Employee education, information and communication technology, workplace organization and trade

A comparative analysis of Greek and Swiss enterprises

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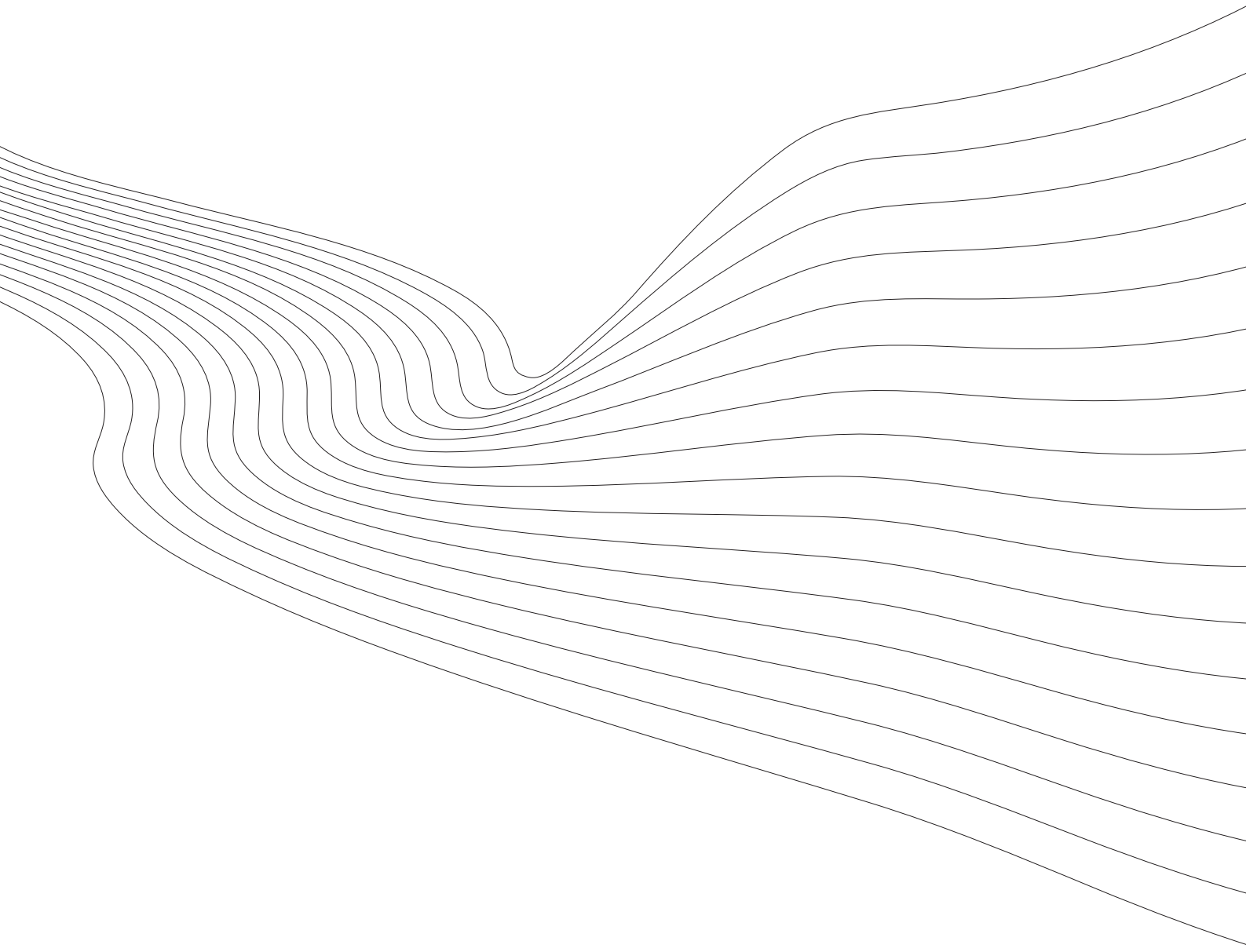

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Employee Education, Information and Communication Technology, Workplace Organization and Trade: A Comparative Analysis of Greek and Swiss Enterprises

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Abstract

This paper aims at investigating empirically at the firm level the effect of the use of modern information and communication technologies (ICT), and also of two other factors, the adoption of new forms of workplace organization and trade (export) activities, on the demand for employees with different levels of (vocational) education. The study is based on firm-level data collected through a common questionnaire from firms' samples of similar composition (concerning firm sizes and industries) in Greece and Switzerland; from these data econometric models of similar specification have been constructed for both countries. The results of multivariate analysis show that the intensive use of ICT correlates positively with the employment shares of high-educated personnel and negatively with the ones of the low-educated personnel. These findings are consistent with the hypothesis of 'skill-biased technical change'. Further, the intensive use of "employee voice"-oriented organizational practices correlates positively with the employment shares of high-educated employees in both countries, and also negatively with the employment share of low-educated ones only for the Swiss firms. The results for the "work design" organizational practices are more ambiguous. Thus, there is only partial confirmation of the hypothesis of skilled-biased organizational change. Finally, we found some evidence in favour of the trade effect (export activities) only for the Swiss firms. Our results show both similarities and differences in the above aspects between Greece and Switzerland and indicate that national context characteristics affect the relationship of the demand for employees with different levels of (vocational) education with ICT use, adoption of new forms of workplace organization and trade.

1. Introduction

There is long-term empirical evidence that both the number and the employment share of high-skilled (or high-educated) workers have grown over time in many OECD countries. In the last years many prominent economists were engaged in an intensive discussion on the reasons for the observed shift of labour demand toward high-skilled workers (see e.g. Johnson 1997 and the other contributions of the symposium in the spring 1997 issue of the *Journal of Economic Perspectives).* One of the most popular explanations which have been offered by the economic literature is based on the so-called „skill-biased technological change"-hypothesis, according to which the reason for the upskilling of labour force is the non-neutrality of technological change, which favours the use of skilled labour more than the use of other labour inputs. Due to the complementarity of skills (education) and technology, an acceleration of the rate of technological change would cause an increase of the demand for skilled labour.[1,2] The reason for the most recent acceleration of technological change is assumed to be the diffusion of Information and Communication Technologies (ICT) which seem to have given new impetus to the substitution process of low-skilled by high-skilled employees. Nevertheless, for some authors it is not clear, whether the observed shift of labour demand is caused mainly by within-sector technological change or by sector-biased technological change, i.e. technological change affecting only some specific sectors (see, e.g., Haskel and Slaughter 2002).

On the whole, the technology hypothesis cannot explain the entire magnitude of the observed labour demand shift. This is the reason why some researchers have looked for other possible alternative or complementary explanations of the change of the composition of the labour force. For industrial and managerial economists such alternative explanations are associated with the reorganization of production which took place parallel to the introduction of ICT (see, e.g., Aoki 1986). This reorganization includes the introduction of new forms of workplace organization, such as team work, job rotation, decrease of hierarchical levels, decision decentralization (see, e.g., Caroli 2001); these new forms of workplace organization are regarded as basic 'complement' of ICT (OECD 2003).

For trade economists such alternative explanations are related to the internationalization of economic activities (see, e.g., Wood 1995). The main hypothesis is that the accelerated growth of world trade and foreign direct investment leads to a new international division of

[1] Yet it is also true that an increase in the supply of skills could also induce an acceleration of technological change; it is mostly assumed that in the long-run the driving force from the demand side is the dominant one (see, e.g., Acemoglu 1998); the empirical evidence seems to support this notion.

[2] For comparative studies for several countries see Berman et al. (1998); and Machin and Van Reenen (1998). Concerning the two countries considered in this study there is to our knowledge only one study for Switzerland that deals with these issues (Arvanitis 2005). For recent surveys of the theoretical and empirical literature on skill-biased technical change see Sanders and ter Weel (2000) and Acemoglu (2002).

labour: the production of goods (and services) with a high content of low-skilled labour is dislocated to developing countries of the South, while activities with a high content of high-skilled labour are concentrated in the developed countries of the North. A combination of all three possible explanations, ICT-induced technological change, organizational change, and trade, is the approach we are going to pursue in this paper.

Most of the research on information systems management that has been conducted concerning the impact of ICT on organizations has been focused mainly on their effects on organizational performance, processes and structure (e.g. Melville et al, 2004, Attaran 2004, Pearson and Saunders 2006, Albadvi et al 2007, Wan et al 2007). However, other aspects of the organizational impact of ICT, such as their effects on the demand for employees' (vocational) education and skills, have not received much attention by the ICT researchers and practitioners, despite their high organizational and social importance.

The present study explores empirically the hypothesis that ICT and new organizational practices are important determinants of the demand for labour of different skills, further that the joint use of these two factors leads to a mutual strengthening of their impact on labour demand. A third hypothesis refers to the influence of trade (in this case: exports) on the composition of a firm's workforce. Firms from developed countries with high wages (as compared to developing countries) can become internationally competitive by selling products and services with a high content of high-skilled labour. Thus, the use of high-skilled labour (often in combination with ICT) is presumably an important precondition for a firm to become internationally competitive. The analytical framework is that of a demand function for employees with different education levels (heterogeneous labour) at firm level. Both the Greek and the Swiss part of this study are based on firm-level data collected through the same questionnaire in 2005 and from samples of similar composition (concerning firm size classes and sectors), and also use the same variables and models specification, so they are comparable.

The study's new contribution to empirical literature consists in (a) taking into consideration all three main factors forwarded in literature for explaining the shift of labour demand in favour of high-skilled labour, which allows a comparison of their effects; (b) investigating possible complementarities among these three factors; and (c) conducting a comparative study of the above effets between two countries, Greeece and Swirzerland, which are characterized by different levels of economic development.

The structure of this paper is as follows: In section 2 the concept ional framework of this study is presented. Section 3 contains a review of the relevant empirical literature. In section 4 the data of both the Greek and the Swiss parts of the study are described. In section 5 the model specification and the variable construction are presented. The results of the econometric estimates are presented and discussed for both samples in section 6. Finally, in

section 7 some policy implications are discussed.

2. Conceptual Background and Research Hypotheses Formulation

2.1 The „Skill-Biased Technical Change"-Hypothesis: The Role of ICT

The shift toward more highly educated workers, which can be observed since the late sixties or possibly the early seventies in many OECD countries, appears to have accelerated in the last twenty years (see e.g. Berman et al. 1998; OECD 1998). While many factors have contributed to this increase most authors think that this effect is attributable primarily to skill-based technical change. The size, breadth and timing of the recent labour demand shift have led many observers to seek skill-biased technical change in the largest and most widespread new technology of the last years, ICT (see Bresnahan 1999; Bresnahan et al. 2002). On the one hand, high-skilled labour is a precondition for the use of ICT; for example, training in problem-solving, statistical process controls and computer skills can increase the benefits of ICT. On the other hand, highly computerized systems not only systematically substitute computer decision-making for human decision-making in routine work, but also produce a large quantity of data which needs high-skilled workers, managers and professionals to get adequately utilized.

The specific influence of ICT adoption and use on the composition of the workforce has been a particular subject of recent theoretical and empirical analysis. One important proposition is that ICT capital (a) substitutes for workers performing cognitive and manual tasks that can be accomplished by following given rules and (b) complements workers in performing non-routine cognitive tasks concerning generalized problem-solving and complex communications (see Bresnahan 1999; Autor et al. 2003). This distinction of routine and non-routine tasks leads to a further differentiation related to the possibility of different effects on the skill mix depending on the type of technology under study. In manufacturing firms with a large scope for factory automation technologies increase of the share of high-skilled or high-educated workers may prove to be rather small in comparison to manufacturing or service firms, in which computer investment is mainly related to the work of non-production workers with administrative or managerial tasks, etc. (see Doms et al. 1997). Therefore our first research hypothesis is:

Hypothesis 1: There are considerable positive (negative) effects of ICT on the demand for high-educated (low-educated) employees.

2.2 The „Skill-Biased Organizational Change“-Hypothesis: The Role of New Forms of Workplace Organization

A further hypothesis put forward in the literature recently refers to the influence of the increasing diffusion and application of intra-firm reorganization processes on the observed change of firms‘ skill requirements. The basic idea is that a gradual shift from rigid „‘Tayloristic‘ organization (characterized by specialization by tasks) to ‚holistic‘ organization (featuring job rotation, integration of tasks and learning across tasks)“ (Lindbeck and Snower 2000, p. 353) is taking place within firms. This phenomenon first appeared in the USA and Japan and has spread later throughout Europe, although at a different pace from country to country (see Aoki 1986, Greenan and Guellec 1994).

The main elements of reorganization at the workplace level according to economic, management and sociological studies on this field are (see Caroli 2001 for a survey of the literature on this subject): (a) decentralization of decision-making by delegation of relevant competences from management to lower hierarchy levels, increased involvement and autonomy of employees at the shopfloor level; (b) new working practices such as team-work (semi-autonomous work-teams, quality circles, etc.), job rotation, other forms of multi-tasking, multi-skilling, etc.. Many authors seem to share the idea that changes in work organization towards more “holistic” structures, definitely require an upgrading of the skill content of most jobs related to these changes. Caroli (2001) presents a series of reasons for it. Current organizational changes increase employees’ responsibility for tasks and operations. This is not only the case for operatives but also for supervisors and technicians, whose roles, hence skills, are considerably modified by the new organizational practices. Interpersonal abilities also become more important owing to the increasing need for communication and co-ordination. Thus, an important precondition for the successful implementation of most of these new organizational practices is the availability of a higher skilled (or higher educated) workforce. Therefore our second research hypothesis is:

Hypothesis 2: There are considerable positive (negative) effects of new forms of workplace organization on the demand for high-educated (low-educated) employees.

2.3 The Trade Hypothesis: The Role of Trade

The main hypothesis is that the accelerated growth of world trade and foreign direct investment leads to a new international division of labour: the production of goods (and services) with a high content of low-skilled labour is dislocated to developing countries of the South, while activities with a high content of high-skilled labour are concentrated in the developed countries of the North (see e.g. Wood 2005). This results in a declining relative demand for high-skilled personnel and increasing relative demand for low-skilled personnel.

Firms from developed countries with high wages (as compared to developing countries) can become internationally competitive by selling products and services with a high content of high-skilled labour. Therefore our third research hypothesis is:

Hypothesis 3: There are considerable positive (negative) effects of trade, especially exports, on the demand for high-educated (low-educated) employees.

2.4 Complementarities: Technical Change Related to Organizational Change

The use of ICT, new organizational practices and human capital build a „complementary system" of activities (Bresnahan et al. 2002, p. 341ff; Milgrom and Roberts 1995, p. 191ff.). According to Milgrom and Roberts (1990 p. 514) „the term ‚complement' is used not only in the traditional sense of a specific relation between pairs of inputs but also in a broader sense as a relation among groups of activities". Also for the organizational practices there exist interdependencies with other factors and inputs. Some of the changes of work design are associated with the introduction and diffusion of information technologies within the firm. For example, Greenan and Guellec (1994) show in a theoretical paper that the relative efficiency of a centralized mode of firm organization in which knowledge is confined to specialized workers and a decentralized one in which every worker participates in learning depends on the technological level of the firm: „whereas the centralized style is more efficient when the technological level is low, the decentralized one becomes more efficient when the technological level is higher" (p. 173). Further, retaining high international competitiveness as expressed by high exports also necessitates more intensive use of ICT and new forms of workplace organization. Hence, our complementarity hypotheses are:

Hypothesis 4a: There is a positive (negative) interrelationship between technology and organization leading to a mutual strengthening of the effects of these two factors on the demand for high-educated and low-educated employees respectively (complementarity hypothesis a).

Hypothesis 4b: There is a positive (negative) interrelationship between technology and organization on the one hand and exports on the other hand leading to a mutual strengthening of the effects of these factors on the demand for high-educated and low-educated employees respectively (complementarity hypothesis b).

3. Comparative Evidence and Survey of Empirical Literature

A comparison with other similar studies (see Table 1)[3] shows that there are considerable differences among the firm samples of the countries under scrutiny. Positive effects for both the technological and the organizational factors for the high-educated are found in all surveyed German studies. Interaction terms for organization and technology were investigated in some cases but no statistical significant effects could be identified. The results for the middle-educated employees were mixed for both the technological and the organizational factor. For low-educated employees, in most studies negative effects of ICT are found; interaction terms were in most cases statistically insignificant.

For French and Italian firms is the influence of technology on the employment shares of employees with different skills or education less important than that of organization. Most studies could not find any discernible effects of technology. With respect to organizational factors there is a tendency for a positive impact for the high-educated and a negative one for the low-educated employees. Interaction terms were in some cases significantly positive for the high-educated and negative for the low-educated employees.

Studies for the USA and the U.K. demonstrate clearly the expected effects of technology on the employment of high- and low-educated employees respectively. The impact of organization is less clear that that of technology, but in most cases as expected.

There are only few studies taking the trade effect into account in combination with technology and/or organization and their results are ambiguous. One of the three studies reviewed here found a (partly) positive effect of trade on the employment of high-skilled employees of French enterprises (Maurin et al. 2002). The second one found a positive effect of trade on the employment of low-skilled employees for a sample of Norwegian firms (Salvanes and Forre 2003). Finally, a study based on German data (Kaiser 2001) came to the conclusion that expert activities could exercise a negative influence on the employment share of skilled workers but have no effect on the employment shares of academics and unskilled workers.

On the whole, the results 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 approach). Further empirical research is required, including all these three factors proposed in the literature for explaining the shift of labour demand in favour of high-skilled labour (ICT, new forms of workplace

[3] The choice of the studies reported in Table 1 was based on following criteria: recent date of publication, consideration of at least two variable blocks (technology; organization; trade) in the model specification, firm-level analysis, covering all sectors of the economy. There are two exceptions from these criteria: (a) the study of Maurin et al. (2002) that investigated only the trade effect; and (b) the study of Kaiser (2001) that studied only service firms.

organization and trade), and also covering countries of different levels of development based on similar samples, variables and models, so that comparisons can be made.

4. Model Specification and Data

The analytical framework we adopted in this study is that of a demand function for employees with different education levels (heterogeneous labour) at firm level. In particular, we considered in this study three categories of employees: high-educated (employees with education at the tertiary level including universities, technical and business colleges, middle-educated (employees with a formal degree in vocational education) and low-educated (employees with some vocational education but without a formal degree or without any formal vocational education). The employment share for each of these categories was used as a dependent variable in our model estimations (variables H_EDUC; M_EDUC; L_EDUC). For each of them we constructed a separate model; all three models contained the same independent variables, which are described in the following paragraphs (see Table 2 for the definition of the model variables).

Since we did not dispose of data on capital use costs and wage data for each education category, we relied on extensive industry controls to seize the influence of these variables.[4]

As measures for technology input, particularly ICT input ("ICT capital"), we used the intensity of use of two important network technologies, internet (linking to the outside world) and intranet (linking within the firm). This intensity was 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 a five-point ordinal variable for the intensity of use of Internet and Intranet respectively. 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 installed personal computers, etc.). In a further step we calculated a composite indicator for ICT by adding together the standardized values (average 0; standard deviation 1) of the two constituent variables for Internet and Intranet (technology variable ICT). We expect in general a positive correlation of technology variables with the employment share of high-educated employees. Further, we expect a negative correlation between the technology variable and the share of low-educated employees. We have no a

[4] Capital use costs do not vary much among industries. In case of wage data and their use as factor prices a further problem is their endogeneity which could cause serious econometric problems; some authors even proposed to omit altogether wage data in one-equation framework (see e.g. Machin and Van Reenen 1998).

priori expectation for the relation between technology variable and the employment share of middle-educated employees.

The measurement of organizational inputs, here restricted to inputs related to workplace organization, 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 and Lynch 2002 and Lev 2003 for a discussion of this matter). In order to choose the variables related to changes and/or introduction and use of new organizational practices at the workplace level we draw on the definition offered by Black and Lynch (2002). They distinguished two components of organizational capital (in a narrow sense, that is without training which we view as part of the human capital of the firm): “work design“ and “employee voice“. Examples of practices that are included in the first component are reengineering efforts that may involve changing the occupational structure of the workplace, the number of levels of management within the firm, the existence and diffusion of job rotation, and job share arrangements. The second component of organizational capital, „employee voice“, is associated with practices such as individual job enrichment schemes, employees being consulted in groups, employees having more decision competences, the existence and diffusion of work in (formally constituted) teams, etc.

Our data enabled us to construct two composite variables for organization, one for “work design”-oriented organizational practices (ORG1) and a second one for “employee voice”-oriented organizational practices (ORG2). The variable ORG1 was constructed as the sum of the standardized values of the following three variables: 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. The variable ORG2 was calculated as the sum of the standardized values of the following eight variables: overall shift of decision competences from managers to employees; employees having the competence to determine: work pace; the sequence of performing tasks; the way of performing tasks; to assign tasks; to solve emerging production problems; to contact customers, to solve problems emerging with customers. We expect an overall positive effect of organizational variables on the share of high-educated employees and a negative effect on the share of low-educated employees. We have no a priori expectations with respect to the middle-educated employees.

The use of these composite variables as overall measures of technology and organization enabled us not only to assess the relative importance of these factors with respect to employee education but also to test the postulated complementarity between technology and organization.

The trade effect was measured in our specification by the export intensity (exports as a percentage of sales; variable EXPQ).

We included three more variables which are related to workplace organization but are not components of organizational capital per se. The first one is referring to incentive-based compensation and is a dummy variable for applying employee compensation according to team-performance. A further variable measures labour flexibility (dummy variable for the intensive use of part-time work). With respect to the compensation variable the sign of the correlation to the dependent variable is not a priori clear for middle- and low-educated employees; we expect that team compensation is considered as more adequate and/or is more often used for higher- than lower-qualified employees. The relation between part-time work and education level of the employees is in the empirical literature not clear and depends on the overall conditions of the labour market as well as its institutional framework.

Further, we included two variables measuring the intensity of price (IPC) as well as non-price competition (INPC). In a recent paper Gersbach and Schmutzler (2006) postulate and derive theoretically two hypotheses about the market conditions under which industry-specific training is likely to occur: (a) concentration is high or competitive intensity is low, and (b) product differentiation is sufficiently strong. We considered the intensity of price competition as measured in this study as a proxy for 'competitive intensity' in the above theoretical context and the intensity of non-price competition as measured in this study as a proxy for 'product differentiation'. Thus, according to hypothesis (a) intensive price competition would exercise a *negative* influence on training propensity. On the contrary, according to hypothesis (b) intensive non-price competition would have a *positive* effect on training propensity. Given that a firm's training propensity is generally positively correlated to the demand for high-qualified employees we conclude that the above-mentioned hypotheses could be directly used as theoretical background for the two competition variables in our model.

In order to test for the complementarity hypotheses we inserted in additional estimations of the model also five interaction terms for possible joint effects of ICT, ORG1, ORG2 and EXPQ.

Finally, we used extensive controls for firm size and industry affiliation to account for firm- or industry-specific influences not taken explicitly into consideration.

The data used in the Swiss part of this study were collected in the course of a survey among Swiss enterprises, which was based on a disproportionately stratified (with respect to firm size) 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 26 industries, and within each industry three industry-specific firm size classes with full coverage of the upper class of large firms); finally valid answers were received from 1710 firms. The data used in the Greek part of the study were collected similarly through a survey among Greek enterprises, which was based on a 'similar' sample to the one of the Swiss part of the study (concerning proportions of firm sizes and industries), using the same questionnaire (translated in Greek). In both parts

of this study a non-response analysis was performed, which did not indicate any serious selectivity bias with respect to the use of ICT and new organizational practices (team-work, job rotation). Both surveys were conducted in autumn 2005 (see Table A.1 in the appendix for the composition of the used data sets). The reference period for the qualitative data is the period 2003-2005 unless otherwise mentioned. The reference year for the quantitative variable is 2004.

5. Results

Table 3 and Table 4 contain the estimates of the model for the employment shares of the high-, middle- and low-educated employees. For the Greek data we used OLS as estimation method; for the Swiss data we estimated a Tobit model in order to take into account the rather high number of observations with the value 0.[5] We estimated the model (a) without interaction terms (column 1, 3 and 5 in Table 3 and Table 4) and (b) with interaction terms (column 2, 4 and 6 in Table 3 and Table 4). Since these results are only cross-section estimates, it is not possible to test directly the existence of causal relations between the independent variables and the dependent variable. Nevertheless, some robust regularities come out, which if interpreted in view of our hypotheses 1 to 4 (see section 2) could possibly indicate the direction of causal links.[6]

5.1 Technological Factors

From Table 3 we can see that for Greece the coefficient of the ICT variable is positive and statistically significant for the high-educated employees, and negative and statistically significant for the middle-educated employees as well as for the low-educated employees. For Switzerland the estimates for the ICT variable coefficient in Table 4 show clearly that the technological factors correlate positively with the share of high-educated employees and negatively with the share of low-educated employees; technology is not discernibly related to the employment share of the middle-educated employees. In sum, we found a positive effect of ICT on the shares of the high-educated and a negative effect on the share of low-educated employees for both countries. Both effects appear to be robust across all estimates. Thus,

[5] There are 62 observations with the value 0 in case of the high-educated, 4 observations in case of the middle-educated and 198 in case of the low-educated employees (see Table 5).

[6] We refrain here from testing the exogeneity of right-hand variables in the econometric sense of the word especially because the variables for ICT and workplace organization are to a considerable extent predetermined being measured as structural characteristics of the last years and not for a concrete point of time (see, e.g., the Swiss questionnaire, which is available in German, Frnch and Italian in www.kof.ethz.ch), while the dependent variables are measured for 2004. This is not the case for the export variable, which is also measured for 2004.

hypothesis 1 of “skill-biased technological change” receives strong support for both countries. This is the most important common finding

5.2 Organizational Factors

From Table 3 we remark that the organizational variables appear to have only a weak influence on the composition of the workforce in Greek firms. We found a positive effect of ORG2 (employee voice) for high-educated employees and a negative one of ORG1 (work design) for the low-educated employees. From Table 4 we can see that organizational practices associated to the “work design“ (variable ORG1) are positive correlated with the share of high-educated and negatively related to the share of middle-educated employees, while no effect is found for the low-educated employees. Thus, for Swiss firms practices such as team-work, job-rotation and flattening of the overall firm organization show the expected positive effect on the share of high-educated employees but a negative effect for the middle-educated employees. Significantly related to all three employment shares is the variable ORG2 measuring various dimensions of “employee voice”. We found positive effects of this variable on the shares of the high- and the middle-educated employees and a negative one for the low-educated employees. In sum, by comparing the two countries organizational factors seem to be much less important for Greek firms than for Swiss firms. Also, the decentralization of decision making, as it is measured by ORG2, shows a positive effect on the share of high-educated employee for both countries; this is the second common finding that provides some empirical evidence for the validity of hypothesis 2 of “skill-biased organizational change”. On the whole, the results for the organizational variables ORG1 and ORG2 are only partly in accordance with hypothesis 2.

5.3 Export activities

Hypothesis 3 is of no relevance for the Greek firms: the export intensity does not show a statistically significant effect on any of the three education-related employmenr shares (Table 3).[7] On the contrary, the trade effect seems to be quite important for Swiss firms due to their much stronger exsposure to the international competition than Greek firms, mainly in highly sophisticated sectors, such as pharmaceuticals, electronics/ instruments, financial and other business services (Table 4). The positive effect of export activities on the share of high-educated employees is in accordance with expectations, but not the positive effect for the low-educated. A possible explanation for the latter effect might be found in the fact that to

[7] We suppose that the complementary hypothesis for the role of import substitution would be much more relevant for Greek firms that suffered much under the fierce international competition in the sectors they are mostly present, e.g. clothing, textiles, metals, food. Unfortunately, import data at an adequately low of aggregation were not available.

internationally competitive firms belong also enterprises, which use production techniques based on automatization that can be operated by workers with low skills. So an increasing degree of production automatization would lead to an increase of the employment of low-educated employees at the cost of middle-educated employees that are typically involved in more traditional production techniques. The above results provide some evidence in favour of the trade effect (export activities) only for the Swiss firms.

5.4 Complementarity Effects

For the Greek firms we could not find any complementarity effects (Table 3). On the contrary, there are several significant effects of the interaction terms in the estimates for the Swiss firms (Table 4). The coefficient of the interaction term ICT*ORG1 is positive (and statistically significant) in the equation for the high-educated employees, significantly negative for the middle-educated employees and insignificantly negative for the low-educated employees. For ICT*ORG2 we found no effect for the high-educated employees, a negative effect for the middle-educated employees and, rather unexpectedly, a positive effect for the low-educated employees. Finally, there was a positive effect of the variable ICT*EXPQ for the high-educated employees.

The result for ICT*ORG1 can be interpreted as a hint for the existence of complementarity of ICT and workplace organization, which means that besides the direct effects of ICT and organization on the employment shares of high- and low-educated employees also exist indirect effects which can be traced back to the joint impact of these two factors on the employment shares. The positive effect of ICT*ORG2 with respect to low-educated employees is contrary to hypothesis 4a. On the whole, hypothesis 4a receives only partly support from these results.

Finally, there is only little evidence in favour of hypothesis 4b: the interaction term EXPQ*ICT has a positive and statistically significant coefficient only in the equation for high-educated employees for Swiss firms.

5.5 Other Factors

Part-time work and team compensation are of no relevance for the Greek firms (Table 3). On the contrary, for the Swiss firms (Table 4), the variable for part-time work correlates negatively with the share of high-educated employees and the share of middle-educated employees, but positively with the share of low-educated employees. These results reflect the relative importance of various dimensions of quantitative labour flexibility for different employee categories. Seemingly, part-time work is considered adequate primarily for low-

educated employees. Further, compensation according to team-performance is not relevant for any of the three employee categories.

The Greek results with respect to the two dimensions of competition, namely a positive effect of the intensity of price competition (IPC) on the share of the low-educated employees, a positive effect of the intensity of non-price education (INPC) for the high-educated and a negative effect of the same variable for the low-educated are in accordance with theoretical expectation (hypotheses (a) and (b) in Gersbach and Schmutzler 2006). For the Swiss firms the competition effects are of considerably smaller importance; we could find only a negative effect of IPC on the share of high-educated employees, which is also in accordance to theoretical prediction.

6. Conclusions

6.1 Summary

In sum, comparing the three examined factors, which have been proposed by the literature for explaining the shift of labour demand in favour of high-skilled labour, the technology (ICT) has been found to have a strong and robust effect on the demand for employees' skills (a positive effect on the demand for high-qualified personnel, and a negative effect on the demand for low-qualified personnel) in both national contexts (i.e. in both a highly developed country as Switzerland and a country not belonging to the highly developed ones as Greece). On the contrary, the new forms of workplace organization in Switzerland seem to have a strong effect on the demand for employees' skills (its pattern of effects differs between new work design and employee voice practices, with both of them increasing the demand for high-qualified personnel), but in Greece this effect is much weaker; this indicates that in the context of Greece, a country not belonging to the highly developed ones, firms have not sufficiently learnt to adapt their personnel composition to new forms of workplace organization. Similarly, the export intensity in Switzerland has a strong effect on the composition of firms' personnel (showing a pattern different from the ones found in the limited previous empirical literature on this topic (see section 3): increasing the shares of high-educated and low educated personnel, and decreasing the shares of middle-educated personnel); however, in Greece, a country with much lower export activity, and therefore a much lower exposure to the corresponding international competition, the export intensity does not affect the composition of firms' personnel.

By comparing the results from the two countries, both similarities and differences in the above aspects can be identified. In Greek firms the main drivers of shift to high-qualified employees is the use of ICT and the decentralization of certain competences; also, the use of ICT is the main driver of reductions in the shares of middle-qualified and low-qualified

personnel. On the contrary, in Swiss firms there is a wider range of significant drivers of shift to high-qualified employees: use of ICT, adoption of new work design practices, decentralization of certain competences, export activity, and also the interaction between ICT and new work design practices, as well as the interaction between ICT and export. Swiss firms seem to be able to take a maximum out of the potential of technology and decentralization through the combination of them with appropriate human skills; in order to remain internationally competitive, Swiss firms also tend to increase the skill content of their products. These results indicate that national context characteristics affect the relationship of the demand for employees' (vocational) education and skills with ICT use, adoption of new forms of workplace organization and trade.

6.2 Policy Implications

The results of this study might have significant implications for firms' management and government policy. Firms' management before making ICT investments, adopting new forms of workplace organization and intensifying their export activities, should have to adapt their personnel skills and probably their personnel composition. Also, government policy makers have to pay special attention to the conditions favouring the formation and growth of required human capital in the economy. In this sense, it is necessary to take into account the results of this study, which indicate that nearly all the examined factors (with very few exceptions) have a negative effect on the demand for middle-educated and low-educated personnel, which can result in increasing unemployment for these groups and therefore complex and multi-dimensional social problems. Therefore they should design appropriate policies for addressing this issue. In order to offer more employment perspectives to middle-educated persons government should promote and develop not only tertiary education, but also education institutions that produce this middle-skilled personnel. For instance, in Switzerland, the system of the "normal" vocational education ("Berufslehre"), which is one of the two pillars of the Swiss "dual" education system" that produces middle-educated personnel, has to be (further) upgraded, especially with respect to the content of education. A more difficult problem is to offer more employment perspectives to low-educated persons. Additional education and/or vocational training is one way of trying to tackle this problem, but it is not a way accessible for all involved persons, particularly not for older ones; for such cases social partners and policy makers have to co-ordinate efforts for specific solutions aiming at the social integration of this category of employees. Finally, taking into account our conclusion concerning the effect of national context characteristics on the above aspects, it should be noted that for designing our corresponding policies both at the firm and government level we cannot just 'copy' solutions from other countries; instead it is necessary to exploit the relevant knowledge of other countries, but in combination with a sound knowledge of the particular characteristics and specificities of our own national context.

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Tables:

Table 1: Survey of Recent Empirical Literature

Study	Dependent Variable	ICT; TECH	ORG	EXPQ	Complementarity ICT;TECH/ORG/EXPQ
USA:					
Capelli/Carter (2000):					
- longitudinal	*average wages of:*				
	managers/ professionals	positive	pos./neg.	n.c.	n.c
	supervisors	positive	pos./neg.(1)	n.c.	n.c.
	technical workers	positive	n.s./neg.(1)	n.c.	n.c.
	office workers	positive	pos./neg.(1)	n.c.	n.c.
	production workers	positive	pos./neg.(1)	n.c.	n.c.
Bresnahan et al. (2002):					
- *cross-section*	*human capital investment*	positive	positive	n.c.	nc
UK:					
Caroli/Van Reenen (2001):					
- longitudinal	*changes in the wage bill shares of:*				
	unskilled manuals	n.s.	negative	n.c.	not robust
	semi-skilled manuals	n.s.	n.s.	n.c.	not robust
	skilled manuals	negative	positive	n.c.	not robust
	clerical workers	ns	n.s.	n.c.	not robust

	supervisors/foremen	positive	n.s.	n.c.	not robust
	managers/technical staff	positive	n.s.	n.c.	not robust
France:					
Caroli/Van Reenen (2001):					
- longitudinal	*changes in the wage bill shares of:*				
	unskilled manuals	n.s.	negative	n.c.	n.s.
	skilled manuals	n.s.	positive	n.c.	n.s.
	clerical workers	n.s.	n.s.	n.c.	n.s.
	middle managers/ technicians	n.s.	n.s.	n.c.	positive
	senior managers	n.s.	n.s.	n.c.	n.s.
Caroli et al. (2001):					
- longitudinal	*probability of employment increase for:*				
	managers	n.a.	n.s.	n.c.	n.c.
	intermediate workers	n.a.	negative	n.c.	n.c.
	operatives	n.a.	negative	n.c.	n.c.
Maurin et al. (2002):					
- longitudinal	*change rate of the employment share of:*				
	skilled non-prod.	n.c.	n.c.	positive	n.c.
	skilled prod.	n.c.	n.c.	n.s.	n.c.
Greenan (2003):					
- cross-section	*employment shares of:*				
	executives	n.s.	negative	n.c.	n.c.
	middle management	negative	n.s.	n.c.	n.c.
	clerks	n.s	n.s.	n.c.	n.c.
	skilled blue workers	n.s.	negative	n.c.	n.c.
	unskilled blue workers	pos./neg.[(2)]	positive	n.c.	n.c.
- cross-section	*growth rate of*				

	employment shares of:				
	executives	n.s.	positive	n.c.	n.c.
	middle management	n.s.	n.s.	n.c.	n.c.
	clerks	negative	negative	n.c.	n.c.
	skilled blue workers	n.s.	negative	n.c.	n.c.
	unskilled blue workers	n.s.	n.s.	n.c.	n.c.
Germany:					
Gerlach/Jirjahn (1998):					
- longitudinal	*employment share of:*				
	workers with vocational degree	positive	n.s.	n.c.	n.c.
	foremen/technicians	n.s.	n.s.	n.c.	n.c.
	university graduates	positive	positive	n.c.	n.c.
Bauer/Bender (2001):					
- longitudinal	*employment share of:*				
	blue-collar workers:				
	- unskilled	n.s	n.s	n.c.	n.s.
	- skilled	n.s	n.s	n.c.	n.s.
	- high-skilled	n.s	n.s	n.c.	n.s.
	white-collar workers:				
	- unskilled	n.s.	negative	n.c.	negative
	- skilled	n.s.	n.s.	n.c.	n.s.
	- high-skilled	n.s.	n.s.	n.c.	n.s.
	average wages of:				
	blue-collar workers:				
	- unskilled	n.s.	negative	n.c.	n.s.
	- skilled	n.s.	negative	n.c.	n.s.
	- high-skilled	n.s	n.s	n.c.	n.s.
	white-collar workers:				
	- unskilled	n.s.	negative	n.c.	n.s.
	- skilled	negative	negative	n.c.	n.s.
	- high-skilled	n.s.	n.s.	n.c.	n.s.

Kaiser (2001):					
- cross-section,	employment share of:				
	academics	positive	n.c.	n.s.	n.c.
	skilled workers	negative	n.c.	negative	n.c.
	unskilled workers	negative	n.c.	n.s.	n.c.
Falk (2002):					
- cross-section	*probability of employment increase for:*				
	university graduates	positive	positive	n.c.	n.c.
	masters/technicians	positive	positive	n.c.	n.c.
	vocational degree	n.s.	positive	n.c.	n.c.
	unskilled workers	n.s.	n.s.	n.c.	n.c.
Hujer et al. (2002):					
- longitudinal	*employment share of:*				
	high-skilled	positive	n.s.	n.c.	n.c.
	low-skilled	negative	n.s.	n.c.	n.c.
Italy:					
Piva et al. (2003:					
- cross-section	*log of difference of the number of:*				
	white-collar workers	n.s.	n.s.	n.c.	positive
	blue-collar workers	n.s.	negative	n.c.	negative
Norway:					
Salvanes/Forre (2003):					
- longitudinal	net job creation of:				
	high-educated empl	positive	n.c.	n.s.	n.c.
	middle-educated empl.	n.s.	n.c.	n.s.	n.c.
	low-educated empl.	n.s.	n.c.	positive	n.c.
Switzerland:					
Arvanitis (2005):					
- cross-section	*employment share of:*				

high-educated empl.	positive	positive	n.c.	negative
middle educated empl.	n.s.	n.s.	n.c.	n.s.
low-educated empl.	negative	n.s.	n.c.	negative

Notes: (1): positive: team-work, reduction of management levels, regular meetings; negative: job rotation; (2): partly positive, partly negative coefficients; ICT: information and communication technologies; ORG: workplace organization; „positive“ (“negative“): statistically significant (at the test level of 10%) positive (negative) coefficient of the variables(s) for ICT, ORG and the interaction term of these two variables respectively; n.s.: statistically not significant (at the test level of 10%); n.c.: not considered; n.a.: not available (for such cases in which the corresponding variables are included in the models, but the results are not explicitly presented).

Table 2: Definition of Model Variables

Variable	Definition and measurement
Dependent variables	
H_EDUC	Employment share of employees with tertiary-level education
M_EDUC	Employment share of employees with a formal degree in vocational education
L_EDUC	Employment share of employees without any formal vocational education or with some vocational education but without a formal degree
Independent variables	
ICT	Sum of the standardized values of the 2 variables INTERNET and INTRANET
INTERNET	Six-level ordinate variable for the intensity of *Internet use*: share of employees using Internet in daily work: 0: 0%; 1: 1-20%; 2: 21-40%; 3: 41-60%; 4: 61-80%; 5: 81-100%
INTRANET	Six-level ordinate variable for the intensity of *Intranet use*: share of employees using intranet in daily work: 0: 0%; 1: 1-20%; 2: 21-40%; 3: 41-60%; 4: 61-80%; 5: 81-100%
ORG1	Sum of the stardardized values of the 3 variables TWORK, JROT and LEVEL
TWORK	Ordinate variable measuring how widespread is *team-work* inside a firm on a five-point Likert scale (1: 'very weakly widespread'; 5: 'very strongly widespread'); team work: project groups, quality circles, semi-autonomous teams, etc.
JROT	Ordinate variable measuring how widespread is *job rotation* inside a firm on a five-point Likert scale (1: 'very weakly widespread'; 5: 'very strongly widespread'); team work: project groups, quality circles, semi-autonomous teams, etc.
LEVEL	Three-level ordinate variable for the change of the number of *managerial levels* in the period 2000-2005: 1: increase; 2: no change; 3: decrease
ORG2	Sum of the standardized values of the 8 variables COMP_OVERALL, COMP_WORKPACE, COMP_WORKSEQ, COMP_WORKASSIGN, CONP_WORKWAY, COMP_PRODUCTION, COMP_CUSTOMER_CONTACT and COMP_CUSTOMER
COMP_OVERALL	Three-level ordinate variable measuring the *change* of the distribution of decision competences between managers and employees inside a firm in the period 2000-2005: 1: shift towards managers; 2. no shift; 3: shift towards employees
COMP_WORKPACE	Ordinate variable measuring the distribution of decision competences to determine work *pace* (1: 'primarily managers'; 5: 'primarily employees')
COMP_WORKSEQ	Ordinate variable measuring the distribution of decision competences to determine the *sequence* of the tasks to be performed (1: 'primarily managers'; 5: 'primarily employees')
COMP_WORKASSIGN	Ordinate variable measuring the distribution of decision *competences to assign tasks* to the employees (1: 'primarily managers'; 5: 'primarily employees')
COMP_WORKWAY	Ordinate variable measuring the distribution of decision competences to determine the *way* of performing tasks (1: 'primarily managers'; 5: 'primarily employees')
COMP_PRODUCTION	Ordinate variable measuring the distribution of decision competences to solve emerging *production problems* (1: 'primarily managers'; 5: 'primarily employees')
COMP_CUSTOMER-CONTACT	Ordinate variable measuring the distribution of decision competences to *contact customers* (1: 'primarily managers'; 5: 'primarily employees')
COMP_CUSTOMER	Ordinate variable measuring the distribution of decision competences to solve emerging *problems with customers* (1: 'primarily managers'; 5: 'primarily employees')
EXPQ	Exports of goods and services as a percentage of sales
ICT*ORG1	Interaction term of the variables ICT and ORG1

ICT*ORG2	Interaction term of the variables ICT and ORG2
EXPQ*ICT	Interaction term of the variables EXPQ and ICT
EXPQ*ORG1	Interaction term of the variables EXPQ and ORG1
EXPQ*ORG2	Interaction term of the variables EXPQ and ORG2
Part-time work	Ordinate variable measuring how important is *part-time work* inside a firm on a five-point Likert scale (1: 'not important'; 5: 'very important')
Group compensation	Ordinate variable measuring how important is *compensation by group or team* inside a firm on a five-point Likert scale (1: 'not important'; 5: 'very important')
IPC	Ordinate variable measuring the intensity of *price competition* at a firm's main market on a five-point Likert scale (1: 'very weak'; 5: 'very strong')
INPC	Ordinate variable measuring the intensity of *non-price competition* (competition with respect to quality, customer services, etc.) at a firm's main market on a five-point Likert scale (1: 'very weak'; 5: 'very strong')
Middle-sized firms	50 to 249 employees
Large firms	250 employees and more

Table 3: OLS Estimates; Greece

	H_EDUC	H_EDUC	M_EDUC	M_EDUC	L_EDUC	L_EDUC
ICT	6.221***	5.920***	-2.325***	-1.878*	-3.896***	-4.042***
	(0.752)	(0.848)	(0.954)	(1.070)	(0.818)	(0.920)
ORG1	0.042	-0.305	1.178	1.866**	-1.220*	-1.561*
	(0.665)	(0.747)	(0.843)	(0.942)	(0.723)	(0.810)
ORG2	0.537*	0.604*	-0.068	-0.087	-0.469	-0.518
	(0.276)	(0.309)	(0.350)	(0.390)	(0.301)	(0.335)
EXPQ	-0.050	-0.035	0.029	0.018	0.021	0.0018
	(0.054)	(0.063)	(0.068)	(0.079)	(0.058)	(0.068)
ICT*ORG1		0.564		-0.630		0.066
		(0.364)		(0.459)		(0.366)
ICT*ORG2		-0.014		-0.287		0.301*
		(0.146)		(0.185)		(0.159)
EXPQ*ICT		0.020		-0.010		-0.010
		(0.043)		(0.054)		(0.046)
EXPQ*ORG1		0.021		-0.046		0.025
		(0.029)		(0.036)		(0.031)
EXPQ*ORG2		-0.005		-0.003		0.009
		(0.013)		(0.016)		(0.014)
PART-TIME	1.065	1.141	-2.138	-2.518	1.074	1.377
	(1.355)	(1.374)	(1.718)	(1.734)	(1.473)	(1.490)
TEAM_COMP	-0.582	-0.611	1.260	1.211	-0.678	-0.600
	(1.035)	(1.040)	(1.312)	(1.312)	(1.125)	(1.128)
IPC	-1.320	-1.486	-1.238	-1.013	2.558*	2.499*
	(1.267)	(1.281)	(1.607)	(1.616)	(1.378)	(1.389)
INPC	2.791***	2.830***	-0.198	-0.161	-2.593**	-2.669**
	(1.130)	(1.141)	(1.433)	(1.439)	(1.229)	(1.238)
Middle-sized firms	2.597	2.689	-5.988*	-5.740	3.392	3.052
	(2.935)	(2.955)	(3.721)	(3.728)	(3.192)	(3.205)
Large firms	-3.488	-3.096	2.632	1.772	0.856	1.324
	(3.258)	(3.288)	(4.131)	(4.148)	(3.543)	(3.566)
Manufacturing/services	5.727**	6.151***	6.280*	6.247*	-12.008***	-12.397***
	(2.582)	(2.617)	(3.274)	(3.301)	(2.808)	(2.838)
Constant	20.206***	20.154***	58.668***	59.873***	21.126***	19.974***
	(6.689)	(6.677)	(8.481)	(0.548)	(7.275)	(7.349)
N						
R^2adj						
F						

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

Table 4: Tobit estimates; Switzerland

	H_EDUC	H_EDUC	M_EDUC	M_EDUC	L_EDUC	L_EDUC
ICT	3.368***	2.970***	0.379	0.870**	-5.326***	-5.485***
	(0.253)	(0.307)	(0.301)	(0.366)	(0.393)	(0.482)
ORG1	0.421**	0.438*	-0.779***	-1.052***	0.428	0.787*
	(0.215)	(0.265)	(0.256)	(0.316)	(0.332)	(0.412)
ORG2	0.277***	0.306***	0.321***	0.259**	-0.800***	-0.747***
	(0.086)	(0.105)	(0.102)	(0.125)	(0.132)	(0.163)
EXPQ	0.072***	0.068***	-0.097***	-0.095***	0.039*	0.041**
	(0.013)	(0.013)	(0.016)	(0.016)	(0.020)	(0.021)
ICT*ORG1		0.375***		-0.385***		-0.054
		(0.115)		(0.137)		(0.182)
ICT*ORG2		-0.032		-0.171***		0.247***
		(0.049)		(0.058)		(0.077)
EXPQ*ICT		0.014**		-0.013		0.001
		(0.006)		(0.008)		(0.010)
EXPQ*ORG1		-0.004		0.013		-0.013
		(0.006)		(0.007)		(0.009)
EXPQ*ORG2		-0.001		0.002		-0.001
		(0.002)		(0.003)		(0.004)
PART-TIME	-0.920**	-0.959***	-0.789**	-0.832**	2.584***	2.645***
	(0.360)	(0.359)	(0.429)	(0.427)	(0.557)	(0.555)
TEAM_COMP	0.409	0.389	-0.175	-0.164	-0.131	-0.111
	(0.338)	(0.337)	(0.404)	(0.401)	(0.523)	(0.521)
IPC	-0.684*	-0.682*	0.081	0.102	0.954	0.924
	(0.380)	(0.379)	(0.453)	(0.450)	(0.588)	(0.584)
INPC	0.202	0.246	-0.330	-0.327	0.294	0.251
	(0.393)	(0.391)	(0.468)	(0.466)	(0.605)	(0.604)
Middle-sized firms	-0.802*	-0.738*	-0.507	-0.557	3.196***	3.178***
	(0.447)	(0.445)	(0.532)	(0.529)	(0.693)	(0.692)
Large firms	-0.753**	-0.743**	-0.498	-0.526	2.954***	2.977***
	(0.378)	(0.376)	(0.451)	(0.448)	(0.587)	(0.585)
High-tech manufacturing	-1.118	-0.776	2.866	2.409	-1.204	-1.006
	(1.588)	(1.590)	(1.894)	(1.893)	(2.436)	(2.441)
Low-tech manufacturing	-5.423***	-4.862***	0.177	-0.262	7.964***	7.852***
	(1.401)	(1.414)	(1.671)	(1.684)	(2.145)	(2.168)
Modern services	14.668***	15.227***	-7.991***	-8.442***	-12.061***	-12.08***
	(1.699)	(0.716)	(2.028)	(2.045)	(2.665)	(2.692)
Traditional services	-5.963***	-5.517***	7.411***	6.951***	-1.955	-1.856
	(1.463)	(1.471)	(1.743)	(1.175)	(2.245)	(2.260
Constant	23.257***	22.735***	62.107***	63.068***	9.199**	8.727***
	(2.475)	(2.480)	(2.947)	(2.950)	(3.826)	(3.843)
N	1688	1688	1688	1688	1688	1688
N(left-censored)	62	62	4	4	198	198
LR chi2	745***	763***	182***	206***	528***	540***

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

Appendix:

Table A.1: Composition of the data sets by industries and firm size classes

	Greeece		Switzerland	
	N	Percentage	N	Percentage
Industry:				
Food, beverage	25	9.2	77	4.5
Textiles	6	2.2	24	1.4
Clothing, leather	7	2.6	6	0.3
Wood processing	3	1.1	27	1.6
Paper	3	1.1	24	1.4
Printing	12	4.4	52	3.0
Chemicals	12	4.4	66	3.8
Plastics, rubber	6	2.2	38	2.2
Glass, stone, clay	9	3.3	28	1.7
Metal	4	1.5	24	1.4
Metal working	7	2.6	106	6.2
Machinery	1	0.4	165	9.7
Electrical machinery	2	0.7	50	2.9
Electronics, instruments	3	1.1	122	7.1
Vehicles	2	0.7	20	1.1
Other manufacturing	5	1.8	30	1.8
Energy	3	1.1	33	1.9
Construction	14	5.2	179	10.5
Wholesale trade	52	19.2	142	8.3
Retail trade	21	7.7	102	6.0
Hotels, catering	27	10.0	56	3.3
Transport, Telecommunication	15	5.2	91	5.3
Banks, insurances	5	1.8	73	4.3
Real estate, leasing	2	0.7	11	0.6
Business services	16	5.9	151	8.8
Personal services	10	3.7	11	0.6
Firm size:				
20-49 employees	88	32.5	474	27.7
50-249 employees	105	38.7	875	51.2
250 employees and more	78	28.8	361	21.1
Total	281	100.0	1710	100.0