The Organization of Work and Innovative Performance: a comparison of the EU-15

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Abstract

This paper explores the link between the organisation of work and innovation by developing national aggregate indicators for the EU member states of organisational forms and innovation modes (how firms innovate). The organisational indicators are constructed from the Third European Survey of Working Conditions results for 8,081 salaried employees in 2000. The innovation mode indicators are calculated using the results of the third Community Innovation Survey (CIS-3) for innovation activities between 1998 and 2000. The analysis shows that in nations where work is organised to support high levels of discretion in solving complex problems firms tend to be more active in terms of endogenous innovation, i.e. innovation developed, at least to some degree, in house. In countries where learning and problem-solving on the job are more constrained, and little discretion is left to the employee, firms tend to engage in a supplier-dominated innovation strategy. Their technological renewal reflects, almost exclusively, absorption of innovations developed elsewhere. These results suggests that European policy efforts to improve innovation performance as part of the revised Lisbon strategy would benefit from organisational indicators that could be directly linked to innovation performance. The bottleneck to improving the innovative capabilities of European firms might not be low levels of R&D, which are strongly determined by industry structures and difficult to change, but the widespread use of forms of work organisation that are unable to provide a fertile environment for innovation.

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1. Introduction

It is widely recognised that while expenditures on research and development and the skills of scientists and engineers with third-level training are important inputs to successful innovation, these are not the only inputs. Developing new products and services also depends critically on the skills developed by employees on-the-job in the process of solving the technical and production-related problems encountered in testing, producing, implementing and marketing new products and processes. Developing these sorts of skills in turn depends not just on the quality of formal education, but also on having the right organisational structures and work environments. Work environments need to be designed to promote learning through problem solving and to encourage the effective use of these skills for innovation.

Further, rather than viewing innovation as a linear process, recent work on innovation in business and economics literatures characterises it as a complex and interactive process involving multiple feedbacks between different services and functions as well as manifold interactions with customers and suppliers (Freeman 1986; Lundvall 1988; Rosenberg 1982; Kline and Rosenberg, 1985; Nonaka, 1994). The development of new products and processes will depend not only on the resources allocated directly to R&D and design work. Innovating producers need to interact and learn from early adopters within or outside the innovating organisation. Factors that block or slow down innovation may be located down-stream and reflect rigid organisational frameworks that give limited incentives for employees to take part in and contribute to the innovation process.

These considerations imply that relevant indicators for innovation need to do more than capture material inputs such as R&D expenditures and human capital inputs such as the quality of the available pool of skills based on the number of years of education. Indicators also need to capture how these material and human resources are used and whether or not the work environment promotes the further development of the knowledge and skills of employees. Despite the wide acceptance of these views, there exists very little quantitative survey-based research focussing on

organisational environments that promote learning and innovation.[1] To our knowledge, there exist no EU-wide studies of this nature.

The main contribution of this paper is to develop a set of EU-wide aggregate measures that are used to explore at the level of national innovation systems the relation between innovation and the organisation of work. In order to construct these aggregate measures we make use of micro data from two European surveys: the third European survey of Working Conditions carried out at the level of employees by the European Foundation for the Improvement of Working Conditions in the 15 EU member countries in 2000; and the third Community Innovation Survey (CIS-3) carried out at the firm-level in 2001 by each of the 15 member nations and referring to innovation activities between 1998 and 2000. The survey data on working conditions are used to develop what we believe to be the first EU-wide mapping of the adoption of different types of organisational practices and policies. The innovation survey data are used to develop a typology of innovation at the firm level and to calculate the distribution of these innovation types within each of 14 EU countries for which data are available. Although our data can only show correlations rather than causality and are aggregated at the national level, they support the view that how firms innovate is linked to the way work is organised to promote learning and problem-solving.[2]

Specifically, we find that in nations where work is organised to support high levels of discretion in solving complex problems firms tend to be more active in terms of endogenous innovation, i.e. innovation developed, at least to some degree, in house. In countries where learning and problem-solving on the job are more constrained, and little discretion is left to the employee, firms tend to engage in a supplier-dominated innovation strategy. Their technological renewal reflects, almost exclusively, absorption of innovations developed elsewhere. Our results challenge some of the established ideas and they raise new questions about the link between work organisation, learning and innovation. For example, they raise doubts about whether the use of such organizational practices such as job rotation and teamwork are relevant indicators for how far firms engage in learning and innovation. It would be worthwhile to obtain disaggregated data to explore this and other issues in much greater depth.

[1] A notable exception is work based on the DISKO survey for Denmark. See Laursen and Foss, 2003; Nielsen and Lundvall, 2006; and Jensen et al., 2005.
[2] Of course, as with any comparative study based on survey questions that may be interpreted differently in different nations, there is a need to be careful in generalizing from the results.

Our analysis may be seen as contributing also to the literature on national systems of innovation. The systematic relations we observe between the organisation of work and innovation suggest that the way work is organised should be seen as a layer below the observed 'technological infrastructure' that is sometimes assumed to structure the innovation system. While differences in the technological infrastructure may be useful to characterise innovation systems, the underlying structure of how people work and learn may be both more fundamental and more deeply rooted in the national institutional framework. Attempts to benchmark innovation policies in order to locate 'best practise' may only give a view of the tip of the iceberg and they may therefore lead to mistaken conclusions.

The paper is structured as follows. Section 2 describes the variables used to characterise work organisation in the 15 countries of the European Union and presents the results of a factor analysis and a hierarchical clustering used to construct a typology of forms of work practice. Section 3 examines differences in the relative importance of these forms across the EU, controlling for the effects of sector, firm size and occupational category. Section 4 presents the data used to construct the typology of innovation modes developed by Arundel and Hollanders (2005) in cooperation with Eurostat.[3] Section 5 uses the two typologies to examine, at the national level, the relation between the organisational practices adopted in a nation and its distribution of innovation modes. Section 6 considers how different aspects of a nation's social and institutional setting may influence the forms of work organisation adopted and the implications of this for innovation. The concluding section considers some of the main implications of the research for European policy.

2. Measuring forms of work organisation in the European Union[4]

In order to map the forms of work organisation adopted by firms across the European Union we draw on the results of the third European Survey of Working Conditions undertaken by the European Foundation for the Improvement of Living and Working Conditions.[5] The survey questionnaire was directed to approximately 1500 active persons in each country with the exception of Luxembourg with only 500 respondents. The total survey population is 21703 persons, of which 17910 are salaried employees. The survey methodology is based on a 'random walk' multi-stage random sampling method involving face-to-face interviews undertaken at the respondent's principal residence. The analysis presented here is based on the responses of the 8081 salaried employees

[3] Results for the UK were provided by the Department of Trade and Industry and results for Denmark by the Danish Centre for Studies in Research and Research Policy.
[4] This section draws extensively on Lorenz and Valeyre, 2005.
[5] The initial findings of the survey are presented in a European Foundation report by D. Merllié and P. Paoli [2001].

working in establishments with at least 10 persons in both industry and services, but excluding agriculture and fishing; public administration and social security; education; health and social work; and private domestic employees.

The choice of variables for the analysis is based on a reading of two complementary literatures which address the relation between the forms of work organisation used by firms and the way they learn and innovate: the 'high performance work system' literature dealing with the diffusion of Japanese-style organisational practices in the US and Europe (Dertouzos, et. al. 1989; Gittleman et al. 1998; Osterman, 1994 and 2000; Ramsay et al., 2000; Truss, 2000; and Wood,1999) and the literature dealing with the relation between organisational design and innovation (Lam, 2005; Lam and Lundvall, 2006, Mintzberg, 1979, 1983). The 'high performance' literature focuses on the diffusion of specific organisational practices and arrangements that are seen as enhancing the firm's capacity for making incremental improvements to the efficiency of its work processes and the quality of its products and services. These include practices designed to increase employee involvement in problem-solving and operational decision-making such as teams, problem-solving groups and employee responsibility for quality control. Many of the practices identified in this literature were innovations developed by large Japanese automobile and electronics firms in the 1970s and 1980s, and some authors refer specifically to the diffusion of the 'lean production' model associated with Toyota. (Womack, John and Roos, 1990; MacDuffie and Pil, 1997). The diffusion of these Japanese-style organisational practices is seen as having contributed to the progressive transformation of more hierarchically structured firms that relied Taylor's principles of task specialisation and a clear distinction between the work of conception and execution.

While the high performance literature makes a dichotomous distinction between hierarchical and flexible or 'transformed' organisations, the organisational design literature has tended to develop more complex taxonomies. For example, Mintzberg (1983), within the context of a broad distinction between bureaucratic and organic organisations, identifies two types of organic organisation with a high capacity for adaptation: the operating adhocracy and the simple organisation. The forms of work organisation and types of work practices that characterise these two organic forms are quite different. The simple form relies on direct supervision by one individual (typically a manager) and a classic example of this type of organisation is the small entrepreneurial firm. Adhocracies rely on mutual adjustment in which employees coordinate their own work by communicating informally with each other. Various liaison devices such as project

teams and task forces are used to facilitate the process of mutual adjustment. While autonomy in work is low in the simple organisation it is high in the adhocracy.

In contrast to these 'organic' forms, Mintzberg identifies two basic bureaucratic forms with a limited capacity for adaptation and innovation: the machine bureaucracy and the professional bureaucracy.[6] The key characteristic of work organisation in the former is the standardization of jobs and tasks through the use of formal job descriptions and rules imposed by management. Thus there is a high degree of centralisation and limited employee discretion over how work is carried out or over the pace of work. In the professional bureaucracy, on the other hand, centralisation is low and behaviour is regulated and standardised through the acquisition of standardised skills and the internalisation of professional norms and standards of conduct. As a result operating procedures are quite stable and routinized despite considerable autonomy in work.

Lam (2005) in a recent synthesis and extension of these two literatures contrasts two ideal organisational forms that support different styles of learning and innovation: the 'operating adhocracy' and the 'J-form'.[7] She observes that the operating adhocracy relies on the expertise of individual professionals and uses project structures to temporarily fuse the knowledge of these experts into creative project teams that carry out innovative projects typically on behalf of its clients. High levels of discretion in work provide scope for exploring new knowledge and adhocracies tend to show a superior capacity for radical innovation. Compared to the operating adhocracy, the J-form is a relatively bureaucratic form that relies on formal team structures and rules of job rotation to embed knowledge within collective organisation. Stable job careers within internal labour markets provide incentives for members to commit themselves to the goals of continuous product and process improvement and the J-form tends to excel at incremental innovation.

In summary, both the high performance and organisational design literatures draw a relation between the forms of work organisation adopted by a firm and its innovative style and capacity. In order to capture the diffusion across the EU of the main types of work organisation identified in

[6] Mintzberg also refers to a third bureaucratic form, the 'divisionalised' form. Unlike the other four configurations, he describes it as a partial structure superimposed on others (i.e. divisions) each of which is driven towards the machine bureaucracy.
[7] The term J-form is used because its archetypical practices and forms of work organisation are best illustrated by the 'Japanese-type' organisation discussed in the work of Aoki (1988) and Nonaka and Takeuchi (1995).

these literatures, we use the Working Conditions survey data to construct 15 binary variables as presented in Table 1 below.[8]

Table 1
Work Organisation Variables

	Percent of employees
Team work	64.2
Job rotation	48.9
Responsibility for quality control	72.6
Quality norms	74.4
Problem solving activities	79.3
Learning new things in work	71.4
Complexity of tasks	56.7
Discretion in fixing work methods	61.7
Discretion in setting work pace	63.6
Horizontal constraints on work pace	53.1
Hierarchical constraints on work pace	38.9
Norm-based constraints on work pace	38.7
Automatic constraints on work pace	26.7
Monotony of tasks	42.4
Repetitiveness of tasks	24.9
n	*8081*

Source: Third Working Conditions survey, European Foundation for the Improvement of Living and Working Conditions

Four of the variables measure the use of the core work practices identified in high performance work systems literature: team work, job rotation, employee responsibility for quality control, and precise quality norms. Two of the variables capture whether employees engage in learning and problem-solving which are characteristics of both adhocracies and the J-form. One question captures whether work tasks are complex or not and is relevant to the operating adhocracy. The forms of discretion in work that are characteristic of adhocracies are measured by two variables that capture whether employees are able to choose or change their work methods and their pace of work. Four variables measure different constraints on employee discretion in setting their pace of work: 'automatic' constraints on work pace which is linked to the rate at which equipment is operated or a product is displaced in the production flow; 'hierarchical' constraints linked to the direct control which is exercised by ones immediate superiors; norm-based constraints on work pace linked to the

[8] For the questions and coding used to construct the measures upon which the statistical analysis is based, see Appendix

setting of quantitative production norms; and 'horizontal' constraints linked to how one person's work rate is dependent on the work of his or her colleagues. Hierarchical and automatic constraints are classic characteristics of taylorist work settings, while norm-based constraints characterise both taylorism and the Japanese forms of work organisation. The horizontal constraints variable provides a measure of whether work is carried out collectively rather than individually. Finally, the two variables measuring task repetitiveness and task monotony capture typical features of taylorist work settings.

Variety in European organisational practice

In order to assign employees to distinct categories or groups, we first undertake a factor analysis[9] to identify the underlying associations that exist among the 15 organisation variables described in Table 1. We then use the factor scores or the coordinates of the observations on the factors as a basis for clustering individuals into distinct groups of work systems, using Ward's hierarchical clustering method. This allows us to distinguish between four basic systems of work organisation as presented in Table 2.[10] For example, 64.3% of all employees with a job subject to discretionary learning report team work.

The first cluster, which account for 39 percent of the employees, [11] is distinctive for the way high levels of autonomy in work are combined with high levels of learning, problem-solving and task complexity. The variables measuring constraints on work pace, monotony and repetitiveness are under-represented. The use of team work is about at the average level for the population as a whole, while less than half of the employees in this cluster participate in job rotation which points to the importance of horizontal job specialisation. The forms of work organisation in this cluster correspond rather closely to those found in adhocracies and due to the combined importance of work discretion and learning we refer to this cluster as the 'discretionary learning' form.

1.

[9] The factor analysis method used here is multiple correspondence analysis (MCA) which is especially suitable for the analysis of categorical variables. Unlike principal components analysis where the total variance is decomposed along the principal factors or components, in multiple correspondence analysis the total variation of the data matrix is measured by the usual chi-squared statistic for row-column independence, and it is the chi-squared statistic which is decomposed along the principal factors. It is common to refer to the percentage of the 'inertia' accounted for by a factor. Inertia is defined as the value of the chi-squared statistic of the original data matrix divided by the grand total of the number of observations. See Benzecri, J.P. (1973); Greenacre (1993, pp. 24-31).

[10] For a graphical presentation of the positions of the centres of gravity of the clusters on the first two factors of the MCA, see Appendix 2.

[11] The percentages are weighted.

Table 2
Work Organisation Clusters

	Percent of employees by work organisation cluster reporting each variable				
Variable	**Discretionary learning**	**Lean production**	**Taylorism**	**Traditional organisation**	**Average**
Team work	64.3	84.2	70.1	33.4	64.2
Job rotation	44.0	70.5	53.2	27.5	48.9
Quality norms	78.1	94.0	81.1	36.1	74.4
Responsibility for quality control	86.4	88.7	46.7	38.9	72.6
Problem solving activities	95.4	98.0	5.7	68.7	79.3
Learning new things in work	93.9	81.7	42.0	29.7	71.4
Complexity of tasks	79.8	64.7	23.8	19.2	56.7
Discretion in fixing work methods	89.1	51.8	17.7	46.5	61.7
Discretion in setting work rate	87.5	52.2	27.3	52.7	63.6
Horizontal constraints on work rate	43.6	80.3	66.1	27.8	53.1
Hierarchical constraints on work rate	19.6	64.4	66.5	26.7	38.9
Norm-based constraints on work rate	21.2	75.5	56.3	14.7	38.7
Automatic constraints on work rate	5.4	59.8	56.9	7.2	26.7
Monotony of tasks	19.5	65.8	65.6	43.9	42.4
Repetitiveness of tasks	12.8	41.9	37.1	19.2	24.9

Source: Third Working Conditions survey, European Foundation for the Improvement of Living and Working Conditions

The second cluster accounts for 28 percent of the employees. Compared to the first cluster, work organisation in the second cluster is characterised by low levels of employee discretion in setting work pace and methods. The use of job rotation and team work, on the other hand, are much higher than in the first cluster, and work effort is more constrained by quantitative production norms and by the collective nature of work organisation. The use of quality norms is the highest of the four clusters and the use of employee responsibility for quality control is considerably above the average level for the population as a whole. These features point to a more structured or bureaucratic style of organisational learning that corresponds rather closely to the characteristics of the Japanese or 'lean production' model associated with the work of MacDuffie and Krafcik (1992) and Womack et al. (1990).

The third class, which groups 14 percent of the employees, corresponds in most respects to a classic characterisation of taylorism. The work situation is in most respects the opposite of that found in the first cluster, with low discretion and low level of learning and problem-solving. Interestingly, three of the core work practices associated with the lean production model – teams, job rotation and quality norms – are somewhat over-represented in this cluster, implying that these practices are highly imperfect measures of a transition to new forms of work organisation characterised by high levels of learning and problem-solving. The characteristics of this cluster draw attention to the importance of what some authors have referred to as 'flexible taylorism' (Boyer and Durand, 1993; Cézard, Dussert and Gollac, 1992; Linhart, 1994).

The fourth cluster groups 19 percent of the employees. All the variables are underrepresented with the exception of monotony in work, which is close to the average. The frequency of the two variables measuring learning and task complexity is the lowest among the four types of work organisation, while at the same time there are few constraints on the work rate. This class presumably groups traditional forms of work organisation where methods are for the most part informal and non-codified.

In summary, the cluster analysis allowed us to identify three work organisation clusters whose features correspond rather closely to the forms of work organisation found, respectively, in adhocracies, J-form organisations, and machine bureaucracies or taylorist firms. It is important to emphasize that what our employee-level data allows us to capture is the adoption of different forms or work organisation within private sector firms in the EU and not the diffusion of particular types of firms or organisational archetypes. Thus, our results are fully consistent with the possibility that multiple forms of work organisation are being used within the same organisation. This, however, is consistent with what the empirical literature in the field of organisational behaviour and design shows. Pure organisational types are unlikely to found in the real world. As Lam (2005) observes, adhocracies are likely to be found in the creative sub-units of firms and may well be combined with other forms of work organisation. Osterman (1994) in his study of US firms classifies 'transformed' organisations as those which involve at least 50 percent of their employees in four core high performance work practices: teams, job rotation, quality circles, and total quality management.

3. How Europe's economies work and learn

As the figures in Table 3 below show, the discretionary learning forms of work organisation are especially developed in several service sectors, notably business services and banks and insurance,

and in the gas, electricity and water utilities. As one would anticipate, the lean model of production is more developed in the manufacturing sector, notably in the production of transport equipment, electronics and electrical production, wood and paper products, and printing and publishing. The taylorist forms are notably present in textiles, clothing and leather products, food processing, wood and paper products and transport equipment. The traditional organisational forms are to be found principally in the services, notably land transport, personal services, hotels and restaurants, post and telecommunications, and wholesale and retail trade.

Table 3

Forms of Work Organisation by Sector of Activity

	Percent of employees by sector in each organisational class				
	Discretionary learning	**Lean production**	**Taylorism**	**Traditional organisation**	**Total**
Mining and quarrying	42.4	41.5	3.4	12.7	100,0
Food processing	18.4	34.9	24.6	22.1	100,0
Textiles, garments, leather products	27.2	25.9	30.2	16.8	100,0
Wood and paper products	27.6	40.7	23.9	7.8	100,0
Publishing and printing	31.1	43.8	14.1	11.0	100,0
Chemicals and plastics	34.7	34.1	21.9	9.2	100,0
Metal products and mechanical engineering	31.8	35.7	19.8	12.7	100,0
Electrical engineering and electronics	41.5	38.5	8.6	11.4	100,0
Transport Equipment	28.1	38.7	23.2	10.0	100,0
Other industrial production	50.9	22.1	18.4	8.5	100,0
Electricity, gas and water	58.5	19.4	6.2	15.8	100,0
Construction	40.9	31.4	10.6	17.1	100,0
Wholesale and retail trade	41.5	20.4	11.7	26.4	100,0
Hotels and restaurants	29.7	25.8	16.6	27.9	100,0
Land transport	26.3	24.0	10.2	39.5	100,0
Other transport	39.2	36.1	5.0	19.7	100,0
Post and telecommunications	38.1	27.1	7.7	27.1	100,0
Financial services	58.1	21.5	3.4	16.9	100,0
Business services	57.6	18.7	6.9	16.7	100,0
Personal services	39.7	18.9	7.6	33.8	100,0
Average	39.1	28.2	13.6	19.1	100,0

Source: Third Working Condition survey. European Foundation for the Improvement of Living and Working Conditions

Table 4 provides evidence on variations in forms of work organisation according to occupational category. As one would expect, the discretionary learning forms of work organisation are especially characteristic of the work of managers, professionals and technicians, while the lean forms of work organisation primarily characterises the work of employees in craft and related trades and machine operators and assemblers. The taylorist forms are most frequent amongst machine

operators and the unskilled trades. Finally, the traditional forms of work organisation grouped in the fourth cluster are especially characteristic of the work of service workers and shop and market sales persons.

Table 4
Forms of Work Organisation according to Occupational Category

	Percent of employees by occupational category in each organisational class				
	Discretionary learning	**Lean production**	**Taylorism**	**Traditional organisation**	**Total**
Managers	69.1	24.7	0.2	6.0	100,0
Engineers and professionals	75.9	14.0	5.2	4.9	100,0
Technicians	61.0	24.6	2.4	12.0	100,0
Clerks	43.2	21.9	9.4	25.5	100,0
Service, shop & market sales persons	30.3	21.4	12.4	35.9	100,0
Craft & related trades	34.2	38.5	16.5	10.8	100,0
Machine operators & assemblers	15.7	37.7	24.3	22.3	100,0
Unskilled trades	14.8	23.9	26.7	34.5	100,0
Average	39.1	28.2	13.6	19.1	100,0

Source: Third Working Condition survey. European Foundation for the Improvement of Living and Working Conditions

Establishment size constitutes a relatively unimportant factor in the use of different organisational models. The learning forms of work organisation are somewhat underrepresented in the medium-size category of establishments (100 to 249 employees). The lean and taylorist forms increase with establishment size (> 250 employees) while the reverse tendency can be observed for the traditional forms of work organisation.

In combination tables 2, 3 and 4 gives us a better idea of what the different clusters represent. Discretionary learning refers to jobs where a lot of responsibility is allocated to the employee who is expected to solve problems on her own. Business services is a typical example where many jobs involve a continuous confrontation with new and complex problems. Although some of the tasks take place in a team, teamwork is not seen as imposing narrow constraints on the work. In this category team-work may involve brain-storming by professional experts as much as collectively solving narrowly defined problems.

Lean production also involves problem solving and learning but here the problems are more narrowly defined and the scale of possible solutions less broad. The work is highly constrained and

it is often repetitive and monotonous. The extensive use of management techniques such as job rotation (between similar tasks within the same division) and team work may be seen as attempts to overcome the limits of taylorist production and to create some degree of active participation of production workers and sales staff in order to limit labour turnover and absenteeism.

Taylorism is distinctive for low levels of learning and for the virtual absence of problem-solving activity. The work is highly constrained and monotonous. It may be seen as the old-style factory work where the tasks to solve are narrowly defined and repetitive. It is a kind of work where the required qualifications are limited and the worker can easily be substituted by another worker or by a machine. In the era of globalisation this category of work is interesting for two reasons. It is a kind of work where immigrants can be as productive as domestic workers but it is also the kind of work that is most easily outsourced to low wage countries.

Traditional organisation involves even less complex problems. It is more individualistic than all the other categories and less monotonous than lean production and taylorism. It includes traditional service jobs. Many of those involve a direct and indirect interaction with local customers and they may therefore be less foot-loose than the taylorist jobs.

National effects on the diffusion of organisational practice

Table 5 shows that there are wide differences in the importance of the four forms of work organisation across European nations. The discretionary learning forms of work organisation are most widely diffused in the Netherlands, the Nordic countries and to a lesser extent Germany and Austria, while they are little diffused in Ireland and the southern European nations. The lean model is most in evidence in the UK, Ireland, and Spain and to a lesser extent in France, while it is little developed in the Nordic countries or in Germany, Austria and the Netherlands. The taylorist forms of work organisation show almost the reverse trend compared to the discretionary learning forms, being most frequent in the southern European nations and in Ireland and Italy. Finally, the traditional forms of work organisation are most in evidence in Greece and Italy and to a lesser extent in Germany, Sweden, Belgium, Spain and Portugal.

Table 5
National Differences in Forms of Work Organisation

	Percent of employees by country in each organisational class				
	Discretionary learning	**Lean production**	**Taylorist organisation**	**Traditional organisation**	**Total**
Belgium	38.9	25.1	13.9	22.1	100.0
Denmark	60.0	21.9	6.8	11.3	100.0
Germany	44.3	19.6	14.3	21.9	100.0
Greece	18.7	25.6	28.0	27.7	100.0
Italy	30.0	23.6	20.9	25.4	100.0
Spain	20.1	38.8	18.5	22.5	100.0
France	38.0	33.3	11.1	17.7	100.0
Ireland	24.0	37.8	20.7	17.6	100.0
Luxembourg	42.8	25.4	11.9	20.0	100.0
Netherlands	64.0	17.2	5.3	13.5	100.0
Portugal	26.1	28.1	23.0	22.8	100.0
United Kingdom	34.8	40.6	10.9	13.7	100.0
Finland	47.8	27.6	12.5	12.1	100.0
Sweden	52.6	18.5	7.1	21.7	100.0
Austria	47.5	21.5	13.1	18.0	100.0
EU-15	39.1	28.2	13.6	19.1	100.0

Source: Third Working Condition survey. European Foundation for the Improvement of Living and Working Conditions

As Tables 3 and 4 have shown, each form of work organisation tends to be associated with particular sectors and occupational categories. This raises the question of what part of the variation in the importance of these forms across EU nations can be accounted for by the nation's specific industrial and occupational structure, or by other unexplained national factors that could influence the use of specific organisational forms. These unexplained national factors could include socio-cultural attitudes on the part of management and workers, historical developments, and the rate at which new organisational forms are adopted by firms. In order to determine the importance of 'national factors', we use logit regression analysis to provide estimates of the impact of national effects on the relative likelihood of adopting the different work models (See Table 6). Germany, the most populous nation within the EU, is the reference case for the estimates of national effects. In each case the dependent variable is a binary variable measuring whether or not the individual is subject to the particular form of work organisation. The independent variable for columns 1 through

4 in Table 6 is a categorical variable for the 14 countries plus the reference category of Germany. Thus column 1 gives the likelihood that employees are subject to the 'discretionary learning' form of work organisation in each country relative to the German case.

Table 6
Logit Estimates of National Effects on Organisational Practice

	Logit estimates without structural controls				Logit estimates with structural controls			
	1	2	3	4	5	6	7	8
	Discretionary learning organisation	Lean organisation	Taylorism	Traditional organisation	Discretionary learning organisation	Lean organisation	Taylorism	Traditional organisation
Belgium	-0.22	0.32	-0.03	0.01	-0.23	0.42*	-0.11	-0.09
Denmark	0.63**	0.14	-0.82**	-0.79**	0.79**	0.29	-0.86**	-1.06**
Greece	-1.24**	0.35	0.85**	0.31	-1.33**	0.42	0.84**	0.12
Italy	-0.61**	0.24*	0.46**	0.20*	-0.51**	0.20	0.33**	0.16
Spain	-1.15**	0.96**	0.31*	0.04	-1.15**	1.08**	0.06	-0.17
France	-0.26**	0.72**	-0.29*	-0.27**	-0.32**	0.84**	-0.33**	-0.38**
Ireland	-0.92**	0.91**	0.45	-0.27	-1.11**	1.14**	0.47	-0.50
Luxembourg	-0.06	0.33	-0.21	-0.11	-0.17	0.42	0.00	-0.20
Netherlands	0.81**	-0.16	-1.10**	-0.59**	0.79**	0.02	-0.94**	-0.74**
Portugal	-0.81**	0.47**	0.58**	0.05	-0.78**	0.51**	0.44*	-0.01
UK	-0.40**	1.03**	-0.31**	-0.56**	-0.68**	1.32**	-0.24*	-0.72**
Finland	0.14	0.45*	-0.15	-0.71*	-0.01	0.63**	-0.07	-0.78*
Sweden	0.33*	-0.07	-0.77**	-0.01	0.22	0.06	-0.68*	0.00
Austria	0.13	0.12	-0.10	-0.24	0.33	0.14	-0.26	-0.43*

*: significant at 5% **: significant at 1% Reference country: Germany

Source: Third European Survey of Working Conditions. European Foundation for the Improvement of Living and Working Conditions.

Columns 5 through 8 present estimates of the relative likelihood of adopting the various forms of work organisation with structural controls. We have introduced three control variables corresponding to sector, establishment size and occupational category. The respective reference categories for the estimates are the vehicle sector, firms with 10 to 49 employees, and the occupational category of machine operator and assembler.

As the column 1 results show, the country the employee works in has a significant impact on the relative likelihood of using the discretionary learning forms. Compared to the German case, for which the use of the discretionary learning forms of work organisation are near the 15-country weighted average (see Table 5 above), there are three countries where the learning model is more

extensively used: Sweden, the Netherlands and Denmark. There are no significant differences in the use of discretionary learning in four countries: Belgium, Luxembourg, Finland and Austria. The learning model is less in evidence in the remaining seven countries. Column 5 indicates that these results are robust after controlling for the effect of firm size, industry structure, and occupation, with the exception of Sweden, for which the coefficient estimate though still positive is no longer significant.

Column 2 of Table 6 presents the estimates of national effects on the likelihood of using the lean forms without controls. Compared to Germany, where the use of the lean model is relatively low in relation to the 15-country weighted average (see Table 5), Spain, France, Ireland, Finland, the UK and Portugal display a relatively high propensity to use lean production methods. The coefficients are especially high for the UK, Ireland and Spain and they increase slightly and remain significant when structural controls are included.

Overall, the results show that structural factors such as firm size, industry and occupation do not explain the marked national differences in the use of the different forms of work organisation. Instead, unexplained national factors that could be due to historically inherited management-worker relations or attitudes to organisational innovation strongly influence national differences in the use of different sets of organisational practices.

These results suggest that as EU nations progressively have moved away from more traditional or hierarchical forms of work organisation and have sought to increase their capacity for learning and problem-solving, they have done this in different ways. Spain, the UK and Ireland stand out for their intensive use of the lean forms, while the Nordic nations and the Netherlands stand out for their use of the discretionary learning forms. Germany, Austria, France, Luxemburg and Belgium present a more balanced picture regarding the use of these two forms of work organisation each characterised by strong learning dynamics. The countries in the south of Europe are all weak in terms of discretionary learning.

In so far as the organisational practices adopted by firms can influence their ability to develop and profit from innovation, the results in Table 6 suggest that the large differences within the European Union in national innovative performance[12] could partly be linked to national differences in the

[12] As an example, the 2005 European Innovation Scoreboard finds a 2.5 fold difference between the best and worst EU-15 member states on the Summary Innovation Index.

distribution of different types of practices, particularly the use of discretionary learning forms that could maximize the opportunities for learning. This possibility is explored in sections 4 and 5.

4. Measuring differences in innovation mode

Economists and business scholars frequently measure innovation by R&D expenditures or by the number of patents applied for or granted. The weaknesses of these measures are well known. R&D doesn't necessarily result in the development of new products or processes and many innovative firms do not perform R&D. A large fraction of innovations are not patented and the importance of patenting varies according to sector. Furthermore, R&D and patents entirely fail to capture innovation that occurs through diffusion processes, such as when a firm purchases innovative production equipment or product components from other firms. The Community Innovation Surveys (CIS) were in part designed to respond to these limitations by providing survey-based estimates of the percentage of manufacturing firms and selected service sector firms[13] that have developed or introduced a new product or process over a three-year time period. However, the CIS estimates of the percentage of innovative firms are based on a very broad definition of innovation ranging from intensive in-house R&D to develop a new-to-market product or process to minimal effort to introduce manufacturing equipment purchased from a supplier. Consequently, a broad all-encompassing definition of an innovative firm is both misleading in international comparisons and fails to provide a clear picture of the structure of innovation capabilities within individual countries.

In order to overcome these limitations, Arundel and Hollanders (2005), in collaboration with Paul Crowley of Eurostat, classified all innovative CIS respondent firms into four mutually exclusive innovation modes that capture different methods of innovating, plus a fifth group for non-innovators.[14]

The classification method uses two main criteria: the level of novelty of the firm's innovations, and the creative effort that the firm expends on in-house innovative activities. The four innovation modes are as follows:

[13] CIS-3, used for determining innovation modes, did not include firms in several sectors covered in the Third Working Conditions Survey: construction (NACE 45) and service sectors as retail trade (NACE 52), automobile trade and repair (NACE 50), hotels and restaurants (NACE 55), some business services (NACE 74.1 and NACE 74.4 to 74.8), and personal services (NACE 90 to 93). CIS-3 did include wholesale trade (NACE 51). The main effect is that the CIS innovation modes data will underestimate the percentage of firms with traditional forms of work organisation (see Table 3).

[14] Data are available for all EU member nations in 2000 with the exception of Ireland. The classification system is dependent on the types of variables available in the CIS and is limited to variables with a reasonably high response rate. For full details on the methodology for innovation modes, see Annex B of the Trend Chart document 'EXIS: An Exploratory Approach to Innovation Scoreboards http://trendchart.cordis.lu/scoreboards/scoreboard2004/pdf/EXIS.pdf).

Strategic innovators (21.9% of all innovative firms): For these firms, creative in-house innovative activities form an important part of the firm's strategy. All firms have introduced a product or process innovation that they developed at least partly in-house, perform R&D on a continuous basis, introduced a new-to-market innovation, and are active in national or international markets. These firms are the most likely source of innovations that are later adopted or imitated by other firms.

Intermittent innovators (30.7% of all innovative firms): All of these firms develop innovations at least in part in-house and all have developed a new for the market innovation. But, they are less likely than the strategic innovators to have developed important innovations that diffuse to other firms, either because they are only active on local or regional markets, or because they only undertake innovative activities intermittently, say when required by the introduction of new product line.

Technology modifiers (26.3% of all innovative firms): These firms primarily innovate through modifying technology developed by other firms or institutions. None of them perform R&D on either an occasional or continuous basis. Many firms that are essentially process innovators that innovate through in-house production engineering will fall within this group.

Technology adopters (21.0% of all innovative firms): These firms do not develop innovations in-house, with all innovations acquired from external sources. An example is the purchase of new production machinery.

Table 7 presents the distribution of firms according to innovation mode for 14 EU nations for which the necessary data are available and also includes the percentage of firms that did not innovate. The results are weighted to reflect the distribution of all firms within the industry and service sectors covered by CIS-3. The results show that Finland, Germany and Luxembourg have the highest percentage of firms in the strategic and intermittent categories of innovators, while Germany, Luxembourg and Austria have the highest percentages of firms that are technology modifiers. In Spain, Greece, and the UK over 80% of firms are either adopters or non-innovators.

Table 7

A Typology of Innovation Modes for EU Member Nations

	Percentage of all firms by country in each innovation mode					
	Strategic	**Intermittent**	**Technology modifiers**	**Technology adopters**	**Non - innovators**	**Total**
Belgium	7	13	16	14	50	100
Denmark	5	14	11	14	56	100
Germany	10	15	25	11	39	100
Greece	4	9	5	10	72	100
Italy	6	12	15	4	64	100
Spain	2	6	5	19	67	100
France	8	12	10	11	59	100
Luxembourg	7	17	20	4	52	100
Netherlands	8	14	16	8	55	100
Portugal	3	15	16	13	54	100
UK	4	7	5	16	68	100
Finland	13	19	10	3	55	100
Sweden	11	14	14	8	53	100
Austria	8	12	20	9	51	100

5. The relation between organisational practice and innovation mode

As our introductory discussion pointed out, much of the discussion in the organisational behaviour literature on the relation between organisation and innovation focuses on whether or not particular organisational designs are better suited for undertaking radical or incremental innovations. The radical/incremental distinction is often seen as corresponding to the degree to which innovations are competence destroying as opposed to competence enhancing. For example, Lam (2005) and Lam and Lundvall (2006) argue that Mintzberg's (1979, 1983) 'operating adhocracy' form of organisation, which relies on networks of professional experts and the creation of adhoc project teams, is especially adapted to novel or radical innovations characteristic of new emerging technologies. The firms of Silicon Valley provide good examples of this organisational form (Bahrami and Evans, 2000; Saxenian, 1996). In contrast, it is widely asserted in the literature on the Japanese firm that its organisational design is especially suited for progressive or incremental improvements in product quality and design. (Aoki, 1990; Coriat, 1991; Womack et. al, 1990). The Japanese organisation relies on firm-specific knowledge that is embedded in the firm's

organisational routines and relatively stable team structures for continuous product and process improvement.

Since the business practices and forms of work organisation captured in our discretionary learning and lean clusters correspond rather closely to those that characterise the 'operating adhocracy' and the 'Japanese-firm', this literature led us to anticipate differences in the relative frequency of radical and incremental innovations in a nation depending on the relative frequency of diffusion of the discretionary learning and lean forms of work organisation. Developing empirical indicators to identify radical and incremental modes of innovation is problematic, however. Survey manuals, such as the Oslo Manual that provides the basis of the CIS questions, do not propose guidelines for how to measure radical innovations. This makes it difficult to bring survey-based evidence to bear on the various propositions developed in the organisational literature.

Our typology of innovation modes captures a different but related distinction in the nature of innovation by distinguishing between firms that have developed, in-house, 'new-to-market' product or process innovations (particularly strategic innovators) versus firms that have only introduced 'new to firm' innovations that were partly or entirely developed outside the firm (particularly technology modifiers and technology adopters). This distinction is not identical to the difference between radical and incremental innovations, since introducing a 'new to the firm' innovation that was originally developed elsewhere could require the firm to make radical changes to its mix of competences, while conversely a 'new-to-market' innovation need not be a radical innovation. However, there are large differences along the continuum between strategic innovators and technology adopters in each firm's capacity to explore new knowledge, which is conceptually similar (although on a different scale) to the difference between radical and incremental innovations.

In order to provide evidence that bears on the proposed link between organisational practice and innovation modes, we present a series of scatter plot diagrams showing the correlations between the frequency of the four innovation modes and the frequency of the discretionary learning and lean forms of work organisation for the 14 EU nations for which the data is available.

Figure 1

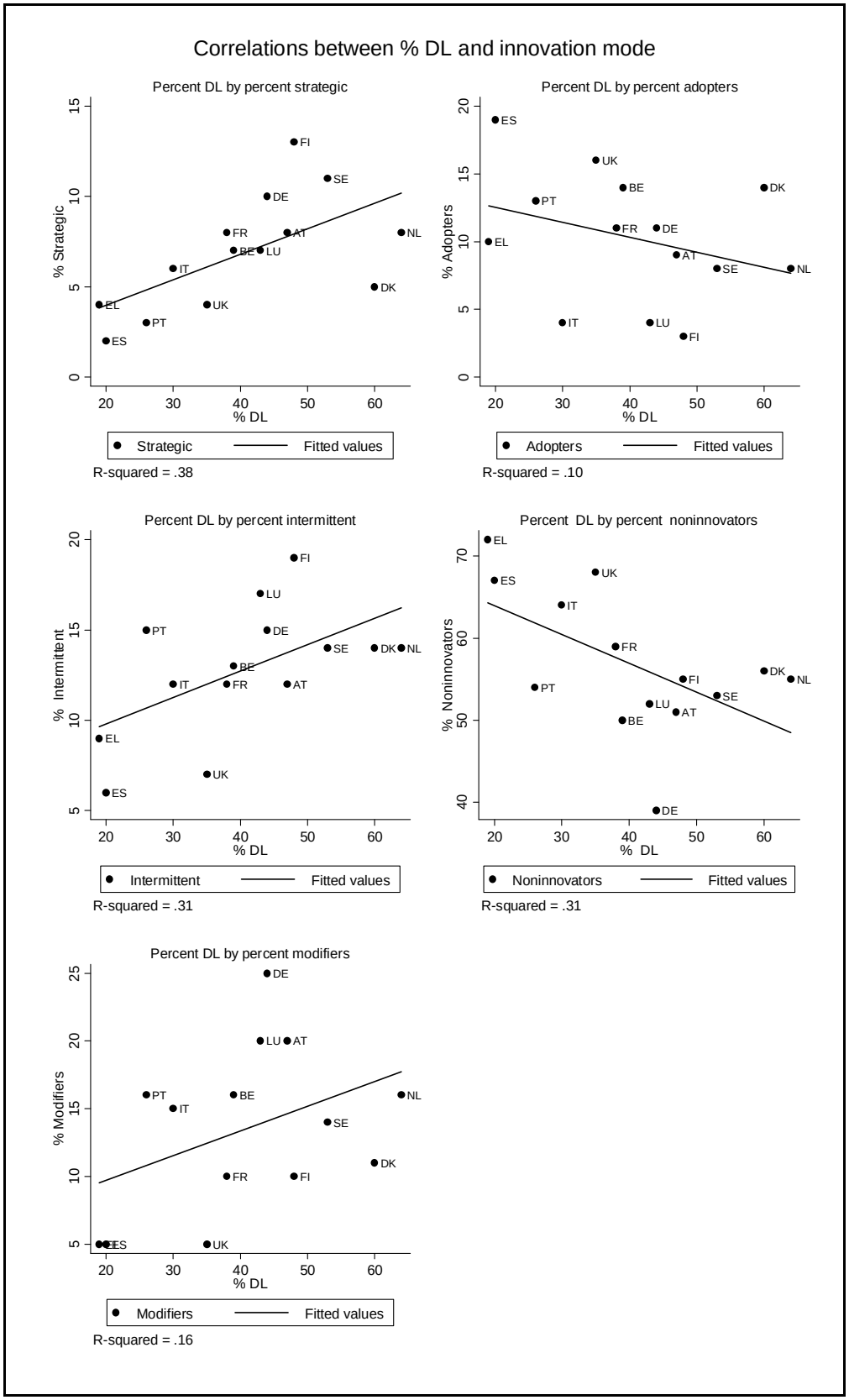

Correlations between % DL and innovation mode
Percent DL by percent strategic
% Strategic
% DL
Strategic
Fitted values
R-squared = .38
Percent DL by percent adopters
% Adopters
% DL
Adopters
Fitted values
R-squared = .10
Percent DL by percent intermittent
% Intermittent
% DL
Intermittent
Fitted values
R-squared = .31
Percent DL by percent noninnovators
% Noninnovators
% DL
Noninnovators
Fitted values
R-squared = .31
Percent DL by percent modifiers
% Modifiers
% DL
Modifiers
Fitted values
R-squared = .16

Figure 1 presents the results of this exercise for the discretionary learning (DL) forms. The main result is that there is a positive correlation between discretionary learning and the frequency of the two innovation modes for which the levels of novelty and creative in-house effort are the highest, the strategic and intermittent modes, while there is a negative correlation between discretionary learning and the frequency of non-innovators. Furthermore, the strongest positive correlation is between strategic innovators and discretionary learning, with 38% of the variation in the percentage of strategic innovators explained by the variation in the percentage of discretionary learning (R^2 of 0.38).[15]

Figure 2 presents the same analysis using the frequency of the lean organisational forms. The results tend to go in the opposite direction of those for discretionary learning. Thus they show a negative correlation between the frequency of the lean forms and the frequency of the three innovation modes which depend on in-house creative effort for innovation, and a positive correlation with the frequency of adopters and non-innovators.[16]

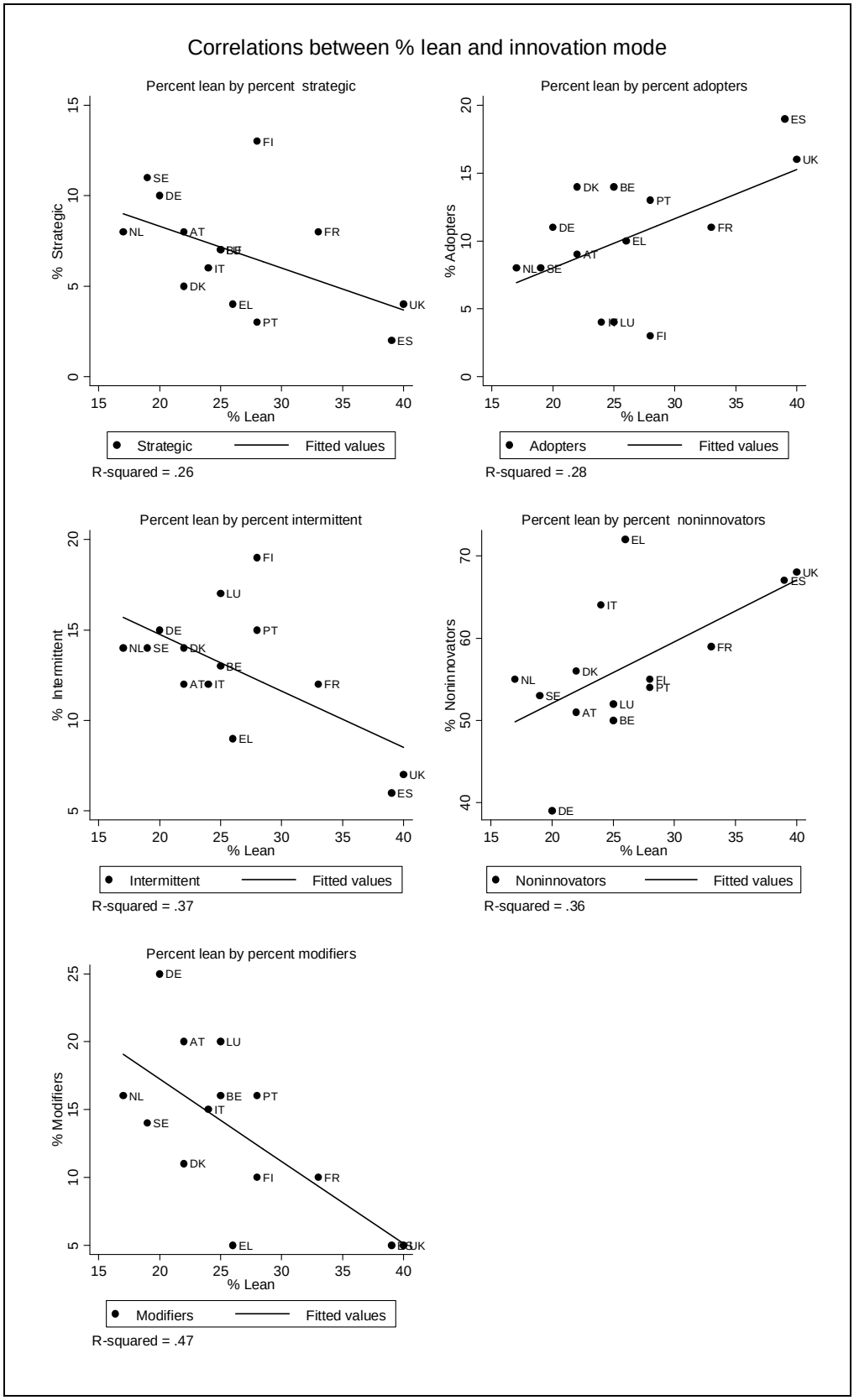
These results provide support for the view that there are systemic links between the way work is organised in a nation and the distribution of different innovation modes.[17] More specifically, the positive correlations between discretionary learning and the strategic and intermittent innovator modes provide support for the hypothesis developed in the qualitative literature that the forms of work organisation characteristic of operating adhocracies support the exploration of new knowledge that is needed for creative, in-house innovative activities that lead to the development of new-to-market innovations and possibly radical innovations.

[15] The correlations between discretionary learning and strategic, intermittent and non-innovators are significant at the .05 level or better. The relatively weak correlations between discretionary learning and the frequency of modifiers (positive) and adopters (negative) are not significant at the .10 level.

[16] All these correlations are significant at the .05 level or better with the exception of the negative correlation between lean and the frequency of strategic innovators which is significant at the .10 level.

[17] The innovation modes are only weakly correlated with the frequency of the traditional forms of work organisation (R-squared less than .10 in all cases). Strategic innovators are negatively correlated with the frequency of the taylorist forms (R-squared = .25, significant at the .10 level) and positively correlated with the frequency of non-innovators (R-squared = .18 but not significant at the .10 level). The taylorist forms are only weakly correlated with the other three innovation modes (R-squared less than .10 in each case).

Figure 2


Correlations between % lean and innovation mode
Percent lean by percent strategic
% Strategic
% Lean
Strategic
Fitted values
R-squared = .26
Percent lean by percent adopters
% Adopters
% Lean
Adopters
Fitted values
R-squared = .28
Percent lean by percent intermittent
% Intermittent
% Lean
Intermittent
Fitted values
R-squared = .37
Percent lean by percent noninnovators
% Noninnovators
% Lean
Noninnovators
Fitted values
R-squared = .36
Percent lean by percent modifiers
% Modifiers
% Lean
Modifiers
Fitted values
R-squared = .47

While the negative correlations shown in Figure 2 between the lean forms of work organisation and the frequency of the strategic and intermittent innovator modes are consistent with our reading of the organisational design literature, the negative correlation with the frequency of modifiers is not. Based on the Japanese experience, we expected the frequency of the lean forms to be positively correlated with the prevalence of technology modifiers, which are dominated by innovation based on minor incremental improvements. Furthermore, the results in Table 2 show that employees subject to the lean forms of work organisation report above rates of problem solving and learning. Nevertheless, the negative correlation with the frequency of technology modifiers is the highest observed (R^2 value of 0.47) while the lean forms are positively correlated with the prevalence of firms that either do not innovate or which only innovate through adopting new technology. Firms grouped in this latter category do not need to invest very much in exploring new knowledge in order to innovate[18].

The lack of a positive correlation between the lean forms and the prevalence of technology modifiers could be due to limitations with the data, but an alternative possibility is that the lean model could have been adopted by European firms as a more efficient alternative to Taylorism, without adopting the Japanese emphasis on the delegation of decision-making responsibility to shop-floor employees. Under these conditions, the problem solving and learning tasks reported by employees subject to lean organisation could be severely limited by the high prevalence of reported constraints (see Table 2), limiting opportunities to suggest or implement incremental improvements.[19] If true, the restrictions on lean organisational forms could explain part of the innovation performance gap between Europe and Japan. In the following section we turn to some of the 'unexplained national factors' that may influence why organisational practice varies by nation and the implications of this for innovation.

[18] Some investment in learning will nevertheless be required, either to select new technology to adopt, or even to decide whether or not to innovate in a given time period.

[19] The vast literature on the transfer of Japanese management practices by Japanese multinationals to their affiliates located in Europe and the US and during the 1980s and 1990s provides evidence relevant to this issue. Most of this literature argues that Japanese management practices are modified in the process of transfer resulting in hybrid organisational forms combining elements of work organisation and HRM practices characteristic of the host country. See Kenney and Florida,1993; Liker et al. 1992; and Oliver and Wilkinson, 1992. For evidence on the limited delegation of decision-making authority to shop floor personnel in Japanese transplants located in the UK, see Lorenz, 2000; and Doeringer et al. 2003.

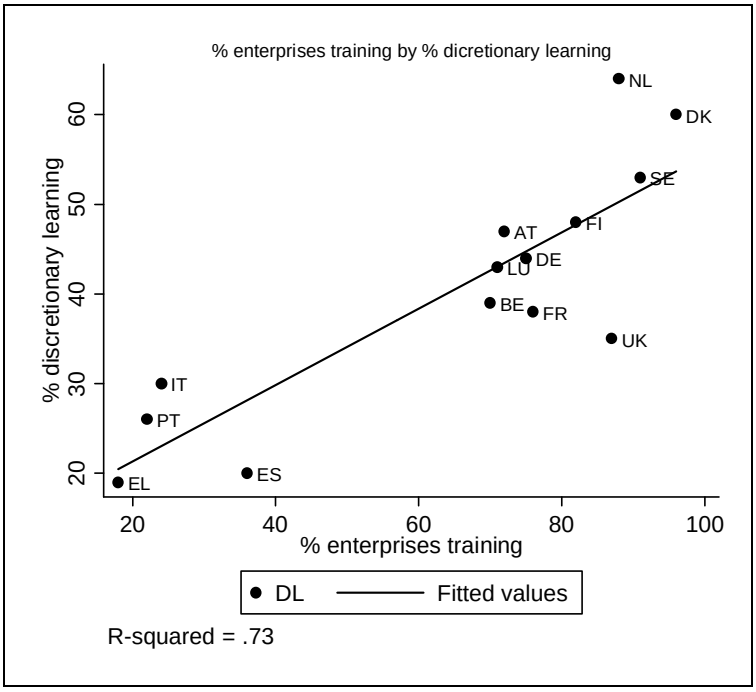
6. National factors and organisational forms

While the discretionary learning and lean forms of work organisation both depend on the capacities of their employees for learning and problem-solving, the former is correlated with in-house innovative capabilities while the latter is only correlated with technology adoption. This raises two questions: what unexplained national factors promote the use of discretionary learning, and what national factors constrain problem solving under lean organisational forms?

Education is clearly a factor. In nations where discretionary learning is widely diffused, there should be a tendency to invest more in the training of employees. Investments in training develop the firm and industry-specific skills of new entrants to the labour market. Life-long learning can also play a critical role in adapting the skills and knowledge of more mature employees' to the requirements of on-going changes in products and technology.

Some support for this proposition can be derived from Figure 3 which shows a strong positive correlation between the frequency of discretionary learning and the percentage of enterprises providing training to their employees. The figure also points to a possible north/south divide within Europe. The four less technologically developed southern nations are characterised by both low levels of enterprise training and low use of discretionary learning, while the more developed northern and central European nations are characterised by relatively high levels of enterprise training and by high level use of the discretionary learning forms.

Figure 3



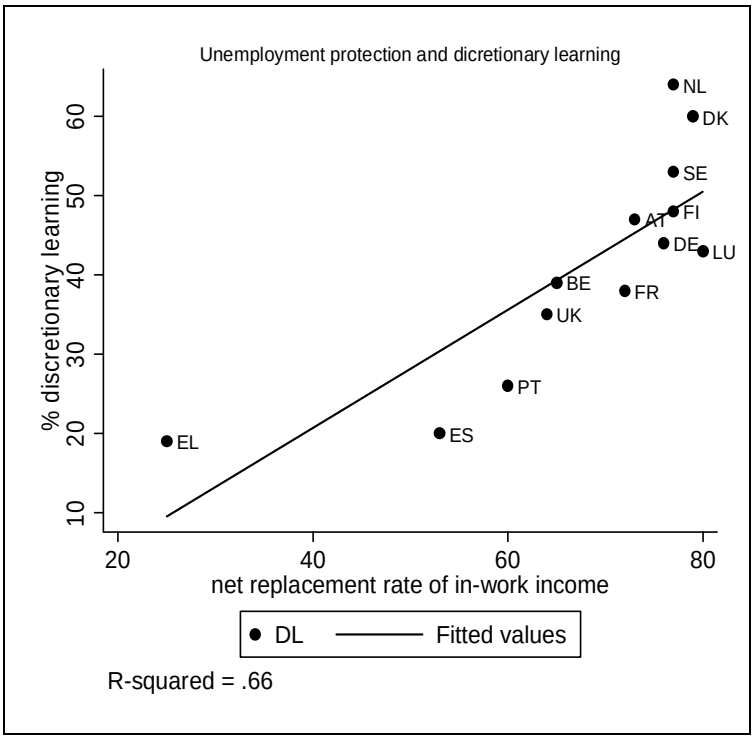
Source: Continuing Vocational Education Survey, 1999 (Newcronos, Eurostat)

Figure 3 points to one anomaly: the UK is the only country within the group of high training nations that uses the lean forms more extensively than the discretionary learning forms (see Table 5). One possibility is that there are unique 'unexplained' factors at work in the UK that influence firms choices of organisational forms. Although it is very difficult to determine what these factors might be, a few clues are provided by Figures 4 and 5 below. Figure 4 shows the relation between the frequency of discretionary learning and an indicator of the strength of a nation's system of unemployment protection. Figure 5 shows the relation between the frequency of discretionary learning and an indicator of the level of national 'social capital'.

Figure 4 indicates that there is a positive relation between the frequency of discretionary learning and the proportion of in-work income being maintained by someone becoming unemployed.[20] One way to interpret this result has to do with the limited tenures that employees often experience in organisations that compete on the basis of strategies of continuous knowledge exploration. As Lam (2005, p. 128) has observed in her discussion of the operating adhocracy, in such organisations the mix of required skills and competences continuously evolves, and careers tend to be structured

around a series of discrete projects rather than advancing within an intra-firm hierarchy. As a result, this kind of organisation has relatively porous organisational boundaries so as to permit the insertion of new knowledge and ideas from the outside. In such a context strong systems of unemployment protection can offer two complementary benefits. First, in terms of incentives, the security such systems provide in terms of income maintenance can encourage individuals to commit themselves to what would otherwise be perceived as unacceptably risky forms of employment and career paths. Secondly, such forms of protection can contribute to the longer term accumulation of knowledge for particular sectors or regions since in their absence unemployed workers would be under greater pressure to relocate with a resulting loss of skills and knowledge.

Figure 4



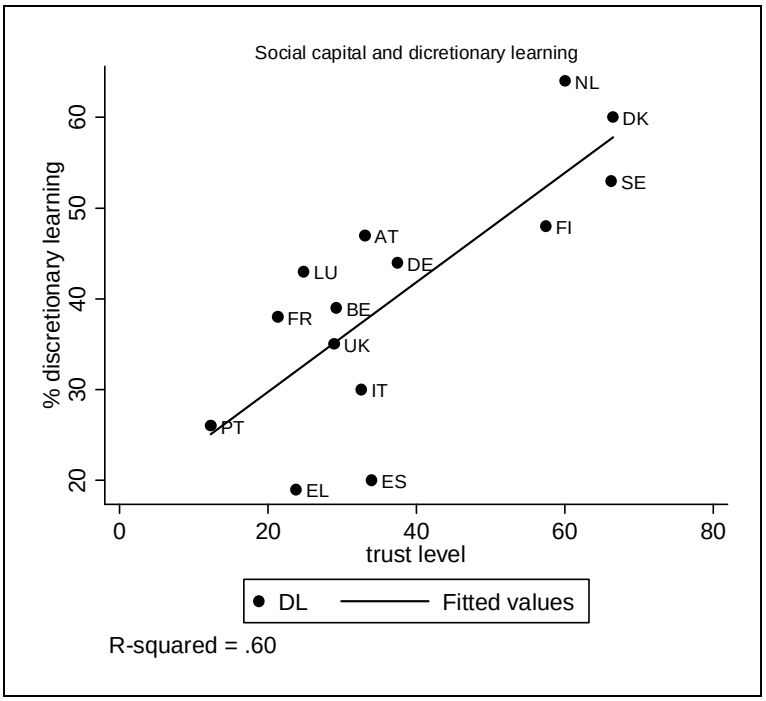
Source: *Benefits and Wages*, OECD (2004, p. 103)

Figure 5 shows a positive relation between the relative frequency of discretionary learning and a measure of the level of generalised trust in a nation that is commonly used in the literature on social capital and productivity growth.[21] The measure of trust is based on a question used in the World

[20] The figures presented in Figure 4 are the net replacement rates of in-work income over 60 months averaged across four family types and two income levels for persons eligible for social assistance. See OECD, *Benefits and Wages*, 2004, p. 103.
[21] See La Porta et al., 1997; Knack and Kneefer, 1997; and Zak and Knack, 1998.

Values Survey in the 1999-2000 wave which provided information on 29 market economies.[22] The question used is: 'Generally speaking, would you say that most people can be trusted, or that you can't be too careful in dealing with people?' For the EU 15, the percentage of the respondents saying that most people can be trusted ranged from a low of 12.3 percent for Portugal to a high of 66.5 percent for Denmark.

Figure 5



World Values Survey, 1999-2000.

One way to interpret these results is that high levels of trust support high levels of autonomy in work whereas low levels of trust tend to give rise to relatively rule-bound and hierarchical forms of organisation. Trust supports autonomy in work for two related reasons. The first pertains to a standard issue raised in the principal-agent literature. The principal (employer) may be unwilling to give the agent (employee) large levels of discretion in work and rely on his or her good intentions in the absence of trust. This would be especially true of employees engaged in processes of knowledge creation which are by their nature complex and uncertain and thus difficult to monitor. The second has to do with the willingness of employees to bear risk. The outcomes of knowledge creation activities are by their nature uncertain and while the forms of autonomy in work which support such creative work may be of intrinsic value to employees they also increase individual responsibility and raise the question of fair treatment in the event of failure. Employees will be more prepared to

[22] See: www.worldvaluessurvey.org

bear these risks in setting characterised by high levels of trust. Of course even in low-trust national settings individual employers can adopt specific human resources policies to foster such trust which more or less goes against the national grain. But such trust will be much easier to foster and sustain in national settings where the presumption is that others can be trusted. Another way of saying this is that high levels of generalised trust in a society spill-over to the work place and have effects on relations of cooperation.

These considerations suggest that the UK's distinctive emphasis on the use of the lean over the discretionary learning forms of work organisation may reflect the way low levels of generalised trust combine with a weak system of unemployment protection to encourage the adoption of bureaucratic and rule-bound forms of organisation. Of course, institutional settings favourable to the adoption of the discretionary learning forms are not entirely absent in the UK. However, they tend to be found in only a few isolated contexts, such as the cluster of high-technology firms around the University of Cambridge, where localised networks of firms provide the necessary 'social capital' for the efficient accumulation of knowledge in an inter-firm career framework.

7. Conclusion

In this paper we have demonstrated that there is a close connection between how people work and learn in a country and the way firms' innovate. In countries where a big proportion of the labour force are engaged in activities that offer them some discretion in organising their work and that involve problem-solving and learning the frequency of 'endogenous' innovation is high. A high frequency of workers engaged in 'lean production' where work is highly constrained does not promote innovation. Management techniques such as job rotation, team working and quality control may be part of the successful Japanese model for incremental innovation. Our data indicate that in Europe these forms do not necessarily stimulate endogenous innovation. It seems as if they need to be combined with some degree of discretion in order to do so.

Though based on simple correlations that cannot establish a causal relation, these results suggest that European policy efforts to improve innovation performance as part of the revised Lisbon strategy need to take a close look at the effect of organisational practice on innovation. The bottleneck to improving the innovative capabilities of European firms might not be low levels of R&D expenditures, which are strongly determined by industry structures and consequently difficult to change, but the widespread presence of working environments that are unable to provide a fertile

environment for innovation. If this is the case, then the next step for European policy is to encourage the adoption of 'pro-innovation' organisational practice, particularly in countries with poor innovative performance. In this respect a better understanding of how the 'unexplained' national factors influence firms' organisational choices could be essential. Some examples of possible factors have been sketched out in Section 6.

The next step in more adequately addressing the relation between organisation and innovation is to obtain complementary firm-level data on both innovation modes and organisational forms. Our results provide a few tentative hypotheses that are consistent with the evidence and which could be explored when better data are available. One option is to develop better indicators of organisational innovation in future CIS surveys, as proposed by the third revision of the Oslo Manual in 2005. The CIS could respond to some of the limitations inherent in relying on the employee-level data of the European Survey on Working Conditions by supplying establishment-level data providing information on the way knowledge flows and knowledge sharing are organised within firms and how they relate to other aspects of corporate strategy.

We hope our results will widen the debate and stimulate further comparative research exploring the links between organisational forms, innovative performance, and the institutional context within Europe.

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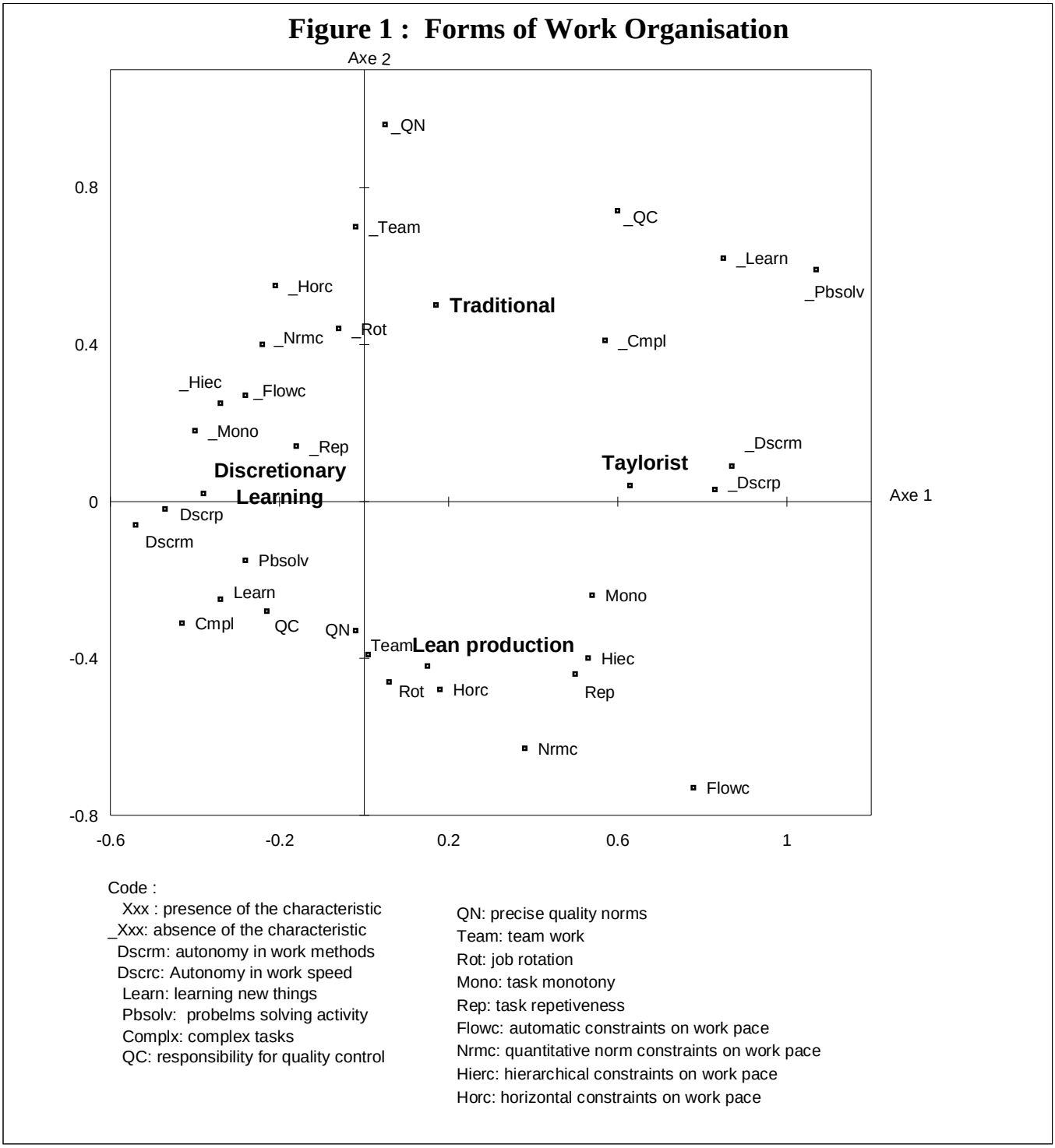
Appendix 1

Organisational Variables

Variable		Mean
Team work	1 if your job involves doing all or part of your work in a team, 0 otherwise	64,2
Job rotation	1 if your job involves rotating tasks between yourself and colleagues, 0 otherwise	48,9
Quality norms	1 if your main paid job involves meeting precise quality standards, 0 otherwise	74,4
Discretion in fixing work methods	1 if you are able to choose or change your methods of work, 0 otherwise	61,7
Discretion in setting work pace	1 if you are able to choose or change your pace of work, 0 otherwise	63,6
Horizontal constraints on work pace	1 if on the whole your pace of work is dependent on the work of your colleagues, 0 otherwise	53,1
Hierarchical constraints on work pace	1 if on the whole your pace of work is dependent on the direct control of your boss, 0 otherwise	38,9
Norm-based constraints on work pace	1 if on the whole your pace of work is dependent on the numerical production targets, 0 otherwise	38,7
Automatic constraints on work pace	1 if on the whole your pace of work is dependent on the automatic speed of a machine or movement of a product, 0 otherwise	26,7
Employee responsibility for quality control	1 if the employee's main paid job involves assessing him or herself the quality of his or her own work, 0 otherwise	72,6
Employee problem-solving	1 if your job involves solving unforeseen problems on your own, 0 otherwise	79.3
Learning new things	1 if your job involves learning new things on your own, 0 otherwise	71,4
Task Complexity	1 if your job involves complex tasks, 0 otherwise	56,7
Task monotony	1 if your job involves monotonous tasks, 0 otherwise	42,4
Task repetitiveness	1 if your work involves short repetitive tasks of less than one minute, 0 otherwise	24,9

Appendix 2

Graphical Representation of Factor Analysis - 15 Organisational Variables



The figure above presents graphically the first two axes or factors of the multiple correspondence analysis (MCA). The first factor or axis, accounting for 18% of the inertia or chi-squared statistic, distinguishes between taylorist and 'post-taylorist' organisational forms. Thus on one side of the

axis we find the variables measuring autonomy, learning, problem-solving and task complexity and to a lesser degree quality management, while on the other side we find the variables measuring monotony and the various factors constraining work pace, notably those linked to the automatic speed of equipment or flow of products, and to the use of quantitative production norms. The second factor or axis, accounting for 15% of the chi-squared statistic, is structured by two groups of variables characteristic of the lean production model: first, the use of teams and job rotation which are associated with the importance of horizontal constraints on work pace; and secondly those variables measuring the use of quality management techniques which are associated with what we have called 'automatic' and 'norm-based' constraints. The third factor, which accounts for 8 percent of the chi-squared statistic, is also structured by these two groups of variables. However, it brings into relief the distinction between on the one hand those organisational settings characterised by team work, job rotation and horizontal interdependence in work, and on the other hand those organisational settings where the use of quality norms, automatic and quantitative norm-based constraints on work pace are important. The second and third axes of the analysis demonstrate that the simple dichotomy between taylorist and lean organisational methods is not sufficient for capturing the organisational variety that exists across European nations.

The projection of the centre of gravity of the four organisational clusters coming out of the hierarchical classification analysis (see Table 2) onto the graphic representation of the first two factors of the MCA shows that the four clusters correspond to the quite different working conditions. The discretionary learning cluster is located to the east of the graph, the lean cluster to the south, the taylorist cluster to the west and the traditional cluster to the north.