Endogenous organizational change and the expected demand for different skill groups

MARTIN FALK

Centre for European Economic Research, L7, 1, D-68161 Mannheim.
E-mail: falk@zew.de

Between 1993 and 1995, the majority of German firms in services introduced new organizational practices (OC), in particular total quality management systems, certified ISO 9000, lean administration, flatter hierarchies, delegation of authority and ICT-enabled organizational changes. This paper analyzes the impact of organizational change on employment expectations. A system of probit equations will be estimated by simulated MLE. To account for endogeneity of organizational change in the labour demand equations a selection equation explaining organizational change is added to the system of equations. The empirical results suggest that organizational change has a positive impact on expected employment for all skill groups except for unskilled labour. Employment effects are robust to endogeneity of organizational change. New ICT and the share of training expenditures are primary forces behind OC.

I. INTRODUCTION

Between 1993 and 1995, the majority of German service firms introduced new organizational practices or changed the organizational structure (OC). Among the most important types of organizational change are total quality management systems, ISO 9000 followed by lean administration including flatter hierarchies and decentralization of decision-making. A number of factors contribute to the rising spread of new organizational practices. New breakthroughs in ICT have made it profitable for firms to introduce new organizational practices such as flatter hierarchies and to allow for greater decentralization of decision-making (Lindbeck and Snower, 1996). Furthermore, previous theoretical and empirical research suggests that organizational change is more likely in firms with higher investment in training and human capital as well as a higher skill intensity of the firm (see Lynch and Black 1995, OECD, 1999, Egger and Grossmann 2000).

It is well known that new organizational practices and new ICT create jobs which require a different skill level (see

Bresnahan, 1999). For France, the UK and the US several empirical studies provide evidence that organizational change may be attributed to the shift in demand towards skilled labour (see Bresnahan *et al.* 2001; Caroli and Van Reenen, 2001). In contrast to these studies, Osterman (2000), using a representative sample between 230 and 400 US firms with 50 or more employees, found that a initial high penetration of HPWOs is associated with a reduction of managerial employment as well as contingent workers during the period 1992–1997.

This paper provides further evidence on the relationship between the past introduction of new organizational practices as well as new ICT and employment change. In order to proxy actual employment growth by educational qualifications we use employment plans for different skill levels. Furthermore, in order to ensure that our results are not affected by potential endogeneity of organizational change in the labour demand equation, a selection equation explaining organizational change is added to the labour demand model. Since the ratio of training expenditures to total wage costs does not directly affect labour demand, it is used as an identifying variable.

II. MULTIVARIATE PROBIT MODEL WITH ENDOGENOUS ORGANIZATIONAL CHANGE

The multivariate probit model is a generalization of the bivariate probit model and contains five structural equations: four employment expectation equations and one equation explaining organizational change (subscript i is suppressed for convenience):[1]

$$\Delta \widetilde{L}^*_{j,t+1} = \alpha_{1j} \Delta OC_t + \alpha_{j2} \Delta ICT_t + \beta'_j X_{1t} + \epsilon_{jt},$$

$$j = 1, 2, 3, 4. \; t = 1$$

$$\Delta OC^*_t = \gamma_{j1} \Delta ICT_t + \gamma'_{j2} X_{1t} + \gamma'_{j3} X_{2t} + \eta_t, \qquad (1)$$

$$\Delta \widetilde{L}_{j,t+1} = 1 \text{ if } \Delta \widetilde{L}^*_{j,t+1} > 0$$

$$\Delta OC_t = 1 \text{ if } \Delta OC^*_t > 0$$

$$\epsilon_t' = [\epsilon_{jt}, \eta_t] \sim N(0, \Sigma)$$

where $\Delta \widetilde{L}^*_{j,t+1}$ represents the employment expectations for different types of educational qualifications during the period between 1995 and 1997 (increase = 1, 0 otherwise). ΔOC_t denotes the introduction of organizational change between 1993 and 1995. ΔICT_t denotes the introduction of new information and communication technologies in the production process. X_{1t} is a vector of other explanatory variables including the high-skilled employment share, ICT investment output ratio, expected output change, as well as a vector of control variables. The vector X_{2t} contains identifying variables, i.e. variables which are assumed to affect the organizational change but not the employment equations. ϵ_t' is assumed to be jointly multivariate normally distributed with zero mean vector. Given that the variance is 1, the variance-covariance matrix, Σ, consists of a correlation matrix including 10 free correlation coefficients. The multivariate probit model will be estimated by the simulated MLE (see Greene, 1997). The empirical part of the paper tests whether the error terms between the equation explaining organizational change and each employment expectation are correlated. When the error terms are correlated, excluding the selection equation will not yield consistent estimates of the parameters on organizational change.

The two main hypotheses are advanced concerning the relationship between organizational change, new ICT and how the combination of new ICT and OC affects employment performance. First, the effects of organizational change should be positive for high-skilled and negative for both medium-skilled and unskilled labour. The reduction of medium-skilled labour can be justified by the fact that OC is often associated with the reduction of middle

managers. The positive effect on high-skilled workers can be justified by the fact that they have a comparative advantage in implementing new technologies due to their ability of solving problems and adapting to changes in the work environment (see Bartel and Lichtenberg, 1987). The second hypothesis states that organizational change is likely to be endogenous.

III. DATA AND DESCRIPTIVE STATISTICS

The data set employed for the subsequent empirical analysis contains the first wave of the Mannheim Service Innovation panel (MIP) 1995. Our measure of organizational change is a dummy variable which equals 1 for an affirmative response to the question:

> Between 1993 and 1995, has your enterprise significantly changed the organizational structure or introduced new organizational processes/practices?

Firms who said that they introduced new organizational practices were then asked:

- What are the most important types of organizational change?'

The questionnaire contains a list with several different types of organizational practices:

- Total quality management systems;
- ISO 9000 and following standards;[2]
- Lean management, lean selling, flatter hierarchies;
- Re-engineering;
- Decentralization of decision-making, more decentralized structures, increased responsibilities; and
- Use of suppliers and subcontractors, work allocation.

One should note that this list only covers some aspects of organizational change. ICT-enabled organizational changes are not explicitly listed in the example list. The second key variable is the introduction of new ICT. Firms were asked:

> Between 1993–1995, did your enterprise introduce new production processes or methods to produce to deliver services?

Examples include new ICT, in particular software, Electronic data exchange (EDI), Intranet and electronic banking. Our measure of employment change are employment expectations for different types of labour. In the 1995 questionnaire the respondents were asked about their expectations for total employment, total sales, and different types of educational qualifications during the three year intervals between 1995 and 1997. Other control variables

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[1] See Greene (1997) for a description of the multivariate probit model.
[2] ISO 9000 is a standard for quality assurance. To obtain the standard, procedures have to be established and then documented. In particular the staff is trained to follow the procedures and the firm is audited by a recognized external body (see International Standards Organization, ISO).

are sales expectations, the ICT investment wage bill ratio and a complete set of sector and size dummies. In distinguishing between firm size, dummy variables based on the number of full time equivalent workers are used. Five classes of size are considered: 5–9, 10–19, 20–49, 50–249, and more than 250 employees.

The initial sample contains information on 2553 German firms. Exclusion of firms with less than five employees as well as firms with no information on organizational change or the introduction of new ICT into the production process leads to a slight sample reduction by 171 firms. However, incomplete information on firms' expectations for different educational qualifications as well as the number of workers by educational qualifications led to a sample reduction by 775 firms to about 1573 firms. A further sample reduction to 1389 firms is due to missing information on the remaining variables.

The sample reduction is quite large, in particular due to missing values on the employment expectations. It is therefore important to know whether firms refusing to answer the employment questions display some systematic pattern depending on both the introduction of ICT and organizational change. For instance, if firms facing negative employment trends avoid to answer the expected employment question rather than report declining employment, and if these firms are less likely to introduce OC, then the coefficient on OC in the employment equation is upward biased. To check whether a selection bias is introduced, a probit equation is estimated explaining the probability to refuse answer on employment expectations. Right-hand variables are size, sector and innovation dummies and other firm characteristics. The probit estimates show that there are few systematic factors which increase the probability of item non-response on employment expectations. In particular, the probability of item non-

response is similar for firms introducing OC compared to non-adopters.[3] It is found, however, that the probability of item non-response slightly depends on the firm size. It is concluded that selection bias is not a serious problem.

Table 1 contains information on the key variables based on the 1995 wave. Between 1993 and 1995 59% of German Service firms experienced at least one of the types of organizational change identified in the survey. The portion of university graduates as a percentage of the total of employees amounts to 17% and the ratio of training expenses to total wage cost amounts to 2.3% (1994). The majority of the service firms expected unchanged or decreasing employment during the three year intervals between 1995 and 1997 ranging between 83% for unskilled labour and 62% for workers with a degree from dual vocational system.

IV. RESULTS FROM THE MULTIVARIATE PROBIT MODEL

Table 2 shows the results for the baseline multivariate probit model which contains four different equations of

Table 1. *Summary statistics*

variable	means
employment expectations (1 increase, 0 oth.)	
university graduates	0.341
masters, technicians	0.301
vocational degree	0.373
unskilled and other workers	0.171
other variables	
high-skilled workershare, L_H/L	0.172
ICT investment to wage costs, ICT/WC	0.052
training expenditure to wage costs, TR/WC	0.023
expected output change (1 growth, 0 otherwise)	0.587
dummy east German firm (1/0), *East*	0.371
new ICT, all types (1/0), ΔICT	0.417
new organizational practices (1/0), ΔOC	0.586

Notes: The number of observations is 1389. *Source*: Mannheim Service Innovation panel 1995.

[3] Results are available upon request.

Table 2. *Simulated MLE of the multivariate probit model for firms' employment expectations and determinants of organizational change*

| Explanatory variables | Probability of employment increase: | | | | |
	university graduates	masters technicians	vocational degree	unsksilled workers	ΔOC*
ΔOC	1.050	0.944	0.580	−0.106	
	(3.73)	(2.95)	(1.67)	(−0.25)	
ΔICT	−0.101	−0.186	−0.193	−0.096	1.270
	(−0.67)	(−1.09)	(−1.14)	(−0.48)	(14.71)
$\Delta EXPY$	0.409	0.284	0.454	0.457	
	(5.18)	(3.71)	(5.86)	(4.66)	
L^H/L	1.068	−0.855	−0.984	−0.719	0.244
	(4.36)	(−3.51)	(−4.42)	(−2.62)	(1.00)
TR/WC					6.010
					(5.70)
EAST	−0.317	−0.331	−0.026	0.018	0.060
	(−3.66)	(−3.94)	(−0.33)	(0.18)	(0.70)
industry, size d.	yes	yes	yes	yes	yes
constant	−1.598	−0.953	−0.653	−1.619	−0.895
	(−9.24)	(−5.87)	(−3.74)	(−6.95)	(−5.28)
Log-L/Obs.	−3513.7/1389				

$$\hat{\Sigma} = \begin{pmatrix} 1 & 0.59 & 0.24 & -0.01 & -0.47 \\ & (12.14) & (3.48) & (-0.09) & (-2.77) \\ & 1 & 0.57 & 0.12 & -0.46 \\ & & (11.12) & (1.49) & (-2.30) \\ & & 1 & 0.41 & -0.22 \\ & & & (6.62) & (-1.03) \\ & & & 1 & 0.11 \\ & & & & (0.45) \\ & & & & 1 \end{pmatrix}$$

Notes: GHK estimator with 200 replications, *t*-values are in parentheses.

employment expectation (see column 1–4) and one equation for new organizational practices (see column 5) as well as the correlation matrix of the error terms. For all specifications we use 200 replications for the Geweke-Hajivassilou-Keane (GHK) estimator. The correlation coefficients of the error terms are significant at the 5% level in six out of ten cases. The positive correlation coefficients of errors terms between the different labour demand equations indicate that firms expecting an increase for one employment group are also expecting an increase for the other employment group conditional on the right-hand variables. In general, the correlations are quite reasonable, with the highest correlation between masters and technicians and workers with university degree. Two out of four correlation coefficients between the errors in the employment equations and the organizational change equation are significant at the five percent level. This indicates that organizational change is not exogenous in the labour demand equation. In addition to the t-test, a Wald test is carried out for the null hypothesis $H_0 : \rho_{n5} = 0, n = 1, ..4$, against $H_1 : \rho_{n5} \neq 0, n = 1, ..4$. For the baseline specification the chi-squared test statistic is 12.1 and therefore larger than the 5% critical value with 4 degrees of freedom.

It is found that organizational change has a significant and positive impact on the probability that firms increase future employment for all skill groups except for unskilled labour. For workers with a certificate from the dual vocational system the coefficient is positive but only significant at the 10 percent level. Turning to the determinants of organizational change the significantly positive coefficient on training expenditures in percent of total wage costs indicates that the probability to introduce new organizational practices depends on ratio of the training expenditures to total wage costs.

For comparison, the multivariate probit estimates assuming exogeneity of organizational change are provided in Table 3. Even though the sign and significance level of the coefficient on organizational change are quite similar across the models, the magnitude of the organizational change effect is remarkably larger based on the multivariate model with endogenous organizational change.

V. CONCLUSIONS

The paper deals with the impact of both organizational changes and the introduction of new ICT on the firms' expectations for future employment. To account for endogeneity of organizational change in the labour demand equations a selection equation explaining organizational change is added to the system of equations. It is found that organizational change has a significant and positive impact on expected employment for all skill groups except for unskilled labour. Controlling for endogeneity of OC in the labour demand equations resulted in a larger OC effect on employment expectations. Estimation results for the equation explaining organizational change indicate that the introduction of new ICT and the ratio of training expenses to total wage costs are primary forces behind organizational change.

Table 3. *Simulated MLE of the multivariate probit model for firms' employment expectations*

	Probability of employment increase:			
	university graduates	masters technicians	vocational degree	unskilled workers
ΔOC	0.296	0.211	0.228	0.176
	(3.23)	(2.41)	(2.66)	(0.39)
ΔICT	0.234	0.121	−0.046	−0.173
	(2.76)	(1.66)	(−0.58)	(−1.63)
$\Delta EXPY$	0.437	0.306	0.466	0.457
	(5.44)	(1.92)	(6.03)	(4.65)
L^H/L	1.232	−0.803	−0.948	−0.760
	(5.42)	(−3.23)	(−4.24)	(−2.75)
$EAST$	−0.329	−0.336	−0.025	0.015
	(−3.80)	(−4.02)	(−0.32)	(0.15)
industry, size d.	yes	yes	yes	yes
constant	−1.493	−0.825	−0.570	−1.667
	(−8.35)	(−5.09)	(−3.54)	(−8.07)
Log-L/Obs.	−2793.1/1389			

$$\hat{\Sigma} = \begin{pmatrix} 1 & 0.54 & 0.21 & 0.04 \\ & (13.52) & (4.29) & (0.54) \\ & 1 & 0.56 & 0.17 \\ & & (14.76) & (2.99) \\ & & 1 & 0.41 \\ & & & (8.35) \\ & & & 1 \end{pmatrix}$$

Notes: GHK estimator with 200 replications, *t*-values are in parentheses.

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