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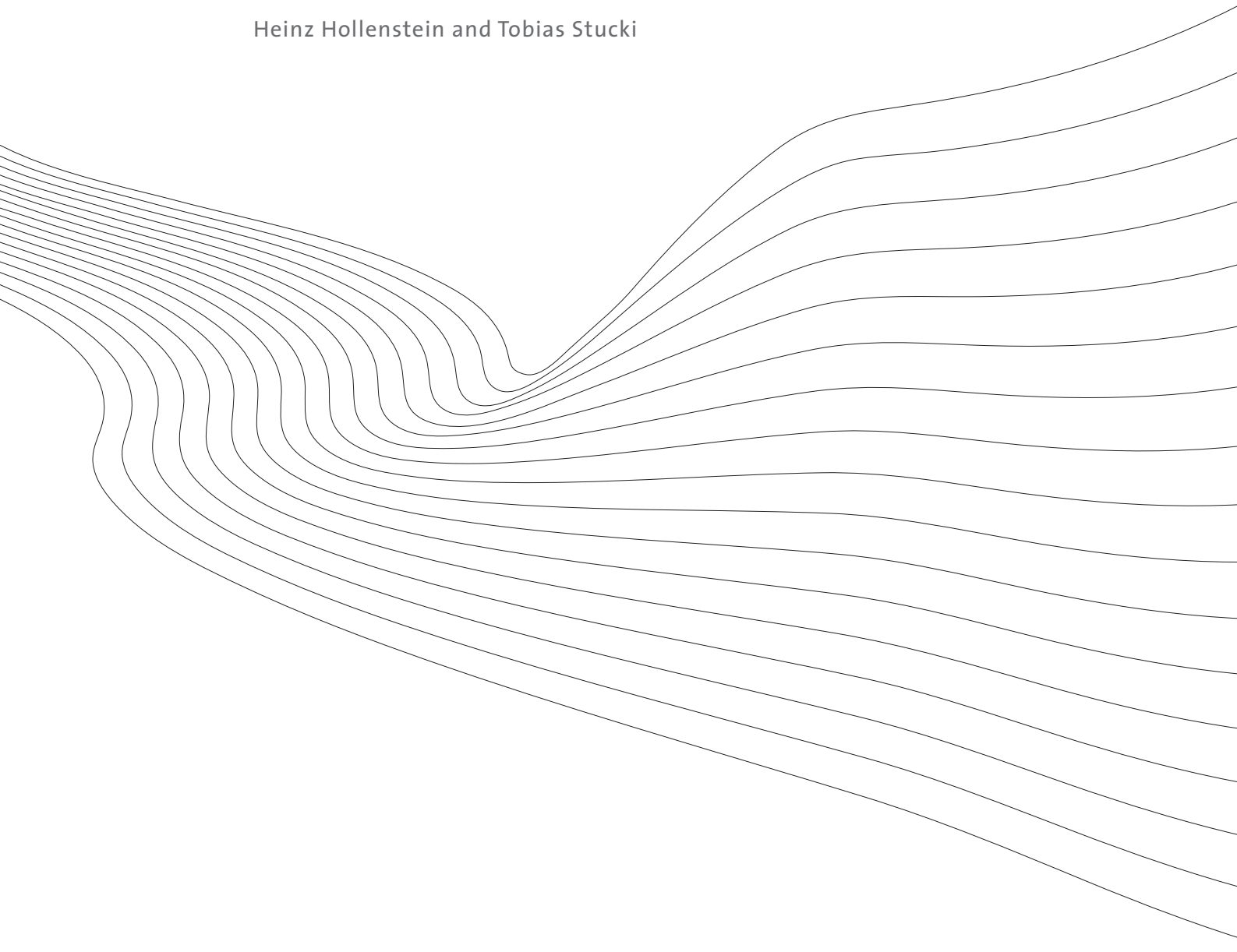

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Summary

Firstly, we investigated the determinants of a) the propensity of Swiss firms to provide apprenticeship training, and b) the intensity of training (measured by the employment share of apprentices). We primarily were interested in the relevance as explanatory factors of the three constituent elements of the "new firm paradigm" that emerged in the course of the last twenty years: intensive usage of ICT; redesign of workplace organisation; shift from lower to higher skills. We found that the skill composition of the workforce (including further training), ICT intensity and, to a lesser extent, workplace organisation are important drivers of apprenticeship-based skill formation, with stronger effects on training propensity than on training intensity. Secondly, we analysed the relationship between apprenticeship training and firm performance. It turned out that productivity and apprenticeships (training propensity *or* intensity) are negatively correlated. The study is relevant for training policy in advanced economies where the new firm paradigm plays a large and growing role.

JEL Code: J2, L2, O3, M5

Key words: Firm-based training; Apprenticeship; Workplace organisation; ICT; Skill formation; Human capital

1. Introduction

In the course of the last twenty years a significant shift in the employment structure from low to high skills has taken place in many countries, industries and firms. There are several factors hypothesised to have driven this development. To mention are, on the demand side, a skill-bias of technical change, in particular the diffusion of Information and Communication Technology (ICT), as well as a skill-bias of changes in the organisation and human resource practices of firms. In addition, globalisation of the economy and the concomitant specialisation of advanced economies on the production of knowledge intensive goods also are likely to shift labour demand towards higher skills. On the supply side, the long term trend of the extension of higher education and stronger preferences of employees for workplaces involving more autonomy, team-based working practices, etc. also contribute to the observed increase in the employment of highly qualified personnel.

According to the literature, the demand side elements, in particular technological (ICT) and organisational change are the key factors driving the observed increase of the share of high skilled workers in total employment. Moreover, the interplay of these forces (complementarities) seems to accentuate the shift towards higher skills, with ICT considered as the causal or enabling factor (for a detailed discussion of the interactions of the variables involved, see Caroli, 2001). Therefore, many authors conceptualised this phenomenon as a shift towards a new firm paradigm that is analysed using different labels: from a “mechanistic” to an “organic” firm structure (Burns and Stalker, 1994), from the “mass production model” to the “flexible multiproduct firm” (Milgrom and Roberts, 1990), or from a “tailoristic” to a “holistic” organisation of work (Lindbeck and Snower, 2000).

The empirical evidence for a skill-bias of labour demand induced by ICT and organisational change (including the adaptation of human resource practices) is quite strong, but the relative importance of these factors is difficult to determine and seems to vary across countries. The impact of ICT investments, for example, is higher than that of the redesign of workplace organisation according to studies for the US, UK, Germany and Switzerland, whereas it is the other way round in France and Italy (see the comparison in Arvanitis, 2005, pp. 154). The evidence is weaker for an additional effect on skill demand due to complementarities among investments in ICT and the redesign of workplace organisation. The results of the few comparable papers dealing with this topic are mixed, with clearly positive joint effects of ICT and workplace organisation only in case of Italy and Switzerland (see again, Arvanitis, 2005), and some “indirect evidence” for the US (see Bresnahan et al., 2002). The differences across countries, however, should not be overrated as the respective studies differ in terms of the firm-

size or industry composition of samples, the specification of core variables or the nature of data (cross-section vs. panel data). Besides, it is important to recognise that the role of complementarities in explaining a skill-biased change of labour demand might be underestimated in the available studies, since speed and costs of adjustment of the factors presumed to be complements is not the same. A significant increase of ICT investments (e.g. as a response to a substantial reduction of the price of ICT) may influence the skill composition of labour demand quite rapidly, whereas the complementary adaptation of a firm's organisation usually is much slower. Therefore, organisation may be considered as a quasi-fixed factor in the short-run (Bresnahan et al., 2002). However, in the medium-run, as the process of redesigning the workplace organisation is completed, the impact of complementarities on the skill-bias of labour demand will be stronger than in the short run. A summary appraisal of the drivers of the skill-bias of labour demand based on recent empirical work is given, for example, by Caroli (2001), Piva et al. (2005) or Arvanitis (2005).

In the following we assume that the shift in labour demand from low to high skilled workers will last in the "relevant" future, since ICT is likely to provoke new challenges of adapting a firm's organisation and human resource practices. Consequently, there will be a sustained need to increase the stock of human capital of firms and of the economy as a whole. Obviously, there are different ways of achieving this objective. At macro level, one may take measures to increase the number and quality of graduates leaving institutions of tertiary-level education and to ensure the corresponding intake from the upper-secondary level. Moreover, raising labour market participation of highly qualified women also may contribute to increasing the human capital stock of the economy. At firm level, hiring first-time labour market entrants trained by other firms (poaching), recruiting other skilled workers from domestic firms, attracting qualified personnel from abroad, up-skilling the own workforce by providing further training and offering apprenticeships (or other firm-based training) are means to strengthen a firm's human capital base.

In this paper we concentrate on apprenticeship training, which in Switzerland, similar to the other German-speaking countries, is a widespread practice of skill formation at the upper-secondary level. About 70% of a cohort strives for a vocational qualification, with 75% of them passing through the apprenticeship system, whereas the other 25% attend full-time vocational schools (Swiss Federal Statistical Office, 2008).[1] The so-called "dual system" of apprenticeship-based vocational training combines education at a vocational school of one or two days a week, where

[1] For an international comparison of systems of vocational skill formation, see, for example, Steedman (2001, 2005), or, with more emphasis on the subsequent labour market experience of trainees having attended specific types of vocational training, see Ryan (2001).

general and occupation-specific skills are acquired, with work of three to four days a week in the training company, where learning is concentrated on occupation-specific and firm-specific skills. In the course of the last ten to fifteen years, there was a certain shift in the content of apprenticeship training towards a higher proportion of general skill provision, in an attempt to better meet the demands of companies in a knowledge-based economy. Among the changes of the institutional arrangement of apprenticeships there is one which probably has the most far-reaching consequences: the introduction of a second, more demanding stream of apprenticeship training with a larger component of schooling ("Berufsmatura"). This diploma guarantees free access to universities of applied sciences that were established in the late nineties. In this way, the career prospects of a substantial share of apprentices[2] significantly improved making apprenticeships more attractive for school leavers as well as for companies (for similar developments in Germany, see Feingold and Wagner, 2002).[3]

The aim of this paper is twofold: firstly, we want to identify, based on an econometric analysis, the factors determining a firm's demand for apprentices. In doing so, we primarily are interested in the relevance as explanatory factors of the three constituent elements of the new firm paradigm, i.e. intensive usage of ICT, redesign of workplace organisation, increase of human capital input. We try to explain whether a firm does or does not provide apprenticeship training ("training propensity"), and, if doing so, to what extent a firm is engaged in this type of training ("training intensity"). Secondly, we analyse the relationship between apprenticeship training and firm performance in the framework of a production function where apprenticeship training is considered as a separate input factor. The investigation is expected to give some indication of the appropriateness of the apprenticeship system as a way of skill formation in a highly advanced knowledge-based economy where the new firm paradigm plays a significant and increasing role.

The data used in this study stem from two surveys conducted in 2000 and 2005 respectively and cover the business sector of the Swiss economy (manufacturing, construction, commercial services). By merging the two cross-sectional datasets we got an unbalanced panel with about 3500 firms, of which more than 2800 could be used in model estimation. Although we are able to perform panel estimations, it is obvious that the database is not sufficient to accomplish a "real" longitudinal analysis.

As set out in the next section, the model explaining the provision of apprenticeship training basically includes six categories of explanatory variables: a) human capital intensity (skill composition of the workforce, further education); b) intensity and variety of ICT usage; c)

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2 In 2005, one out of six apprentices got the diploma from the high-level stream of apprenticeship training.

3 The institutional changes of the apprenticeship system that occurred in the course of the last ten to fifteen years were consolidated by the adoption of a new "Training Act" ("Berufsbildungsgesetz") which became effective in 2004 (see http://www.admin.ch/ch/d/as/2003/4557.pdf).

different aspects of new workplace organisation and human resource practices; d) physical capital intensity and average wage level; e) structural firm characteristics (size, foreign/domestic ownership); f) controls (dummies) for regional location (reflecting region-specific institutional arrangements of apprenticeship training, regional labour market regulations, etc.), for industry affiliation (capturing industry-specific demand prospects, market structure, intensity of competition and other factors not explicitly specified in the model) as well as a time dummy (controlling for macroeconomic developments, changes in training policy and time-dependent firm heterogeneity). The dummies for region and industry affiliation are assumed also to represent a significant part of the differences among firms with respect to the costs of training.

The model of (labour) productivity is based on a production function with ICT usage, workplace organisation, physical capital, human capital (skill composition, further training) and (endogenous) apprenticeship training as factor inputs. Besides, it contains controls for firm size, foreign ownership, region, industry affiliation and time.

The empirical literature dealing with a firm's demand for apprentices so far did not pay much attention to the influence of ICT usage and workplace organisation. The use of ICT is included as a variable that determines apprenticeship training only in Arvanitis and Stucki (2008) and Beckman (2002, 2008). To our knowledge, the impact of new workplace organisation on apprenticeship training has not been econometrically investigated to date. In contrast, human capital was taken into account in several studies dealing with the provision of apprenticeship training (e.g. Franz et al., 2000; Niederalt, 2004; Beckmann, 2008; Arvanitis, 2008; Mühlemann and Wolter, 2007). However, in most instances, the heterogeneity of human capital was neglected as, typically, it is only distinguished between skilled and unskilled labour. The effect of apprenticeship training on firm performance got some attention only recently (Fougère and Schwerdt, 2002; Zwick, 2007; Mohrenweiser and Zwick 2008; Arvanitis and Stucki, 2008; Arvanitis, 2008).[4] In conclusion, given the state of research, the present paper provides new insights in the determinants and effects of apprenticeship training, mainly by analysing the influence of the three constituent elements of the new firm paradigm, i.e. ICT usage, workplace organisation and human capital. Moreover, there are some other elements of the analysis which distinguish it from many other studies, particularly the large number of determinants of apprenticeship training and the use of panel data.

The remainder of the paper is organised as follows: In Section 2, the conceptual background of the empirical analysis is presented. In the Sections 3 and 4, we describe the database and analyse the pattern of apprenticeship training in Switzerland based on some structural criteria (firm size,

[4] Dearden et al. (2006) analysed the productivity effects of firm-based training *in general*.

industry affiliation, etc.) and, in particular, in terms of the intensity/variety of ICT usage and some characteristics of new workplace organisation. In Section 5 we specify the empirical model used to explain the propensity and intensity of apprenticeship training and present the econometric results. Section 6 is devoted to the econometric analysis of the relationship between training activity and labour productivity. Finally, we summarise and discuss the results and draw some policy conclusions.

2. Conceptual Background

The seminal paper of Becker (1964) serves as starting point for this investigation, as it is the case in most studies on firm-based training. In his view, firms as well as apprentices conceive firm-based training as an investment in human capital enabling both parties to profit from higher productivity in the future. However, the firm provides training only if the expected benefits, i.e. productivity gains, from such human capital investments are higher than the costs it has to bear.[5] Whether this is the case depends on the type of skills generated by training (general vs. firm-specific knowledge), the costs of training (net of the trainees' productive contribution and subsidies) and the functioning of the market for skilled labour. A firm provides general (i.e. transferable) skills only at zero net training costs if labour markets work perfectly well (what is assumed in Becker's model). The firm is not prepared to provide general skills at higher costs, since the trainees can leave the firm at the end of the apprenticeship at any time in search of higher wage offers.

In older empirical work the authors were puzzled by the finding that the net costs of apprenticeship training were positive in many occupations. Against this background the investment theory of training has been further developed, with Acemoglu and Pischke (1998, 1999a and b) probably the most influential contributions (see also Elbaum and Singh, 1995; Franz and Soskice, 1995; Harhoff and Kane, 1997; Dustmann and Schönberg, 2004; Kessler and Lülfesmann, 2006; Finegold and Wagner, 2002). This literature explains the empirical finding of widespread net costs of firm-based training (such as apprenticeships) mostly with labour market imperfections: asymmetric information between the training firm and other companies about the apprentices' productivity; unions and work councils enforcing firms to accept net training costs during the apprenticeship; mobility costs (job search, costs of introduction at a new job);

[5] In this paper, we only consider the investment motive of providing training and do not discuss other motives which may be of some importance such as the production or the reputation motive; for the relevance of different motives see, for example, Niederalt (2004) and Mohrenweiser and Backes-Gellner (2006).

reputation effects; etc. In addition, general and firm-specific skills often may be complements and are provided as a package.[6]

In sum, these considerations imply that the *expected* net costs of (apprenticeship) training a firm has to bear, in the first place, depend on all factors that determine *future* demand for skilled labour.[7]

In the following, more or less in accordance with the literature (see e.g. Franz et al., 2000; Niederalt, 2004; Beckmann, 2008), we identify five categories of variables that may influence the future demand for labour skills and therefore a firm's willingness to provide apprenticeship, and add as a sixth category the redesign of workplace organisation.

Human capital

Firstly, a firm's provision of apprenticeship training depends on the skill composition of its workforce. As apprenticeship training leads to qualifications at medium level, we expect that the share in total employment of this skill group is positively related to the number of apprentices. The same might hold for employees with higher qualifications, as far as they are application-oriented and based on courses on top of apprenticeships (in Switzerland: various types of professional schools up to universities of applied sciences that primarily provide vocational-oriented knowledge and skills). In contrast, we doubt whether academic qualifications are complementary to apprenticeships, since this type of tertiary education mostly develops general knowledge on top of general (and not vocational) upper-secondary education. Therefore, we do not expect a significant relationship between the share of university graduates and apprenticeship training. Apprentices and low-skilled workers (i.e. no vocational training degree; on-the-job training only) tend to be substitutes (at least in case of less demanding streams of apprenticeships); hence, we expect a negative correlation between the share of low-skilled workers and apprenticeship training. Finally, the extent of further training also may influence the willingness to provide apprenticeships. We expect a complementary relationship as further training in most countries is positively related to the skill level (see Swiss Federal Statistical Office, 2006).

Intensity of ICT usage

According to the literature discussed in the introductory section, investment in ICT is considered as the enabling (if not causal) factor for a shift towards a new firm paradigm. As the process of

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[6] Most of the extensions of the Becker model mentioned in this paragraph were derived from a (simple) theoretical model already in the early eighties in a paper of Jones and Hollenstein (1983).

[7] This approach differs from the "classical" line of research in this field characterised by (direct) *accounting* of costs and benefits of training; see, among others, for Switzerland: Wolter and Schweri (2002) and Schweri et al. (2003); for Germany: Beicht et al. (2004). Our analysis stresses the *structural and behavioural aspects* of a firm that drive the cost-benefit outcome.

diffusion of ICT and the generation of innovations in the field of ICT is likely to go on, we expect that the relative demand for skilled labour will further increase. According to the literature, there are several properties of ICT driving the substitution of lower skills: a) ICT allows automating routine and well-defined tasks, whereas it is much more difficult to do the same in case of more complex tasks that involve judgement and creativity (Bresnahan, 1999; Bresnahan et al., 2002; Autor et al., 2000); b) highly computerised systems produce large quantities of data that need high-skilled workers to get adequately utilised (Arvanitis, 2005); c) the adoption of ICT itself and its integration in the firm's productive system requires skilled workers, the more so as the use of ICT involves many uncertainties (Caroli, 2001). Whereas it is quite clear that a more intensive application of ICT increases relative demand for skilled labour as a whole, it is less obvious which category of higher skills will "profit" from this technical change. According to the results of empirical work summarised in Arvanitis (2005), the demand for graduates from universities increases, whereas the evidence with respect to skills at the medium level is mixed (positive or neutral effect). According to the majority of empirical studies, the demand for skills at the higher intermediate level (qualifications below a university degree but higher than medium skills) is positively affected. In sum, we expect that the intensity of ICT usage is positively related to apprenticeship training.

Redesign of workplace organisation and human resource practices

The effects of organisational redesign on skill requirements should not be very different from those of ICT. Again the demand for skilled employees is expected to increases at the expense of unskilled workers. According to Caroli (2001) flattening hierarchies, decentralisation of decision making, greater involvement at the shop floor, collective work practices (teamwork, quality circles, etc.), multi-tasking and job rotation are the core elements of a work organisation that fits into a production system characterised by strong usage of ICT. Whereas a general shift from low to high skills resulting from new workplace organisation is well documented in the literature, it is quite unclear which of the above-mentioned three categories of skilled labour profits from this change in labour demand (see Arvanitis, 2005). In the Swiss case, the effects are qualitatively the same as for ICT usage (neutral in case of the demand for medium skills, positive for high qualifications), but the skill effect of organisational change is weaker than that of ICT, what is in line with the results for most countries for which empirical results are available (exceptions are France and Italy where the impact of workplace organisation is stronger than that of ICT). Moreover, the empirical studies show that the different aspects of the multi-dimensional phenomenon of workplace organisation are not correlated to the same extent with the demand for higher skills. In the Swiss case, for example, teamwork and some, but not all, aspects of delegation of competencies are positively related to the demand for high skills, whereas

flattening of hierarchies or job rotation are not. In conclusion, we expect that a) new workplace organisation as a whole is positively related with apprenticeship training; b) this only holds true for some of the organisational dimensions; c) the influence of a redesign of organisation is weaker than that of ICT.[8]

Physical capital and average wage costs

Physical capital is another production factor which may influence a firm's demand for apprentices. However, it is not quite clear whether a positive or a negative impact should be expected. On the one hand side, one may argue that apprenticeships in capital intensive firms involve an above-average proportion of firm-specific training, what is an incentive for hiring apprentices (see e.g. Beckmann, 2002). On the other hand, since a break-down of a capital intensive production process usually is very costly, a firm may not take the risk of (even partially) entrusting apprentices with tasks related to complex processes; it may prefer to rely for such jobs exclusively on qualified and experienced workers. Which of the two effects dominates is an empirical question.

Furthermore, we include wage costs per employee as a variable explaining the demand for apprentices. Since a firm's overall demand for labour is negatively related to wage costs, high average wages, other things being equal, reduce the requirement of qualified workers and, therefore, negatively affect the demand for apprentices.

Firm size and foreign ownership

In accordance with the bulk of empirical studies, we expect that large firms have a higher *propensity* to provide apprenticeship training than small companies. Economies of scale in providing in-house training (availability of specialised instructors, specific training facilities, etc.) as well as some monopsony power on the (local) labour market and the existence of internal labour markets, both involving higher retention rates, are probably the most important reasons for a higher propensity of larger firms to provide apprenticeships.[9] We expect that the effect of firm size is levelling off beyond a certain threshold (number of employees). In case of training *intensity* (share of apprentices in total employment), however, the size effect may be neutral or negative, at least for two reasons: a) if training infrastructure is available, the costs for apprenticeship training are variable what implies that smaller firms are not at a disadvantage; b) the proportion of tasks to be performed by managers (central functions of all kind) and specialists (e.g. R&D) is higher in large firms. Since apprenticeship training, in many cases, is not a suitable

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[8] Finegold and Wagner (2002) argue convincingly that hiring apprentices becomes more attractive when work organisation gets more flexible and, in particular, when the incidence of teamwork increases.

[9] In addition, if one assumes that a large firm is a multiple of small firms (e.g. several divisions producing different products), it is just more likely that large firms employ at least one apprentice than small firms.

way of acquiring such qualifications, the small firms' demand for apprentices, in relative terms, might be the same or even higher than that of large firms.

Furthermore, we expect that foreign-owned companies less often provide apprenticeship training than domestic firms, since they usually are less familiar with the Swiss apprenticeship system and may apply "modes of training" taken over from their home-country.[10]

Control variables

The location of a firm (represented by dummies for geographic regions), as we mention below, should capture differences with respect to the institutional arrangement of the provision of apprenticeship training, the size and functioning of the regional labour market, the quality of the regional education system, etc. (see Mühlemann and Wolter, 2007).

Besides, a firm's "product market environment" in terms of demand prospects, market structure, intensity of price and non-price competition may influence training activities. Favourable demand prospects for a firm's products should be positively related to its willingness to offer apprenticeships (analogous to the positive correlation between macroeconomic growth and the overall number of apprentices). Moreover, Gersbach and Schmutzler (2006) argue that high market concentration and low intensity of competition are a disincentive for industry-specific training, whereas extensive product differentiation has the opposite effect. The impact of market structure on (apprenticeship) training, however, remains ambiguous. As the link to the provision of training primarily runs via innovative activities, we only can express a well-founded expectation with respect to this (potential) determinant of apprenticeship training if there is a well-established relationship between market conditions and innovation performance. However, this is not the case according to the empirical literature (see e.g. Cohen, 1995). We assume that the demand and market-related variables, which, for data limitations, cannot explicitly included in our model, are to a large extent industry-specific; hence, they are captured by dummies controlling for industry affiliation.[11]

So far the cost side of training provision largely has been neglected. Training costs vary among firms, in the first place, because of differences with regard to technological requirements (reflecting, e.g. the intensity of use of physical and ICT capital), the structure of the local labour market for trainees and skilled workers (market power of local firms, regulations, etc.), the institutional framework for apprenticeship and other vocational training as well as for education

[10] Another variable used in some empirical work to explain the provision of apprenticeship training is the age of the firm. We could not include this variable because data are missing for the year 2000. However, estimates (not reported here) based on the cross-section of 2005 showed, as one would expect, that older firms are more engaged in apprenticeship training than younger ones. This finding is in line with that of studies based on panel data (Arvanitis, 2008; Arvanitis and Stucki, 2008).

[11] The product market environment is explicitly included in the empirical studies of Arvanitis (2008) and Arvanitis and Stucki (2008).

at the upper-secondary level. We expect that such variations, to a large extent, are industry-specific and/or, as mentioned above, region-specific. Therefore we assume that the costs of training, in addition to the measures we include for ICT usage and physical capital intensity, are captured by the regional and industry dummies.

Finally, we include a time dummy which may reflect macroeconomic developments, changes in training policy (which, as mentioned above, indeed occurred in the period at hand), or time-varying firm heterogeneity.

Since theory does not offer specific explanations for the propensity and the intensity of apprenticeship training, we use the same set of independent variables in the two empirical models. However, the importance of the individual explanatory variables or even the direction of their influence is likely to differ among the two dependent variables. An obvious example, as mentioned above, is firm size that is expected to exert a positive influence in case of training propensity and a neutral or negative one for training intensity.

3. Data

The data used in this study were collected in the course of two surveys among Swiss companies conducted in 2000 and 2005 respectively. The surveys were based on a disproportionately stratified random sample of firms covering the business sector (28 industries) and three firm size classes with a cut-off point of 20 employees.[12] We did not collect data for smaller companies as the organisational features we are interested in might be irrelevant for most of them (e.g. "flattening hierarchical structures"). In 2000, we received answers from 1688 firms; in the year 2005 the number of respondents was slightly higher (1803 firms). The corresponding response rates were 39.9% and 36.8% respectively. The questionnaires covered questions about the intra-firm diffusion of several ICT technologies (Internet, intranet, extranet, etc.) and new organizational practices (team-work, job rotation, employees' involvement in decision-making), the employees' vocational and further training. It also contained some financial and other basic firm data such as sales, value of intermediate inputs, wage bill, investment expenditures, number of employees, etc.).[13]

The composition of the respondents of the two surveys in terms of industry affiliation, regional location and firm size classes is more or less the same and corresponds to a large extent to the

[12] The sample of the two surveys was based on the number of employees with at least 20 employees as reported in the Census of Enterprises of 1998 and 2001 respectively. As employment in some companies was lower when the survey was carried out as compared to the preceding Census, the dataset used for the analysis also contains some firms with less than 20 employees (2.4% of the total number of firms; see Table A1 in the Appendix).

[13] The questionnaires were 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 questionnaires in German, French and Italian can be downloaded from www.kof.ethz.ch.

underlying samples. A (unit) non-response analysis, based on a follow-up survey of a sample of non-respondents, did not indicate any serious selectivity bias with respect to the core variables of this study, i.e. intra-firm diffusion of ICT and new organizational practices. The composition of the merged data set of the two surveys containing 3491 observations is shown in Table A1 in the Appendix.

Item non-response is another (potential) problem of the econometric analysis of survey data. We used the multiple imputation technique of Rubin (1987) to substitute for missing values. The model estimations presented in this paper are based on the mean of five imputed values for every missing value of a certain variable (for a detailed report on the procedure used, see Donzé, 2001). For some variables imputation was not feasible; therefore model estimations are based on a reduced sample containing 2859 observations.

4. Training Activities in the Swiss Business Sector

Table 1 shows data on the firm's willingness to offer apprenticeships (training propensity) and, based on data for firms having apprentices, the (average) training intensity in the business sector as a whole as well as in sub-sectors and two-digit industries. 75% of the firms in our data set employ at least one apprentice, with an average share of apprentices in total employment of 7%.[14] Training propensity (column 1 of the table) is much higher in the construction sector (88%) than in the manufacturing and the service sector (74% and 72% respectively). Knowledge-intensive service industries like business or computer services offer vocational training less often than traditional services. In the manufacturing sector, the training propensity of high-tech industries, on average, is somewhat higher (with the important exception of the chemical industry) than in low-tech industries; but some of the latter show the highest training propensity among all manufacturing industries (printing, wood processing, energy). Training intensity (column 2 of Table 1) again is highest in the construction sector (8.7%). In contrast to training propensity, the service sector exhibits a significantly higher training intensity than manufacturing (7.9% vs. 6.0%). However, this result might reflect the different firm size composition of the two sectors as the share of small firms (which have a higher training intensity than big firms; see Table 2) is much higher in services than in manufacturing.

A closer look at Table 2 shows that the training propensity correlates positively with firm size up to 499 employees; beyond this threshold the propensity remains at about 90%. A negative

[14] The data shown in this paper significantly differ from those reported by Müller and Schweri (2006) because they used the full Census data (i.e. all firms independent of the number of employees), whereas firms with less than 20 workers are excluded in our analysis. Since very small firms by far dominate the Census population and training propensity increases with firm size, it is no surprise that the average training propensity is much higher in our sample (75% vs. 18% in the entire population), whereas the opposite is true for training intensity (7% vs. 26%).

correlation is observed for the training intensity. The employment share of apprentices strongly decreases up to a firm size of 99 workers (from 16% to 7%), with a further (slight) reduction for the next two size classes (up to 499 employees) and some increase beyond this threshold. Training activities quite strongly differ among regions (Table 3). Training propensity and intensity are much higher than on average in Eastern and Central Switzerland and far below the mean value in the French and the Italian speaking parts of Switzerland (where school-based vocational training is more widespread than in the rest of Switzerland). Finally, the training propensity is slightly higher in 2005 than in 2000, whereas it is the other way round in case of training intensity (Table 4).

Table 5 gives some information on the differences between firms providing apprenticeship training ("training firms") and those without apprentices ("non-training firms") in terms of the variables which are at the core of our interest, i.e. human capital, ICT usage and workplace organisation (share of firms with above-average values of the respective indicators). It turns out that human capital intensity is much higher in training firms than in non-training firms. In training firms, particularly the share of skilled workers at the intermediate and the non-university tertiary level is higher and that of low-skilled workers lower than in non-training firms; moreover, further training is a more widespread practice. Training firms also are more intensive users of ICT: intra-firm diffusion of the intranet and variety/complexity of Internet applications are significantly higher than in non-training firms, whereas we do not find any differences between the two categories of firms in case of the general use of the Internet (i.e. not specified in terms of application area). With regard to workplace organisation, the differences between training and non-training firms are much less accentuated than for human capital and ICT. All organisational practices considered are more prevalent in training than in non-training firms, but we find a significant difference only in case of the diffusion of teamwork.

5. Econometric analysis of the determinants of apprenticeship training

5.1 Specification of the empirical model

Dependent variables

We used two dependent variables: firstly, *training propensity* (TPR), a binary variable measuring whether a firm does or does not provide apprenticeship training, and, secondly, *training intensity* (TIN), a quantitative variable indicating the extent of a firm's involvement in training activities, measured as the percentage share of apprentices in total employment of a firm. TIN is only used for "training firms".

Determinants of TPR and TIN

According to the theoretical framework presented in Section 2, we distinguish six categories of variables potentially determining training activities. In the following we specify for each of these groups of variables the measures we used in model estimation (for a precise definition we refer to Table 6). TPR and TIN are explained by the same set of independent variables, with one variable dropped in case of TIN to satisfy the requirements of econometric theory (see below).

- *Human capital*

The firm's use of human resources is measured by the skill composition of the workforce and the participation of employees in further training activities. The skill composition is represented by the employment share of four categories of workers reflecting different qualification levels (full-time equivalents): employees with university degrees (LHIGH1); with other tertiary degrees, including those from universities of applied sciences (LHIGH2); with diploma from apprenticeship training or full-time vocational training at upper-secondary level (LMED), and, finally, employees without any (formal) vocational degree (LLOW). These variables are used as proxies for anticipated demand for the respective skill group. As set out in Section 2, we expect positive signs for LMED and LHIGH2 and a negative one for LLOW, whereas we do not expect a significant influence on the provision of apprenticeship training for LHIGH1. Moreover, further training (FTRAIN), measured by the share of employees engaged in further training activities during the reference year, should be positively related to apprenticeship training.

- *Intensity of ICT usage*

There are many indicators one could use to capture the intensity of ICT use (see, among others, European Commission, 2007; Hollenstein et al., 2003; Bocquet and Brossard, 2007). For the present study, we decided to rely on two variables (for details see Table 6), the first one reflecting the intensity of use of a firm's ICT infrastructure, the second one referring to the variety and complexity of Internet applications. The first aspect is represented by the variable "intra-firm diffusion of the intranet", measured by the share of employees regularly working with this element of ICT infrastructure (five dummy variables, running from low (INTRA_1) to high intensity of use (INTRA_5), with "no use" as reference group). To capture the second aspect, we draw on detailed information about the purposes for which a firm employs the Internet, ranging from simple "search for information" up to more demanding functions like "E-selling". We just add up the number of such applications (up to eight applications) and take the mean to get a measure of the variety and complexity of the Internet use (INTER: value range of 0 to 1). Based on the reasoning in Section 2, we expect that INTER is positively related to apprenticeship training. The same applies for the intensity of use of the intranet; INTRA_5 should show the strongest, INTRA_1 the weakest positive correlation with the propensity and intensity of apprenticeship training.

- *Workplace organisation*

The redesign of workplace organisation has many dimensions (see Section 2), several of them included in the specification of our empirical model. At the level of the firm as a whole, we consider the "change of the number of hierarchical layers" having occurred during the five year period preceding the survey of 2000 and 2005 respectively: dummy variable Δ_LEVEL, with value 1 ("the number of hierarchical layers decreased") and 0 ("remained the same or increased"). Similarly, Δ_DECENTR captures the "change of the degree of delegation of competencies at the workplace" that occurred in the preceding five years, with value 1 ("degree of delegation of competencies increased") and 0 ("remained the same or decreased"). The variables TEAM and ROTATION stand for the current level of diffusion of teamwork on a permanent basis (quality circles, semi-autonomous production teams, etc.) and of job rotation respectively. Both variables are measured on a six-point Likert scale running from value 0 ("no use of the respective work practice") up to 5 ("very widespread use"). Finally, we rely on a composite measure of the "distribution of competencies at the work place among managers and workers" (DECENTR). This variable reflects the firms' assessments of the degree of decentralisation of decision-making at the workplace in seven specific matters (e.g. "who decides on the work pace?; for details see Table 6). The assessment for each item is measured on a five-point Likert scale running from value 1 ("the line manager decides fully on his own") up to 5 ("the worker decides fully on his own"). The composite indicator DECENTR represents the arithmetic mean of the single assessments; therefore, its value range runs from 1 ("fully centralised decision making") up to 5 ("fully decentralised decision-making").

New workplace organisation, though not to the extent as ICT, is positively related to human capital intensity in most empirical studies (see Section 2). Therefore, it also should positively affect the provision of apprenticeship training. However, we do not expect that this is the case for each dimension of organisation and human resource practices included in the model. It would not be surprising if there is no significant relationship between Δ_LEVEL and ROTATION respectively and apprenticeship training. In case of Δ_LEVEL, one could argue that a reduction of the number of hierarchical layers is a change at the level of the firm as a whole, whereas decisions on apprenticeship training are primarily related to the needs at a much lower level of organisation ("shop floor"); the two decisions may thus be hardly correlated. Job rotation, in many companies, may be a measure implemented by the management for maintaining work motivation among low skilled workers (assembly-line workers, machine operators, etc.); in this case, ROTATION would be negatively correlated (or at least uncorrelated) with apprenticeship training. Teamwork might be a very different matter. We presume that working in teams is an organisational arrangement that is well-suited for integrating apprenticeship training, since team

leaders and experienced team workers are on the spot for supporting work-based training of apprentices. Therefore, we expect a positive sign for TEAM.

A high degree of decentralisation of decision-making at the workplace (DECENTR), at first sight, also may be expected to be conducive to apprenticeship training. However, depending on the hierarchical level at which it is decided on hiring apprentices, the training propensity may differ. One could argue that the workers at low hierarchical level have a rather low preference for apprenticeships because they are directly confronted with the costs of training (part of which they have to bear themselves). If decisions on the provision of training are taken at a higher hierarchical level (what is *not* reflected in DECENTR) to guarantee a longer-term view on apprenticeship training, the preferences of the employees at the bottom of the hierarchy may be overridden. These arguments also may apply to Δ_DECENTR ("degree of delegation of competencies increased"). In sum, although we hold on to expect a positive sign for DECENTR and Δ_DECENTR, reflecting the general hypothesis of a positive effect of the redesign of workplace organisation on the training propensity, we would not be surprised if the correlation of these two variables with apprenticeship training is weak or even negative. We conclude from this (partly speculative) reasoning on the possible effects of the various aspects of workplace organisation on training provision that the *direction* of the influence mostly is an empirical matter.

- *Physical capital and average wage costs*

We use gross capital income (i.e. gross value added minus wage costs) per employee as an indicator of the physical capital intensity of a firm's activities (LCL). As set out in Section 2, because of countervailing influences there is no a priori sign expectation. The average wage level of a firm (LWL), for which we expect a negative sign, is measured as wage costs per employee.

- *Firm size and foreign ownership*

In order to allow for a non-linear relationship between firm size and apprenticeship training, we use dummies for firm size classes (SIZE_1 up to SIZE_6), with firms employing less than 20 workers as reference group.[15] As set out in Section 2, we expect a positive influence of firm size on TPR, whereas in case of TIN the sign is likely to be negative or statistically insignificant. Foreign ownership is measured by a binary variable (FOREIGN), with value 1, if the firm is foreign-owned, and value 0 otherwise; we expect a negative impact on apprenticeship training.

- *Control variables*

We used dummies to control for regional effects (REG_1 up to REG_6, with "Ticino" as reference region) and industry effects (IND_1 up to IND_27, with "personal services" as

[15] The data set contains some firms with less than 20 employees for reasons set out in footnote 12, although the sampling frame only did account for larger firms.

reference industry). We also inserted a time dummy (Y2005) to control for time-related specificities of 2005 as compared to 2000.

In the appendix, we show the descriptive statistics for the dependent and independent variables (Table A2) as well as the correlation matrix of the explanatory variables (Table A3). Multicollinearity is no serious problems for model estimations as the correlation with other variables is weak, with very few exceptions (e.g. INTRA_5, TEAM or LLOW).

5.2 Empirical results: "training propensity" (TPR)

The probit model is an appropriate estimation procedure as training propensity (TPR) is a binary variable (provision of apprenticeships yes/no). We estimated two different probit models, the first one with pooled data for the years 2000 and 2005 and a time dummy, the second one with random effects to take into consideration firm heterogeneity.

The results are shown in the first two columns of Table 7. Both models are satisfactory in terms of model fit and yield more or less the same results. The overall pattern of explanation is in line with the underlying model although not all covariates turn out to be statistically significant.

In the first place, we are interested in the impact on training propensity exerted by the variables that are the basic ingredients of the new firm paradigm, i.e. human capital, ICT usage and redesign of workplace organisation. Firstly, the results with respect to human capital are (practically) fully in line with the a priori expectations. Firms with a high share of employees with a vocational qualification at the medium level (LMED) and of employees with a non-university tertiary-level degree of vocational orientation (LHIGH2) are significantly more likely to offer apprenticeships. Participation in further training (FTRAIN) shows a positive sign as well but is statistically not significant. Firms with a high share of employees without a formal degree or any vocational qualification (LLOW) are less likely to provide apprenticeship training (although the statistical significance is not overwhelming). Finally, as expected, the employment share of university graduates (LHIGH1) is uncorrelated with training propensity.

The second element of the new system of production, i.e. the usage of ICT, also is positively related to training propensity what again is in line with theoretical prediction. This holds for both proxies of the intensity of ICT usage, the variety and complexity of Internet use (INTER) and the degree of intra-firm diffusion of the intranet (INTRA_1, …, INTRA_5, representing increasing shares of employees regularly working with the intranet). The influence of the intra-firm

diffusion of the intranet is not linear; we find the strongest effect on training propensity for firms where 40% to 80% of the employees regularly use this element of a firm's ICT infrastructure.[16]

The third element, i.e. the redesign of workplace organisation, as expected, is correlated with training propensity to a much lower extent than the intensity of ICT usage. In view of our reasoning in the previous sub-section, it is not surprising that only some of the dimensions of new workplace organisation are correlated with the likelihood of providing apprenticeship training. Working in a team (TEAM), as hypothesised, is a favourable environment for in-house vocational training. It is also not very surprising that Δ_LEVEL (flattening of hierarchies) and ROTATION (job rotation) do not influence training propensity. The negative sign we find for the degree of decentralisation of competencies (DECENTR) and the insignificant coefficient of [17] are not in line with the general hypothesis of a positive effect of the redesign of workplace organisation on the training propensity. However, as argued above, this result could reflect that in a (strongly) decentralised work organisation, the employees on the "shop floor" do not have much incentive to instruct apprentices, since this activity would reduce their "direct" contribution to the firm's output (which probably is more awarded than the "output" from training apprentices which is hard to measure). In conclusion, we find that working in teams is a learning environment which is well-suited for apprenticeship training, whereas the other dimensions of new workplace organisation do not raise the propensity to provide apprenticeship training. We find thus evidence for some influence of new workplace organisation on the training propensity but it is rather weak and not uniform for the different organisational dimensions.[18]

The influence of the other explanatory variables is in line with the expectations: Firms with high average wages provide less apprenticeship training than those with low wages. Physical capital intensity is not correlated with training propensity; there is thus no significant net effect of the two countervailing forces we mentioned in Section 2.[19] Foreign firms, as expected, are less involved in apprenticeship training than domestic ones. Training propensity more or less monotonically increases with firm size beyond a minimum threshold of fifty employees, with some flattening between 500 and 1000 employees. We also find a positive time effect for the year 2005 what may reflect, among other things, some policy measures taken in the aftermath of

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16 The insignificant result for firms where 81-100% of employees work with the intranet either may reflect the quite significant correlation with INTER and human capital intensity, or may indicate that such firms, in terms of ICT use, are so complex that apprenticeship training is not an appropriate way of recruiting qualified labour.

17 Finegold and Wagner (2002) argue convincingly that hiring apprentices becomes more attractive when work organisation gets more flexible and, in particular, when the incidence of teamwork increases.

18 When we consider all organisational dimensions at once, by calculating a composite organisation indicator based on a principal component factor analysis of the five dimensions of organisation, we do not get a statistically significant effect on the training propensity.

19 Based on a sub-sample pertaining only to high-tech industries and knowledge-intensive services we got a statistically significant negative coefficient, what is quite plausible in view of the complexity of the production process in many firms of this part of the economy (see the argument put forward in Section 2).

the economic downturn of 2001/03 to foster training provision (exerting pressure on employers to provide apprenticeships; introduction of a new "Training Act", establishing less demanding types of apprenticeships for low-ability school leavers, etc.). Finally, the dummies reflecting regional and industry effects are jointly statistically significant.

To sum up, the model explaining a firm's propensity to provide apprenticeship training is quite well supported by the data. There is strong evidence for a positive relationship with the training propensity for two out of the three core elements of the new firm paradigm: a) human capital intensity (the vocational-oriented types of labour qualifications, including further training); b) intensity of use of ICT (intra-firm diffusion of the intranet, variety and complexity of Internet use). The effect of new workplace organisation is much weaker and is significant only for some of the organisational dimensions included in the model. Nevertheless, we conclude that a change towards the new firm paradigm, as characterised in Section 1, goes along with an increasing propensity of firms to apprenticeship training.

5.3 Empirical results: "training intensity" (TIN)

TIN (employment share of apprentices) only refers to firms actually providing apprenticeship training. In this case, OLS is not an appropriate estimation method as the results may suffer from a selection bias. Therefore we estimated a two-stage Heckman selection model (Heckman, 1979), where the probit model in column 1 of Table 7 is used as selection equation. The variable FOREIGN has deliberately been dropped in the TIN equation, shown in column 3, to make sure that the estimated coefficients are reliable (see Wooldridge, 2002).[20] The mills ratio turns out to be statistically significant at the 1%-level indicating a selection bias; the Heckman model is thus clearly more appropriate than OLS estimation. The results of the Heckman estimation of the TIN equation are shown in column 3 of Table 7.

In strong contrast to the results for TPR, we find that the three core elements of the new firm paradigm, i.e. human capital, ICT and workplace organisation, do hardly contribute to explaining TIN. Even human capital input, with the exception of the extent of further education (FTRAIN), has no explanatory power (the negative sign for the share of academicians LHIGH1 is not at variance with model expectations). These somewhat surprising results are partly due to errors in the measurement of TIN, reflecting the way the data were collected: the firms did not provide the absolute number of apprentices but only an estimate of their share in total employment. Since it is (very) low in many companies (the sample average of TIN is only 7%), the differences of TIN among firms may not be very reliable. Therefore, in order to get some clue of the relevance of the measurement problem for the outcome of model estimation, we transformed the quantitative

[20] In addition, we had to omit LLOW as it is highly correlated with other human capital variables.

TIN variable onto an ordinal scale. We grouped the firms according to their TIN value in five ordinal classes of similar size. We then estimated ordered probit models and got the following results for the key variables: Human capital intensity becomes now a significant determinant of training intensity in more or less the same way as it was the case for training propensity (positive effect of medium-level and non-university tertiary-level qualifications as well as of further training). However, the results for the other two elements of the new firm paradigm remained the same as in the Heckman estimation, meaning that ICT usage and workplace organisation do not influence the *intensity* of training.

The explanatory variables not related to the new firm paradigm, i.e. average wages, physical capital intensity and firm size, show the expected sign and are statistically significant; the same holds for the region, industry and time dummies. Whereas the size effect turned out to be (more or less monotonically) positive in case of training propensity, we find a *discrete* negative relationship between firm size and training *intensity*: all firms employing more than 50 employees provide, to the same extent (no significant difference between the coefficients of SIZE_2 up to SIZE_6), less training than firms with less than 20 workers.

To sum up: we found strong evidence for a positive impact on training propensity of *at least* two out of the three categories of variables representing the new firm paradigm (human capital and ICT). In case of training intensity, however, only *one* of the three variable sets (human capital) exerts a positive influence, whereas this is definitely not the case for ICT and workplace organisation.

6. Econometric analysis of the impact of apprenticeship training on labour productivity

6.1 Specification of the empirical productivity model

The model explaining a firm's labour productivity is based on a production function with the input factors human capital (skill composition, further training), ICT, workplace organisation, physical capital and, finally, apprenticeship training (represented, alternatively, by the training propensity and the training intensity). We expect a positive effect on productivity for all input variables, with the exception of the apprenticeship training variable for which we do not have an a priori sign expectation (in particular as data limitations prevent us to estimate a model where the impact of apprenticeship training on productivity primarily may become effective in the future).

We estimated the following specification of the productivity model: Labour productivity (LQL: value added per employee; logarithm) is used as dependent variable.[21] The explanatory variables ICT usage, workplace organisation, physical capital intensity (logarithm) and the two alternative measures of apprenticeship training (TPR, TIN) are specified in the same way as in the "training model" (see sub-section 5.1). Human capital input is captured by two variables, firstly, the share of employees of the two highest skill levels (as used in the "training model") in total employment, and, secondly, the share of employees participating in further training. The equation we estimated also contains a set of binary control variables (foreign ownership, firm size classes, regions, industry affiliation and time).

We estimated two separate models: in the first one, the input of apprentices is represented by the training propensity (TPR), in the second one by training intensity (TIN). To take into account the endogenous character of TPR and TIN we applied instrumental variable estimation (2SLS), based on pooled data or random effects. The results for TPR (in this case the first stage are probit estimates) are shown in the columns 1 and 2 of Table 8, and those for TIN (the first stage is based on OLS regressions) in columns 3 and 4. In case of TPR, we additionally used a two-step consistent Maximum Likelihood estimator (MLE).[22] This procedure considers the influence of the endogenously chosen binary variable TPR on the endogenous continuous variable LQL, conditional on two sets of independent variables (see the results in column 5 of Table 8). The variable FOREIGN that correlates with TPR but not with LQL is the identifying variable in the instrumental variable estimations including TPR (columns 1 and 2 of Table 8) and the Maximum Likelihood estimation (column 5 of Table 8). The dummy "export yes/no" serves as identifying variable in the instrumental variable estimations including TIN (columns 3 and 4 of Table 8).

6.2 Empirical results

Productivity model based on "training propensity"

The model fit is satisfactory and the estimates yield qualitatively the same results for the three estimation methods (columns 1, 2 and 5 of Table 8). The productivity effects are weaker for some variables (e.g. ICT) in MLE estimates as compared to 2SLS estimations.

In line with our expectations, we find a statistically significant positive productivity effect of a) physical capital intensity (LCI), b) human capital intensity represented by the share of high skilled employees (LHIGH12) and the share of workers participating in further training (FTRAIN), and c) ICT intensity measured by the share of intranet users (INTRA_2, …,

[21] Alternatively, we used value added per non-apprentice employee as a measure for labour productivity since one may presume that the productivity effect of apprenticeship training is biased in view of the above-average share of apprentices in small firms. However, this alternative specification did not change the results.

[22] We used the STATA "treatreg" procedure.

INTRA_5) as well as the variety and complexity of internet use (INTER). The productivity effect of new workplace organisation is quite small; only "working in teams" (TEAM) shows the expected positive productivity effect, and "job rotation" (ROTATION) is negatively related to labour productivity. Finally, firms having apprentices are less productive than those providing no apprenticeships (negative sign of TPR).

Productivity model based on "training intensity"

This model also fits the data quite well. As expected, we get statistically significant positive productivity effects for a) physical capital intensity, b) human capital intensity (though weaker than in the model with TPR), c) workplace organisation (much stronger than in the model with TPR: significantly positive effects of the variables "team work", "decentralised distribution of competencies" and "flattening of hierarchies"; negative effect of "job rotation" and of an "increase of the delegation of competencies at the workplace. The productivity effect of ICT is weaker than in the model with TPR (significant positive sign only in case of a very high degree of intra-firm diffusion of the intranet). Finally, in accordance with the estimates with TPR, we find that the correlation between TIN and labour productivity is significantly negative, meaning that, among the firms providing training, those with a high employment share of apprentices are less productive than those with a low share.

To sum up, both the propensity of a firm to offer apprenticeship training (TPR) and, given apprenticeship training is provided, the employment share of apprentices (TIN) are negatively correlated with labour productivity. These results are based on estimation techniques taking into account the endogenous character of training activities.

7. Summary, Discussion, Policy Implications

In the first part, we identified the factors determining a firm's demand for apprentices using two alternative training variables, i.e. the firms' willingness to offer apprenticeships ("training propensity") and the extent of training provided by companies having apprentices ("training intensity"). The investigation particularly emphasised as explanatory variables the three constituent elements of the new firm paradigm proposed in the literature in the course of the last two decades: a) intensity of use of ICT, b) new workplace organisation, and c) human capital intensity. In addition, we took into account physical capital intensity, the average wage level, firm size and foreign/domestic ownership of the company; moreover, we controlled for regional, industry and time effects. In the second part, we analysed in a production function framework the relationship between apprenticeship training and firm performance, treating the two (alternative) measures of training activity as endogenous variables. The study is based on an unbalanced panel of Swiss firms for which we collected data by means of surveys in 2000 and 2005 respectively.

7.1 The provision of training

Training propensity

In case of the training propensity, there is strong evidence for a positive impact of two out of the three core elements of the "new firm model": a) human capital intensity (significant variables: share of employees with medium-level qualifications, with non-university application-oriented tertiary degrees and with participation in further training (and significant negative sign of the employment share of low-skilled worker)); b) intensity of ICT usage (degree of intra-firm diffusion of the intranet; variety and complexity of Internet applications). The third constituent element of the new firm paradigm, i.e. the redesign of workplace organisation, is less important as a determinant of training propensity as we find a significantly positive effect only for one of the organisational dimensions taken into consideration (intra-firm diffusion of teamwork). Nevertheless, the results suffice to conclude that a change towards the "new firm paradigm" goes along with an increasing propensity of firms to provide apprenticeship training.

The effects of the explanatory variables that are not related to the new firm paradigm are largely in line with the expectations: negative effect for the average wage level; no significant relationship for physical capital intensity, significant effect of dummies for regions and industries. Of special interest from a policy point of view are the results for foreign ownership, firm size and the time dummy for 2005. Firstly the training propensity of foreign firms is lower than that of domestic companies, what may indicate that such firms often are not familiar with the Swiss apprenticeship system and/or prefer to use "modes of training" taken over from their country of origin. Secondly, the willingness to provide apprenticeship training increases with firm size more or less monotonously, in particular in the range of 50 up to 500 employees. Thirdly, we find a positive time effect for the year 2005 that cannot be explained by macroeconomic developments as the cyclical state of the economy was more favourable in 2000 than in 2005. We presume that the time effect, to some extent, reflects institutional changes of the apprenticeship training as well as specific measures taken in the period 2000-2005 to foster the provision of apprenticeships (see Section 1).

Training intensity

In contrast to the training propensity, we only find evidence for a positive influence on training intensity for one of the three constituent elements of the new firm model, i.e. for human capital (positive effect for medium-level and non-university tertiary-level qualifications as well as for further training). ICT usage and workplace organisation do not seem to influence the intensity of training provision.

The results for the explanatory variables not related to the new firm paradigm (capital intensity, average wage and foreign ownership[23] as well as industry, region and time effects) are very similar to those we got for the training propensity. The only exception is firm size: whereas the training propensity more or less monotonically increases with firm size, we find a discrete negative relationship for the training intensity: all firms employing more than 50 workers provide, to the same extent, less training than firms with less than 20 workers.

In a policy perspective, the results with respect to foreign ownership and time, which are the same as for training propensity, again are interesting. The negative sign for foreign ownership implies that foreign firms, even if they provide apprenticeship training, offer less apprenticeship positions than domestic ones. The positive time effect for 2005 again may reflect policy measures taken in the period 2000-2005. Furthermore, the relatively low training intensity of the larger firms, which mostly provide high-quality training, may be a problem as these companies contribute, in absolute terms, a lot to the overall training output.

Assessment and policy implications

How do the findings with regard to the core variables of our model compare to the results of previous econometric work? The very few studies that take account of ICT yield divergent results. Beckmann (2002, 2008) got a positive effect, based on a very rough measure of IT investments, both on training propensity and on training intensity for a cross-section of German firms, whereas we did so only in case of training propensity. Arvanitis and Stucki (2008) found some weak evidence for a negative influence of the usage of Internet and intranet on training propensity based on a cohort of Swiss start-up firms. In view of the different measurement of ICT usage and sample characteristics (new vs. established firms) a comparison of the results of the few studies with our findings might not be reliable. As the present paper, to our knowledge, is the first one investigating econometrically the impact of new workplace organisation on training provision, it is obvious that the results cannot be compared to previous work. In contrast, there are several studies including human capital as a variable explaining apprenticeship training (see, among others, Franz et al., 2000; Niederalt, 2004; Beckmann, 2002, 2008; Arvanitis, 2008; Mühlemann and Wolter, 2007). Unequivocally and in accordance with this paper, these authors find a positive effect. However, our investigation is more differentiated than most previous ones as these only distinguish between qualified and unqualified labour and do not analyse the role of further training. We show, similar to Arvanitis (2008), that the positive impact of human capital on training propensity can be traced back to vocational qualifications at the medium level

[23] The effect of foreign ownership on training intensity is not reported in Table 7 for reasons we discussed in subsection 5.3. Specific estimates showed that the effect of this variable is negative (as in case of training propensity).

(apprenticeships) and to application-oriented non-university tertiary education, whereas the share of academics is negatively or not correlated with training propensity. Moreover, we find that further training also positively influences the provision of training; apprenticeship and further training are thus complements rather than substitutes; Arvanitis and Stucki (2008) get the same result for a cohort of young firms.

In a policy perspective, the results with respect to the impact of human capital, ICT usage and new workplace organisation on the propensity to provide apprenticeship training are encouraging. These imply that the Swiss apprenticeship system is appropriate to adapt to the changes required for a transition to the new firm paradigm. The fact that a high share of non-university tertiary degrees is positively related to the training propensity also is a promising result. In policy terms, one may conclude that the vocational-oriented higher education should (continue to) get high priority in policy making. The complementarity of apprenticeship and further training also points to the appropriateness of the apprenticeship system; it might provide a good basis for coping with the continuous adaptation of skills required in a knowledge-based economy. Nevertheless, it remains an open question whether specific measures are required to strengthen the incentives (e.g. through the tax system) for further training.

So far some policy recommendations derived from the results for the core variables of our model. In the policy context, the results for some other variables also may be informative. Firstly, since foreign firms are less involved in apprenticeship training in terms of propensity as well as intensity, it is important to identify the factors preventing these firms from offering (more) apprenticeships places. Only then one can assess whether it is necessary to design policy measures specifically targeted to this category of firms. Secondly, it should be investigated why the training intensity of medium-sized and large companies is lower than that of small firms (even having controlled for industry effects and foreign ownership). Is it because the apprenticeship system has become less attractive for this group of firms than it used to be, and, if it is the case, for what reasons (e.g. internationalisation of the firms' activities and/or their management; higher preference for recruiting foreign workers, graduates of upper-secondary schools of *general* education or graduates from tertiary education institutions; etc.)? Based on the results of such an analysis, one could deliberate whether specific policy measures are required. Thirdly, as the positive time effect for 2005 may be the result of policy actions taken in the period 2000-2005, it would be helpful to evaluate their effect (and efficiency) to get some guidelines for future policy; however, it may still be too early to evaluate the effects of the new "Training Act" that became effective in 2004.

7.2 The relationship between apprenticeship training and productivity

We identified the relationship between apprenticeship training and a firm's labour productivity in a production function framework with several inputs: human capital (skill composition, further training), ICT, workplace organisation, physical capital and (endogenous) apprenticeship training (alternatively, training propensity and intensity). We found a negative relationship between both measures of apprenticeship training and labour productivity. For the other input factors we got the predicted positive signs. Since we controlled for firm size, foreign ownership and the effects of industry, region and time, the negative correlation is well established.

The relationship between apprenticeship training and firm performance was analysed only recently. In accordance with the present paper, Arvanitis (2008), using Swiss panel data, found a negative correlation between training propensity and training intensity respectively and labour productivity. Arvanitis and Stucki (2008), based on a cohort of Swiss start-ups, also detected a negative sign. It is thus a common result of the studies for the Swiss economy that apprenticeship training and labour productivity are negatively correlated. Fougère and Schwerdt (2002) estimated productivity functions for a sample of German and French firms differentiated by three firm size classes. They did not find any significant relationship for small and large firms in both countries, but got a negative sign for medium-sized firms (20 to 200 employees) in case of Germany but not for France. Quantile regressions showed positive correlations for the first three quartiles in the French case, whereas for Germany the results were mixed (positive sign for the fourth, negative for the first quartile). Zwick (2007) did not find a significant correlation between training propensity and productivity for the German economy as a whole, but Mohrenweiser and Zwick (2008) showed that this result is due to diverging effects for specific occupations: for manufacturing occupations the correlation is negative, whereas it is positive in case of craft and construction as well as commercial and trade occupations. In sum, the studies for France and Germany are not very conclusive: they only show a weak correlation of training propensity and productivity at the aggregate level, whereas negative or positive effects are found depending on which specific segment of the economy is considered.

What can we learn from the results for Switzerland? First of all, one should be very cautious in interpreting the negative relationship between apprenticeship training and labour productivity. One problem is that the results are derived from estimating a productivity equation which, for data limitations, does not take into account dynamic effects. In other words, we relate investments in apprenticeship training with contemporaneous productivity; thus we abstract from productivity gains that may be realised in the future. As a consequence, the correlation between apprenticeship training and labour productivity must not be interpreted as a causal relationship. The negative sign rather reflects a (descriptive) association between the two variables: highly

productive firms less often offer apprenticeships and the employment share of apprentices is lower in this category of firms.

We presume that the negative relationship between productivity and apprenticeship training reflects some structural characteristics of the economy. Low productivity firms may be concentrated, to a certain extent, in the domestic (construction, trade, etc.) and/or the craft sector (e.g. parts of metal working) rather than in the (export-oriented) industrial sector; or they are operating in more traditional, less dynamic companies. Firms of these segments of the economy, in many instances, are well integrated in the apprenticeship system for various reasons (tradition, low training costs, etc.), what is not the case, for instance, for the fast growing computer and business services (see Table 1). Industry and size dummies capture the above-mentioned structural characteristics not as differentiated as one would like (e.g. the construction industry contains craft firms as well as integrated developers, general contractors, etc.). One should thus differentiate the industry dummies and add controls for the type of firm (e.g. craft vs. industrial) or the specificities of the production process (client-specific production, production in batches, continuous flow production). In any case, one is well advised not to draw far-reaching conclusions without a more in-depth analysis of the relationship between apprenticeship training and productivity; it certainly would be worthwhile to study specifically the training and recruiting behaviour of highly productive companies as we do not really understand why they offer less apprenticeship places than less productive firms.

If the apprenticeship system should keep its position as the most prominent way of producing (basic) vocational knowledge, it is necessary that it is (or becomes more) strongly established in the high-growth part of the economy. The fact that the core variables of the new firm paradigm positively correlate with the training propensity may indicate that this is the case to a significant extent (although the negative correlation between training and productivity casts some doubt on this positive assessment). Policy should emphasise even more than in the past the flexibility and adaptability of the apprenticeship system in order to cope with the challenges and requirements of the knowledge-based economy which increasingly is internationalised and/or based on high-value added services. Moreover, it is necessary to optimise the *overall* system of education and training rather than the apprenticeship system in itself, since the links between the different system elements (general upper-secondary education, apprenticeship system, full-time vocational schools, further education, non-university vocational-oriented tertiary education) have become tighter. Policy already moved in this direction to a significant extent in the course of the last fifteen years. In particular, establishing “Berufsmatura” and “Fachhochschule” and implementing a new “Training Act” that became effective in 2004 were big steps forward.

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Table 1: Training propensity and training intensity by sector and industry

Industry / sector	"Training propensity" (share of firms providing apprenticeship training)	"Training intensity" (average share of apprentices in total employment) *(reference: firms with apprentices)*
Food, beverage, tobacco	68.1	3.5
Textiles	74.5	4.9
Clothing, leather	66.7	5.8
Wood processing	82.4	6.9
Paper	77.8	4.6
Printing	83.2	6.9
Chemicals	68.5	3.8
Plastics, rubber	73.5	4.9
Glass, stone, clay	65.1	4.3
Metal	75.0	5.4
Metalworking	75.6	5.7
Machinery	77.3	7.5
Electrical machinery	78.9	6.2
Electronics, instruments	74.1	5.8
Watches	52.3	7.1
Vehicles	75.7	8.1
Other manufacturing	69.2	7.1
Energy	91.9	7.1
Manufacturing	*74.4*	*6.0*
Construction	*88.2*	*8.7*
Wholesale trade	75.6	8.7
Retail trade	76.4	9.8
Hotels, catering	76.4	10.2
Transport, telecommunication	64.6	4.7
Banks, insurance	71.9	5.5
Real estate, leasing	93.8	4.5
Computer services	66.2	5.2
Business services	69.8	8.5
Personal services	52.2	5.3
Services	*72.2*	*7.9*
Total	75.0	7.0
N	3401	2552

Table 2: Training propensity and training intensity by firm size

Firm size (number of employees)	"Training propensity" (share of firms providing apprenticeship)	"Training intensity" (average share of apprentices in total employment) *(reference: firms with apprentices)*
Less than 20	50.0	16.4
20-49	61.7	10.1
50-99	72.9	6.6
100-199	82.5	5.8
200-499	90.0	4.8
500-999	88.1	5.4
1000 and more	94.6	5.7
Total	75.0	7.0
N	3401	2552

Table 3: Training propensity and training intensity by region

Region	"Training propensity" (share of firms providing apprenticeship)	"Training intensity" (average share of apprentices in total employment) *(reference: firms with apprentices)*
Lac Léman	68.3	6.0
Espace Midland	76.1	7.1
North-western Switzerland	74.7	6.7
Zurich	73.2	7.0
Eastern Switzerland	80.8	8.0
Central Switzerland	81.9	7.3
Ticino	64.1	5.1
Total	75.0	7.0
N	3401	2552

Table 4: Training propensity and training intensity by year

Year	"Training propensity" (share of firms providing apprenticeship)	"Training intensity" (average share of apprentices in total employment) *(reference: firms with apprentices)*
2000	73.8	7.2
2005	76.2	6.8
Total	75.0	7.0
N	3401	2552

Table 5: Training vs. non-training firms: human capital, ICT and workplace organisation

	Firms with apprentices	Firms without apprentices
Variables / indicators	Percentage of firms	
Human capital		
High participation at further training activities	63.1	56.1
High share of employees with university degree	50.1	47.9
High share of employees with a non-university tertiary degree	65.7	58.4
High share of employees with a medium-level vocational degree	67.4	51.9
High share of employees with a low-level or no vocational degree	67.4	51.9
ICT usage		
Strong use of the Internet	49.4	47.3
Strong use of the intranet	46.1	37.9
High variety and complexity of Internet use	54.4	45.5
Workplace organisation		
Number of hierarchical levels decreased	12.5	12.0
Degree of delegation of competencies increased	43.8	42.0
Teamwork is common	53.2	44.6
Job rotation is common	20.9	18.3
Delegation of competencies is common	41.8	41.5

Table 6: Variable definition and measurement

Variable	Definition / measurement
Dependent variables	
TPR	Having at least one apprentice yes/no (training propensity)
TIN	Share of apprentices in total employment (training intensity) *(only firms having apprentices*)
LQL	Value added per employee (full-time equivalent); logarithm
Independent variables	
Human capital	
LHIGH1	Share of employees with a university degree (academics); logarithm
LHIGH2	Share of employees with a non-university tertiary-level degree; logarithm
LHIGH12	Share of employees with all types of tertiary-level degrees; logarithm
LMED	Share of employees with an intermediate level vocational degree (graduates from apprenticeships or school-based vocational education); logarithm
LLOW	Share of employees without or with a low-level vocational degree ("Anlehre"); logarithm
FTRAIN	Share of employees participating at further training activities (ordinal variable: 0%; 1-10% 11-15%; 16-25%; 26-49%; 50% and more)
Information and communication technology (ICT)	
INTRA	Share of employees regularly using the intranet (dummy variables with 0% as reference group: 1-20% (INTRA_1); 21-40% (INTRA_2); 41-60% (INTRA_3); 61-80% (INTRA_4); 81-100% (INTRA_5))
INTER	Variety and complexity of Internet applications (mean of *eight* dummies for different types of Internet usage) 1) general search for information; 2) detailed search for market/price information; 3) presentation of the firm; 4) supply of product information; 5) internal communication; 6) further training; 7) E-purchasing; 8) E-selling
Workplace organisation	
Δ_LEVEL	Change of the number of hierarchical levels in the preceding five years (decrease (value 1); increase or no change (value 0))
Δ_DECENTR	Change of the degree of delegation of competencies in the preceding five years (decrease or no change (value 0); increase (value 1))
DECENTR	Degree of decentralisation of competencies: (mean of *seven* ordinal variables ranging from "line manager decides alone" up to "employee decides alone"; 5-point scale) 1) speed of work, 2) procedures of work, 3) distribution of tasks, 4) modality of the execution of tasks, 5) problems in production, 6) regular contact with clients, 7) complaints of clients
ROTATION	Prevalence of job rotation (six-level ordinal variable, ranging from "very high" (value 5) to "inexistent" (value 0))
TEAM	Prevalence of team work (six-level ordinal variable, ranging from "very high" (value 5) to "inexistent" (value 0))
Other explanatory variables	
LCL	Gross capital income per employee; logarithm
LWL	Labour costs per employee; logarithm
SIZE	Dummy variables for six firm size classes based on the number of employees

	(reference group: “less than 20”) 20-49 (SIZE_1); 50-99 (SIZE_2); 100-249 (SIZE_3); 250-499 (SIZE_4); 500-999 (SIZE_5); 1000 and more (SIZE_6):
FOREIGN	Foreign-owned firm yes (value 1), no (value 0)
Control variables	
REG	Dummies for six regions (reference region: Ticino): Lac Léman (REG_1); Espace Midland (REG_2); North-western Switzerland (REG_3); Zurich (REG_4); Eastern Switzerland (REG_5); Central Switzerland (REG_6)
IND	Dummies for 27 industries (reference industry: “personal services”)
Y2005	Time dummy for the year 2005 (reference: year 2000)

Table 7: Estimates of the propensity and intensity of apprenticeship training [a]

Explanatory variables	TPR		TIN [b]
	Pooled probit	Random effect probit	Heckman selection model
Constant	2.666**	2.831	49.56***
	(1.26)	(2.37)	(6.10)
LHIGH1	-0.00990	-0.0156	-0.162**
	(0.017)	(0.032)	(0.081)
LHIGH2	0.0771***	0.146***	0.0525
	(0.023)	(0.043)	(0.13)
LMED	0.300***	0.539***	-0.123
	(0.046)	(0.091)	(0.32)
LLOW	-0.0355*	-0.0498	//
	(0.020)	(0.037)	//
FTRAIN	0.0259	0.0553	0.543***
	(0.022)	(0.042)	(0.10)
INTRA_1	0.0598	0.130	-0.999**
	(0.088)	(0.16)	(0.40)
INTRA_2	0.148	0.277	-0.0694
	(0.095)	(0.18)	(0.44)
INTRA_3	0.267**	0.406**	0.0399
	(0.10)	(0.19)	(0.47)
INTRA_4	0.211*	0.329	-0.581
	(0.13)	(0.24)	(0.55)
INTRA_5	-0.0567	-0.0966	-0.491
	(0.11)	(0.21)	(0.52)
INTER	0.365***	0.639**	0.0532
	(0.13)	(0.26)	(0.67)
Δ_LEVEL	-0.0633	-0.157	0.776*
	(0.087)	(0.17)	(0.40)
Δ_DECENTR	-0.0414	-0.138	-0.0434
	(0.061)	(0.12)	(0.28)
DECENTR	-0.179***	-0.333***	-0.0296
	(0.045)	(0.092)	(0.24)
ROTATION	0.00217	-0.00122	-0.186
	(0.025)	(0.046)	(0.11)
TEAM	0.0380**	0.0681*	-0.0532
	(0.019)	(0.036)	(0.091)
LCL	-0.0361	-0.0655	-0.318**
	(0.031)	(0.057)	(0.14)
LWL	-0.297***	-0.373*	-3.762***
	(0.11)	(0.20)	(0.54)
SIZE_1	0.106	0.288	-5.358***
	(0.19)	(0.35)	(1.09)
SIZE_2	0.564***	1.148***	-7.487***
	(0.19)	(0.38)	(1.15)
SIZE_3	0.923***	1.803***	-7.723***
	(0.20)	(0.40)	(1.22)
SIZE_4	1.380***	2.669***	-7.828***
	(0.22)	(0.48)	(1.36)
SIZE_5	1.301***	2.472***	-7.450***
	(0.25)	(0.52)	(1.40)
SIZE_6	1.705***	3.342***	-6.126***
	(0.28)	(0.61)	(1.52)
FOREIGN	-0.420***	-0.776***	//
	(0.078)	(0.17)	//

Mills ratio	//	//	3.197**
	//	//	(1.51)
Y2005	0.104*	0.204*	0.652**
	(0.061)	(0.11)	(0.28)
Region dummies	yes	yes	yes
Industry dummies	yes	yes	yes
N	2859	2859	2859
N censored			684
Pseudo R^2	0.171		
Wald chi^2	426.86***	104.60***	914.07***
Rho		0.731	
LR test of rho=0		86.25***	

[a] The significance of the parameters is indicated with ***, ** and * resp. representing the 1%-, 5%- and 10%-level with standard errors in brackets.

[b] The variable FOREIGN is dropped to avoid biased estimates (see Wooldridge, 2002). Variable LLOW also is omitted because of multicollinearity with other human capital variables (see sub-section 5.3).

Table 8: Estimates of labour productivity (incl. apprenticeship training as input factor) [a]

Explanatory variables	LQ/L (IV regression)				LQ/L (MLE)
	Pooled regression	Random effect regression	Pooled regression	Random effect regression	Pooled regression
Constant	7.790***	7.790***	7.944***	7.847***	7.679***
	(0.17)	(0.12)	(0.21)	(0.13)	(0.098)
TPR	-0.583***	-0.583***	///	///	-0.342***
	(0.095)	(0.084)			(0.051)
TIN	///	///	-0.0307***	-0.0228***	///
			(0.0068)	(0.0024)	
INTRA_1	0.00192	0.00192	-0.0350**	-0.0223	-0.00126
	(0.019)	(0.018)	(0.018)	(0.016)	(0.015)
INTRA_2	0.0338*	0.0338*	-0.00145	0.00645	0.0261
	(0.019)	(0.020)	(0.017)	(0.017)	(0.016)
INTRA_3	0.0581***	0.0581***	0.0216	0.0184	0.0433**
	(0.021)	(0.022)	(0.018)	(0.018)	(0.018)
INTRA_4	0.0737***	0.0737***	0.00942	0.0150	0.0614***
	(0.024)	(0.026)	(0.022)	(0.021)	(0.021)
INTRA_5	0.0754***	0.0754***	0.0674**	0.0591***	0.0834***
	(0.026)	(0.024)	(0.032)	(0.021)	(0.019)
INTER	0.0657**	0.0657**	-0.0185	-0.0377	0.0388
	(0.032)	(0.031)	(0.030)	(0.026)	(0.024)
Δ_LEVEL	0.0136	0.0136	0.0513**	0.0336**	0.0182
	(0.019)	(0.019)	(0.021)	(0.016)	(0.015)
Δ_DECENTR	-0.0186	-0.0186	-0.0197*	-0.0186*	-0.0168
	(0.013)	(0.013)	(0.012)	(0.011)	(0.011)
DECENTR	0.000273	0.000273	0.0265***	0.0284***	0.0115
	(0.010)	(0.010)	(0.0089)	(0.0086)	(0.0082)
ROTATION	-0.00822*	-0.00822	-0.0129***	-0.0109**	-0.00745*
	(0.0050)	(0.0052)	(0.0044)	(0.0046)	(0.0042)
TEAM	0.0113***	0.0113***	0.00478	0.0115***	0.00916***
	(0.0043)	(0.0041)	(0.0040)	(0.0036)	(0.0033)
LCL	0.362***	0.362***	0.352***	0.356***	0.364***
	(0.013)	(0.0065)	(0.015)	(0.0058)	(0.0053)
LHIGH12	0.0236***	0.0236***	0.0116	0.0112**	0.0173***
	(0.0058)	(0.0054)	(0.0080)	(0.0053)	(0.0042)
FTRAIN	0.0106**	0.0106**	0.0136***	0.00770*	0.00810**
	(0.0050)	(0.0047)	(0.0051)	(0.0042)	(0.0038)
FOREIGN	-0.0133	-0.0133	0.0293*	0.0362**	0.0158
	(0.022)	(0.020)	(0.017)	(0.018)	(0.015)
Y2005	0.0484***	0.0484***	0.0377***	0.0327***	0.0419***
	(0.013)	(0.013)	(0.012)	(0.0095)	(0.010)
Firm size dummies	yes	yes	yes	yes	Yes
Region dummies	yes	yes	yes	yes	Yes
Industry dummies	yes	yes	yes	yes	Yes
N	2859	2859	2175	2175	2859
F	48.26***		54.67***		
Root MSE	0.3165		0.2656		
R^2 adj.	0.526		0.643		
Overall R^2		0.583		0.709	
Wald chi^2		4496.62***		5204.50***	7162.30***
Rho		0		0.641	
Hazard ratio					0.188***

[a] The significance of the parameters is indicated with ***, ** and * resp. representing the 1%-, 5%- and 10%-level with standard errors in brackets.

Table A1: Composition of the data set by industry, firm size, region and year

	N	Percentage of firms
Industry / sector		
Food, beverage, tobacco	149	4.3
Textiles	53	1.5
Clothing, leather	24	0.7
Wood processing	52	1.5
Paper	54	1.5
Printing	112	3.2
Chemicals	127	3.6
Plastics, rubber	70	2.0
Glass, stone, clay	64	1.8
Metal	45	1.3
Metalworking	234	6.7
Machinery	309	8.9
Electrical machinery	91	2.6
Electronics, instruments	179	5.1
Watches	66	1.9
Vehicles	38	1.1
Other manufacturing	66	1.9
Energy	63	1.8
Manufacturing	*1796*	*51.4*
Construction	*377*	*10.8*
Wholesale trade	312	8.9
Retail trade	214	6.1
Hotels, catering	132	3.8
Transport, telecommunication	179	5.1
Banks, insurance	150	4.3
Real estate, leasing, computer services	17	0.5
Computer services	66	1.9
Business services	225	6.4
Personal services	23	0.7
Services	1318	37.8
Firm Size (number of employees)		
Less than 20	84	2.4
20-49	1001	28.7
50-99	845	24.2
100-199	873	25.0
200-499	366	10.5
500-999	166	4.8
1000 and more	156	4.5
Region		
Lac Léman	433	12.4
Espace Midland	761	21.8
North-western Switzerland	536	15.4
Zurich	708	20.3
Eastern Switzerland	583	16.7
Central Switzerland	309	8.9
Ticino	161	4.6
Year		
2000	1688	48.4
2005	1803	51.6
N	3491	100.0

Table A2: Descriptive statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
Dependent variables				
TPR	0.7504	0.4329	0	1
TIN	6.9992	6.5252	1	100
LQL	11.8804	0.4706	10.8223	13.8085
Independent variables				
LHIGH1	0.0030	2.0459	-2.3026	4.6052
LHIGH2	2.0382	1.3969	-2.3026	4.6052
LHIGH12	2.3621	1.3660	-2.3026	4.6052
LMED	3.6516	0.8321	-2.3026	4.6052
LLOW	2.5188	1.9269	-2.3026	4.6052
FTRAIN	3.9722	1.4267	1	6
INTRA_1	0.1502	0.3573	0	1
INTRA_2	0.1225	0.3280	0	1
INTRA_3	0.1050	0.3065	0	1
INTRA_4	0.0776	0.2675	0	1
INTRA_5	0.1335	0.3402	0	1
INTER	0.5477	0.2321	0	1
Δ_LEVEL	0.1232	0.3287	0	1
Δ_DECENTR	0.4361	0.4960	0	1
DECENTR	2.3752	0.6869	1	5
ROTATION	0.5535	1.1863	0	5
TEAM	2.1613	1.6670	0	5
LCL	10.8559	0.9818	3.8670	13.7418
LWL	11.2816	0.3299	10.0958	12.1873
FOREIGN	0.1610	0.3676	0	1

Table A3: Correlation matrix: independent variables

Variable	INTRA_1	INTRA_2	INTRA_3	INTRA_4	INTRA_5	INTER	Δ_LEVEL	Δ_DECENTR	TEAM	ROTATION	DECENTR	FTRAIN	LHIGH1	LHIGH2	LHIGH12	LMED	LLOW	LCL	LWL
INTRA_2	-0.17	1.00																	
INTRA_3	-0.16	-0.15	1.00																
INTRA_4	-0.13	-0.12	-0.11	1.00															
INTRA_5	-0.16	-0.15	-0.14	-0.12	1.00														
INTER	-0.01	0.02	0.06	0.10	0.22	1.00													
Δ_LEVEL	-0.02	0.05	0.05	0.03	-0.01	0.07	1.00												
Δ_DECENTR	-0.02	0.04	0.04	0.04	-0.01	0.10	0.21	1.00											
TEAM	0.01	0.04	0.04	0.09	0.17	0.22	0.08	0.19	1.00										
ROTATION	0.01	0.01	0.05	0.00	0.00	0.10	0.07	0.13	0.17	1.00									
DECENTR	-0.05	0.00	0.07	0.11	0.15	0.16	0.05	0.17	0.18	0.02	1.00								
FTRAIN	-0.06	-0.03	0.08	0.09	0.19	0.14	0.08	0.16	0.22	0.10	0.19	1.00							
LHIGH1	-0.09	0.02	0.06	0.13	0.27	0.19	0.07	0.02	0.22	0.01	0.17	0.18	1.00						
LHIGH2	-0.06	0.00	0.05	0.09	0.14	0.09	0.06	0.05	0.13	0.02	0.13	0.14	0.26	1.00					
LHIGH12	-0.08	0.00	0.06	0.12	0.22	0.14	0.06	0.05	0.18	0.02	0.16	0.19	0.52	0.90	1.00				
LMED	-0.03	0.00	0.05	0.05	0.00	0.07	-0.04	-0.02	-0.03	-0.05	0.07	0.10	-0.12	-0.05	-0.09	1.00			
LLOW	0.12	0.10	-0.01	-0.07	-0.27	-0.08	0.02	0.05	-0.04	0.05	-0.17	-0.21	-0.16	-0.22	-0.28	-0.31	1.00		
LCL	-0.05	0.04	0.04	0.05	0.10	0.10	0.04	0.05	0.10	0.04	0.11	0.10	0.12	0.04	0.06	0.03	-0.04	1.00	
LWL	-0.10	0.00	0.09	0.11	0.24	0.13	0.04	-0.04	0.16	-0.03	0.14	0.16	0.27	0.24	0.29	0.06	-0.21	0.08	1.00
FOREIGN	-0.03	-0.01	0.09	0.03	0.13	0.08	0.02	0.02	0.11	0.01	0.11	0.08	0.13	0.10	0.10	-0.01	-0.04	0.11	0.15