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The Open Economics Journal

Provided in Cooperation with:
The Open Economics Journal

Suggested Citation: Arvanitis, Spyros (2010) : Are firm innovativeness and firm age relevant for the supply of vocational training? A study based on Swiss micro data, The Open Economics Journal, ISSN 1874-9194, Bentham Open, Sharjah, Vol. 3, pp. 43-57, http://dx.doi.org/10.2174/1874919401003010043

This Version is available at:
http://hdl.handle.net/10419/67433

Are Firm Innovativeness and Firm Age Relevant for the Supply of Vocational Training? – A Study Based on Swiss Micro Data

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Abstract: In this study we investigated the determinants of the propensity of Swiss firms to train apprentices. Innovation, firm age and competition conditions on the product market are determining factors that were especially emphasized in this investigation. We found that the skill composition of the employment, innovation activities, firm age, labour costs, capital intensity, and competitive pressures all play a discernible role, even if not at the same extent, in determining the propensity of apprentice training.

The data used in this study were collected in the course of four surveys among Swiss enterprises in the years 1996, 1999, 2002 and 2005 using a questionnaire which included besides questions on basic firm characteristics also several innovation indicators.

New elements of the analysis that distinguish it from already done work on this subject, especially in Switzerland, are: (a) the focus on the role of innovation and firm age for apprentice training; (b) the consideration of effects of competition on the product market; (c) the separate investigation of three sectors of the economy (manufacturing; services; construction); (d) the wide spectrum of determinants of training propensity that are taken into consideration; (e) the use of a panel of firms covering a period of about ten years (1995-2004).

JEL Classification: J24; O30.

Keywords: Apprentice training, innovation, firm age.

1. INTRODUCTION

Firm-funded training of apprentices covering a wide spectrum of skills from construction to information technologies and banking is the most important source of "medium-level" human capital for the Swiss economy. The employees with such "medium-level" vocational education build the largest group among employed persons. Moreover, having such a (nationally organized) vocational qualification is a precondition for the acquisition of every other type of higher tertiary-level education (with the exception of academic education). Thus, it is quite reasonable that both economists and economic policy-makers are greatly interested in better understanding the factors influencing positively or negatively the willingness of private enterprises to offer apprenticeships.

Of particular interest is the training behaviour of technologically advanced enterprises. There is long-term empirical evidence that both the number and the employment share of high-skilled (or high-educated) workers have grown over time in many OECD countries. Most observers think that this effect is attributable primarily to skill-biased technical change. Thus, technical change is expected to further shift labour demand in favour of high-qualified persons. In this context, it is important for policy-makers to know if the supply of apprenticeships, thus the supply of middle-educated persons, would be adequate also under the new technological conditions.

In many cases new technologies and new products are introduced by young firms that just entered the market. Therefore, it is also relevant to have information on the relationship between training behaviour and firm age. Due to the increasing openness of world markets, firms are operating under the conditions of intense (international) competition. As a consequence, it might be of interest to know how product market competition is influencing training behaviour (see, e.g., Gersbach and Schmutzler [1]).

Within contemporary advanced economies "apprenticeship typically denotes employer-sponsored programmes which integrate part-time schooling with part-time training and work experience [in a firm]… within an externally defined curriculum which contains mandatory part-time schooling and leads to a nationally recognized vocational qualification and takes at least two years to complete" [2]. This is exactly the definition of apprenticeship as it is exercised also in Switzerland.

This study investigates the determinants of the propensity of Swiss firms to train apprentices. Innovation, firm age and competition conditions on the product market are possible determining factors that are especially emphasized in this investigation. Innovative firms and new firms being drivers of economic growth, it is obvious that the training behaviour of these two firm categories is of great importance for the further development of the "dual system" (practical exercise

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1874-9194/10

in a firm in combination with formal education) of vocational education in Switzerland.

The data used in this study were collected in the course of four surveys among Swiss enterprises in the years 1996, 1999, 2002 and 2005 using a questionnaire which included besides questions on some basic firm characteristics (sales, exports, employment, investment and employees' vocational education) also several innovation indicators.

New elements of the analysis that distinguish it from already done work on this subject, especially in Switzerland (for a survey of relevant literature see Frick and Wirz [3] and Wolter [4]), are: (a) the focus on the role of innovation and firm age for apprentice training; (b) the consideration of effects of competition on the product market; (c) the separate investigation of three sectors of the economy (manufacturing; services; construction); (d) the wide spectrum of determinants of training propensity that are taken into consideration; (e) the use of a panel of firms covering a period of about ten years (1995-2004).

The paper is organized as follows. Section 2 discusses the conceptual framework of the study. In section 3 the data are presented; this section contains also a description of the main facts with respect to the training propensity of the firms in our sample. In section 4 we present the specification of the training propensity equation. The results of the econometric estimations are presented in section 5. Section 6 contains a comparison with results of similar studies. Finally, section 7 concludes with a summary of the main results.

2. INCENTIVES AND DISINCENTIVES RELATED TO THE DECISION TO TRAIN APPRENTICES

Starting point of our conceptual framework is the human capital approach introduced by Becker [5] according to which the acquisition of vocational education can be considered as an investment in human capital that enables the capital owner to achieve a higher individual performance in the future, e.g., higher productivity. Both employees and employers can have incentives for such investment, if the difference of the *expected benefits* (e.g., productivity gains for the enterprises, labour income increases for the employees) and the *expected costs* (e.g., training costs) is positive. We concentrate here on firms' incentives and motives to invest in human capital by offering training, especially training for apprenticeships. We refrain here from discussing other motives of training (production motive; reputation motive) that are not taken into consideration in the empirical part of the study (see, e.g., Niederalt [6] and Mohrenweiser and Backes-Gellner [7] for a discussion of the literature dealing with the relevance of different motives).

Vocational training contains general skills that satisfy the firms' requirements at industry, sector or even country, but also a portion of firm-specific skills that are not transferable to other firms (or are transferable at a high cost). According to the original human capital approach, employers have an interest to pay only for an investment in firm-specific skills but not for general skills that have to be financed either by the employees or the state. However, in practice we can observe that firms bear a significant fraction of the costs of training, even if this training contains general skills. The investment hypothesis has been further elaborated and refined by Acemoglu and Pischke [8, 9]. According to this new approach, it can be more profitable for a firm to use skilled employees that have been trained by the firm than unskilled employees, even if the training is not firm-specific. The main reason for this conclusion is the existence of labour markets imperfections due to asymmetric information with respect to the productivity of external employees, search costs, labour market institution such as unions and minimum wages, etc. However, in a recent paper Kessler and Lülfesmann [10] show that when general and specific skills are complementary to each other employers may be willing to sponsor general training even in competitive labour markets.

Put in a more abstract way, the main argument should be that the expected benefits and costs of training for a firm are primarily determined by all factors that influence the (future) demand for skilled labour. This indirect approach differs from that used in an important branch of empirical literature that investigates the direct the net cost and gains of training apprentices, see, e.g., Schweri *et al*. [11] for Switzerland and Beicht *et al*. [12] for Germany.

We hypothesize that a series of factors that would influence *positively* the expected demand for skilled labour would be also important for a firm's decision to train apprentices. In accordance with literature, we identified a series of such factors that we comprise in two groups: internal factors such as the endowment human resources and physical capital, innovation and technology; external factors such demand and competition conditions (see, e.g., Franz *et al*. [13] and Niederalt [6] for a similar approach). A further group of determinants that would influence *negatively* the expected demand for skilled labour refers to cost aspects.

A firm's demand for apprentices depends among other things on the demand for employees with different levels of vocational education. The relationship between the demand for apprentices and the demand for other categories could be substitutive or complementary. We expect a complementary relationship between apprentices and middle-educated employees (upper secondary education level; 'Berufslehre') and a substitutive relationship between apprentices and low-educated employees (vocational education without a formal degree; no vocational education). It is more difficult to disentangle the relationship of apprentices to high-qualified employees (tertiary-level education). Given that middle-educated and high-educated are mostly positively correlated, we expect a positive relationship of apprentices to high-qualified employees.

There is long-term empirical evidence that both the number and the employment share of high-skilled (or high-educated) workers have grown over time in many OECD countries. While many factors have contributed to this increase most authors think that this effect is attributable primarily to skill-based technical change. One of the most popular explanations which have been offered by the economic literature is based on the so-called „skill-biased technological change"-hypothesis, according to which the

reason for the up-skilling of labour force is the non-neutrality of technological change, which favours the use of skilled labour more than the use of other labour inputs. Due to the complementarity of skills (education) and technology, an acceleration of the rate of technological change would cause an increase of the demand for skilled labour (for recent surveys of the theoretical and empirical literature on skill-biased technical change see Sanders and ter Weel [14] and Acemoglu [15]). The reason for the most recent acceleration of technological change is assumed to be the diffusion of Information and Communication Technologies (ICT) which seem to have given new impetus to the substitution process of low-skilled by high-skilled employees (see Bresnahan *et al*. [16]). Empirical evidence for Switzerland shows that technological changes (e.g., the use of ICT) shift skill requirements in favour of high-qualified (tertiary-level education) employees and appear to be neutral with respect to middle-educated employees (upper secondary education level; 'Berufslehre'), which is the most numerous category of employees in the Swiss economy (see Arvanitis [17]). The demand for apprentices is closely related to the demand for middle-educated employees, therefore the expected effect of innovation and technology on the training propensity of Swiss firms is not a priori clear.

The theoretically expected impact of physical capital on training propensity is also ambiguous. It depends on the relationship between capital and the different employee categories. We would expect that in many cases a complementary relationship exists between capital and the high-qualified (tertiary-level education) employees. Symmetrically, a substitutive relationship could be probable between capital and low-qualified employees. It is not clear a priori how capital and the share of middle-educated employees – the employee category that interests mostly in this study – are related to each other.

The external demand and competition conditions might also influence a firm's decision to train apprentices. The demand for any category of employees is dependent on the expected level of firm activity as measured, e.g., by the expected product demand or by sales. The extent of this dependence is related to the relative importance of a certain category of employees in a firm's skill mix. In general, we expect positive effects of the variables measuring firm activity.

In a recent paper Gersbach and Schmutzler [1] postulate and derive theoretically two hypotheses about the market conditions under which industry-specific training is likely to occur: (a) concentration is high or competitive intensity is low, and (b) product differentiation is sufficiently strong. We consider the intensity of price competition (as measured in this study; see Table **4**) as a proxy for 'competitive intensity' in the above theoretical context and the intensity of non-price competition (as measured in this study; see Table **4**) as a proxy for 'product differentiation'. Thus, according to hypothesis (a) intensive price competition would exercise a *negative* influence on training propensity. On the contrary, according to hypothesis (b) intensive non-price competition would have a *positive* effect on training propensity.

What about *expected costs*? Costs (e.g., training costs, recruitment costs, and learning by doing of newly-hired employees) depend mostly on the requirements of technology used, the labour market situation, and the existing institutional framework with respect to training of apprentices. We expect a large portion of these costs to be industry-specific, sector-specific or even region-specific. For example, in the Swiss apprenticeship system duration of training, formal requirements for trainers, performance requirements for apprentices, and (partly) apprentices' wages are determined either by the state and/or the employers' associations at industry or sector level.

Further, we expect that the propensity to train apprentices would increase with increasing *firm size*. Larger firms have more resources than small ones, thus a larger potential for investing in education and vocational training. Moreover, if economies of scale exist, e.g., with respect to the facilities of vocational education, larger firms would have a comparative advantage vis-à-vis smaller ones, e.g., regarding training costs.

We are especially interested in understanding the relationship between *firm age* and training propensity. A general characteristic of an average young firm that distinguishes it from the average established firm is the considerably smaller size of the young enterprise. Thus, young firms would be expected to have generally a lower training propensity than established firms. An additional reason for newly-founded firms to be reluctant with respect to training activities would be that due to the more urgent problems of positioning the firm in the market little attention is paid to training, especially when the firm founder is also the apprentice trainer. On the whole, we expect a positive relationship between firm age and the training propensity (see also, e.g. Niederalt [6]).

3. DESCRIPTIVE RESULTS

Description of the Data

The data used in this study were collected in the course of four surveys among Swiss enterprises in the years 1996, 1999, 2002 and 2005 using a questionnaire which included besides questions on some basic firm characteristics (sales, exports, employment, investment and employees' vocational education) also several innovation indicators quite similar to those in the Innovation Surveys of the European Community (CIS). The survey was based on a (with respect to firm size) disproportionately stratified random sample of firms with at least 5 employees covering the manufacturing sector, the construction sector and commercial service industries as well as several firm size classes (on the whole 28 industries and within each industry three industry-specific firm size classes with full coverage of the class of large firms). Answers were received from 33.0% (1996), 33.8% (1999), 39.6% (2002) and 38.7% (2005) respectively of the firms in the underlying sample. The response rates do not vary much across industries and size classes with a few exceptions. In this sense our final data reflect quite well the structure of the underlying stratified random sample. Nevertheless, because of the low overall response rate it is difficult to assess the representativeness of the data used in

the study, especially in case non-respondents behave with respect to vocational training in another way as respondents. However, our non-response analysis (with a random sample of about 450 firms for each wave) referring only to innovation behaviour showed no significant differences for three innovation variables. Thus, we have no reason to expect that such differences would exist for training behaviour, but we cannot exclude it.

The final data set includes 9306 enterprises from all fields of activity and size classes (see Table **A1** in the appendix for the structure of the used data set by industry, firm size, and year respectively). Due to missing values for some variables, also to the fact that for construction and service firms the information on the shares of innovative products in the years 1996 and 1999 was not comparable with that for the other two cross-sections and had to be removed from the panel, the data set used in the econometric estimations contained finally 7007 observations. The resulting panel is considerably unbalanced.[1]

Training Propensity in the Swiss Business Sector 1995-2004

In Table **1**, column 1 we present data on the vocational training propensity and the intensity of vocational training of the firms in our sample by sector and industry.

At the sector level construction firms show the highest propensity to vocational training: 78.9% of them reported having apprentices all over the period of observation. The respective figures for manufacturing and service were 66.8% and 63.8% respectively. Thus the difference between manufacturing and service sector is small. Printing, energy and wood processing are the (low-tech) manufacturing industries with the highest shares of firms having apprentices (76%-81%). Paper (also a low-tech industry) and machinery, electrical machinery and vehicles (all three of them high-tech industries) come next with shares of 71%-72%. Such innovative industries as chemicals, plastics and electronics/ instruments show a rather low train propensity. Among service industries we find an above-average frequency of firms having apprentices in retail trade (traditional services) and bank/insurance (knowledge-intensive services). On the contrary, computer services, an increasingly important industry, show a very low frequency of firms training apprentices.

The percentage of firms having apprentices grows with increasing firm size (measured by the number of employees in full-time equivalents (Table **2**).

Table **3** contains some information on the training propensity by firm age (Table **5**). Very young firms (firm age of 0 to 5 years) seem to have a higher propensity than firms with a firm age of 6-10 years and 11-20 years respectively (column 2). Older firms (more than 20 years) show a higher propensity than very young firms. The relationship between firm age and training propensity seems to be non-linear.

Table 1. Propensity of Training of Swiss Enterprises 1995-2004 by Sector and Industry

Industry/Sector	Percentage of Enterprises Having Apprentices
Food, beverage, tobacco	59.8
Textiles	58.2
Clothing, leather	50.0
Wood processing	76.0
Paper	71.4
Printing	81.0
Chemicals	58.0
Plastics, rubber	56.4
Glass, stone, clay	54.6
Metal	70.3
Metalworking	64.1
Machinery	71.1
Electrical machinery	72.5
Electronics, instruments	61.3
Watches	45.5
Vehicles	71.0
Other manufacturing	63.8
Energy	78.8
Manufacturing	66.8
Construction	78.9
Wholesale trade	65.5
Retail trade	73.7
Hotels, catering	63.7
Transport, telecommunication	48.9
Banks, insurance	69.7
Real estate, leasing	50.8
Computer services	38.7
Business services	66.8
Personal services	46.6
Dienstleistungen	63.8
Total	65.6
N	9306

4. SPECIFICATION OF THE TRAINING PROPENSITY MODEL

Dependent Variables

We use the following dependent variable for the models of training propensity: firms reporting that they have apprentices yes/no (TRP) (see Table **4**).

Table 2. Propensity to Training of Swiss Enterprises 1995-2004 by Firm Size

[1] Table **A2** in the appendix contains information on the descriptive statistics of the model variables by sector. The Tables **A3**-**A5** show the correlations between the right-hand variables in the models for manufacturing, services and construction respectively.

Firm Size	Percentage of Enterprises having Apprentices
5-19 employees	42.6
20-49 employees	60.1
50-99 employees	69.6
100-199 employees	83.5
200-499 employees	89.2
500-999 employees	92.0
> 1000 employees	94.0
Total	**65.6**

Table 3. Propensity to Training of Swiss Enterprises 1995-2004 by Firm Age

Firm Age	Percentage of Enterprises having Apprentices
0-5 years	62.4
6-10 years	46.3
11-20 years	48.2
> 20 years	69.7
Total	65.7

Independent Variables

In section 2 we discussed potential determinants of apprentice training. In this section we specify variables for these determinants (see Table **4** for details).

Human resources. We used four dummy variables for the following four categories of employees with different education level: employees with university education yes/no (LHQUAL1); employees with other tertiary-level education (including graduates of universities of applied sciences) (LHQUAL2); employees with upper secondary education ('Berufslehre') (LMQUAL); and employees (with vocational education without a formal degree; no vocational education) (LLQUAL). We used these variables as proxies for the expected demand for the respective employee categories. We expected a positive effect for the high-educated and the middle-qualified employees (upper secondary education-level) and a negative effect for the low-qualified employees.

Innovation. We used the following seven indicators to measure innovation: two variables for innovation *input* ('R&D activities yes/no' (R&D) and 'R&D expenditure/sales' (LRDS)); three indicators for innovation *output* ('product innovations yes/no' (INNOPD); 'process innovations yes/no' (INNOPC); and 'patent applications yes/no' (PAT)); and two *market-oriented* indicators ('sales share of new products (LNEWS) and 'sales share of considerably modified already) existing products' (LIMPS)). The use of several alternative indicators that cover various aspects of the innovation process helped to test the robustness of the effects of innovation on training. The sign of the innovation effect was not a priori clear.

Firm activity level. We used a measure for the development of a firm's specific product demand (mean of past and expected development; variable D) to proxy the effect of firm activity level. We expected a positive effect of this variable.

Physical capital. Due to lack of data for capital stocks we use a flow variable (capital income per employee; variable LC) as a proxy for physical capital. We have no a priori expectations for the capital effect.

Market conditions. The competition pressure was measured directly by the two variables 'intensity of price competition' (IPC) and 'intensity of non-price competition (INP). A third variable measured the effect of market structure; 'number of principal competitors on the (worldwide) product market' (CONC). We expected a positive effect for INPC and a negative effect for IPC. For CONC we expected also a negative effect.

Costs. We used the labour costs per employee (LLCL) as a proxy for costs in general that are related with recruitment and training of employees. Labour costs are negatively correlated – even if not at the same extent – with the demand for any category of employees. Thus, we expected a negative effect of this variable.

Firm age was a further variable that was included in our model. We expected a positive effect for the variable 'number of years since foundation' (LAGE).

Finally, the model contained a dummy variable for foreign firms (FOREIGN): We expected that foreign firms being less accustomed to the Swiss institutional environment than domestic firms would show a lower training propensity than domestic firms. We also used extensive control variables for time (if necessary), firm size, and industry.

A formal expression of the training propensity equation is as follows:

$$TRP_{it} = \alpha_0 + \alpha_1 LLCL_{it} + \alpha_2 LHQUAL1_{it} + \alpha_3 LHQUAL2_{it} + \alpha_4 LMQUAL_{it} + \alpha_5 LLQUAL_{it} + \alpha_6 LC_{it} + \alpha_7 INNOV_{it} + \alpha_8 LAGE_{it} + \alpha_9 FOREIGN_{it} + \alpha_{10} D_{it} + \alpha_{11} IPC_{it} + \alpha_{12} INPC_{it} + \alpha_{13} CONC(>50)_{it} + \alpha_{14} CONC(16\text{-}50)_{it} + \alpha_{15} CONC(11\text{-}15)_{it} + \alpha_{16} CONC(6\text{-}10)_{it} + control\ variables + u_{it} \quad (1)$$

(for firm i in time t; INNOV: alternatively INNOPD; INNOPC; R&D; PAT: LRDS; LNEWS; LIMPS).

5. ECONOMETRIC RESULTS

We estimated a probit model (binary dependent variable TRP) separately for the manufacturing sector, the service sector, and the construction sector (a) with pooled data of all four waves and time dummies for the years 1998, 2000 and 2004 respectively; and (b) with random effects to take into consideration firm heterogeneity effects (Table **5**).

Fix effects models could not be estimated because for most firms the variable TRP takes the same value (0 or 1) in all four periods. However, using a random-effects estimator has its price, because in this case the strong assumption has to be made that the unobserved (individual) effects are uncorrelated with the right-hand variables of the model (Wooldridge [18], p. 252). In this sense, the use of the random-effects estimator is a

Table 4. Definition and Measurement of Model Variables

Variable	Definition/Measurement
Dependent Variables	
TRP	Having at least one apprentice yes/no (training propensity)
Independent Variables	
LLCL	Labour costs per employee
LHQUAL1	Natural logarithm of the share of employees with university degree (academics)
LHQUAL2	Natural logarithm of the share of employees with tertiary-level education (other than university education)
LMQUAL	Natural logarithm of the share of employees with a formal degree in vocational education ('middle' education; 'Berufslehre')
LLQUAL	Natural logarithm of the share of employees with vocational education a formal degree ('Anlehre') or without any vocational education ('low' education)
LC	Natural logarithm capital income per employee (capital income = value added minus labour costs)
LRDS	Natural logarithm of R&D expenditures divided by sales
LNEWS	Natural logarithm of sales share of *new* products
LIMPS	Natural logarithm of sales share of (already existing) considerably modified products
INNOPD	Introduction of *product* innovations yes/no
INNOPC	Introduction of *process* innovations yes/no
PAT	At least 1 patent application yes/no
R&D	R&D activities yes/no
LAGE	Natural logarithm of firm age (number of years since foundation: year of survey minus founding year of the firm)
FOREIGN	Foreign-owned firm yes/no
D	Mean of two five-level ordinal variables (level 1: 'strong decrease'; 5; 'strong increase'), the first one referring to the development of a firm's specific product demand in the last three years, the second one in the next three years (reference year: survey year); transformation of this mean to a binary variable (value 1: values 4 to 5 of the original five-level variable; value 0: values 1 to 3 of the original variable)
IPC	Intensity of price competition; transformation of a five-level ordinal variable (level 1: 'very weak'; level 5: 'very strong') to a binary variable (value 1: levels 4 and 5 of the original five-level variable; value 0: levels 1, 2 and 3 of the original variable)
INPC	Intensity of non-price competition; original and transformed variables as for IPC
CONC	Dummies for four different market types: more than 50 competitors on the (worldwide) product market; 16 to 50 competitors; 11 to 15 competitors; 6 to 10 competitors; (reference group: up to 5 competitors)
Controls	
Firm size	Dummies for six firm size classes: 20 to 49 employees; 50 to 99 employees; 100-199 employees; 200 to 499 employees; 500 to 999 employees, 1000 and more employees (reference group: 5-19 employees)
Industry	Manufacturing: dummies for 17 2-digit industries (reference industry: food, beverage, tobacco; services: dummies for 8 2-digit industries (reference industry: retail trade)
Year	Three dummies for the three reference years for the quantitative variables (1998, 2001, 2004); reference year: 1995

Note: The ordinal variables refer to the 3-year periods 1994-1996, 1997-1999, 2000-2002 and 2003-2005 respectively; the quantitative variables refer to the years 1995, 1998, 2001 and 2004 respectively.

second-best solution. The values for rho in Table **5** show the relevance of the panel-level variance component. When rho is zero, the panel-level variance component is unimportant, and the panel estimator is not different from the pooled estimator. In our case the rho value is relatively large in the estimates of all three sectors in Table **5**.

We present first the results for manufacturing and then we com-pare them with those for the other two sectors of the economy.

Human resources. We obtained statistically significant (at the usual test levels) positive coefficients for the share of employees with tertiary-level education other than university (LHQUA2) and the share of middle-educated employees (LMQUAL), but significantly negative coefficients for the variables for employees with academic education as wells as the low-educated employees (LLQUAL). Similar effects for LHQUA2 and LLQUAL were found also in the other two sectors. A negative effect for LHQUAL1 was found also for the construction sector but not for the service sector. A positive coefficient for LMQUAL was also found in the service sector but not in construction.

In sum, the higher a firm's employment share of high-educated (without academics) and/or the higher the share of middle-educated (with the exception of construction), the higher is the training propensity. On the contrary, the higher

a firm's employment share of low-educated employees, the lower is the likelihood of offering apprenticeships. Firms with a high share of academics seem to be less inclined to apprentice training than firms with a low share of academics. Nevertheless, the strong positive effect for LHQUAL2 is a clear hint that apprentice training remains a relevant channel for human capital formation even if labour demand is shifting toward high-educated employees.

Innovation. Table **6** shows the results for each sector and for all seven alternatively used innovation indicators. We found only positive significant effects, but only for 4 estimates out of 14 estimates in manufacturing, for 1 out of 14 in the service sector and for 2 out of 14 in construction. Thus, if there is any statistically significant effect of innovation on training propensity, it is positive and is found primarily in manufacturing. Particularly the effect of R&D intensity in manufacturing firms appears to be robust. It can presumably be traced back to large pharmaceutical firms and firms producing capital goods that have a long tradition of offering apprenticeships.

Firm age. We found a positive effect for firm age (LAGE), an effect with particular importance for this study. Thus, younger firms seem to be less inclined to train apprentices than older ones. This effect was observed in the manufacturing as well as in the service sector but not in construction. For firms in the construction sector, which is the most apprentice-intensive sector of the Swiss economy, firm age is not a hindrance for employing apprentices that are cheap workers that can become productive in short time, at least in some occupations and whose training does not absorb much management resources.[2]

Firm activity level. Rather unexpectedly, the variable for demand development shows no effect in the estimates for manufacturing and services (and a weak negative effect in one of the estimates for construction). Given the volatility of macroeconomic conditions in the reference period 1995-2004, this result could be interpreted as a hint that the training propensity is a kind of structural characteristic of a firm, thus independent of demand conditions.

Market conditions. The results for the variable CONC show some weak evidence for the free competition effect, contrary to hypothesis (a) of Gersbach and Schmutzler [1], at least for some types of markets. In manufacturing and partially in the service sector this is the case for firms operating in markets with more than 50 competitors versus firms operating in markets with less than 5 competitors; in construction this effect is found for firms in markets with 11-15 competitors versus firms in markets with less than 5 competitors. Thus, to some extent firms operating in less concentrated markets are more likely to have apprentices than those in more concentrated markets. But the relationship between concentration and training propensity is not monotonically increasing: for example, in manufacturing no effect is found for firms operating in markets with 16-50, 11-15 or 6-10 competitors. Otherwise, competitive pressures as measured directly by the variables IPC and INPC do not seem to be of relevance for the likelihood of offering apprenticeships. On the whole, the market conditions in the product market do not appear to exercise a strong influence on the training propensity.

Costs. We found a significant negative coefficient for the cost variable LLCL for the manufacturing and the service sector but not for construction. Firms with high labour costs per employee seem to be less inclined to offer apprenticeships than firms with low labour costs (with the exception of the construction firms).

Physical capital. The general tendency is of a negative effect of the variable LC on training propensity. For manufacturing and construction this effect is not very robust. It is at strongest in the service sector. Thus, especially in the service sector firms having high capital intensity are less inclined to train apprentices than firms with low capital intensity.

Firm size. In manufacturing up to the threshold of 500 employees there is a clear positive relation between firm size and training propensity. For the coefficients for the four lower firm size classes we found based on two-tailed t-tests not presented here that the coefficient of a higher size class is significantly larger that that of a lower class. No difference is discernible among the three upper firm size classes (200-499 employees; 5000-999 employees; and 2000 and more employees). The same effect was found in the service sector only up to the threshold of 200 employees, in construction only up to 50 employees. Therefore, the size-dependence of the training propensity is limited up to a certain size class, which is at lowest in the construction sector.

Other control variables. As expected, firms in foreign ownership show a low propensity to offer apprenticeships than domestic ones.

Table **A6** in the appendix provides additional information on the marginal effects of the determinants of training propensity. Among internal factors the variables with the largest positive marginal effects in manufacturing and in services are besides firm size the share of middle-educated employees and the firm age. Innovation and the share of employees with tertiary-level education other than academic

[2] We used an alternative specification for firm age, namely three dummy variables for 6-10 years, 11-20 years and more than 20 years, to investigate the seemingly "irregular" effect of very young firms (0-5 years) that appears in the descriptive results (see Table **3**). We found statistically insignificant coefficients for the first two dummy variables and a significantly positive one for the third dummy variable for manufacturing and services and throughout insignificant coefficients for all three dummy variables for the construction sector. These results point to the existence of a threshold (20 years), above of which the positive relationship between firm age and training propensity holds.

Table 5. Training Propensity TRP by Sector; Pooled Probit and Probit Random Effects Estimates 1995-2004

Explanatory Variables	Manufacturing		Services		Construction	
	TRP	TRP	TRP	TRP	TRP	TRP
	Pooled Probit	Random Effect Probit	Pooled Probit	Random Effect Probit	Pooled Probit	Random Effect Probit
Internal Factors						
LLCL	-0.420***	-0.512***	-0.425***	-0.730***	-0.407	-0.482
	(0.090)	(0.178)	(0.101)	(0.219)	(0.265)	(0.424)
LHQUAL1	-0.131***	-0.162***	-0.028	-0.038	-0.302***	-0.358***
	(0.026)	(0.059)	(0.029)	(0.070)	(0.111)	(0.193)
LHQUAL2	0.058**	0.127**	0.091***	0.204***	0.297***	0.430***
	(0.024)	(0.051)	(0.028)	(0.063)	(0.067)	(0.131)
LMQUAL	0.201***	0.366***	0.147***	0.306***	0.107	0.144
	(0.041)	(0.089)	(0.038)	(0.086)	(0.108)	(0.194)
LLQUAL	-0.172***	-0.285***	-0.142***	-0.221***	-0.204***	-0.320**
	(0.026)	(0.054)	(0.026)	(0.058)	(0.061)	(0.129)
LC	-0.043*	-0.068	-0.094***	-0.172**	-0.056***	-0.072
	(0.023)	(0.049)	(0.035)	(0.072)	(0.074)	(0.139)
LIMPS	0.018*	0.009	0.017	0.028	0.051	0.083
	(0.009)	(0.019)	(0.015)	(0.031)	(0.048)	(0.082)
LAGE	0.192***	0.362***	0.234***	0.480***	0.043	0.006
	(0.029)	(0.065)	(0.037)	(0.090)	(0.084)	(0.156)
FOREIGN	-0.307***	-0.602**	-0.591***	-1.275***	-1.410***	-2.382***
	(0.068)	(0.167)	(0.093)	(0.255)	(0.327)	(0.712)
External Factors						
D	-0.049	0.042	-0.020	-0.078	-0.395*	-0.231
	(0.057)	(0.111)	(0.079)	(0.166)	(0.238)	(0.418)
IPC	-0.006	-0.054	0.105	0.115	-0.024	-0.039
	(0.053)	(0.106)	(0.065)	(0.139)	(0.178)	(0.303)
INPC	0.013	0.021	-0.050	-0.134	0.036	0.016
	(0.048)	(0.094)	(0.066)	(0.137)	(0.167)	(0.297)
CONC						
> 50 main competitors	0.231***	0.389***	0.134*	0.206	0.146	0.416
	(0.069)	(0.145)	(0.081)	(0.177)	(0.210)	(0.387)
16-50 main competitors	0.111	0.174	-0.098	-0.199	0.108	0.404
	(0.077)	(0.156)	(0.105)	(0.225)	(0.244)	(0.430)
11-15 main competitirs	-0.083	-0.241	0.324	0.271	1.099***	1.393**
	(0.098)	(0.194)	(0.226)	(0.449)	(0.364)	(0.705)
6-10 main competitors	0.089	0.101	0.088	0.225	0.299	0.352
	(0.062)	(0.124)	(0.088)	(0.194)	(0.244)	(0.395)
Year						
1998	0.203***		0.160***		0.041	
	(0.068)		(0.124)		(0.213)	
2000	0.285***		0.174		0.045	
	(0.068)		(0.115)		(0.217)	
2004	0.209***		0.042		0.402*	
	(0.069)		(0.114)		(0.219)	

(Table 5) contd…..

Explanatory Variables	Manufacturing		Services		Construction	
	TRP	TRP	TRP	TRP	TRP	TRP
	Pooled Probit	Random Effect Probit	Pooled Probit	Random Effect Probit	Pooled Probit	Random Effect Probit
Controls						
Firm Size						
20-49 employees	0.578***	1.260***	0.598***	1.329***	0.645***	1.025***
	(0.066)	(0.174)	(0.080)	(0.219)	(0.177)	(0.401)
50-99 employees	1.154***	2.452***	0.841***	1.866***	1.727***	2.997***
	(0.073)	(0.214)	(0.101)	(0.279)	(0.233)	(0.722)
100-199 employees	1.690***	3.581***	1.267***	2.705***	1.675***	2.909***
	(0.085)	(0.261)	(0.119)	(0.349)	(0.264)	(0.713)
200-499 employees	2.307***	4.815***	1.390***	3.042***	2.133***	3.698***
	(0.111)	(0.349)	(0.149)	(0.409)	(0.433)	(0.967)
500-999employees	2.428***	5.159***	1.695***	3.911***	1.395***	2.387***
	(0.192)	(0.514)	(0.230)	(0.698)	(0.511)	(1.043)
1000 and more employees	2.555***	4.878***	1.949***	4.270***		
	(0.258)	(0.559)	(0.263)	(0.723)		
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	4180	4180	2210	2210	617	617
Pseudo R2	0.260		0.216		0.312	
Wald chi2	1014***	300***	502***	120***	166***	38*
Sigma_u		2.002***		2.075***		1.542***
Rho		0.800***		0.812***		0.704***

Notes: See Table **4** for the variable definitions; ***, **, * denote statistical significance at the 1%, 5% and 10% test level respectively; manufacturing: 17 industry dummies. Rho: proportion of the total variance contributed by the panel-level variance component.

university show significantly lower marginal effects. The largest negative marginal effects come from average labour costs, foreign ownership and the share of low-qualified employees. The construction sector shows a different pattern: the largest marginal effect was found for the share of employees with tertiary-level education other than academic university.

6. COMPARISON WITH THE RESULTS OF RECENT EMPIRICAL STUDIES

We refer here primarily to studies from Germany, Austria and Switzerland that deal explicitly with apprenticeship training. These three countries have similar institutional systems of vocational education with many common characteristics. Despite this similarity a close comparison with other studies is not possible due to differences either in the composition of the data with respect to industry affiliation or in model specification.

Switzerland

Wolter and Schweri [19] in a study for Swiss firms found a negative effect of net costs of training and a positive effect of firm size on training intensity. Mühlemann *et al.* [20] investigated also for Swiss firms the determinants of training propensity found a positive firm size effect and a negative effect for firms being foreign (a result we also found in our investigation). Finally, Mühlemann and Wolter [21] found also in a study on the training propensity of Swiss firms a positive effect of the number of skilled workers (as we also found), a negative effect of firms being foreign, further negative effects for firms having difficulties to find skilled workers and firms with a high percentage of young people with 'college degree'. A further finding was that the number of young people per firm correlated positive with the training propensity.

In sum, our results with respect to the relationship of training propensity to the number or share of middle-

Table 6. Training Propensity TRP by Sector; Alternative Innovation Variables; Pooled Probit and Probit Random Effects Estimates 1995-2004

Innovation Variables	Manufacturing		Services		Construction	
	TRP Pooled Probit	TRP Random Effects Probit	TRP Pooled Probit	TRP Random Effects Probit	TRP Pooled Probit	TRP Random Effects Probit
INNOPD	0.031	-0.162	-0.002	-0.030	0.145	0.218
	(0.053)	(0.109)	(0.056)	(0.110)	(0.148)	(0.275)
INNOPC	-0.046	-0.192	0.128**	0.133	0.001	-0.169
	(0.048)	(0.120)	(0.057)	(0.110)	(0.150)	(0.268)
R&D	0.062	-0.031	0.023	-0.043	-0.033	-0.358
	(0.053)	(0.109)	(0.065)	(0.125)	(0.179)	(0.335)
PAT	0.122*	0.054	-0.141	-0.170	-0.056	-0.439
	(0.064)	(0.134)	(0.133)	(0.278)	(0.338)	(0.512)
LRDS	0.017**	0.026*	-0.001	-0.004	0.005	-0.015
	(0.008)	(0.016)	(0.010)	(0.020)	(0.033)	(0.058)
LNEWS	0.007	0.002	0.018	0.038	0.102*	0.174*
	(0.010)	(0.020)	(0.016)	(0.032)	(0.055)	(0.096)
LIMPS	0.017*	0.009	0.017	0.028	0.051	0.083
	(0.009)	(0.019)	(0.015)	(0.031)	(0.048)	(0.082)

Notes: see Table **4** for the variable definitions; **, * denote statistical significance at the 5% and 10% test level respectively; this table contains only the coefficients and the standard errors of the innovation variables.

educated employees (skilled workers), firm size and foreign ownership are in accordance with similar Swiss studies. Our variables cover a wider spectrum of determinants of training propensity, for which there are no comparable results in earlier studies.

Germany

Franz *et al*. [13] in a study with a cross-section of German firms for 1996 (separate estimates for manufacturing and services) found a positive effect for the employment share of 'qualified workers' ('Fachkräfte') (corresponding to our group of 'middle-educated' employees), but no significant effect for the number of employees with education at the level of 'Fachhochschule' (we found a positive effect for the share of employees with tertiary-level education other than university) and no significant effect for innovation performance. Also the variables for sales expectations (partly corresponding to our variable D) and the variables for expected shortage for qualified workers showed no effect. Finally, there was a positive correlation between firm size and training propensity, as in our case.

Beckman [22] in study on training propensity with German firm data for 2000 found a positive effect for firms applying 'new technologies' and having high investment expenditure but a negative effect for the share of qualified workers. There was no clear-cut pattern with respect to firm size. Further, there were negative effects for the rate of quits, the rate of recruitments and the share of fix-duration workers. On the contrary, unionization and subsidization seemed to have a positive influence both on the training propensity.

In a further study that is based on German firm data for the year 2000 Niederalt [6] found –besides the usual positive firm size effect – that the propensity to train apprentices is positively correlated (a) with a variable measuring the technological level of the production equipment; (b) the share (of the sum) of middle-qualified and high-qualified employees; and (c) expected shortage of high-qualified employees; and negatively correlated with (a) the investment expenditures per employees; (b) the share of newly recruited high-qualified employees; (c) the share of newly recruited low-qualified employees; and (d) positive expected employment development. Further, it appeared to be of no relevance for the training propensity whether a firm was newly-founded or not. Finally, firms in foreign ownership showed a lower training propensity than domestic ones. The estimated model contained also further factors that were not considered in our study (share of employees with fix-term contracts; regional unemployment rate; etc.). The common pattern of the results of our study and this German study, which is the only other study known to us considering a wide spectrum of determining factors, is as follows: positive effects for innovation measures (only partly in the Swiss case), with the share) of high-qualified (provided that it refers to tertiary education other than academic university)

and middle-qualified employees, negative effects of the share of high-qualified as well as low-qualified employees and of foreign ownership. The results differ as to the impact of physical capital (positive in Germany, negative in Switzerland) and firm age (no effect in Germany, positive effect in Switzerland).

Smits and Zwick [23] in a study comparing German and Dutch firms analyzed the reasons of firms for not offering apprenticeships. These were (a) the preference of hiring experienced skilled employees, (b) the assessment that existing professions in the dual apprenticeship system are not compatible with the qualifications required, and (c) the assessment that training contents are outdated due to technological progress. Apprenticeships being too expensive or apprentices being too often absent form work due to school obligations were not reasons for not offering apprenticeships.

Summing up the results of German studies, the composition of the workforce with respect to professional education and innovation are also for German firms an important factor that influences training propensity but the effects are mixed.

Austria

Stöger and Winter-Ebner [24] investigated the determinants of training propensity in Austrian firms for three points of time (1983, 1990, and 1998). They found a positive effect for firm age and also for firm size. They included in their training equations also variables related to the age and gender structure of the employees.

In sum, there are only few findings that can be considered as robust across the existing empirical studies. The most robust ones refer to the effects of firm size on training propensity (throughout positive).

7. SUMMARY AND CONCLUSIONS

This study investigated the determinants of the propensity of Swiss firms to train apprentices. Human resources, innovation activities, firm age, competition conditions on the product market, and firm size are the determining factors that were especially emphasized in this investigation. The detailed results can be summarized as follows:

Resource endowment. For training propensity we found in all three sectors a more or less similar pattern: (a) positive effects for the share of employees with tertiary-level education (other than university); for the share of middle-educated employees (exception: no significant effect in the construction sector); and (b) negative effects for the highest (academics) (no significant effect for services) and the lowest educational category (no vocational education completed).

The physical capital intensity is negatively correlated with the training propensity (at strongest in the service sector).

Innovation. The differences between the sectors with respect to training propensity are small. When there is any statistically significant effect, it is positive and is found primarily in manufacturing. Particularly the effect of R&D intensity in manufacturing firms appears to be robust.

Firm activity level. Rather unexpectedly, with respect to the training propensity the variable for demand development shows either no effect (as in the estimates for manufacturing and services) or a weak negative effect (as in one of the estimates for construction). Given the volatility of macroeconomic conditions in the reference period 1995-2004, the result for the training propensity could be interpreted as a hint that the training propensity is a kind of structural characteristics of a firm, thus independent of demand conditions.

Market structure, competitive pressures. There is some weak evidence for the free competition effect with respect to training propensity at least for some types of markets. On the whole, the market conditions in the product market do not appear to exercise a discernible influence on the training propensity.

The *labour costs* per employee seem to be negatively correlated with the training propensity (with the exception of the construction sector for which no significant effect could be found.

Firm age and *firm size*. Younger firms seem to be less inclined to train apprentices than older ones. This effect was observed for training propensity in the manufacturing as well as in the service sector but not in construction. Firm size is positively correlated with training propensity.

A first important point of an overall assessment of results of the study is the finding of the strong positive effect on training propensity of the share of employees with tertiary-level education (without academics), which together with the even stronger positive effect for the share of the middle-educated employees for the manufacturing and the service sector can be interpreted as a clear hint that apprentice training remains a relevant channel for human capital formation even if labour demand is shifting toward higher educated employees. A second important point is that firms with high capital intensity are less inclined to train apprentice. In addition, there is some (rather weak) evidence for a positive effect of innovation activities in manufacturing, but not in the services and in the construction sector. Finally, a third important point is that younger firms seem to have a lower training propensity than older firms.

A condition for the Swiss enterprise-based system of vocational education in order to keep its position as the most prominent channel of generating (basic) vocational knowledge is to remain (or to become) strongly established in the innovative (high-productivity and high-growth) part of the economy that also shows a high entry rate of new innovative firms. In this sense, the three abovementioned points could be a relevant starting point for a policy discussion that goes beyond the aim of this paper.

ACKNOWLEDGEMENTS

This study was funded by the Swiss Federal Office for Professional Education and Technology (OPET) through its

Leading House on the Economics of Education, Firm Behaviour and Training Policies. The views expressed herein are those of the author and do not necessarily reflect the views of the OPET or the Leading House. Any remaining errors are the responsibility of the author. The author gratefully acknowledges the useful comments and suggestions of the participants of the ISU Workshop, University of Zurich, Switzerland, 24th June 2008 and of the annual Conference of the Swiss Society of Economics and Statistics (SSES), Geneva, 26-27th June 2009 as well as of two referees of this journal.

APPENDIX

Table A1. Composition of Data set Used by Industry, Firm Size and Region

Industry/Sector	N	Percentage of Firms
Food, beverage, tobacco	363	3.9
Textiles	141	1.5
Clothing, leather	66	0.7
Wood processing	204	2.2
Paper	112	1.2
Printing	289	3.1
Chemicals	295	3.2
Plastics, rubber	225	2.4
Glass, stone, clay	205	2.2
Metal	111	1.2
Metalworking	668	7.2
Machinery	760	8.2
Electrical machinery	218	2.3
Electronics, instruments	473	5.1
Watches	167	1.8
Vehicles	93	1.0
Other manufacturing	199	2.1
Energy	132	1.4
Construction	925	9.9
Wholesale trade	796	8.6
Retail trade	590	6.3
Hotels, catering	377	4.1
Transport, telecommunication	477	5.1
Banks, insurance	406	4.4
Real estate, leasing	65	0.7
Computer services	199	2.1
Business services	659	7.1
Personal services	91	1.0
Firm Size (Number of Employees)		
5-19 employees	2593	27.8
20.49 employees	2164	23.3
50-99 employees	1510	16.2
100-199 employees	1391	15.0
200-499 employees	1016	10.9
500-999 employees	348	3.7
>= 1000 employees	284	3.1
Year		
1996	1993	21.4
1999	2172	23.3
2002	2586	27.8
2005	2555	27.5
Total	9306	100

Table A2. Descriptive Statistics of Model Variables; by Sector

Variable	Manufacturing		Services		Construction	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
TRP	0.653	0.476	0.628	0.483	0.786	0.410
LLCL	11.237	0.297	11.218	0.402	11.200	0.306
LHQUAL	-2.258	1.094	-2.247	1.401	-2.454	1.041
LHQUAL1	-3.834	1.033	-3.645	1.347	-4.296	0.672
LHQUAL2	-2.523	1.086	-2.602	1.318	-2.565	1.034
LMQUAL	-0.998	0.769	-0.969	0.982	-0.931	0.772
LLQUAL	-1.1598	1.290	-2.480	1.608	-1.827	1.472
LC	10.827	1.017	11.021	0.981	10.407	0.942
LRDS	-7.398	3.734	-9.915	3.011	-10.595	2.177
LNEWS	0.741	2.514	-0.947	2.183	-1.672	1.591
LIMPS	0.730	2.627	-0.936	2.270	-1.646	1.669
INNOPD	0.654	0.476	0.420	0.494	0.240	0.427
INNOPC	0.556	0.497	0.394	0.489	0.275	0.447
R&D	0.597	0.490	0.270	0.444	0.179	0.384
PAT	0.265	0.441	0.042	0.198	0.047	0.212
LAGE	3.747	0.879	3.531	0.965	3.748	0.842
FOREIGN	0.141	0.348	0.132	0.339	0.045	0.207
D	0.237	0.425	0.245	0.430	0.097	0.296
IPC	0.736	0.441	0.661	0.473	0.777	0.416
INPC	0.403	0.491	0.395	0.489	0.213	0.410
CONC (16-50 competitors	0.223	0.416	0.354	0.478	0.402	0.491
CONC (11-15 competitors)	0.136	0.343	0.126	0.332	0.208	0.406
CONC (6-10 competitors	0.067	0.249	0.039	0.193	0.067	0.250
CONC (up to 5 competitors)	0.300	0.458	0.218	0.413	0.196	0.397

Table A3. Correlation Matrix; Manufacturing

	LWL	LHQUAL	LHQUAL1	LHQUAL2	LMQUAL	LLQUAL	LC	LRDS	LNEWS	LIMPS	INNOPD	INNOPC	R&D	PAT	LAGE	FOREIGN	D	IPC	INPC	CONC(16-50)	CONC(11-15)	CONC(6-10)
LHQUAL	0.29																					
LHQUAL1	0.30	0.66																				
LHQUAL2	0.23	0.93	0.30																			
LMQUAL	0.11	-0.08	-0.07	-0.06																		
LLQUAL	-0.13	-0.26	-0.18	-0.26	-0.52																	
LC	0.10	0.06	0.08	0.03	0.01	0.03																
LRDS	0.18	0.31	0.32	0.24	-0.10	0.00	0.05															
LNEWS	0.09	0.21	0.18	0.17	-0.09	0.08	0.05	0.56														
LIMPS	0.06	0.22	0.15	0.19	-0.07	0.05	0.05	0.52	0.61													
INNOPD	0.13	0.22	0.21	0.17	-0.09	0.04	0.05	0.64	0.63	0.60												
INNOPC	0.06	0.10	0.13	0.06	-0.04	0.04	0.02	0.37	0.41	0.42	0.36											
R&D	0.14	0.25	0.26	0.19	-0.12	0.07	0.06	0.89	0.58	0.55	0.68	0.41										
PAT	0.16	0.22	0.26	0.17	-0.04	0.04	0.03	0.45	0.32	0.30	0.37	0.20	0.41									
LAGE	0.04	-0.04	-0.03	-0.05	-0.01	0.14	0.03	-0.01	0.03	0.00	0.03	0.04	0.03	0.06								
FOREIGN	0.14	0.13	0.13	0.11	-0.01	0.00	0.08	0.10	0.09	0.06	0.09	0.00	0.08	0.09	-0.07							
D	0.08	0.13	0.16	0.10	0.00	-0.03	0.09	0.19	0.14	0.13	0.14	0.12	0.17	0.12	-0.08	0.05						
IPC	0.03	0.00	-0.03	0.00	-0.05	0.10	-0.04	0.02	0.02	0.03	0.02	0.02	0.03	0.04	0.07	0.00	-0.10					
INPC	0.02	0.07	0.06	0.06	0.01	-0.05	0.03	0.13	0.10	0.10	0.10	0.08	0.11	0.08	-0.10	0.06	0.10	-0.06				
CONC(16-50)	-0.12	-0.10	-0.14	-0.07	0.06	-0.07	-0.06	-0.17	-0.16	-0.10	-0.16	-0.02	-0.16	-0.17	-0.04	-0.12	-0.06	0.09	0.01			
CONC(11-15)	-0.03	-0.06	-0.04	-0.05	-0.02	0.06	-0.03	-0.07	-0.02	-0.01	-0.02	-0.02	-0.05	-0.04	0.03	-0.01	-0.08	0.01	-0.03	-0.20		
CONC(6-10)	-0.05	-0.05	-0.03	-0.05	0.01	0.04	-0.03	0.00	-0.04	0.01	-0.04	0.01	0.01	0.02	0.05	-0.02	0.00	0.00	0.02	-0.14	-0.10	
CONC(<5)	0.03	0.06	0.05	0.05	-0.07	0.06	0.03	0.07	0.09	0.07	0.10	0.03	0.10	0.07	0.04	0.07	0.05	0.00	0.03	-0.36	-0.03	-0.18

Table A4. Correlation Matrix; Services

	LWL	LHQUAL	LHQUAL1	LHQUAL2	LMQUAL	LLQUAL	LC	LRDS	LNEWS	LIMPS	INNOPD	INNOPC	R&D	PAT	LAGE	FOREIGN	D	IPC	INPC	CONC(16-50)	CONC(11-15)	CONC(6-10)
LHQUAL	0.34																					
LHQUAL1	0.31	0.64																				
LHQUAL2	0.30	0.89	0.32																			
LMQUAL	0.05	-0.33	-0.30	-0.27																		
LLQUAL	-0.26	-0.37	-0.34	-0.30	-0.16																	
LC	0.09	-0.03	-0.06	-0.02	0.11	-0.04																
LRDS	0.18	0.25	0.27	0.20	-0.10	-0.09	-0.07															
LNEWS	0.12	0.19	0.16	0.18	-0.04	-0.04	-0.02	0.46														
LIMPS	0.09	0.20	0.16	0.19	-0.04	-0.04	-0.02	0.49	0.76													
INNOPD	0.16	0.19	0.15	0.17	-0.03	-0.04	-0.02	0.53	0.74	0.70												
INNOPC	0.15	0.22	0.21	0.18	-0.04	-0.07	-0.01	0.45	0.58	0.58	0.53											
R&D	0.18	0.23	0.25	0.19	-0.06	-0.04	-0.04	0.90	0.50	0.54	0.57	0.51										
PAT	0.12	0.11	0.16	0.05	-0.04	-0.02	-0.04	0.29	0.20	0.13	0.21	0.13	0.25									
LAGE	0.12	0.02	-0.03	0.02	0.15	0.02	0.04	-0.02	0.00	-0.02	0.01	0.02	0.00	-0.05								
FOREIGN	0.13	0.10	0.07	0.11	0.04	-0.01	0.09	-0.01	0.09	0.07	0.07	0.02	-0.01	0.01	-0.07							
D	0.11	0.05	0.01	0.05	0.06	-0.05	0.11	0.02	0.10	0.12	0.12	0.16	0.04	0.07	-0.01	0.04						
IPC	0.03	0.03	-0.02	0.07	0.07	0.03	0.02	0.03	0.08	0.09	0.09	0.12	0.06	-0.01	0.07	0.05	0.01					
INPC	0.04	0.02	0.00	0.04	0.04	-0.02	0.04	0.04	0.11	0.09	0.09	0.04	0.04	0.06	0.02	0.07	0.05	0.06				
CONC(16-50)	-0.07	0.03	0.07	0.02	-0.10	-0.01	-0.02	0.02	-0.02	-0.01	-0.05	-0.02	0.00	-0.03	-0.09	-0.05	-0.08	-0.01	0.01			
CONC(11-15)	-0.05	0.00	-0.03	0.01	0.05	0.00	-0.06	0.00	0.00	0.03	0.01	-0.03	0.00	0.02	0.02	0.00	0.01	0.07	-0.01	-0.27		
CONC(6-10)	-0.04	-0.09	-0.08	-0.07	0.04	0.00	0.00	-0.06	-0.11	-0.11	-0.12	-0.12	-0.75	-0.03	0.03	0.00	0.05	-0.04	0.17	-0.13	-0.07	
CONC(<5)	0.06	0.01	0.00	0.02	0.06	0.02	0.03	0.02	0.07	0.06	0.07	0.06	0.03	0.01	0.05	0.05	0.02	0.06	0.05	-0.41	-0.21	-0.10

Table A5. Correlation Matrix; Construction

	LWL	LHQUAL	LHQUAL1	LHQUAL2	LMQUAL	LLQUAL	LC	LRDS	LNEWS	LIMPS	INNOPD	INNOPC	R&D	PAT	LAGE	FOREIGN	D	IPC	INPC	CONC(16-50)	CONC(11-15)	CONC(6-10)
LHQUAL	0.12																					
LHQUAL1	0.10	0.32																				
LHQUAL2	0.08	0.96	0.09																			
LMQUAL	-0.08	-0.11	-0.20	-0.06																		
LLQUAL	0.20	-0.12	0.10	-0.16	-0.55																	
LC	-0.09	0.02	0.04	0.01	0.02	-0.06																
LRDS	0.14	0.17	0.23	0.11	-0.07	0.09	0.01															
LNEWS	0.13	0.15	0.10	0.12	-0.06	-0.04	-0.06	0.50														
LIMPS	0.13	0.16	0.09	0.13	0.00	-0.04	-0.06	0.50	0.80													
INNOPD	0.11	0.16	0.44	0.13	-0.04	-0.02	-0.03	0.57	0.60	0.60												
INNOPC	0.14	0.15	0.16	0.11	-0.03	0.02	-0.03	0.55	0.57	0.68	0.50											
R&D	0.15	0.16	0.25	0.10	-0.03	0.07	0.01	0.89	0.45	0.47	0.60	0.57										
PAT	0.15	0.13	0.11	0.08	0.00	-0.03	0.05	0.36	0.24	0.22	0.27	0.24	0.33									
LAGE	0.01	0.04	-0.11	0.07	0.05	0.06	-0.11	0.09	0.00	0.01	-0.04	0.01	0.03	-0.20								
FOREIGN	0.07	0.05	0.17	0.02	0.09	-0.03	0.11	0.11	0.01	-0.03	0.02	0.08	0.14	0.24	-0.10							
D	-0.01	0.15	-0.03	0.12	-0.03	-0.04	-0.05	0.15	0.07	0.12	0.05	0.16	0.13	0.21	-0.05	0.01						
IPC	0.11	0.07	0.03	0.08	-0.10	0.09	-0.09	0.02	0.03	0.04	0.04	0.13	0.05	0.05	0.02	-0.02	0.06					
INPC	-0.04	0.04	0.03	0.05	0.04	-0.10	0.06	0.00	-0.01	-0.04	-0.02	-0.05	0.01	0.07	-0.17	0.02	-0.01	0.06				
CONC(16-50)	-0.03	0.05	0.08	0.04	-0.06	0.01	0.04	0.01	-0.02	-0.03	0.06	-0.01	0.01	-0.08	-0.03	-0.12	-0.01	0.05	0.03			
CONC(11-15)	0.00	-0.07	-0.10	-0.05	-0.01	0.14	-0.17	0.00	0.03	0.06	0.00	0.08	0.03	-0.09	0.17	-0.01	0.00	0.11	-0.09	-0.42		
CONC(6-10)	-0.05	-0.01	-0.04	-0.01	0.01	0.01	0.07	-0.12	-0.16	-0.16	-0.16	-0.17	-0.13	-0.06	0.00	0.11	-0.05	-0.10	0.01	-0.26	-0.15	
CONC(<5)	0.02	-0.03	0.04	-0.04	0.01	-0.06	-0.15	-0.03	-0.02	-0.04	-0.05	-0.07	-0.04	0.16	-0.05	0.07	0.04	0.03	0.03	-0.40	-0.24	-0.15

Table A6. Training Propensity by Sector; Marginal Effects (Pooled Probit)

Explanatory Variables	Manufacturing	Services	Construction
Internal Factors			
LLCL	-0.143	-0.167	-0.089
LHQUAL1	-0.044	-0.016	-0.055
LHQUAL2	0.020	0.030	0.061
LMQUAL	0.068	0.055	0.022
LLQUAL	-0.058	-0.054	-0.007
LC	-0.014	-0.034	-0.094
LIMPS	0.006	0.007	0.010
LAGE	0.065	0.087	0.017
FOREIGN	-0.110	-0.221	-0.489
External Factors			
D	-0.017	-0.006	-0.106
IPC	-0.002	0.035	-0.003
INPC	0.004	-0.011	0.005

(Table A6) contd…..

Explanatory Variables	Manufacturing	Services	Construction
CONC			
> 50 main competitors	0.076	0.035	0.029
16-50 main competitors	0.037	-0.036	0.031
11-15 main competitirs	-0.029	0.107	0.139
6-10 main competitors	0.030	0.026	0.064
Year			
1998	0.067	0.063	0.007
2000	0.093	0.072	0.008
2004	0.069	0.031	0.085
Controls			
Firm Size			
20-49 employees	0.175	0.189	0.102
50-99 employees	0.296	0.243	0.203
100-199 employees	0.373	0.320	0.192
200-499 employees	0.389	0.322	0.185
500-999employees	0.318	0.324	0.132
1000 and more employees	0.306	0.347	

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Received: September 6, 2010 Revised: October 4, 2010 Accepted: October 11, 2010