (d) a narrow vs. broad knowledge base (e.g. Cyert, Kunert and Williams, 1993; Cohen and Levinthal, 1990; March, 1991, Prahalad and Hamel, 1994). Interestingly, it is the combination of these choices, which leads the authors to identify clusters of knowledge strategies (e.g. innovators, exploiters).

The current study focuses on “innovator strategies”. Innovators in Bierly and Chakrabarti’s (1996) study are characterised by an innovative competitive orientation, high levels of internal learning, strong linkages to external knowledge sources, as well as by a high internal learning speed.

The strategy literature has increasingly stressed the importance of knowledge access and absorption (Cohen and Levinthal, 1990) through interpartner learning both in vertical relations and through linkages to external knowledge institution such as think tanks and universities (e.g. Hamel, 1991; Lyles and Stark, 1996; Dyer and Singh, 1998). Moreover, the role of interactive learning between cooperating firms (in particular interaction between suppliers and users) and other institutions has been increasingly stressed (Lyles and Stalk, 1996; Dyer and Singh, 1998). Such collaborations can contribute to a firm’s innovation strategy. However, whether and how fast, for example innovating firms can access, absorb, and integrate external knowledge depends on the “organisational absorptive capacity” (Cohen and Levinthal, 1990); that is, the ability of the firm to acquire and utilise external knowledge internally. As Matusik and Hill (1999: 685) argue, research on cooperative organisational arrangements, “...highlights the importance of integration mechanisms in gaining knowledge from partnerships ... Boundary-spanning positions, resources committed to attaining information, formal strategy toward knowledge acquisition, and rewards for attaining information are some examples of external knowledge integration mechanisms.” If achieving competitive advantage through innovation depends upon the firm’s ability to utilise existing knowledge and its ability to generate new knowledge more efficiently relative to competitors, human resource practices may be employed to support the absorption and utilisation of external knowledge, as well as to integrate it with internal learning. Thus, we are entitled to expect:

H2a: Innovator strategies are positively related to the application of new human resource practices

H2b: Vertical linkages and linkages to knowledge institutions are positively related to deploying new human resource management practices

2.2. COMPLEMENTARITY AMONG HUMAN RESOURCE PRACTICES

The aim of this section is to substantiate why different human resources management practices might cross-fertilise each other by being complementary in the Edgeworth sense. One starting point for such a discussion is to show how the application of individual work practices can make contributions to the same underlying processes of knowledge creation and utilisation. Moreover, it is (a) necessary to show that these work practices do not impede each other, but rather that they (b) mutually reinforce their impact on the processes of knowledge creation and utilisation.

2.2.1. *The impact of human resource practices on knowledge creation and utilisation*

Achieving competitive advantage depends upon a firm's ability to exploit existing knowledge and to generate new knowledge, relative to other firms. Human resource practices can contribute to the creation, integration and utilisation of knowledge in a number of ways (see e.g. Lado and Wilson, 1994). For example, increased delegation of responsibility may better allow for the discovery and utilisation of local and dispersed knowledge in the organisation (Hayek 1945; Jensen and Meckling, 1992). Jensen and Meckling (1992) suggest that, when knowledge is tacit, complex and hard to transfer to some central authority, and when knowledge is also valuable in decision making and problem solving, co-locating decision rights and knowledge through delegation increase knowledge utilisation. In this context, job rotation can be very effective in mobilising personal knowledge as it helps organisational members to understand a company's business from a variety of perspectives (Inkpen, 1996). Often, the willingness and ability to rotate jobs (be it temporarily or not) is rewarded through individual bonuses.

Additionally, several forms of team work (e.g. total quality management (TQM), and interdisciplinary teams) are conducive to the integration and creation of knowledge. For example, Deming (1986) suggests that TQM programmes fuel the creation of firm specific knowledge by combining scientific methods and widespread teamwork: thus training in using efficiency methods assists teamwork in quality circles. Often, TQM initiatives are also focused on efficiency improvements in well-defined problem situations where output measures such as cycle time, throughput, and customer satisfaction find application. Wruck and Jensen (1994) add that TQM initiatives involve a process for re-allocation of decision rights that co-locate them with employee's knowledge and skills.

Interdisciplinary teams often integrate knowledge (Grant, 1996) that hitherto existed separately and dispersed across function. Through interactive learning, group specific communication codes or combinative capabilities (Arrow, 1974; Kogut and Zander, 1992; Monteverde, 1995) are generated. Different "communities of knowing" can engage in strategic conversation to creatively combine and blend a variety of knowledge (Boland and Tenkasi, 1995; Leonard and Sensiper, 1998). Teamwork can also facilitate cross-functional communication, enhance worker involvement, and develop or better utilise talent to serve strategic aspiration. Through integrating knowledge of individual members, teams may not only blend knowledge and insights beyond what individual members may achieve; new knowledge development may also be stimulated by conversations and language based learning in teams (e.g. Brown and Duguid, 1991; Boland and Tenkasi, 1995). Teamwork may also fuel knowledge creation resulting in "new combinations" (Schumpeter 1934). For example, Brown and Duguid's (1991) analysis of communities of practice suggests that shared learning is inextricably linked to social interaction in teams.

Both internal and external training programmes contribute to organisational knowledge creation (Nonaka and Takeuchi, 1995) through social interaction in processes of socialisation (experiencing interaction with tacit knowledge), internalisation (where explicit knowledge is internalised), externalisation (articulating prior tacit knowledge), and combinations of explicit knowledge (cognitive learning). However, the emphasis of external training might be more in the internalisation phase, while internal training stresses more the externalisation and socialisation phase of knowledge creation. Thus, while internal and external training contribute to knowledge creation, they appear to contribute in different ways. Because of changes in technology, production methods, required skills etc., firms upgrade skills and expertise of employees in external seminars. Although the acquired knowledge may be specific to a certain area of expertise (e.g. a technology, production method, software), in the majority of cases, external training is used to provide general, and codified knowledge that is useful, but not firm specific (Becker, 1964). Although, the organisation's knowledge base may be updated and broadened through external training, reliance on such training may find its limits when external wisdom is used repeatedly as a quick fix to substitute external knowledge for internal knowledge creation. In such cases, absorptive capacity (Cohen and Levinthal, 1990) for subsequent knowledge absorption to fuel new knowledge development might be compromised. By contrast, on-the-job training, internal seminars, and learning-by-doing programs can be used to create firm specific human capital.

Furthermore, compensation systems have been regarded as influential to elicit employees' contribution. For example, high-powered incentives – often represented as the contingent portion of pay – may be used to induce contributions through providing larger shares of quasi-rents to employees (Williamson, 1996). But at the same time the use of high-powered incentives is regarded as complicated if measuring problems obtain and if constraints are present that relate to perceived inequity among employees (e.g. Pfeffer and Langton, 1993; Ouchi, 1980). For example, Ouchi (1980) suggests that poorly understood cause-effect relations and uncertainty results in ambiguities of performance evaluation – particularly if tasks are highly interrelated. Only if performance ambiguity is low output based performance pay seems effective in aligning conflicting interest. If this is not the case, variable rewards might be appropriate if pay and control can relate to specified behaviour or to other forms of standardisation (e.g. processes), which can serve as a basis for measuring performance. Unfortunately, to the extent that standardisation of behaviour or processes is prevented, such as in the case of many forms of teamwork, neither behaviours nor outputs can be determined with precision. In this case, Ouchi (1980) suggests, clan control might be the solution to promote cooperation and mitigate conflict of interest: the basis of control becomes a set of internalised values and norms. Jones (1987) agrees when he finds that “increasing performance ambiguity leads to less reliance on behavioural and output controls” in the service industry. Snell (1992) specifies that increasing interdependence and the

absence of standards negatively impact the use of output and input based controls and rewards.

Moreover, individual high-powered incentives can inhibit cooperation in teamwork, which may make such incentives undesirable when task performance crucially depends on the exchange of information and mutual adaptation (Thompson, 1967). Balkin and Gomez-Mejia (1992) go so far as to note that individual rewards may be the antithesis of teamwork in quality circles even if process outcomes are measurable: individual incentives promote internal strife rather than cooperation. More generally, pay-for-performance may encourage individual employees to meet their own personal or professional goals at the expense of organisational knowledge creation and utilisation. By contrast left with low powered incentives, employees have less to lose by engaging in information sharing and less to gain by withholding information (Williamson, 1996). As Holmström and Milgrom (1994: 998) note, “the use of low powered incentives ... is also an important vehicle for inspiring cooperation and coordination.”

2.2.2. Complementarities among human resource practices

Although individual human resource practices can contribute individually to support processes of knowledge creation and utilisation, recent contributions (Ichniowski, Shaw and Prennushi, 1997; Baron and Kreps, 1999; Mendelsson and Pillai, 1999) suggest that much research has focussed too narrowly on isolated human resource practice effectiveness; and that this might be a limiting factor in advancing research on human resource practices. As a consequence, a focus on complementarity effects (Milgrom and Robert, 1990; Holmström and Milgrom, 1994) resulting from a combination of practices is recommended. Arthur (1994), for example, found that in steel mini mills, a combination of human resource practices designed to elicit employee commitment was associated with higher productivity levels. Building on these results, Huselid (1995) illustrated the significant impact of a combination of several work practices on employee turnover and corporate financial performance. Relatedly, Ichniowski, Shaw and Prennushi, (1997: 311) conclude from their study of steel production that “... systems of innovative HRM practices have large effect on production worker’s performance, while changes in individual work practices have little or no effect.”

As pointed out in the introduction to this paper, human resource practices are regarded as complements in the present context, if applying more of one practice increases the effectiveness in terms of knowledge creation, integration, and utilisation to applying (more of) another. For example, various forms of team work are made more effective if responsibilities are delegated to team members because it allows them to bring to bear their existing knowledge and to develop new knowledge for tasks that managers up in the hierarchy are unable to understand. Likewise, internal training might assist quality circles by blending leading practices developed in one part of the organisation with local knowledge in another part. Similar functional integration and interdisciplinary work groups might enhance

the effectiveness of the collection of employee proposals, for example, if such proposals concern improvements of interfaces between functions and disciplinary expertise.

Thus, we add to the notion of “complementarity”, the question of why complementarities exist and argue that complementarity effects among HR practices (Milgrom and Robert, 1990; Holmström and Milgrom, 1994) are due to the mutually reinforcing impact of several practices on processes of knowledge creation, integration, and utilisation in firms. As a consequence of the arguments and findings presented above we expect:

- H3a:** Complementarities between work practices contributing to the exchange of information and knowledge creation between employees (interdisciplinary workgroups, quality circles, employee proposals, job rotation, and integration of functions) will be particularly strong
- H3b:** Complementarities between performance related pay and work practices contributing to the exchange of information and knowledge creation between employees (interdisciplinary workgroups, quality circles, employee proposals, job rotation, delegation of responsibility, and integration of functions) will be particularly weak
- H3c:** Complementarities between firm external training and other work practices will be weaker than complementarities between internal training and other work practices.

3. Empirical Analysis

3.1. SAMPLE AND DESCRIPTIVE STATISTICS

The main source of data for this paper is the *DISKO database*. The database is based on a questionnaire which aims at tracing the relationship between technical and organisational innovation in a way that permits an analysis of new principles for work organisation and their implications for the use and development of the employee’s qualifications in firms in the Danish private business sector. The survey was carried out by the DISKO project at Aalborg University in 1996. The questionnaire was implemented by Statistics Denmark and was submitted to a national sample of 4,000 firms in manufacturing and in service firms (i.e. public services and the primary sector were excluded). First, all Danish firms with at least 100 employees were included in the sample, i.e. a total of 913 firms. Subsequently, 3087 firms were drawn as a stratified, but random sample among manufacturing firms with at least 20 full-time employees and non-manufacturing firms with at least 10 full-time employees (out of a population of about 9,500 firms). In sum, the questionnaire was mailed to 1,316 manufacturing and to 2,684 non-manufacturing firms at the end of April 1996, followed by a reminder on May 29th and telephone interviews with top managers in non-responding firms during June. The resulting numbers of respondents were 684 manufacturing and 1,216 non-manufacturing

firms, corresponding to response rates of, respectively, 52 per cent and 45 per cent.⁴ The resulting response rate of 48 per cent for the total sample is acceptable when you compare the distribution of response rates across industries and the sample representativity (see Lund and Gjerding, 1996). Overall, the survey yields a satisfactory coverage of the Danish private business sector. The first descriptive analysis of the survey can be found in Gjerding (1997). The database is held by Statistics Denmark, and the data on the firms in the database, can be linked to regular register data, also held by Statistics Denmark. In our case we have obtained data on the size of the firms in the sample from regular register data.

Table I displays descriptive statistics for our variables. The questions on the basis of which some of the variables (A.-M. in Table I) are constructed, can be found in Appendix 1. It can be seen from the Table 1 that between 36 and 84 per cent of the firms in our sample apply each one of the nine HRM practices, described above. 36 per cent apply planned job rotation, while 84 per cent apply delegation of responsibility. On a methodological note, it should be stressed that the questions in the questionnaire only concern whether or not a certain work practice is applied or not (a “quantity”) – it says nothing about the “quality” of the application of work practice in question. The issue of the quality of HRM practice applications is left for future research.

As is common in studies of this type (e.g. Lorentz, 1998; Michie and Sheehan, 1999) we control for firm size and firm type. We include a variable measuring the size of the firm⁵ based on register data, and we include nine firm types. For what concerns the firm classification, we apply the Pavitt taxonomy. However, we construct five additional firm types for the service firms (scale intensive services, specialised traditional services, wholesale trade and crafts) in our sample. In this “augmented” Pavitt taxonomy (see also Appendix 2), firm types with the strongest internal capacity to develop new products and services are *specialised supplier firms*, *science based firms* and *ICT intensive service firms*. Consequently, we consider these firm types to have the highest knowledge intensity. Firm types with the lowest capacity to develop new products and services internally are *craft firms*, *specialised traditional service firms*, *scale intensive service firms*, and to some extent *supplier dominated (manufacturing) firms*. *Scale intensive firms* and *wholesale trade firms* may be considered to be intermediate in relation to knowledge intensity (see Laursen and Foss, 2000: 12).

All firms in our sample have been classified according to industry by Statistics Denmark. Based on that categorisation we further aggregate the industries into the 9 sectors. The assignment of 83 industries into our 9 sectors can be traced in Appendix 3 to this paper. Both for what concern size and firm type, it can be seen from Table I that the firms are in general spread equally across our categories.

In the innovation variable we have 928 non-innovators, 728 firms which produced products/services new only to the firm itself, 125 firms which produced products/services new on the national market, while 103 firms introduced products/services, new to the world. Other variables in the analysis, include

Table I. Descriptive statistics for a set of DISKO variables (N = 1884)

Variable	Number of firms	% of total sample
A. Interdisciplinary workgroups	923	49.0
B. Quality circles	707	37.5
C. Systems for collection of employee proposals	828	43.9
D. Planned job rotation	673	35.7
E. Delegation of responsibility	1585	84.1
F. Integration of functions	1061	56.3
G. Performance related pay	734	39.0
H. Firm internal training	976	51.8
I. Firm external training	1305	69.3
J. Vertical linkages	1572	83.4
K. Link to knowledge institutions	811	43.0
L. Subsidiary of other firm	820	43.5
M. Non-innovators	928	49.3
Introduced product/services new to the firm	728	38.6
Introduced product/services new to the country	125	6.6
Introduced product/services new to the world	103	5.5
N. Scale intensive	254	13.5
Supplier dominated	225	11.9
Science based	67	3.6
Specialised suppliers	138	7.3
Crafts	273	14.5
Wholesale trade	333	17.7
Specialised traditional services	370	19.6
Scale intensive services	94	5.0
ICT intensive services	130	6.9
M. 1–10 employees	221	11.7
11–50 employees	979	52.0
51–100 employees	205	10.9
100+ employees	479	25.4

whether or not the firm in question has increased its vertical interaction with other firms, being it either upstream or downstream (“vertical linkages”), and whether or not the firm in question has increased its interaction with knowledge institutions (“link to knowledge institutions”), including technical support institutions, consultancies or with universities. Although both variables concern whether the firms have increased their external linkages, we interpret these variables more broadly as measuring the strength of the respective linkages. The reason for this is that we argue that respondents who have strong linkages with external partners are

very likely to answer that they have *increased* interaction with partners. Finally, we control for whether or not the firm is a subsidiary of a larger firm (for a discussion of the effect of this variable, see Harris and Trainor, 1995).

3.2. ANALYSIS AND RESULTS

As argued by Athey and Stern (1998), two types of approaches for measuring Edgeworth complementarities have been applied in the literature. The first type builds on the empirical productivity literature. The approach relies on a regression (various techniques have been applied) of a measure of productivity on a set of regressors, including the interaction effect between different practices, as estimates of complementarity parameters. A prominent example of an application of this procedure can be found in Ichniowski, Shaw and Prennushi (1997), discussed in Section 2.2 above. The second approach tests whether the correlation among practices is positive, conditional on observables. While applying this type of methodology, Colombo and Mosconi (1995) find complementarities between the application of new process technology on the one hand and organisational and managerial innovations on the other hand. Likewise, Arora and Gambardella (1990) find that certain strategies of 81 large chemical and pharmaceutical producers are indeed complementary.

In this paper we apply the Arora and Gambardella (1990) approach for gauging possible complementarities between HRM practices. The advantage of this procedure is that it is applicable when the value of complementarities cannot be tested directly, since the value of the practices might not be directly measured. In this case we are constrained to testing an important implication of complementarity. The logic can be illustrated by an example. If for instance, an increase in application of the delegation of responsibility increases the value of applying a work practice implying an integration across functions, it is intuitively persuasive that we would expect that firms which apply the work practice associated with the delegation of responsibility, would also tend to apply the work practice implying integration across functions in the firm. To put it differently, given that decision makers (managers) are at least partially rational, when they undertake decisions of whether or not to adopt new HRM practices, if two strategies are complements, one would expect them to be positively correlated.⁶

However, it should be pointed out that a simple correlation might be spurious, given the fact that a common set of factors might influence both of the variables. Such factors include a set of firm specific characteristics such as size, but also factors such as innovator's knowledge strategies including external linkages to suppliers, customers and knowledge institutions (e.g. universities, consultancies etc.). This implies that we have to account for such factors.

Accordingly, we follow the two step procedure, suggested by Arora and Gambardella (1990). First we regress our nine HRM practices on a set of regressors, displayed in Table I. The first nine variables in Table I are dependent

variables (the nine HRM practices), while the rest of Table I contains our explanatory variables. All variables are binary, except for the innovation variable, which takes the value of 0 if the firm in question is a non-innovator; if the firm has introduced (in the period 1993–1995) a product or service, new to the firm the value is 1; if the firm has introduced a product new in Denmark over the period, the value is 2; while the value for this variable is 3 if the firm has introduced a product (or service) which is new to the world. The second step of the procedure consists of making a correlation analysis of the residuals from the first step in order to reach some conclusions concerning whether or not our nine human resource management practices can be seen to be complementary.

Table II contains the estimations conducted in the first step. From the table it can be seen that our observables explain the application of interdisciplinary work groups and of firm internal training much better than the other work practices, since we in those cases explain about 20 per cent of the variation, while we only explain about 8 per cent in the other cases.

Concerning the relationship between size and the application of the nine work practices, and judging from the sign of the parameters, it can be seen from the table that large firms are in general more prone to apply new HRM practices than are smaller firms. Eight out of nine parameters have a positive sign, although only three of them are statistically significant (interdisciplinary workgroups, planned job rotation and firm internal training). However, smaller firms appear to be more prone to use firm external training than do larger firms (a negative parameter is observed for this variable), which might be explained by the smaller amount of internal resources available to smaller firms. Hence, smaller firms might have to rely more on external resources. In addition, being a part of a larger firm (subsidiary) appears to affect to the likelihood of adopting any of the work practices, except for planned job rotation. In this context we can speculate that parent firms are likely to impose these types of HRM practices on their subsidiaries.

If one looks at Table II from the point of view of the application of individual work practices it can be concluded that hypothesis *Ia*, stating that the four manufacturing firm types apply quality circles and job rotation more than other firms is generally supported by the evidence. For what concerns job rotation, it can be seen that the four parameters for the manufacturing firms are consistently higher than the parameters for the service firms. In relation to quality circles the parameters are also higher as compared to service firms in general, but firms in ICT intensive services tend to apply this practice to a relatively high degree as well.

In hypothesis *Ib*, it is affirmed that firm types which can safely rely on standardisation of input, behaviour, jobs and output are expected to use performance related pay more often than other firm types. Nevertheless, while it appears to be true that ICT intensive service firms apply performance related pay less than other firm types (lowest parameter of all), the three firm types which use this practice the most include scale science based firms (knowledge intensive), scale intensive firms, and firms in wholesale trade (medium knowledge intensity). None of the firm

Table II. Regression results for OLS models explaining the application of nine work practices (N = 1884)

Independent variables	Dependent variable								
	Interdisciplinary workgroups	Quality circles	Systems for collection of employee proposals	Planned job rotation	Delegation of responsibility	Integration of functions	Performance related pay	Firm internal training	Firm external training
	R ² = Estimate	R ² = Estimate	R ² = Estimate	R ² = Estimate	R ² = Estimate	R ² = Estimate	R ² = Estimate	R ² = Estimate	R ² = Estimate
	p-value	p-value	p-value	p-value	p-value	p-value	p-value	p-value	p-value
<i>Intercept</i>	0.554	0.322	0.000	0.297	0.829	0.535	0.341	0.627	0.375
<i>SIZE</i>	0.011	0.005	0.114	0.010	0.002	0.301	0.005	0.010	-0.005
<i>FIRM TYPE control*</i>									
Scale intensive	-0.043	0.387	0.947	0.201	-0.081	-0.047	0.116	-0.152	0.097
Supplier dominated	-0.149	0.003	0.000	0.196	-0.086	0.028	0.083	-0.202	0.000
Science based	-0.050	0.462	0.083	0.193	-0.065	0.227	0.119	-0.053	0.442
Specialised suppliers	0.026	0.642	0.072	0.206	-0.084	0.054	0.087	-0.179	0.001
Crafts	-0.336	0.000	-0.124	0.014	-0.145	-0.177	0.132	-0.292	0.000
Wholesale trade	-0.194	0.000	-0.107	0.027	-0.054	-0.005	0.144	-0.151	0.001
Specialised trad. services	-0.277	0.000	-0.056	0.248	-0.120	-0.154	0.065	-0.241	0.000
Scale intensive services	-0.290	0.000	-0.200	0.002	-0.037	-0.113	0.071	-0.220	0.000
ICT intensive services	0.045	0.001	0.029	0.042	0.026	0.017	0.077	0.076	0.011
Innovation capacity	0.111	0.000	0.096	0.002	0.130	0.000	0.073	0.134	0.000
Vertical linkages	0.121	0.000	0.124	0.000	0.062	0.000	0.061	0.122	0.000
Link to knowledge inst.	0.134	0.000	0.072	0.002	0.047	0.009	0.102	0.179	0.000
Subsidiary									0.040
									0.079

*For the sector controls the levels of significance refer to being significantly different from the benchmark. For the rest of the parameters the levels of significance refer to being significantly different from the zero.

types with a typically low level of knowledge intensity – i.e. where standardisation is easier – use this practice in particular.

Hypothesis *H1c* elucidates that knowledge intensive firm types are expected to apply work practices associated with organic type of organisations (“interdisciplinary workgroups”, “systems for collection of employee proposals”, “delegation of responsibility”, and “integration of functions”) in particular. To recap, we consider knowledge intensive firm types to be *specialised supplier firms*, *science based firms* and *ICT intensive service firms*. In general, it can be concluded that this expectation fits the empirical evidence pretty well. The finding is particularly clear-cut for the application of “integration of functions” as well as for “interdisciplinary workgroups”. For what concerns “systems for collection of employee proposals” the three knowledge intensive firm types are among those firm types with the highest parameter, although the scale intensive firm type has a high parameter as well. The only HRM practice associated with organic types of organisations, not applied in particular by all of the knowledge intensive firm types is “delegation of responsibility”. This practice appears to be applied particularly by *ICT intensive services*, while neither *science based*, nor *specialised supplier types of firms* use this practice above average. However, it should also be noted the firm types with low knowledge intensities (*craft firms*, *specialised traditional service firms* and *scale intensive service firms*) apply this practice to a much lower degree than other firm types.

With respect to the effect of firms being innovators on the application of HRM practices, it can be seen that innovation performance is related to the application of all work practices, except for firm external training. This finding squares with the finding of Lorenz (1998), who found British firms are more likely to adopt new work practices, given higher levels of R&D intensity. The finding is also in line with our hypothesis (*H2a*) stating that innovator strategies are related to the application of the work practices in question.

It can also be concluded from Table II, that the application of all types of new work practices are related to the strength of firms’ external relations, being it either to suppliers or users or to knowledge institutions. This finding supports hypothesis *H2b* which asserts that firms which apply new human resource management practices are also more prone to have strong external linkages than are other firms. Hence our results confirms the results due to Forsgren, Pedersen and Foss (1999), since they found that firm internal strength (e.g. technological expertise) were strongly related to the strength of firms’ external relations, in particular to lead users and to suppliers.

As explained above, the “second step” consists of performing a correlation analysis of firm’s application of practices, based on the residuals from the regressions reported in Table II. The outcome of this correlation analysis is reported in Table III. From Table III it can be concluded that all our work practices are pairwise complementary in the sense that all combinations of work practices correlate, when observable factors are controlled for. One can argue that it is surprising that

Table III. Correlations among the residuals (N = 1884)

	IW*	QC	EP	JR	DR	IF	PRP	FI
Quality circles (QC)	0.36							
<i>p</i> -value	0.000							
Systems for collection of employee proposals (EP)	0.29	0.32						
<i>p</i> -value	0.000	0.000						
Planned job rotation (JR)	0.25	0.29	0.27					
<i>p</i> -value	0.000	0.000	0.000					
Delegation of responsibility (DR)	0.24	0.17	0.20	0.17				
<i>p</i> -value	0.000	0.000	0.000	0.000				
Integration of functions (IF)	0.26	0.25	0.19	0.19	0.29			
<i>p</i> -value	0.000	0.000	0.000	0.000	0.000			
Performance related pay (PRP)	0.19	0.21	0.21	0.22	0.17	0.22		
<i>p</i> -value	0.000	0.000	0.000	0.000	0.000	0.000		
Firm-internal training (FI)	0.21	0.20	0.13	0.14	0.15	0.11	0.12	
<i>p</i> -value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Firm-external training (FE)	0.11	0.08	0.12	0.06	0.14	0.07	0.06	0.07
<i>p</i> -value	0.000	0.001	0.000	0.006	0.000	0.001	0.009	0.002

*Interdisciplinary workgroups.

all practices are in fact complementary to some degree. However, as noted in the introduction to Section 2 of this paper, we have not selected the work practices examined at random. Rather we have chosen some of the practices previously identified in the literature as being relevant candidates for obtaining complementarities (with other practices). Nevertheless, the results of Table III show that the correlations coefficients differ in strengths. In this context hypothesis 3a contends that complementarities between work practices contributing to the exchange of information and knowledge creation between employees (“interdisciplinary workgroups”, “quality circles”, “employee proposals”, “job rotation”, “delegation of responsibility” and “integration of functions”) will be particularly strong. This hypothesis is consistent with the empirical evidence to a high degree since most coefficients between those six practices are relatively large (in most cases $\rho > 0.24$). In particular the relatively strong correlations between “interdisciplinary workgroups” and the other five work practices contributing to the exchange of information and knowledge creation between employees can be noted. The only exception concerns the fact that the coefficients between “quality circles” and “job rotation” on the one hand and “delegation of responsibility” on the other hand,

are not particularly high (in both cases $\rho = 0.17$). However, this might not be so surprising after all, since quality circles and job rotation are better used were tasks can be more easily specified, and hence delegation of decision rights might not be so important in this case.

The empirical evidence does not confirm hypothesis *3b* in asserting that complementarities between performance related pay and work practices contributing to the exchange of information and knowledge creation between employees are particularly weak. In fact the correlation coefficients are neither particularly high or low in comparison with the other coefficients in the matrix, since we find significant correlation coefficients of about 0.2 with all other practices other than the two training related practices. Hence, it seems that performance related pay can in fact reinforce team based (or rather work practices contributing to the exchange of information and knowledge creation between employees) work practices and vice-versa, as opposed to what is suggested by contingency theory and by conventional theories of the firm.

Finally, hypothesis *3c*, asserts that firm internal training is a stronger complement to other work practices than firm external training, given that internal training can involve training directly related to the relevant tasks. This hypothesis squares with the empirical results, since the correlation coefficients are in general much lower between external training and other practices, as compared to the coefficients between internal training and other work practices.

4. Conclusion

One of the most powerful recent trends is the thrust to develop a knowledge based theory of the firm. In general, such a theory might best proceed by investigating coordination mechanisms as components of governance structures (Grandori, 1997: 33). In particular, human resource practice combinations help as coordination mechanisms to organise knowledge creation and exploitation in complex social relations. Related empirical investigations have remained sparse, however.

This study addressed this research gap by examining firm types, and knowledge strategy in relation to the application of (complementary) human resource practices in a large scale and cross sectional sample. A key finding of our study is that (a) human resource practices intensities employed are contingent on firm types and knowledge strategies pursued (e.g. innovator strategies) and (b) complementarity effects between the human resource practices included in our analysis obtain, but these complementarities differ in strength.

In particular we found that those firm types who are innovators and/or have strong external knowledge linkages have a stronger tendency to adopt the types of HRM practices discussed in this paper. Moreover, we have shown that manufacturing firms – which to a higher degree can rely on standardisation of job descriptions and processes – are more prone to adopt quality circles and planned job rotation. Moreover and as expected, we found that firm types who can be char-

acterised as being knowledge intensive do apply those HRM practices typically associated with the “organic type” of organisations, more than do other firm types.

However, we found no particular pattern in which firm types apply performance related pay more than other firm types. In this context, it should be noted that a tension between the theories can be detected. On the one hand, the contingency theorists argue that performance related pay should be applied in situations where standardisation of input, behaviour, jobs and output is relatively easy. However, in knowledge intensive firms (e.g. in science based firm types) standardisation of input, behaviour, jobs and output cannot be considered to be relatively easy. On the other hand, it is exactly in those knowledge intensive firms where quasi-rents can be appropriated, and in order to reap such rents firms may need to give pecuniary rewards to employees – possibly in form of performance related pay.

For what concerns complementarities between HRM practices, we found that firm internal training is a stronger complement to other work practices than is firm external training. Also our hypothesis stressing that those (six) work practices contributing to the exchange of information and knowledge creation between employees are mutual complements, found empirical support. Regardless, no support for the contingency hypothesis advancing the claim that performance related pay will be a weak complement (if at all) to other practices, could be detected in the present study. This suggests that while contingencies certainly matter, they may not be as strong in their effects as previously thought. In fact our findings contradicts the “strong” version of the contingency theory, claiming that there is only one “superior” set of HRM practices suitable to govern a particular type of economic activity. Such an observation is not only supported by the fact that we found that performance related pay and team based practices are often complements in the empirical reality, but moreover, by the fact that while we found regularities in terms of statistically significant relationships, we also found that the explanatory power of the relations were not particularly strong, neither when the aim was to explain the type of HRM practice applied, nor when looking at correlation coefficients between the different practices. In other words these findings suggest that there is quite some room for managerial discretion, even when contingencies are taken into account.

In having carried out the present analysis we also believe that we have shown that the notion of complementarities is useful when discussing the adoption of human resource practices. In particular – as pointed out by Grandori (2000) – it is a concept which is easier to deal with empirically, given that it is relatively well-defined as compared to earlier (rather fuzzy) notions of “fit” and “consistency”, very common in the HRM literature. Since the effect of complementarities is easier to identify, we believe that managers may benefit from using the concept, when they decide on which portfolio of HRM practices should be adopted.

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Appendix 1: The Questions from the DISKO Survey Used in this Paper

The letters in square brackets refer to the variables found in Table I.

1. Does the firm use any of the following ways of organising work? (yes/no)
 - a. *Interdisciplinary working groups* [A]
 - b. *Quality circles* [B]
 - c. *Systems for collection of employees proposals* (not quality circles) [C]
 - d. *Planned job rotation* [D]
 - e. *Delegation of responsibility* [E]
 - f. *Integration of functions* (e.g. sales, production/service, finance) [F]
 - g. *Performance pay* (not piece work) [G]
2. Have the firm's employees taken part in *firm internal courses or educational schemes*? (yes/no) [H]
3. Have the firm's employees taken part in *firm external courses or educational schemes*? (yes/no) [I]
4. To which the firm developed a closer co-operation with the following actors during the period 1993–95? (4 point Lickert scale).
 - a. Customers
 - b. Subcontractors
 - c. Consultants' firms
 - d. Knowledge centres such as universities and technological institutes
 - e. Educational institutions

If the respondent answered "to a high Extent" or "to some extent", the variables reflecting *vertical linkages* (customers and subcontractors) [J] and *linkages to knowledge institutions* (consultants' firms; knowledge centres such as universities and technological institutes; and educational institutions) [K] respectively, were given the value of one, else the variables were coded with the value of 0.
5. Is the firm a *subsidiary* of a larger firm? (yes/no) [L]
6. Has the firm introduced new products/services during the period 1993–95 when excepting minor improvements of existing products? (yes/no)

If the respondent answered yes to this question he/she was asked whether similar products/services could be found . . .

 - a. . . . on the Danish market (yes/no)
 - b. . . . on the world market (yes/no)

If the respondent answered that a similar product could be found both on the Danish market and on the world market, the *innovation variable* [M] was coded with the value of 1 (“new to the firm”). If respondent answered that a similar product could be found on the world market, but not on the Danish market, the innovation variable was coded with the value of 2 (“new to the country”). If the respondent answered that similar product could neither be found on the Danish market, nor on the world market, the innovation variable was coded with the value of 3 (“new to the world”). If the respondent answered no the first question under (4), the variable was assigned with the value of 0 (non-innovator).

Appendix 2: The Firm Types Used in this Paper Following the Pavitt Taxonomy

In the study of Pavitt (1984) four types of firms were identified, namely supplier dominated firms, scale intensive firms, specialised suppliers and science based firms. *Supplier dominated* firms are typically small and most technology used comes from suppliers of equipment and material. Such firms “...make only minor contributions to their process or product technology” (p. 356). Additionally, because RandD capabilities are rather low, such firms build their business on professional skills, design, trademarks and advertising (ditto). *Scale intensive*, by contrast are firms which rely on internal sources of technology, such as strong RandD departments to support product innovation. External sources of technology include mainly interactive learning with specialised suppliers, but also inputs from science based firms play an important role. *Specialised suppliers* are firms, which are producers of, typically, production equipment and control instrumentation. Their main internal sources are primarily design and development. External sources of technology are users, such as science based and scale intensive firms. Finally, *science based firms* rely heavily on internal RandD and production engineering. Important external sources of technology include universities, but also specialised suppliers. Since the Pavitt taxonomy was created mainly with the manufacturing sector in mind (although our *crafts* sector could be included in the *supplier dominated* sector, if one were to follow the original Pavitt taxonomy), and since we are conducting an analysis of firms in both manufacturing as well as in services, we have added five additional firm types. *ICT intensive* firms provide business services and financial services. *Wholesale trade firms* consists of firms selling bulk materials or machines. *Scale intensive services* consists of typically large firms in the transport industries, cleaning service as well as of supermarkets and warehouses. *Specialised traditional service firms* is made up of smaller firms including miscellaneous shops, hotels and restaurants, taxi companies etc. *Crafts* consists of firms in construction business, as well as of automobile repair shops.

Appendix 3: The Assignment of Industries into our Nine Sectoral Categories

No.	Industry	Sector
1	Production etc. of meat and meat products	SCAI
2	Manufacture of dairy products	SCAI
3	Manufacture of other food products	SCAI
4	Manufacture of beverages	SCAI
5	Manufacture of tobacco products	SCAI
6	Manufacture of textiles and textile products	SDOM
7	Mfr. of wearing apparel; dressing etc. of fur	SDOM
8	Mfr. of leather and leather products	SDOM
9	Mfr. of wood and wood products	SDOM
10	Mfr. of pulp, paper and paper products	SDOM
11	Publishing of newspapers	SDOM
12	Publishing activities, excl. newspapers	SDOM
13	Printing activities etc.	SDOM
14	Mfr. of refined petroleum products etc.	SCAI
15	Mfr. of chemical raw materials	SCIB
16	Mfr. of paints, soap, cosmetics, etc.	SCAI
17	Mfr. of pharmaceuticals etc.	SCIB
18	Mfr. of plastics and synthetic rubber	SCAI
19	Mfr. of glass and ceramic goods etc.	SDOM
20	Mfr. of cement, bricks, concrete ind. etc.	SCAI
21	Mfr. of basic metals	SCAI
22	Mfr. construction materials of metal etc.	SCAI
23	Mfr. of hand tools, metal packaging etc.	SDOM
24	Mfr. of marine engines, compressors etc.	SPEC
25	Mfr. of other general purpose machinery	SPEC
26	Mfr. of agricultural and forestry machinery	SPEC
27	Mfr. of machinery for industries etc.	SPEC
28	Mfr. of domestic appliances n.e.c.	SCAI
29	Mfr. of office machinery and computers	SCIB
30	Mfr. of radio and communication equipment etc.	SCIB
31	Mfr. of medical and optical instruments etc.	SPEC
32	Building and repairing of ships and boats	SCAI
33	Mfr. of transport equipment excl. ships, etc.	SCAI
34	Mfr. of furniture	SDOM
35	Mfr. of toys, gold and silver articles etc.	SDOM
36	General contractors	CRAF
37	Bricklaying	CRAF
38	Install. of electrical wiring and fittings	CRAF

No.	Industry	Sector
39	Plumbing	CRAF
40	Joinery installation	CRAF
41	Painting and glazing	CRAF
42	Other construction works	CRAF
43	Sale of motor vehicles, motorcycles etc.	SSER
44	Maintenance and repair of motor vehicles	CRAF
45	Service stations	SSER
46	Ws. of agricul. raw materials, live animals	WTRA
47	Ws. of food, beverages and tobacco	WTRA
48	Ws. of household goods	WTRA
49	Ws. of wood and construction materials	WTRA
50	Ws. of other raw mat. and semimanufactures	WTRA
51	Ws. of machinery, equipment and supplies	WTRA
52	Commission trade and other wholesale trade	WTRA
53	Re. sale of food in non-specialised stores	SCIS
54	Re. sale of food in specialised stores	SSER
55	Department stores	SCIS
56	Retail sale of phar. goods, cosmetic art. etc.	SSER
57	Re. sale of clothing, footwear etc.	SSER
58	Re. sale of furniture, household appliances	SSER
59	Re. sale in other specialised stores	SSER
60	Repair of personal and household goods	SSER
61	Hotels etc.	SSER
62	Restaurants etc.	SSER
63	Transport via railways and buses	SCIS
64	Taxi operation and coach services	SSER
65	Freight transport by road and via pipelines	SSER
66	Water transport	SCIS
67	Air transport	SCIS
68	Cargo handling, harbours etc.; travel agencies	SCIS
69	Monetary intermediation	ITIS
70	Other financial Intermediation	ITIS
71	Insurance and pension funding	ITIS
72	Activities auxiliary to financial intermediates	ITIS
73	Letting of own property	SSER
74	Real estate agents etc.	SSER
75	Renting of machinery and equipment etc.	SSER
76	Computer and related activity	ITIS
77	Research and development	ITIS
78	Legal activities	ITIS

No.	Industry	Sector
79	Accounting, book-keeping and auditing Activities	ITIS
80	Consulting engineers, architects etc.	ITIS
81	Advertising	ITIS
82	Building-cleaning activities	SCIS
83	Other business services	ITIS

SCAI = Scale intensive firms; SDOM = Supplier dominated firms; SCIB = Science based firms; SPEC = Specialised suppliers; CRAF = Crafts; WTRA = Whole sale trade; SSER = Specialised traditional services; SCIS = Scale intensive services; ITIS = ICT intensive services.

Notes

¹ In fact it could be interesting to analyse the diffusion patterns of the HRM practices in order to examine the extent to which “old” and “new” practices and systems are in fact complements or substitutes. Unfortunately, since we do not have data on the adoption of HRM practices over time, we have to set this issue aside.

² We interpret human resource practices as explicit organisational coordination-mechanisms. For a comprehensive treatment of other coordination-mechanisms see Grandori (1997).

³ Clan theorists admit, however, that if clan-like organisations build on repeated interaction and longevity of association, stressing clan-control “may entail costs in terms of . . . innovative capabilities” (Grandori, 2001: 151). Our point in this connection is that the human resource practices we associate with knowledge intensive work must not necessarily be restricted to organisations that employ clan-control types.

⁴ Of the total of 1900 responding firms, data are not available for size or sectoral affiliation for 16 of those firms. Hence, we conduct our analysis using information on 1884 firms.

⁵ In the stratification of the sample, firms with less than 10 employees were excluded from the analysis. However in our analysis, we have a size category containing firms smaller than 10 employees. The reason for this is that when the sample was stratified, size was measured at a given point in time. However, in this paper we measure size as the number of full time employees over a full year.

⁶ If managers adopt HR practices for reasons other than efficiency concerns this will influence the measurement of complementarity when using the correlation method for gauging complementarities. This may be true in some cases. However, we have no reason to expect that managers are more likely to ignore efficiency concerns systematically rather than following them.

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