Numerical and Functional Labour Flexibility at Firm Level: Are There Any Implications for Performance and Innovation? Evidence for the Swiss Economy*

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1. Introduction

Flexible working patterns have been the subject of considerable interest as well as the source of much controversy in the past twenty years. Particularly, what is regularly emphasized is the importance of human resource management practices that enable organizations to adapt quickly to rapid developments in technology, mismatch in labour markets, stronger price and non-price competition in product markets and financial restructuring in capital markets.

Flexibilization of labour has many dimensions. Researchers have emphasized two distinct strategies of flexible labour utilization (see e.g. Hutchinson and Brewster 1994, Kalleberg 2001). A first one is „numerical flexibility", which addresses the variation of the quantity of labour input. This variation can take place within the firm (overtime, flexible monthly hours, etc.) or by use of the (external) labour market (fixed-term contracts, lay-offs/dismissals, subcontracting, etc.) and aims at reducing firm costs. Many observers assume that high numerical flexibility is at the core of the „American Model" of new employment systems.

A second aspect of flexibility, which is often ascribed to the „European Model", is called „functional flexibility". This term is related to the multiple competencies of workers in general, the parallel work in different functions („multi-tasking"), the sequential work in different functions („job rotation"), participation in decision-making, etc.. It is assumed that broadly-based vocational qualifications are a precondition for the well-functioning of this type of flexible use of labour at firm level. The same holds true for the functional flexibility at the level of the labour market, since workers with broadly-based skills are well-suited to undertake a new task in another firm, which reduces frictional unemployment in times of low labour demand.

Much of the discussion on labour flexibility has centered on the model of the "flexible firm" combining both types of flexibility through the employment of a "core" workforce consisting of full-time permanent employees and a "peripheral" one of part-time and temporary workers (Atkinson 1984). The debate about this model has focused mainly on whether it is an accurate representation of employers' labour utilization strategies, or whether the changes associated with it are the result of high unemployment, reduced trade union influence or other factors beyond management's control (Kalleberg 2001). This narrowing of the discussion has hindered the development of models and the empirical investigation of the relationship between functional and numerical flexibility. Thus, this is an open research question to be further pursued.

What about the situation in the Swiss labour market and the Swiss business sector? An empirical analysis that we have conducted in an earlier study (Arvanitis et al. 2002) shows that no spectacular changes have taken place in the Swiss labour market in the last fifteen years with respect to new types of quantitative flexibilization such as part-time jobbing, fix-term contracting, mediation of workers through manpower agencies and so on. The reason for the lack of great changes in terms of the above-mentioned type of numerical flexibility in the

nineties is that the Swiss labour market has already being flexible before the period of economic stagnation. The crucial transformations which took place since the middle of the eighties were related to a) the increase of the share of foreign workers having the same rights in labour market as natives and b) the rise of the participation rate of women (often via part-time employment).

With respect to functional flexibility, we get the following picture: high average educational level, job-related training, intensive use of information technologies and wide-spread flexible organizational practices at firm level seem to be positively correlated with each other; this tendency has been accentuated in the second half of nineties (see also section 4). Thus, some important preconditions for functional flexibility seem to be fulfilled in many important sectors of the Swiss economy. On the whole, the available evidence shows that the Swiss labour market is developing in the direction of more functional flexibility, numerical flexibility having attained already in the nineties a satisfactory level.

Aim of this study is to define and measure numerical and functional flexibility at the firm level and investigate the impact of each of these flexibility modes on performance, cost and innovation measures as well as the interrelationship between them.

In section 2 the conceptional background of the paper is briefly sketched, out of which a series of hypotheses are formulated. In section 3 we present information on the type of data used and on the data sources. Section 4 offers a description of the data material for the Swiss business sector. In section 5 the empirical model of the study is specified. The model estimates are discussed in section 6. Finally, section 7 contains a summary and some conclusions.

2. Conceptional Background

We are going to focus to two types of flexibility which are located at the microeconomic level and are therefore closely related to the strategies of enterprises. The first one is *numerical flexibility* defined as a process through which firms react to changes in the demand for their products/services by adjusting the amount of labour they employ. It is achieved through overtime, part-time work, variable working hours, fixed-time contracts or lay-offs. There is a further distiction among the various forms of numerical variation of labour which is both conceptually and empirically advisable to keep in mind: temporary and part-time work (which is often permanent work). A main reason for making this distinction is that “the motivation of employers for using the two types of labour is likely to differ, as are the problems facing employers in managing the two different labour forces” (see Osterman 1999, p. 55). In this context, temporary work includes temporary help firm employees, on-call workers (who work for a firm for a specific period of time but are not part of the regular work force), freelance workers / independent contractors and other people with jobs that are temporary for one of the

following four reasons: they are temporarily replacing another worker, their job is seasonal, they are working only on a specific project, or they are working on a fixed-term contract (see Osterman 1999, p. 85; see also Bronstein 1991 for definitions of temporary work).

The second type of flexibility is *functional flexibility* meaning a process through which enterprises adjust to changes in the demand for their output by an internal re-organization of workplaces based on multi-skilling, multi-tasking, team-working and the involvement of workers in job design, innovation, technology and the organization of work. According to new theoretical approaches to workplace organization, functional flexibility is generated through the combined use of new information technologies and new forms of workplace organization, both of them requiring high-skilled labour to be operated (see e.g. Milgrom and Roberts 1990 and Lindbeck and Snower 2000 for formal theoretical models; Kalleberg 2001 for non-formal concepts of functional flexibility defined as a fundamental characteristic of "High-Performance Work Organizations"; see also Osterman 1999, Ch. 4 for a description of the American experience on this matter).

In this paper our primary goals are, first, to investigate the impact of numerical and functional flexibility respectively on firm performance und innovativeness, and, second, to determine the relative importance of numerical and functional flexibility with respect to a series of performance, cost and innovation measures at firm level. To this end, we use the theoretical framework of a production function in order to model the relationship between numerical and functional flexibility respectively and various outcomes of firm activities. Our estimation equation contains, besides the classical production factors labour and physical capital, ICT capital, organization capital and human capital.

According to standard theory and recent empirical evidence, we expect considerable direct positive effects of ICT, organization and human capital on firm performance (see Brynjolfsson and Hitt 2000 for a recent survey of empirical literature along this line). If we proxy functional flexibility with the existence within a firm of a series of new organizational practices such as team-work, job rotation, decentralization of decision-making, flattening of management hierarchies, etc., then we would also expect a positive effect of it on firm performance (see Kalleberg 2001 and Appelbaum et al. 2000).

From a theoretical point of view the quantitative flexibilization of labour, e.g. in form of part-time and fixed-term contract work, aims at reducing labour costs, smoothing the burden of regular work or providing the firm with specialized services (see e.g. Abraham and Taylor 1996); so we would expect a positive correlation of proxies of numerical flexibility to performance and a negative correlation to cost measures. Nevertheless, we should have to bear in mind that the evidence in the empirical literature, e.g. for part-time work and fixed-term contract work, is mixed and depends on the overall conditions of the labour market as well as its institutional framework (see e.g. Hutchinson and Brewster 1994 for detailed firm case studies in several European countries dealing with the advantages and disadvantages of

several flexibility measures). We expect a positive effect for flexible working time, particularly for flexible yearly working time which does not only expand employee time sovereignty but also contributes to a more efficient combination of labour and equipment.

In a further step, we also investigate the relationship between these two types of flexibility by testing the hypothesis of the complementarity between numerical and functional flexibility. This hypothesis is better known as the "core-periphery" model of the firm (see Atkinson 1984 for the original formulation of the „core-periphery" model of the firm and Kalleberg 2001 for a review of the empirical literature on this subject). According to a stylized version of this model there exist a series of firm-specific key activities which are conducted by a numerically stable "core group" of employees characterized by functional flexibility (involving e.g. multi-discipline project teams, re-training, changing career); to this employee group belong e.g. managers, technicians, technical sales staff, etc.. The central characteristic of this group is that their skills cannot readily be bought-in. Around these core activities there are also many other important tasks which are not firm-specific and can be performed by numerically flexible employees ("peripheral group") which can be relatively easily recruited from the external labour market. These jobs are not firm-specific either because they are highly specialized (e.g. systems analysis) or because they are low-skilled (e.g. clerical occupations); in both cases firms are inclined to resource them outside and have an interest to do this in a flexible way. In this view these two kinds of activities and employee groups respectively are complementary to each other and so are also the corresponding flexibility modes.

3. Data

The data used in this study were collected in the course of a survey among Swiss enterprises using a questionnaire which included questions on the incidence and within-firm diffusion of several ICT technologies (e-mail, internet, intranet, extranet, etc.) and new organizational practice (team-work, job rotation, employees' involvement, etc.), employees' vocational education and job-related training, flexibility of working conditions and labour compensation schemes.[1] The survey was based on a (with respect to firm size) disproportionately stratified random sample of firms with at least 20 employees covering all relevant industries of the business sector as well as firm size classes (on the whole 28 industries and within each industry three industry-specific firm size classes with full coverage of the upper class of large firms). Answers were received from 1667 firms, i.e. 39.4% of the firms in the underlying sample. The response rates do not vary much across industries and size classes with a few exceptions (over-representation of paper and energy industry, under-representation of hotels, catering and retail trade). The non-response analysis (based on a follow-up survey of a sample

[1] The questionnaire was based to a considerable extent on similar questionnaires used in earlier surveys (see EPOC 1997, Francois et al. 1999, Vickery and Wurzburg 1998, Canada Statistics 1999). Versions of the questionnaire in German, French and Italian are available in www.kof.ethz.ch.

of the non-respondents) did not indicate any serious selectivity bias with respect to the use of ICT and new organizational practices (team-work, job rotation). A careful examination of the data of these 1667 firms led to the exclusion of 285 cases with contradictory or non-plausible answers with respect to the performance and cost variables; there remained 1382 valid answers which were used for the explicative analysis (see table A.1 in the appendix for the structure of the used data set by industry and firm size class).[2]

Further, we used the multiple imputations technique by Rubin (1987) to substitute for missing values in the variables due to item non-response (see Donzé 2001 for a detailed report on these imputations). The estimations are based on the mean of five imputed values for every missing value of a certain variable.

4. Labour Flexibility, Working Time Flexibility and the Use of New Organizational Practices in the Swiss Business Sector

According to our data 23.8% of firms report that part-time work is very important, 19.5% that temporary work[3] is very relevant for their operation (see table 1). Above-average shares of firms with relatively many part-time employees are found not only in traditional service industries such as trade, hotels and catering but also in some high-tech branches such as chemicals and electronics/instruments. There are no significant differences with respect to part-time work between large and small firms. Temporary work is much used, apart from industries with seasonal demand fluctuations such as construction and hotels, also in the metal industry, in machinery and in electrical machinery. Temporary work is to be found much more often in large firms than in small ones. In sum, both types of numerical flexibility appear to some extent in most industries and size classes in the Swiss business sector.

Table 1 contains also information on the incidence of two types of flexible work schedules: working time flexible within a month and working time flexible within a year. For 20.9% of all firms was the monthly work schedule very important, for 32.1% of them was the flexibilization of working time within a year of great relevance. No specific sectoral pattern was discernible for the former type of working time flexibilization; the latter one was found more frequently in manufacturing and construction firms than in service enterprises. Working time flexibility is significantly more often used in large than in small firms.

All four types of labour flexibility show positive correlations to each other (table A.2); the most strong relations are those between part-time and temporary work (r=0.264) and between the two types of working time flexibility (r=0.310). These clearly positive relations among

[2] Table 1 and table 2 of the descriptive analysis are based on data for 2589 firms including also those with less than 20 employees for which no data on new organizational practices are available; tables 3 to 6 are based on data for 1667 firms reporting on organizational changes.

[3] Temporary work in Switzerland includes such forms as fixed-term contract work, work temporarily hired from manpower agencies, other firms, etc.

these variables is a hint that firms are applying most of these flexibility modes not alternatively but in a complementary way.

Table 2 yields some information on the relationship between output fluctuations and labour flexibility. The stronger a firm is exposed to output fluctuations, the more important is labour flexibility in order to cope successfully with output fluctuations. This is true for all types of flexibility to be taken into consideration in this study: the frequency of using one of these flexibility modes is significantly higher for firms which are exposed to strong output fluctuations than for those which are not.

Tables 3 to 5 present some information on the incidence of several new organizational practices in the Swiss business sector which can be considered as preconditions for functional flexibility. Team-work was used in 35.7%, job rotation in 10.4% of all firms in the year 2000; these figures have doubled between 1995 and 2000 (table 3). There are significant differences with respect to the diffusion of these two practices in the manufacturing and the service sector, manufacturing firms using considerably more team-work and job rotation than service and construction firms. 20.8% of all firms, i.e. 58.3% of firms with team-work, use this organizational practice intensive, for job rotation the corresponding figures are 4.2% and 40.4% respectively (table 4). There are no significant differences among the sectors with respect to the intensity of use of these two organizational practices. As the data in table 5 show, the number of managerial levels did not change much between 1995 and 2000 for firms in all sectors of the economy; 9.4% of firms reported a decrease, 4.8% an increase, on the balance only 4.6% of all firms flattened their hierarchical structure in this period. The same table contains also data on the overall shift of competences from managers to employees in the period 1995-2000: 40.0% of all firms reported such a shift; this figure was somewhat higher in manufacturing (48.5%), approximately the same in the service sector (42.4%) and considerably lower in the construction industry (21.2%).

Finally, it is interesting to compare managers‘ subjective assessment of the impact on performance of the use of new organizational practices with the results of a microeconometric model like the one to be presented in the next section. In view of our results (see section 6) it is rather astonishing that 70.4% of all firms applying some or all of the new organizational practices assessed the impact of these changes on firm efficiency to be positive (see table 6); only 26.7% of them could not find any influence, the assessments with respect to the impact of organizational change on firm efficiency are quite similar among the sectors of the economy. Do managers exaggerate this effect in order to justify their own involvement in introducing and carrying through new organizational practices? The question is sensible but difficult to answer without further information.

5. Model Specification and Variable Construction

In this study we use four continuous and three discrete variables as dependent variables. The continuous variables are: (a) the logarithm of sales per employee (log(S/L); average labour productivity), (b) exports as a share of sales (EX/S), (c) the logarithm of labour costs per employee (log(C/L)) and (d) the logarithm of labour costs as a share of sales (log(C/S)) (see also note to table 7). When log(S/L) is used as the dependent variable, we insert a right-hand variable to control for intermediate (material and service) inputs (logarithm of the value of intermediate inputs per employee). Since we do not dispose of data on physical capital, we rely on extensive industry controls to seize the influence of this important variable.

As measures for technology input, particularly ICT input („ICT capital"), we use the intensity of use of two important network technologies, internet (linking to the outside world) and intranet (linking within the firm). This intensity is measured by the share of employees using internet and intranet respectively in their daily work. The firms were asked to report this share not by a precise figure but within a range of twenty percentage points (1% to 20%, 21% to 40% and so on). Based on these data we constructed five dummy variables for each technology covering the whole range from 1% to 100% (see note to table 7). The idea behind this variable is that a measure of the diffusion of a certain technology within a firm would be a more precise proxy for „ICT capital" than the mere incidence of this technology or some kind of simple hardware measure (e.g. number of personal computers, etc.). We expect in general a positive correlation of technology variables with average labour productivity, in particular an increasing positive correlation with a higher percentage of employees using a certain technology.

A second important category of production inputs is related to human capital. We use three variables to approximate human capital: the share of employees with education at the tertiary level (universities, business and technical colleges, etc.); the share of employees receiving job-related training (internal and/or external training courses initialized or supported by the firm); a dummy variable for strong orientation of training particularly to computer training (see also note to table 7). According to standard analysis (see e.g. Barro and Lee 1994) we expect a strong positive correlation of these variables to labour productivity.

The measurement of organizational inputs is an issue still open to discussion, since there is not yet any agreement among applied economists to the exact definition of „organizational capital" (see Black/Lynch 2002 for a discussion of this matter; see also Appelbaum et al 2000, Ch. 7 for definitions of high-performance work system variables). Our data enable us to construct the following dummy variables covering most of the aspects of organizational capital discussed in the literature (full model version; see table 7): intensive use of team-work (project groups, quality circles, semi-autonomous teams, etc.); intensive use of job rotation; decrease of the number of management levels; overall shift of decision competencies from managers to employees; employees having the competence to solve relatively autonomously

emerging production problems (production) or to contact customers (sales) (see also note to table 7). We expect an overall positive correlation of organizational variables with average labour productivity, but we do not have sign expectations for every single variable.

In a second model version we constructed a composite index of the six single organizational variables used in the full model version (variable ORGANS in table 9). This was calculated as a sum of the stardardized values (average 0; standard deviation 1) of the six constituent variables. This composite variable can be viewed as a proxy for functional flexibility for which a positive effect on firm performance is expected.

To measure numerical flexibility we use two variables: (a) a dummy variable for the relevance of *part-time work* and (b) a dummy variable for the importance of *temporary work*. Both variables are originally measured on a five-point Likert scale (1: „no importance“; 5: „very high importance“) and transformed in a binary variable by putting together levels 1, 2 and 3 and levels 4 and 5 respectively.

We also include two more variables which are related to working time flexibility which can be viewed as a further dimension of numerical flexibility: (a) a dummy variable for *monthly* flexible working time and (b) a dummy variable for *yearly* flexible working time (see also note to table 7). These two variables are also measured on a five-point Likert scale (1: „no importance“; 5: „very high importance“) and transformed in a binary variable by putting together levels 1, 2 and 3 and levels 4 and 5 respectively.

In general, as already mentioned in section 2 we expect for all four dummy variables for numerical flexibility a positive correlation with average labour productivity and export share and a negative with cost variables (labour costs per employee; labour costs as a share of sales); it is not a priori clear what should be the effect on innovation.

Finally, our model contains also a variable referring to incentive-based compensation: it is a dummy variable for the existence of employee compensation according to team-performance (see note to table 7). With respect to the compensation variable the sign of the correlation with the dependent variable is not a priori clear; whether compensation according to team-performance enhances employee incentives to higher achievements is an open empirical question.

6. Results of the Model Estimations

Performance and Cost Measures (Full Model)

Table 7 contains the results of the OLS estimates of the full model for the four metric dependent variables log(S/L), EX/S, log(C/L) and log(C/S). Since the results are only cross-section estimates, it is not possible to formulate causal relations between the independent variables and the dependent variable. Nevertheless, some robust regularities come out, which

if interpreted in view of our hypotheses (see section 2) could possibly indicate the direction of causal links. The overall fit of the model (R^2=0.202 to 0.494) is satisfactory for a cross-section investigation.

We comment first the results for log(S/L) with respect to the information and communication technology (ICT) and human capital variables, then in summary those for the other metric variables. The coefficients of nine of the ten dummy variables for the intensity of use of internet and intranet, as expected, are positive and statistically significant. The general tendency is that the higher the intensity of use of these technologies among firm employees, the higher is also the positive correlation to labour productivity. Thus, there is a more or less systematic positive correlation between the level of intensity of use of ICT and the level of labour productivity. There are positive correlations of the internet and intranet dummy variables also with the endogenous variables EX/S and log(C/L), but the effects are considerably weaker; only some of the coefficients of the dummy variables are in these cases statistically significant at the 10% test level. High export shares and/or high labour costs per employee are not necessarily positively correlated with the intensive use of ICT, but high productivity is closely linked to it. For log(C/S) we find a negative correlation with the ICT variables. A high share of labour costs, indicating a high labour intensity of production, is not compatible with a high intensity of use of ICT which is related to a high overall (ICT and non-ICT) capital intensity of production.

All three proxy variables for human capital, as expected, show statistically significant positive coefficients in the estimates for log(S/L). The strongest effect comes from formal education, but job-related training is also important; computer training seems to be a quite effective type of training, it also helps to utilize ICT more efficiently (complementarity effect). The effect with respect to formal education was found also for EX/S and log(C/L) (in this case also with respect to job-related training), but not for log(C/S); for log(C/S) we find a negative correlation to the variable for computer training, quite in accordance with the negative correlation of this variable with the ICT variables above.

In the estimates for log(S/L) we could find statistically significant positive effects for two organizational variables, for the within-firm use of team-work (project groups, quality circles, semi-autonomous teams, etc.) and for the existence of employee competences to contact autonomously customers. No effect could be found for the change of the number of management levels which was relevant only for few firms in our sample. There was also no indication of significant effects for the overall delegation of competences from managers to employees. We conclude that an overall shift of competences towards employees may prove to be too unspecific to lead to a positive performance impact; moreover it is the clear-targeted delegation of specific competencies from managers to employees, for example, with respect to production and customer problems, that could enhance productivity. We could not find any significant effect of the organizational variables for EX/S; there is a positive effect of the

variable for employee competences to contact customers with respect to the dependent variable log(C/L) and also a positive effect for the variable for job rotation with respect to log(C/S).

Finally, employee compensation according to team performance correlates significantly positive with productivity via positive employee incentives. It also correlates positively with log(C/L), but negatively with log(C/S).

On the whole, the organizational variables correlate considerably weaker with the dependent variable (and explain less of its variance) than the technological variables and the variables for human capital. If we interpret the overall effect of the organizational variables as an effect that can be traced back to functional flexibility then this effect is positive but rather weak compared to the effects for technology and human capital (see also the results for the model version with the composite index ORGANS). If the relative strength of the effects of the organizational, technology and human capital variable block in the estimates with log(S/L) is approximated by the mean of the standardized coefficients of the variables belonging to each block, we obtain an average coefficient value of 0.087 for technology, 0.054 for human capital and 0.028 for the organizational variables proxying functional flexibility.

We turn now to the variables for numerical flexibility. In the productivity equation we obtain significantly negative coefficients for part-time work and for working time which is flexible within a year; for the other two variables, for temporary work and for working time flexible within a month, the coefficients are statistically insignificant at the test level of 10%. We find no discernible effect of all four variables for numerical flexibility with respect to EX/S. Part-time work is negatively correlated with log(C/L) and working time flexible within a year positively correlated with log(C/S).

On the whole, the variables for numerical flexibility correlate negatively and rather weakly with the performance and cost measures used in this study (with the exception of log(C/S)).

Innovation measures (Full model)

Table 8 contains the results of the probit estimates of the full model for the three binary innovation variables. The intensity of use of ICT correlates positively with innovation propensity, i.e. the probability that new products and new processes were introduced by a firm in the period 1998-2000 (column 1). Internet use is particularly relevant for firms with product innovations (column 2), intranet, i.e. within-firm communication, is more important for firms which introduced changes of the production techniques (column 3). Only the variable for job-related training has a positive and statistically significant coefficient in two of three innovation equations; the coefficients for the other two variables for human capital are positive but not significant at the test level of 10% in all three equations. Employee compensation according to team performance correlates significantly positive with two innovation variables.

Only one of the organizational variables reflecting functional flexibility, the variable for overall delegation of competences from manages to employees, correlates positively with all three innovation variables. A possible interpretation of this result is that a more decentralized decision-making structure enhances innovation which contributes to the long-term performance improvement, even if at a first glance it does not influence directly productivity or some other performance variable reflecting rather short-term firm efficiency.

In divergence from the results for the performance and cost measures in table 7, the variable for temporary work has a positive and significant coefficient in the equation for innovations (INNO) and for product innovations (INNOPD). A possible reason for such a positive correlation could be the existence of a demand for specialized services, for example of the R&D departments of the firms, which is satisfied by hiring high-skilled personnel from specialized firms. Innovating firms need such high-skilled technicians and scientists for certain tasks temporarily, while non-innovating firms rely for their mostly routine tasks primarily on their permanent personnel. We also obtain positive effects for the variable for working time flexibility within a month, but we have no apparent explanation for these effects.

Model version with ORGANS

In Table 9 are presented the estimates for the four continuous dependent variables in which the six organizational variables of the full model in table 7 are substituted by the composite variable ORGANS which is constructed as the sum of the stardardized values of the six variables related to new organizational practices (team-work, job rotation, decrease of the number of managerial levels, overall transfer of competences from managers to employees, competences of employees to splve autonomously productio problems and to contact customers; see note to table 7). We find a positive and statistically significant coefficient of the variable ORGANS only in the productivity equation (column 1). Table 10 shows the results for the innovation variables. The coefficient of ORGANS is positive but not significant in all three innovation equations. On the whole, the results in table 9 and 10 are quite in accordance with those in table 7 and 8.[4]

Relationship between Numerical and Functional Flexibility

Cross-tabulations of the six organizational variables used as proxies for functional flexibility in the full model and of the two variables for numerical flexibility (part-time work and temporary work) are shown in table 11. Less than one third of the firms using one or more of the new organizational practices listed in table 11 use intensively part-time or temporary work (column 1 and 3), or the other way around more than two thirds of firms with these organizational practices do not use intensively part-time or temporary work. The shares of

[4] We obtain similar results also with a further version of a composite variable for organizational capital based on the factor scores of a one-factor solution of principal component factor analysis of the six varibles for workplace organization.

firms using job rotation which also have many part-time and temporary workers are somewhat higher than one third (35.7% and 38.6% respectively; column 1 and 3). These results can be interpreted as first evidence that the single organizational practices which constitute functional flexibility and the two types of numerical flexibility are not applied complementary.

This first hint for non-complementarity between functional and numerical flexibility as measured in this study is to some extent confirmed, particularly for part-time work, by the results in table 12. The table contains only the coefficients of the two pairs of variables which were alternatively inserted instead of ORGANS in estimations with all other independent variables and for all dependent variables used in this study (i.e. the specification remained otherwise the same as in table 7 and table 9). The pairs of variables were constructed as follows: when the dummy variable for part-time work takes the value of 1, then a new variable is defined which takes the value of ORGANS, otherwise it takes the value 0. Similarly, if the dummy variable for part-time work takes the value of 0, a second new variable is defined which takes the value of ORGANS, otherwise 0. The same procedure was used to construct a pair of new variables with respect to the dummy variable for temporary work. In this way we are able to estimate separately the coefficients for the variable ORGANS for a high and a low level of part-time and temporary employment respectively. Complementarity of the two types of labour flexibility with respect to the seven measures of performance, costs and innovation used in this study is indicated when the coefficients of ORGANS in column 1 are themselves positive and statistically significant and significantly larger than the coefficients of ORGANS in column 2 (for part-time work) and those in column 3 larger than those in column 4 (for temporary work).

The most clear-cut result is found for the productivity variable log(S/L). For both types of numerical flexibility (part-time and temporary work) the effect for the combined use of numerical and functional flexibility in form of new organizational practices as measured by the variable ORGANS is positive but small and not significant, while that for the use of functional flexibility alone is also positive but much larger and statistically significant (row 1). This means that firms with high productivity are those which apply new forms of workplace organization but do not engage many part-time and temporary workers. A similar result we obtain also for the variable log(C/L). For the variables EXP/S and log(C/S) no effects at all are discernible in table 12.

The results for the innovation variables show that some complementarity does exist between functional flexibility and numerical flexibility related to temporary work. For INNO and INNOPC the coefficients of the variable ORGANS for firms using much temporary work are positive and significantly larger as the coefficients of ORGANS for firms without temporary work (row 5 and row 7 respectively). These results are quite in accordance with those in table 10.

Comparison with the Results of Similar Empirical Studies

A comparison with other similar studies also using the analytical framework of a production function shows that most studies find a positive effect with respect to labour productivity for ICT and organization respectively, some of them also for human capital (see e.g. Black and Lynch 2000, Capelli and Neumark 2001 for the USA; Caroli and Van Reenen 1999 for France; Bertschek and Kaiser 2001 for Germany). With respect to these direct effects Swiss firms tend to give more attention to human capital than to organization relative to firms in other countries. A second group of primarily British studies investigate specifically the influence of several dimensions of functional flexibility, such as the existence of "joint consultative committees", quality circles, problem-solving groups, briefing groups, etc. on labour productivity; these studies find some mixed results (positive and negative effects) (e.g. Addison and Belfield 2001, Pérotin and Robinson 2000). In a study with Dutch firm data Kleinknecht (2003) finds a positive correlation between a variable for functional flexibility (percentage of personnel who were given a new function or were transferred to a different department within the same firm) and firm sales and employment growth respectively.

Interpreting the variables for new organizational practices as proxies for functional flexibility allows us to conclude that most studies find a positive performance impact for this flexibility mode. The results of these studies are indicative but not completely comparable because some of the observed differences can be traced back to differences with respect to the sectors and industries covered in the studies, the specification of the organizational variables and the nature of the investigations (cross-sectional versus longitudinal).

There are relatively few studies investigating the impact of numerical flexibility in form of part-time and / or fixed-term contract work on firm performance. For example, Pérotin and Robinson (2000) included in their model also a variable for the percentage of part-time workers which showed a positive but statistically not significant effect on productivity; Shepard et al. (1996) found a positive effect of working time flexibility on productivity for the British pharmaceutical industry.

Kleinknecht (2003) conducted a cross-section study based on a microeconometric model of firm costs and firm performance with Dutch firm data of the year 1994. He included in his model three different measures of numerical flexibility (the percentage of personnel being on temporary contracts, the percentage of a firm's total working hours worked by people hired from private manpower agencies and the percentage of personnel who were newly hired or have left the firm in a certain period). The variable for temporary contact work showed no significant effect on the performance variables and a negative effect on the cost measures; for the variable for labour hired by manpower agencies no effect was found with respect to the cost variables and a positive effect with respect to the performance measure profits as a percentage of sales. On the balance, numerical flexibility tended to have a negative influence on performance.

Finally, there are also some studies dealing with the linkages between numerical and functional flexibility. Pil and Macduffie (1996) could not find any significant correlation between a variable for production worker tenure and a composite index measuring the incidence of high-involvement work practices in U.S. plants at the beginning of the nineties. Gittleman et al. (1998) showed that if an establishment offers flexible work schedules this has a positive impact on the probability of adopting one or more of new workplace practices such as worker teams, quality circles, job rotation, total quality management, etc.. The main pieces of evidence indicating to some complementarity between numerical and functional flexibility come from studies based on EPOC firm data (OECD 1999, European Foundation 1999). The former study found throughout positive correlations between both the rise in proportion of working part-time and the rise in proportion of temporary contracts at firm level and the use of a number of new workplace practices; the key findings of the latter are as follows: first, functional flexibility (the delegation of decision-making to the individual or to the work group) and numerical flexibility (part-time work and temporary contract work) are not mutually exclusive, most workplaces practise both to some extent, and, second, the combination of different forms of flexibility, together with innovation and consultation, has a positive effect on employment growth. However, both studies do not show explicitly that the two flexibility modes discussed here are complementary with respect to some performance measure (e.g. productivity). Finally, once more is to say that the results of these studies are indicative but not completely comparable.

7. Summary and Conclusions

The main results of the study are as follows.

The results for both the full model and the model version with the composite variable ORGANS show that ICT and human capital are the most important factors correlating positively with log(S/L), EX/S, log(C/L) and the three innovation measures INNO, INNOPD and INNOPC. The positive relation to log(C/L) indicates that labour costs per employee are higher in firms with an intensive use of ICT and human capital than in those with a weak engagement in this type of investment. The variable log(C/S) correlates negatively (with the exception of the variable for job rotation) or not at all with these factors, which means that labour-intensive firms do not utilize intensively intangible factors such as ICT and human capital.

Numerical flexibility in the narrow sense denoted by the extent of firms‘ using part-time and temporary work in ordinary operations is not so widespread in the Swiss business sector. According to our data 23.8% of firms report that part-time work is very important for them, 19.5% of them that temporary work is very relevant.

Functional flexibility defined as the result of the combined use of new organizational practices such as team-work, job rotation, shift of competences from managers to employees, flattening of management hierarchies, etc. is rather widespread in the Swiss economy compared with other OECD countries. High relevance of team-work is reported by 20.8% of the firms, but only 4.2% of them find job rotation very important; 40.0% of all firms say that an overall shift of competences from managers to employees found place in the period 1995-2000, but only 4.8% of them report an increase of the number of managerial levels in the same period.

According to the results of the microeconometric analysis part-time work correlates negatively with average labour productivity and labour costs per employee (after controlling for technology, workplace organization and industry affiliation). This can be interpreted as a hint that the extensive use of part-time work can lead to a reduction of average labour costs but this is not equivalent with a productivity increase. For example, if part-time jobs are less qualified as full-time jobs, then the cost reduction due to the introduction of part-time work leads to a reduction of human capital and, if all other things remain the same, potentially to a productivity decrease.

There are no significant effects of the two variables for numerical flexibility with respect to the export share and the labour cost share of sales.

There is no correlation between temporary work and labour productivity or labour costs per employee. This second form of numerical flexibility does not seem to be relevant with respect to the performance and costs measures used in this study.

There is a negative correlation of one of the variables for the numerical flexibility in a wide sense (working time flexible within a year) with labour productivity.

Functional flexibility proxied by the composite variable ORGANS shows a clear positive effect on labour productivity in accordance to theoretical expectation. We could not find any significant effects for the other performance and costs variables. With respect to export share this means that exporting firms in our sample are not better than non-exporting, which is not astonishing if we take into consideration that more than half of our firms belong to the construction or the service sector producing many non-tradables. As to the cost variables, we can conclude that functional flexibility is „cost neutral“ because it enhances firm capabilities without changing firms‘ factor mix.

In sum, we find that firms pursuing a strategy of functional flexibility tend to have the same labour costs per employee as firms without functional flexibility, but the former better perform in terms of labour productivity than the latter ones. Employing much part-time labour is correlated to significantly lower average labour costs but also to a significantly lower labour productivity, due to the presumably lower human capital of part-time employees. No effects could be found for temporary labour.

When innovation measures are used as dependent variables, a somewhat different pattern of the results with respect to the impact of numerical flexibility emerges. Two of the innovation variables correlate positively with the variable for temporary work, indicating presumably the existence of a demand for specialized services, for example of the R&D departments of the firms, which is satisfied by hiring high-skilled personnel from specialized firms. There is also a positive correlation of all three innovation variables with the variable for working time flexibility on a monthly base.

Numerical and functional flexibility as measured in this study are not complementary with respect to the performance measures. For both types of numerical flexibility (part-time and temporary work) we could not find a statistically significant effect of the combined use of numerical and functional flexibility in form of new organizational practices on labour productivity and wage costs per employee. On the contrary, firms with high productivity are those which apply new forms of workplace organization but do not engage many part-time and temporary workers.

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Tables:

Table 1: Labour Flexibility and Working Time Flexibility in the Swiss Business Sector 2000

	Part-time Work[1]	Temporary work[1]	Working time flexible within a month[1]	Working time flexible within a year[1]
Industry		Percentage of firms		
Food, beverage	39.2	23.7	28.1	42.7
Textiles	28.6	8.6	28.6	48.6
Clothing, leather	0.0	14.3	9.5	23.8
Wood	8.9	8.9	13.3	37.8
Paper	17.7	14.7	26.5	32.4
Printing	36.0	18.7	17.3	25.3
Chemicals	33.7	20.9	17.4	19.8
Rubber, plastics	20.0	15.6	26.7	26.7
Glass, stone, clay	11.1	15.6	11.1	40.0
Metal	15.4	42.3	7.7	57.7
Metalworking	15.4	20.3	22.0	41.2
Machinery	12.9	26.4	23.0	44.3
Electrical machinery	21.0	29.0	29.0	40.3
Electronics, instruments	35.4	23.6	30.7	35.4
Watches	11.9	28.6	21.4	28.6
Vehicles	8.0	16.0	24.0	44.0
Other manufacturing	27.1	20.8	27.1	31.3
Energy	7.9	7.9	21.1	29.0
Construction	8.1	31.8	18.0	44.1
Wholesale trade	23.3	15.0	20.8	22.5
Retail trade	43.4	13.9	18.5	21.4
Hotel, catering	37.5	21.4	19.6	27.7
Transport, communications	34.4	16.6	22.3	23.1
Finance, insurance	26.2	8.7	19.8	23.8
Real estate, leasing	30.8	7.7	7.7	0.0
Computer services, R&D	21.2	7.7	25.0	25.0
Business services	25.0	17.5	18.5	28.0
Personal services	15.0	0.0	0.0	20.0
Firm size (number of employees)				
5-49	18.5	8.8	12.8	18.6
50-99	20.3	15.7	20.1	31.9
100-199	27.7	24.2	23.9	36.2
200-499	28.6	31.8	26.8	42.9
500 and more	27.2	28.9	30.2	44.4

Total	23.8 (N=616)	19.5 (N=506)	20.9 (N=542)	32.1 (N=831)

Note: (1): all four flexibility measures are measured on a five-point Likert scale (1: „no importance“; 5: „very great importance“) reflecting a firm's assessment of the relevance of a certain type of labour flexibilty and/or working time schedule for this firm. The percentages in the above table refer to firms reporting 4 or 5 on the five-point Likert scale; data for 2589 firms; multiple imputations for missing values; the data were corrected for unit non-response bias and weighted in order to reflect the population of Swiss enterprises belonging to the 2-digit industries listed in table A.1.

Table 2: Output Fluctuations and Labour Flexibility

	Part-time Work	Temporary work	Work time flexible within a month	Work time flexible within a year
Output fluctuations:				
- strong	59.4	66.7	60.0	66.5
- weak	40.6	33.3	40.0	33.5
	100	100	100	100

Note: firms with strong and weak output fluctuations resp. as a percentage of firms with the values 4 and 5 on a five-point Likert scale measuring the relevance of the four flexibility categories (part-time work, temporary work, working time flexible within a month, working time flexible within a year) from a firm's point of view. Output fluctuations are also measured on a five-point scale (values 1, 2 and 3 for „weak"; values 4 and 5 for „strong"; original scale: 1: „no fluctuations"; 5: „very strong fluctuations"); data for 2589 firms; multiple imputations for missing values; the data were corrected for unit non-response bias and weighted in order to reflect the population of Swiss enterprises belonging to the 2-digit industries listed in table A.1.

Table 3: Diffusion of New Organizational Practices in the Swiss Business Sector (percentage of all firms)

	Manu-facturing	Construction	Services	Total
Job rotation				
Before 1995	7.8	4.7	4.1	5.1
1995-1997	2.3	0.5	1.9	1.8
1998-2000	7.1	0.1	2.9	3.5
Total	17.2	5.3	8.9	10.4
Team-work				
Before 1995	18.6	14.2	17.0	16.9
1995-1997	11.3	3.5	7.0	7.4
1998-2000	14.5	13.4	9.4	11.4
Total	44.4	31.1	33.4	35.7

Note: data of 1667 firms; multiple imputations for missing values; the data were corrected for unit non-response bias and weighted in order to reflect the population of Swiss enterprises belonging to the 2-digit industries listed in table A.1.

Table 4: Intensity of Use of New Organizational Practices 2000

	Manu-facturing	Construction	Services	Total
	(percentage of firms using intensively(1) an organizational practice)			
Job rotation	5.0	3.9	3.3	4.2
Team-work	20.7	16.0	22.4	20.8

(1): percentage of firms reporting value 4 or value 5 on a five-point Likert scale

Note: data 1667 firms (job rotation, team work); multiple imputations for missing values; the data were corrected for unit non-response bias and weighted in order to reflect the population of Swiss enterprises belonging to the 2-digit industries listed in table A.1.

Table 5: Changes with Respect to Some Organizational Practices 1995-2000 (percentage of firms)

Change of the number of managerial levels

	Decrease (1)	No change (2)	Increase (3)	Difference (1)-(3)
Manufacturing	13.6	80.7	5.7	7.9
Construction	13.6	82.8	3.6	10.0
Services	6.3	88.9	4.8	1.6
Total	9.4	85.8	4.8	4.6

Overall shift of competences

	No shift (1)	Toward employees (2)	Toward managers (3)	Difference (2)-(3)
Manufacturing	50.0	48.0	2.0	46.0
Construction	78.2	21.2	0.6	20.6
Services	53.6	42.4	4.0	38.4
Total	57.0	40.0	2.9	37.1

Note: data of 1667 firms; multiple imputations for missing values; the data were corrected for unit non-response bias and weighted in order to reflect the population of Swiss enterprises belonging to the 2-digit industries listed in table A.1.

Table 6: Impact of New Organizational Practices on Overall Firm Efficiency (percentage of firms)

	Decrease (1)	No change (2)	Increase (3)	Difference (3)-(1)
New organizational practices				
Manufacturing	3.3	26.9	69.8	66.7
Construction	7.7	29.8	62.5	54.8
Services	2.1	26.5	71.4	69.3
Total	2.8	26.7	70.4	67.6

Note: data of 1667 firms; multiple imputations for missing values; the data were corrected for unit non-response bias and weighted in order to reflect the population of Swiss enterprises belonging to the 2-digit industries listed in table A.1.

Table 7: Performance and Cost Measures and Labour Flexibility; Full Model

	log(S/L)[1] (OLS)	EX/S[1] (Tobit)	log(C/L)[1] (OLS)	log(C/S)[1] (OLS)
Intercept	5.255***	-38.905***	4.270***	1.461***
	(0.142)	(12.177)	(0.078)	(0.128)
Log(materials/employee)[2]	0.743***			
	(0.242)			
Technology:				
Use of internet (% of employees):[3]				
1-20	0.038	8.304	0.020	-0.003
	(0.043)	(5.288)	(0.030)	(0.040)
21-40	0.105**	14.523**	0.048	-0.029
	(0.052)	(5.712)	(0.034)	(0.049)
41-60	0.145**	13.498**	0.103**	-0.072
	(0.070)	(6.751)	(0.042)	(0.064)
61-80	0.299***	11.877	0.151***	-0.154**
	(0.081)	(7.570)	(0.049)	(0.078)
81-100	0.216*	3.047	0.123**	-0.108
	(0.114)	(9.564)	(0.062)	(0.095)
Use of intranet (% of employees):[3]				
1-20	0.122***	-0.489	-0.002	-0.141***
	(0.043)	(5.030)	(0.032)	(0.040)
21-40	0.201***	-0.682	0.042	-0.186***
	(0.048)	(4.745)	(0.031)	(0.041)
41-60	0.206***	4.845	0.010	-0.209***
	(0.048)	(4.648)	(0.031)	(0.040)
61-80	0.177***	0.297	0.044	-0.167***
	(0.051)	(5.429)	(0.035)	(0.049)
81-100	0.358***	1.216	0.073*	-0.314***
	(0.073)	(6.130)	(0.044)	(0.072)
Workplace Organization:				
Team-work[4]	0.071*	1.522	0.023	-0.031
	(0.037)	(3.134)	(0.020)	(0.035)
Job rotation[4]	-0.070	4.857	-0.015	0.119**
	(0.076)	(5.720)	(0.041)	(0.050)
Delegation of competences from managers to employees:				
Overall delegation of competences from managers to employees[5]	-0.007	-3.978	-0.016	-0.005
	(0.026)	(2.627)	(0.017)	(0.026)
Employees competence to solve production problems[6]	0.104	-2.140	-0.059	-0.103
	(0.085)	(6.271)	(0.041)	(0.079)
Employees competence to contact customers[6]	0.116***	-3.622	0.088***	-0.040
	(0.037)	(3.375)	(0.020)	(0.037)

Decrease of number of managerial levels[7]	0.014 (0.065)	0.064 (5.406)	0.004 (0.032)	0.010 (0.066)
Human capital:				
Share of employees with high education[8]	0.275*** (0.114)	0.555*** (0.083)	0.248*** (0.059)	0.128 (0.101)
Share of employees receiving job-related training[9]	0.126** (0.059)	0.043 (0.051)	0.067* (0.035)	0.030 (0.053)
Computer training[10]	0.060** (0.028)	1.420 (2.635)	0.078 (0.169)	-0.046* (0.027)
Labour flexibility, compensation:				
Team compensation[11]	0.068** (0.029)	1.882 (2.743)	0.030* (0.017)	-0.052* (0.029)
Part-time work[12]	-0.076** (0.033)	-0.633 (2.997)	-0.032* (0.019)	0.031 (0.031)
Temporary work[12]	0.038 (0.035)	1.347 (3.049)	-0.012 (0.020)	-0.020 (0.032)
Working time flexible within a month[12]	-0.023 (0.030)	4.669 (2.871)	-0.009 (0.019)	-0.019 (0.031)
Working time flexible within a year[12]	-0.051* (0.028)	-4.136 (2.700)	0.013 (0.017)	0.057** (0.027)
N	1382	1517	1491	1478
Left censored		779		
Log Likelihood		-4094.5		
DF	52	57	57	57
SER	0.494		0.302	0.484
F	26.3***		7.6***	17.5***
R^2adj.	0.488		0.202	0.389

Notes: (1): log(S/L): logarithm of sales per employee; EX/S: exports as a sales share; log(C/L): logarithm of labour costs per employee; log(C/S): logarithm of labour costs as a sales share; for all variables the number of employees is calculated in full-time equivalents; all values are for the year 1999; (2): logarithm of intermediate (material and service) inputs per employee 1999; (3): dummy variables (value 1 for firms reporting that the share of employees using *internet (intranet*) is between 1% and 20%, 21% and 40%, 41% and 60%, 61% and 80%, 81% and 100% respectively; reference group: firms which do *not* use internet (intranet)); (4): dummy variable (value 1 for firms reporting that the use of *team-work* (project groups, quality circles, semi-autonomous teams, etc.) or *job rotation* is ‚widespread' (values 4 and 5 on a five-point Likert scale)); (5): dummy variable (value 1 for firms reporting that in the period 1995-2000 (not further specified) competences were transferred from managers to employees); (6): dummy variables (value 1 for firms reporting that at the workplace level employees have the competence to solve autonomously emerging *production problems* or to contact autonomously *customers* (values 4 and 5 on a five-point Likert scale)); (7): dummy variable (value 1 for firms reporting that the number of *managerial levels* decreased in the period 1995-2000); (8): high education: education at the *tertiary* level (universities, technical and business colleges, etc.); (9): job-related training: internal and/or external training courses initialized or supported by the firm; (10): dummy variable (value 1 for firms reporting that *computer training* is ‚important' (values 4 and 5 on a five-point Likert scale)); (11): dummy variable (value 1 for firms reporting that employee compensation according to *team performance* is ‚important' (values 4 and 5 on a five-point Likert scale)); (12): dummy variables (value 1 for firms reporting that *part-time work, temporary work, flexible monthly* and *yearly working time* is ‚important' (values 4 and 5 on a five-point Likert scale)); estimations include also 2-digit industry (27 dummies) and firm size controls (6 dummies); ***,

**, * denote statistical significance at the 1%, 5% and 10% level respectively; heteroscedasticity robust standard errors (White procedure).

Table 8: Innovation Measures and Labour Flexibility; Full Model

	INNO[1] (Probit)	INNOPD[1] (Probit)	INNOPC[1] (Probit)
Intercept	-0.338	-0.517	-1.190***
	(0.398)	(0.357)	(0.334)
Technology:			
Use of internet (% of employees):[2]			
1-20	0.264**	0.221*	0.061
	(0.134)	(0.131)	(0.130)
21-40	0.361**	0.349**	0.077
	(0.157)	(0.148)	(0.146)
41-60	0.175	0.306*	-0.107
	(0.195)	(0.182)	(0.179)
61-80	0.231	0.381*	-0.026
	(0.230)	(0.210)	(0.205)
81-100	0.573*	0.688**	0.161
	(0.316)	(0.271)	(0.260)
Use of intranet (% of employees):[2]			
1-20	0.250*	0.107	0.327**
	(0.138)	(0.131)	(0.131)
21-40	0.300**	0.133	0.251**
	(0.138)	(0.128)	(0.128)
41-60	0.191	0.156	0.162
	(0.130)	(0.124)	(0.124)
61-80	0.356**	0.223	0.305**
	(0.161)	(0.148)	(0.147)
81-100	0.381**	0.236	0.334**
	(0.192)	(0.172)	(0.170)
Workplace Organization:			
Team-work[3]	0.150	0.131	0.180**
	(0.107)	(0.092)	(0.091)
Job rotation[3]	0.231	0.147	0.018
	(0.231)	(0.182)	(0.177)
Delegation of competences from managers to employees:			
Overall delegation of competences from managers to employees[4]	0.252***	0.163**	0.219***
	(0.082)	(0.074)	(0.073)
Employees‘ competence to solve production problems[5]	0.248	-0.263	-0.164
	(0.187)	(0.175)	(0.173)
Employees‘ competence to contact customers[5]	0.150	0.028	0.108
	(0.109)	(0.096)	(0.095)
Decrease of number of managerial levels[6]	0.013	-0.037	0.055
	(0.171)	(0.154)	(0.150)

Human capital:			
Share of employees with high education[7]	0.174 (0.289)	0.219 (0.252)	0.116 (0.245)
Share of employees receiving job-related training[8]	0.400** (0.168)	0.218 (0.147)	0.445*** (0.145)
Computer training[9]	0.126 (0.082)	0.079 (0.075)	0.077 (0.074)
Labour flexibility, compensation:			
Team compensation[10]	0.234** (0.091)	0.089 (0.079)	0.243*** (0.078)
Part-time work[11]	0.099 (0.100)	-0.004 (0.087)	0.091 (0.086)
Temporary work[11]	0.186* (0.102)	0.242*** (0.090)	-0.051 (0.088)
Working time flexible within a month[11]	0.503*** (0.104)	0.237*** (0.086)	0.224*** (0.084)
Working time flexible within a year[11]	0.016 (0.088)	-0.026 (0.078)	0.023 (0.077)
N	1517	1517	1517
DF	57	57	57
Likelihood Ratio (χ^2)	324.6***	277.5***	248.5***
R^2 (rescaled)	0.283	0.225	0.202
%-concordant	78.7	73.6	72.2

Notes: (1): INNO: introduction of innovations 1998-2000; INNOPD: introduction of product innovations 1998-2000; INNOPC: introduction of process innovations 1998-2000; (2): dummy variables (value 1 for firms reporting that the share of employees using *internet (intranet*) is between 1% and 20%, 21% and 40%, 41% and 60%, 61% and 80%, 81% and 100% respectively; reference group: firms which do *not* use internet (intranet)); (3): dummy variables (value 1 for firms reporting that the use of *team-work* (project groups, quality circles, semi-autonomous teams, etc.) or *job rotation* is ‚widespread' (values 4 and 5 on a five-point Likert scale)); (4): dummy variable (value 1 for firms reporting that in the period 1995 (not further specified) competences were transferred from managers to employees); (5): dummy variables (value 1 for firms reporting that at the workplace level employees have the competence to solve autonomously emerging *production problems* or to contact autonomously *customers* (values 4 and 5 on a five-point Likert scale)); (6): dummy variable (value 1 for firms reporting that the number of *managerial levels* decreased in the period 1995-2000); (7): high education: education at the *tertiary* level (universities, technical and business colleges, etc.); (8): job-related training: internal and/or external training courses initialized or supported by the firm; (9): dummy variable (value 1 for firms reporting that *computer training* is ‚important' (values 4 and 5 on a five-point Likert scale)); (10): dummy variable (value 1 for firms reporting that employee compensation according to *team performance* is ‚important' (values 4 and 5 on a five-point Likert scale)); (11): dummy variable (value 1 for firms reporting that *part-time work, temporary work, flexible monthly* and *yearly working time* is ‚important' (values 4 and 5 on a five-point Likert scale)); estimations include also 2-digit industry (27 dummies) and firm size controls (6 dummies); ***, **, * denote statistical significance at the 1%, 5% and 10% level respectively; heteroscedasticity robust standard errors (White procedure).

Table 9: Performance and Cost Measures and Labour Flexibility; Model Version Containing a Composite Index for Organization Substituting for the Six Single Variables for Workplace Organization in the Full Model)

	log(S/L)[1] (OLS)	EX/S[1] (Tobit)	log(C/L)[1] (OLS)	log(C/S)[1] (OLS)
Intercept	5.275***	-40.264***	4.272***	1.464***
	(0.145)	(12.216)	(0.079)	(0.127)
Log(materials/employee)[2]	0.759***			
	(0.244)			
Technology:				
Use of internet (% of employees):[3]				
1-20	0.036	8.143	0.019	-0.001
	(0.043)	(5.299)	(0.030)	(0.040)
21-40	0.100*	14.258**	0.044	-0.027
	(0.053)	(5.720)	(0.034)	(0.049)
41-60	0.134**	13.277**	0.097**	-0.067
	(0.068)	(6.759)	(0.042)	(0.065)
61-80	0.304***	12.086	0.155***	-0.159**
	(0.081)	(7.565)	(0.049)	(0.078)
81-100	0.201*	4.528	0.116*	-0.099
	(0.115)	(9.537)	(0.062)	(0.120)
Use of intranet (% of employees):[3]				
1-20	0.122***	-1.040	-0.004	-0.141***
	(0.043)	(5.025)	(0.032)	(0.040)
21-40	0.202***	-1.265	0.037	-0.189***
	(0.048)	(4.726)	(0.031)	(0.042)
41-60	0.210***	4.236	0.007	-0.213***
	(0.048)	(4.642)	(0.031)	(0.040)
61-80	0.192***	-0.669	0.048	-0.176***
	(0.052)	(5.411)	(0.036)	(0.049)
81-100	0.371***	0.283	0.079*	-0.322***
	(0.073)	(6.125)	(0.045)	(0.072)
Human capital:				
Share of employees with high education[4]	0.300***	0.559***	0.252**	0.115
	(0.114)	(0.082)	(0.063)	(0.100)
Share of employees receiving job-related training[5]	0.125**	0.037	0.069**	0.024
	(0.055)	(0.051)	(0.032)	(0.054)
Computer training[6]	0.058**	1.568	0.061	-0.044*
	(0.028)	(2.639)	(0.171)	(0.027)
ORGANS[7]	0.173***	-0.367	0.054	-0.048
	(0.061)	(0.531)	(0.034)	(0.055)

Labour flexibility, compensation:				
Team compensation[8]	0.066**	1.662	0.026	-0.052*
	(0.029)	(2.702)	(0.017)	(0.029)
Part-time work[9]	-0.077**	-0.699	-0.034*	0.032
	(0.033)	(2.999)	(0.020)	(0.031)
Temporary work[9]	0.036	1.782	-0.013	-0.017
	(0.036)	(3.049)	(0.021)	(0.033)
Working time flexible within a month[9]	-0.027	4.587	-0.009	-0.016
	(0.030)	(2.868)	(0.019)	(0.028)
Working time flexible within a year[9]	-0.051*	-4.546*	0.012	0.058**
	(0.028)	(2.699)	(0.017)	(0.027)
N	1382	1517	1491	1478
Left censored		779		
Log Likelihood		-4096.8		
DF	47	52	52	52
SER	0.495		0.304	0.484
F	28.8***		8.0***	19.0***
R^2adj.	0.486		0.195	0.387

Notes: (1): log(S/L): logarithm of sales per employee; EX/S: exports as a sales share; log(C/L): logarithm of labour costs per employee; log(C/S): logarithm of labour costs as a sales share; for all variables the number of employees is calculated in full-time equivalents; all values are for the year 1999; (2): logarithm of (intermediate) material and service inputs per employee 1999; (3): dummy variables (value 1 for firms reporting that the share of employees using *internet (intranet*) is between 1% and 20%, 21% and 40%, 41% and 60%, 61% and 80%, 81% and 100% respectively; reference group: firms which do *not* use internet (intranet)); (4): high education: education at the *tertiary* level (universities, technical and business colleges, etc.); (5): job-related training: internal and/or external training courses initialized or supported by the firm; (6): dummy variable (value 1 for firms reporting that *computer training* is ‚important' (values 4 and 5 on a five-point Likert scale)); (7): sum of the standardized values of the variables for work place organization (six dummy variables for: job rotation; team-work; decrease of the number of managerial levels in the period 1995-2000; overall transfer of (unspecified) competences from managers to employees in the period 1995-2000; employees have at the workplace level the competence to solve autonomously emerging *production problems*; employees have at the workplace level the competence to contact autonomously *customers*; (8): dummy variable (value 1 for firms reporting that employee compensation according to *team performance* is ‚important' (values 4 and 5 on a five-point Likert scale)); (9): dummy variable (value 1 for firms reporting that *part-time work, temporary work, flexible monthly* and *yearly working time* is ‚important' (values 4 and 5 on a five-point Likert scale)); estimations include also 2-digit industry (27 dummies) and firm size controls (6 dummies); ***, **, * denote statistical significance at the 1%, 5% and 10% level respectively; heteroscedasticity robust standard errors (White procedure).

Table 10: Innovation Measures and Labour Flexibility (Model Version Containing a Composite Index for Organization Substituting for the Six Single Variables for Workplace Organization in the Full Model)

	INNO[1] (Probit)	INNOPD[1] (Probit)	INNOPC[1] (Probit)
Intercept	-0.407	-0.529	-1.139***
	(0.396)	(0.356)	(0.333)
Technology:			
Use of internet (% of employees):[2]			
1-20	0.259**	0.216*	0.054
	(0.134)	(0.130)	(0.129)
21-40	0.350**	0.339**	0.073
	(0.156)	(0.147)	(0.146)
41-60	0.189	0.310*	-0.100
	(0.194)	(0.181)	(0.179)
61-80	0.221	0.378*	-0.021
	(0.228)	(0.209)	(0.204)
81-100	0.534*	0.669**	0.122
	(0.314)	(0.270)	(0.259)
Use of intranet (% of employees):[2]			
1-20	0.288**	0.130	0.360***
	(0.136)	(0.130)	(0.130)
21-40	0.340**	0.164	0.295**
	(0.136)	(0.127	(0.127)
41-60	0.234*	0.181	0.199
	(0.129)	(0.123)	(0.123)
61-80	0.405**	0.251*	0.354**
	(0.160)	(0.147)	(0.145)
81-100	0.419**	0.262	0.378**
	(0.190)	(0.171)	(0.169)
Human capital:			
Share of employees with high education[3]	0.180	0.225	0.129
	(0.288)	(0.250)	(0.243)
Share of employees receiving job-related training[4]	0.493***	0.290**	0.512***
	(0.165)	(0.144)	(0.143)
Computer training[5]	0.126	0.078	0.071
	(0.082)	(0.075)	(0.074)
ORGANS[6]	0.186	0.048	0.183
	(0.171)	(0.150)	(0.149)
Labour flexibility, compensation:			
Team compensation[7]	0.280***	0.124	0.283***

	(0.090)	(0.078)	(0.077)
Part-time work[8]	0.117	0.011	0.108
	(0.099)	(0.087)	(0.085)
Temporary work[8]	0.184*	0.242***	-0.054
	(0.101)	(0.090)	(0.087)
Working time flexible within a month[8]	0.502***	0.247***	0.233***
	(0.103)	(0.086)	(0.084)
Working time flexible within a year[8]	0.036	-0.015	0.037
	(0.087)	(0.078)	(0.076)
N	1517	1517	1517
DF	57	57	57
Likelihood Ratio (χ^2)	309.6***	267.2***	234.3***
R^2 (rescaled)	0.271	0.217	0.192
%-concordant	78.2	73.3	71.8

Notes: (1): INNO: introduction of innovations 1998-2000; INNOPD: introduction of product innovations 1998-2000; INNOPC: introduction of process innovations 1998-2000; (2): dummy variables (value 1 for firms reporting that the share of employees using *internet (intranet*) is between 1% and 20%, 21% and 40%, 41% and 60%, 61% and 80%, 81% and 100% respectively; reference group: firms which do *not* use internet (intranet)); (3): education at the *tertiary* level (universities, technical and business colleges, etc.); (4): job-related training: internal and/or external training courses initialized or supported by the firm; (5): dummy variable (value 1 for firms reporting that *computer training* is ‚important' (values 4 and 5 on a five-point Likert scale)); (6): sum of the standardized values of the variables for workplace organization (six dummy variables for: job rotation; team-work; decrease of the number of managerial levels in the period 1995-2000; overall transfer of (unspecified) competences from managers to employees in the period 1995-2000; employees have at the workplace level the competence to solve autonomously emerging *production problems*; employees have at the workplace level the competence to contact autonomously *customers*; (7): dummy variable (value 1 for firms reporting that employee compensation according to *team performance* is ‚important' (values 4 and 5 on a five-point Likert scale)); (8): dummy variable (value 1 for firms reporting that *part-time work, temporary work, flexible monthly* and *yearly working time* is ‚important' (values 4 and 5 on a five-point Likert scale)); estimations include also 2-digit industry (27 dummies) and firm size controls (6 dummies); ***, **, * denote statistical significance at the 1%, 5% and 10% level respectively; heteroscedasticity robust standard errors (White procedure).

Table 11: Labour Flexibility and New Organizational Practices (Functional Flexibility)

	Part-time work (dummy= 1	0)	Temporary work (dummy= 1	0)
Teamwork	30.7	69.3	30.4	69.6
Job rotation	35.7	64.3	38.6	61.4
Overall delegation of competences from managers to employees	30.5	69.5	26.5	73.5
Employees‘ competence to solve production problems	24.3	75.7	22.9	77.1
Employees‘ competence to contact customers	30.0	70.0	21.1	78.9
Decrease of number of managerial levels	27.5	72.5	22.0	78.0

Note: the values in table 11 are percentages of firms and are read as follows: for example, in the first row 30.7% of the firms using team-work are also using intensively part-time work, but 69.3% of the firms are not using part-time work intensively, and so on.

Table 12: Relationship between Measures of Labour Flexibility and the Composite Index for Organization ORGANS in Estimates of Various Performance and Cost Variables

	ORGANS (if dummy for *part-time* work = 1)	ORGANS (if dummy for *part-time* work =0)	ORGANS (if dummy for *temporary* work = 1)	ORGANS (if dummy for *temporary* work = 0)
Log(S/L)	0.095 (0.108)	0.204*** (0.075)	0.107 (0.129)	0.197*** (0.070)
EX/S	-0.056 (0.952)	-0.029 (0.622)	-0.129 (1.011)	-0.004 (0.610)
Log(C/L)	0.021 (0.039)	0.137** (0.067)	0.043 (0.062)	0.058 (0.040)
Log(C/S)	-0.003 (0.100)	-0.065 (0.064)	0.069 (0.106)	-0.087 (0.063)
INNO	0.447 (0.354)	0.106 (0.194)	0.643* (0.380)	0.064 (0.191)
INNOPD	-0.082 (0.279)	0.098 (0.175)	0.312 (0.308)	0.034 (0.170)
INNOPC	0.281 (0.281)	0.146 (0.173)	0.572* (0.298)	0.058 (0.170)

Notes: The table contains only the coefficients (and standard errors in brackets) of the two pairs of variables which were alternatively inserted instead of ORGANS in estimations with all other independent variables and for all dependent variables used in this study (otherwise the specification remained the same as in table 7 and table 9). The table contains the results of 14 separate regressions. The pairs of variables were constructed as follows: when the dummy variable for *part-time work* takes the value of 1, then a new variable is defined which takes the value of ORGANS, otherwise it takes the value 0. Similarly, if the dummy variable for *part-time work* takes the value of 0, a second new variable is defined which takes the value of ORGANS, otherwise 0. The same procedure was used to construct a pair of new variables with respect to the dummy variable for *temporarary work*. For the definition of the dependent variables see note to table 6. ***, **, * denote statistical significance at the 1%, 5% and 10% level respectively; heteroscedasticity robust standard errors (White procedure).

Appendix:

Table A.1: Composition of the Dataset

	N	Percentage
Industry:		
Food, beverage	62	4.5
Textiles	24	1.7
Clothing, leather	13	0.9
Wood processing	17	1.2
Paper	24	1.7
Printing	51	3.7
Chemicals	50	3.6
Plastics, rubber	28	2.0
Glass, stone, clay	28	2.0
Metal	15	1.1
Metal working	107	7.7
Machinery	123	9.0
Electrical machinery	33	2.4
Electronics, instruments	74	5.4
Watches	24	1.7
Vehicles	15	1.1
Other manufacturing	30	2.2
Energy, water	24	1.7
Construction	151	11.0
Wholesale trade	145	10.5
Retail trade	84	6.1
Hotels, catering	33	2.4
Transport, telecommunication	63	4.6
Banks, insurances	54	3.9
Real estate, leasing	4	0.3
Computer services	20	1.4
Business services	79	5.7
Personal services	7	0.5
Firm Size:		
20-49 employees	443	32.1
50-99 employees	336	24.3
100-199 employees	278	20.1
200-499 employees	198	14.3
500-999 employees	69	5.0
> 1000 employees	58	4.2
Total	1382	100

Table A.2: Correlations between the Variables for Labour Flexibility and Working Time Flexibility (Spearman rank correlation coefficient)

	Part-time work	Temporary work	Working time flexible within a month
Temporary work	0.264		
Working time flexible within a month	0.120	0.117	
Working time Flexible within a year	0.078	0.227	0.310