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ABSTRACT

Hiring Costs of Skilled Workers and the Supply of Firm-Provided Training*

This paper analyzes how the costs of hiring skilled workers from the external labor market affect a firm's supply of training. Using administrative survey data with detailed information on hiring and training costs for Swiss firms, we find evidence for substantial and increasing marginal hiring costs. However, firms can invest in internal training of unskilled workers and thereby avoid costs for external hiring. Controlling for a firm's training investment, we find that a one standard deviation increase in average external hiring costs increases the number of internal training positions by 0.7 standard deviations.

JEL Classification: J23, J24, J32

Keywords: hiring costs, apprenticeship training, firm-sponsored training

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1 Introduction

A firm's expenditures for hiring skilled workers constitute an important component of non-wage labor costs. To find suitable job candidates, a firm typically has to post vacancies, screen resumes, and conduct interviews with a number of potential candidates. Once a candidate is hired, it still takes time and possibly some extra training for him or her to become fully productive. Empirical studies show that hiring costs are substantial, averaging between one and two quarters of wage payments (Blatter et al. 2012; Ejarque and Nilsen 2008; Manning 2006; Merz and Yashiv 2007). In addition, these studies point towards a convex structure of hiring costs, i.e., marginal hiring costs increase with the number of hires. Thus hiring from the external labor market can be very expensive, especially if firms need to hire a large number of workers in a particular period. However, firms have the possibility of reducing external hiring by training unskilled workers internally and retaining them after training (Stevens, 1994). As long as the expected costs of recruiting, training, and successfully retaining a trainee are smaller than those of an external hire, internal training will be the more cost-effective strategy.

Our empirical analysis uses representative Swiss establishment-level data that includes detailed and direct measures of hiring costs and training costs. While the idea that the structure of hiring costs affects a firm's training behavior can be applied to various types of training, we focus in our analysis on a firm's supply of apprenticeship training positions: Trainees accumulate a substantial amount of human capital over three to four years, making them viable substitutes for skilled workers hired externally. We carry out our empirical estimations in a generalized Tobit model, accounting for (i) truncation at zero in the supply of training, (ii) selectivity in the firm's training and hiring decisions, and (iii) simultaneity issues in observed hiring and training costs.

We find that hiring costs are substantial and have a convex structure, which means that firms hiring many workers each period will face higher average costs to fill a vacancy than firms with a low number of hires. Furthermore, we find that the structure of (net) training costs is concave, implying that offering additional training positions reduces average net training costs. Our analysis shows that firms facing high (potential) external hiring costs supply more internal training positions, as training reduces or even eliminates the need to hire externally. Thus firms can save future hiring costs for skilled workers by recruiting and training young workers internally.

The paper is organized as follows: The next section gives a brief overview of the literature on hiring and training costs. Section 3 introduces our theoretical model. Section 4 describes the data, and section 5 presents the econometric modeling and the empirical results. Section 6 concludes.

2 Literature on hiring and training costs

Firms may supply training positions because they expect some future return from an initial net investment in training (Oatey, 1970; Lindley, 1975; Merrilees, 1983). This idea was first formalized by Stevens (1994) in an investment model for a firm's supply of training. While the costs associated with internal training constitute the employer's investment, returns on the investment are given by reduced hiring costs for skilled workers. However, given the lack of data on both hiring costs and net costs of training, Stevens (1994) has to make strong assumptions about the structure of both types of costs. For example, data on wages serves as a proxy for training costs, whereas a variable indicating a shortage of skilled labor in the firm serves as a proxy for hiring costs.

Before focusing on our own contribution, we first review the empirical evidence on hiring and training costs.

2.1 Evidence on hiring costs

Few empirical studies contain direct data on hiring costs. In a first study, Oi (1962) shows that hiring costs are equal to about three weeks of wage payments in the U.S., whereas Barron et al. (1985) reports hiring costs of one week's pay. More recent estimates for the U.S. report average hiring costs of $4,000 per vacancy (Dube et al., 2010). Blatter et al. (2012) show that hiring costs in Switzerland range between 10 and 17 weeks of wage payments.[1]

The magnitude of hiring costs is crucial for a firm's supply of training. If training costs exceed hiring costs, a firm will not supply any internal training. However, it will offer training positions if training costs are lower than hiring costs, and if it expects to retain a sufficiently high number of trainees. Thus if training costs were sufficiently low, a firm would not hire externally but instead only retain former trainees as skilled workers.

Depending on the structure of hiring costs, a firm may find it optimal to hire externally *and* supply some training. This situation applies if hiring costs are convex, i.e., if hiring more workers in a given period becomes increasingly expensive. If hiring costs were concave, firms would find it cheaper to hire many workers at once – making internal training less beneficial to the firm. In a recent contribution, Blatter et al. (2012) show that hiring costs ins Switzerland are convex. Manning (2006) provides evidence that hiring costs are convex in the UK, and Pfann and Verspagen (1989) find increasing marginal hiring costs for Dutch firms that increase their labor force significantly. For France, Abowd and Kramarz (2003) report that hiring costs are concave, whereas Kramarz and Michaud (2010) later find evidence for linear hiring costs.

2.2 Evidence on training costs

Direct and detailed data on training costs are relatively scarce. Much of the training literature focuses on a firm's training decision rather than on its training costs.

A series of surveys contains information on the costs and benefits of training apprentices in Germany and Switzerland, two countries with a long tradition of apprenticeship training. While the costs of apprenticeship training are outweighed by short-term training benefits for Swiss firms, apprenticeship training tends to be a net investment for German firms (Muehlemann et al., 2010). A recent survey on apprenticeships, including both a detailed

[1] A recent survey on hiring costs appears in Manning (2011), with the earlier literature summarized in Hamermesh and Pfann (1996).

treatment of cost-benefit analysis and the general features of apprenticeship markets is provided by Wolter and Ryan (2011).

Without considering hiring costs, Muehlemann et al. (2007) find that expected training costs are an important determinant of a firm's decision to train apprentices in Switzerland. Muehlemann et al. (2010) show that expected training costs are significantly higher in Switzerland for non-training firms than for firms that offer training, whereas they find no significant difference in Germany.

A number of studies attempt to *indirectly* assess post-training benefits by analyzing retention rates of apprentices, tenure, or wages of movers and stayers (e.g., Booth and Satchell, 1994; Cappelli, 2004; Dustmann et al., 1997; Euwals and Winkelmann, 2002; Winkelmann, 1996).

In contrast to the literature on firm-sponsored training, we can carry out our analysis using detailed and direct firm-level data on both hiring and training costs. Thus our contribution is to simultaneously estimate the effects of hiring costs and training costs on a firm's supply of apprentices.

3 Model

In this section, we use a model for dynamic labor demand to formalize the idea that firms can adjust their skilled labor force not only by hiring skilled workers from the external labor market, but also by training unskilled workers internally and retaining them after training. The incentives for investment in costly training are given by lower hiring costs in the future.

The role of training in the decision-making process of the firm can be illustrated by the following inter-temporal profit maximization problem, where the firm's hiring and training decision can be regarded as a problem of investment under uncertainty (Stevens 1994, Yashiv 2000).

$$\max_{R_t,N_t,L_t} \Pi = E_t \left\{ \sum_{i=0}^{\infty} \beta^i \left[F(N_{t+i}) - w_{t+i}N_{t+i} - f(R_{t+i}, N_{t+i}) - g[L_{t+i}] \right] \right\}$$

subject to the constraint representing the law of motion for the firm's number of employees

$$N_{t+1} \quad = \quad (1-\delta_t)N_t + R_t + (1-\gamma_t)L_{t-s}$$

where E_t is the expectation operator conditional on information in period t. The firm's production function $F(N)$ depends on the number of skilled workers N. The wage is denoted by w. Training lasts s periods, hence a trainee recruited in period $t-s$ may be employed as a skilled worker in period $t+1$. Skilled workers and trainees have separation rates δ and γ respectively, with $0 \leq \delta \leq 1$ and $0 \leq \gamma \leq 1$. The trainees' separation rate γ implies that if L_t trainees are recruited in period t, there will remain $(1-\gamma)L_t$ trainees at the end of their training. β is the discount factor. We represent the costs of hiring by $f(R_{t+i}, N_{t+i})$. This function has as its arguments the number of recruits R and the number of skilled workers N. At this point, we do not yet specify a functional form of the hiring costs function. However, the results in the empirical section indicate that the hiring cost function is convex in the number of recruits.

Net costs of training are denoted by $g(L_{t+i})$. These costs are defined as *net* of a trainee's contribution to the firm's output. Therefore, skilled labor is the only production factor in our model.

The constraint representing the evolution of the firm's number of employees illustrates the two possibilities of a firm to increase the number of skilled workers N. The firm can expand its skilled workforce either by recruiting skilled workers R on the labor market or by hiring trainees L and retaining them as skilled workers after their training.

The solution to the dynamic optimization problem determines the firm's demand for trainees which we will estimate in the empirical analysis in Section 6. Our results indicate that the demand for trainees is positively related to the (potential) costs of hiring skilled workers from the external labor market. Before turning to the econometric modeling, we first introduce the data we use for our analysis.

4 Data

4.1 Survey design and data

We use data from two administrative and representative establishment-level surveys conducted in Swiss firms in 2000 and 2004 by the Centre for Research in Economics of Education at the University of Berne and the Swiss Federal Statistical Office.[2] Overall, we have information on 4486 Swiss firms, of which have information on hiring costs for 4052 firms (434 firms did not hire externally), as well as information on training costs for 2815 firms (1671 firms did not offer any internal training).[3]

The survey contains information on the number of skilled workers (in this case with a vocational degree) that a firm hired in the preceding three years. Management or the person in charge of human resources supplied the information in a paper-based survey that the Swiss Federal Statistical Office sent by regular mail.[4] The survey contains information on the average costs of hiring a skilled worker with a vocational degree from the external labor market. For ease of comparison across firms, firms had to fill out the survey for only one occupation. To avoid selectivity issues, the Swiss Federal Statistical Office assigned each firm an occupation based on the occupation's relative importance, before sending out the survey.

4.2 Calculation of hiring costs

The calculation of hiring costs can be divided into two parts: the costs of recruiting a worker, denoted by r, and the costs of the initial training necessary for the worker's adapting to the new job, denoted by a.

Recruiting costs r_i consist of the costs for posting a vacancy v_i and interview costs $J_i c_{ai}$, where J_i denotes the number of applicants per vacancy

[2]This data was originally collected for estimating total private sector expenditures on vocational education and training in Switzerland, as those expenditures are part of official OECD statistics on educational expenditures (OECD 2009).

[3]We excluded public firms and non-profit organizations from the sample, as the principle of profit-maximization does not fully apply to such firms.

[4]The survey is a stratified random sample at the establishment level, where the two-digit industry level and the firm size serve as strata.

invited for an interview, and c_{ai} denotes the costs of conducting an individual interview, i.e., the product of interview time and the wage of the interviewer(s).[5] In addition, we denote the costs for external advisors or placement agencies by e_i. Summarizing, recruitment costs are

$$r_i = v_i + J_i c_{ai} + e_i$$

The second part of hiring costs arises because a newly employed skilled worker is not immediately fully productive. In the survey, firms report for how many days d_{ai} a new worker is less productive than an average skilled worker in the firm. The relative productivity of a new recruit is denoted by p_i. There are several reasons for a new recruit being initially less productive. One is firm-specific human capital, such as learning the firm culture, learning production processes, and becoming acquainted with work colleagues.

Another reason for lower worker productivity is that new recruits receive training outside the workplace. First, the firm has to pay the worker the daily salary w_{di} during the number of training days d_{ti}. Second, there are direct training costs c_{ti} for internal and external training personnel, travel costs, or course fees. Thus adaptation costs a_i can be written as

$$a_i = d_{ai}(1 - p_i)w_{di} + d_{ti}w_{di} + c_{ti}$$

Total hiring costs H for filling a vacancy are the sum of recruitment and adaptation costs

$$H_i = r_i + a_i$$

4.3 Calculation of the net costs of training apprentices

We define net costs of apprenticeship training as the difference between the firm's costs and the benefits of training. Training costs c consist of the wages of apprentices w_a and the costs of training personnel w_T. We denote

[5]There are five job categories for interviewers: management, skilled workers with a vocational degree (by the subcategories of administration, technical or social, or crafts), and workers with no vocational degree (i.e., unskilled workers).

the remaining costs by x, which includes costs for materials, infrastructure, external courses, hiring, and administrative tasks.

Thus the average training costs for firm i are

$$c_i = w_{ai} + w_{Ti} + x_i$$

Training benefits b are calculated by the type of work an apprentice performs. An apprentice spends a fraction α of his work hours performing unskilled tasks that require no formal qualifications. During the remaining time $(1 - \alpha)$, the apprentice carries out skilled tasks. While we assume that the apprentice's performance is equal to that of an unskilled worker (w_u), the apprentice's performance in skilled tasks, ςw, is lower compared to that of a skilled worker. Finally, we denote the wage of a skilled worker by w.

$$b_i = \alpha w_{ui} + (1 - \alpha)\varsigma w_i$$

Thus, the average net costs of training C constitute the difference between the costs c and the benefits b of training, so that

$$C_i = c_i - b_i$$

4.4 Descriptive Statistics

In this section we provide descriptive statistics on the external and internal hiring process. Firms with internal training and external hiring activity report the costs for internal training and external hiring for the same occupation, facilitating the comparison of internal vs. external training costs.[6]

Table A1 shows that hiring costs are 11,888 Swiss francs (CHF[7]) in firms that hire externally and also offer internal training. These firms hire on average 3.5 new workers each period.[8] Firms that solely hire externally fill on average 2.6 vacancies each period at an average cost of CHF 14,286.

[6]Firms without internal training report hiring costs for the occupation in which they would most likely offer internal training if they decided to do so.

[7]At current exchange rates, 1 CHF = 0.9 \$, and 1 CHF = 1.2 Euro.

[8]We provide detailed descriptive statistics of the different components of hiring costs in table A2.

Firms with both external hiring and internal training hire more workers each period, however, the separation rate of skilled workers δ in these firms is only 10.2%, while separation rate is 14.7% in firms without internal training. These results seem surprising at first sight, as firms without internal training even pay slightly higher wages to skilled worker (albeit this difference is not statistically significant at the 5% level). However, firms without internal training are typically much smaller than training firms, both in their number of skilled workers in the occupation of interest, but also in the number of other workers. Therefore, the observed differences in descriptive statistics may be attributed to economies of scales in external hiring for large firms, allowing large firms to achieve a better match quality at lower costs.[9]

Internal training results on average in a net benefit of CHF 7304 for firms that also hire externally (Table A1). Firms that solely recruit my means of internal training in our observation period generate on average a net benefit of CHF 9959. However, about one third of all Swiss training firms bear substantial net training costs. The separation rate of apprentices γ, i.e., the fraction of trained apprentices who leave the firm within the first year after training, is on average 68.3% for training firms that also hire externally, and 74.05% for training firms that do not hire externally.

A firm's number of new hires consists of the number of external hires as well as number of trainees that were taken on as skilled workers after completion of training.[10]

The summary statistics for all other variables are provided in table A3.

[9]Idson (1993) provides evidence for lower turnover rates in large firms. Blatter et al. (2012) also show that large firms find it less costly to hire a given number of new workers than small firms. However, marginal hiring costs for large firms are convex if hiring is above a firm's expected hiring rate.

[10]Alternatively, we defined a firm's number of new hires by the number of external hires and the average retention rate of trainees, multiplied with the current number of trainees (rather than simply adding the number of trainees that were actually retained). For firms that did neither hire externally nor retained any trainees we estimate their potential number of hires by ordinary least squares, using firm size, wages, occupation and industry as independent variables. Our main findings remain robust to alternative specifications of the number of hires, and also if we drop observations of firms without new hires in the period of observation. All results are available upon request.

Training firms are on average larger than non-training firms, are more likely to have domestic owners and are located more frequently in the construction and industry sector.

5 Econometric modeling and empirical results

Our aim in this section is to estimate the causal effect of hiring costs on a firm's supply of internal training positions. We are interested in testing whether firms that face high potential costs of hiring all their skilled workers externally supply more training.

We need to deal with two problems for which we need an econometric solution: selectivity and endogeneity. We observe a firm's hiring costs only if that firm has hired skilled workers externally in the preceding three years. We also observe training costs only for firms that actually train apprentices. Furthermore, observed hiring costs differ from potential hiring costs for firms that hire externally but also supply internal training. The reason is that training firms need to hire fewer workers externally (because they retain some trainees), and hiring fewer workers results in lower *observed* average hiring costs due to the convex cost structure.

Endogeneity problems arise because firms can influence both hiring and net training costs. A firm can influence its hiring costs by adjusting time and effort for screening job applicants (thereby affecting the fluctuation rate). A firm can also influence net training costs: While training regulations require firms to enforce minimum training standards, it is always possible for a firm to provide extra training. A final complication is that the dependent variable of interest, the supply of training positions, is truncated at zero.

We use a type-4 Tobit model to account for selectivity, endogeneity of hiring costs and training costs, and truncation of training supply at zero. The following subsection describes the econometric model in detail.[11]

[11]For a classification of different types of Tobit models, see Amemiya (1985).

5.1 Econometric modeling

To estimate our econometric model, we assume that hiring costs can be described as $H^T = h_0 R^\alpha N_s^\beta N_o^\gamma w^\delta$ (see, e.g., Manning, 2011). We thereby account for the dependence of hiring costs H on the number of recruits R and the number of employees N_s (skilled workers in the corresponding occupation) and N_o (the number of other employees), as well as the wage of skilled workers w. Our specification therefore captures the stylized fact that larger firms typically hire more workers in a given period and pay higher wages. Thus marginal hiring costs are given by

$$\frac{\partial H^T}{\partial R} = \alpha h_0 R^{\alpha-1} N_s^\beta N_o^\gamma w^\delta$$

In our data we observe average hiring costs, which are given by

$$H = \frac{H^T}{R} = h_0 R^{\alpha-1} N_s^\beta N_o^\gamma w^\delta$$

Taking logs on both sides, we will estimate a regression model of the form $\ln H = (\alpha - 1)\ln R + \beta \ln N_s + \gamma \ln N_o + \delta \ln w$.[12] Marginal hiring costs are increasing if $\alpha > 0$, and decreasing if $\alpha < 0$.

The supply of training also depends on net training costs C. We estimate a linear regression model, because net training costs can be negative (i.e., firms can generate a net benefit from training if the productive contribution during training exceeds the training costs). Thus specifying $\ln C$ as the dependent variable is not feasible.[13]

Consider the structural model of a firm's supply of training positions.

$$\ln H = x_1\beta_1 + \varepsilon_1 \quad (1)$$

$$C = x_2\beta_2 + \varepsilon_2 \quad (2)$$

$$L = \max[0, x_3\beta_3 + \alpha H + \delta C + \varepsilon_3] \quad (3)$$

[12] As noted in Manning (2011), marginal hiring costs can be described in terms of average hiring costs, i.e., $\frac{\partial H^T}{\partial R} = \alpha \frac{H^T}{R}$.

[13] We also estimate a model with interaction terms of firm size and the number of trainees, as large firms offer more training positions. However, we find no statistically significant effects. Results are available upon request.

where L denotes the number of trainees, H the average costs of hiring skilled workers and C the average net costs of training.

We always observe (x, L), H is observed if $L = 0$, and C is observed if $L > 0$. The error terms $(\varepsilon_1, \varepsilon_2, \varepsilon_3)$ are independent of x, with a zero-mean trivariate normal distribution. The vector x_1 contains firm characteristics, including the number of recruits, the number of employees, skilled worker wage, firm ownership, occupation and industry. Furthermore, x_1 needs to contain at least one element that is not in x_3 but has a significant effect on hiring costs. We use the binary variable "difficulties in finding skilled workers" as a measure of the tightness of the labor market. As firms have to spend more resources on the search of appropriate job candidates when the labor market is tight, hiring costs increase. However, the firm's supply of training positions is not directly related to labor market tightness, conditional on other observed firm characteristics. Similarly, x_2 must contain at least one element that is not in x_3 but that significantly affects net training costs. We use the variable "population share of potential trainees", which is defined as the product of "local share of young people age 15-19" $\times$ (1-"share of young people in grammar school").[14] Thus the variable "population share of potential trainees" captures the variation in the supply of local trainees due to demographic and institutional differences across local labor markets.[15] A higher share of suitable candidates reduces the net costs of training by increasing the probability that a firm finds a suitable trainee, i.e., a good match. Compared to a situation in which a firm needs to hire a less suitable candidate, a good match will reduce the firm's required effort for a trainee to reach the desired skill level.

The coefficients of interest are the structural parameters α and δ. For

[14] We follow Muehlemann and Wolter (2011), defining a local labor market as containing all cities an individual can reach by car from the center of a local labor market within 30 minutes. The variable "share of young people in grammar school" is a lagged variable that measures the local share of youth enrolled in grammar schools the year before firms in our sample decided to offer internal training.

[15] As a robustness check we have used each of the two variables separately as an individual instrument. For both cases, the results remain qualitatively similar, but of slightly lower statistical significance.

identification, we follow the procedure described in Wooldridge (2002).

The reduced form for equation (3) is

$$\begin{aligned} L &= \max[0, x_3\beta_3 + \alpha(x_1\beta_1 + \varepsilon_1) + \delta(x_2\beta_2 + \varepsilon_2) + \varepsilon_3] \\ &= \max[0, x\rho_3 + \alpha\varepsilon_1 + \delta\varepsilon_2 + \varepsilon_3] \\ &= \max[0, x\rho_3 + u_3] \end{aligned} \tag{4}$$

First, we regress L on x by a standard Tobit regression using all observations. Doing so enables us to generate a generalized residual (Vella, 1992):

$$\hat{u}_{3i} = -\hat{\sigma}_3(1 - I_i)\phi(x_{3i}\hat{\beta}_3/\hat{\sigma}_3)(1 - \Phi(x_{3i}\hat{\beta}_3/\hat{\sigma}_3))^{-1} + I_i(L_i - x_{3i}\hat{\beta}_3)$$

where I_i is an indicator function denoting whether a firm offers training. Second, we need a consistent estimate of u_{3i} to obtain estimates of β_1 and β_2, as

$$E(\ln H|L = 0, x, u_3) = x_1'\beta_1 + E(\varepsilon_1|x, u_3) = x_1'\beta_1 + E(\varepsilon_1|u_3) = x_1'\beta_1 + \gamma_1 u_3$$

and

$$E(C|L > 0, x, u_3) = x_2'\beta_2 + E(\varepsilon_2|x, u_3) = x_2'\beta_2 + E(\varepsilon_2|u_3) = x_2'\beta_2 + \gamma_2 u_3$$

where $u_3 = \alpha\varepsilon_1 + \delta\varepsilon_2 + \varepsilon_3$. We can use the coefficients γ_1 and γ_2 to test for selectivity (Vella, 1992).

Using observations for firms that hire solely externally, we regress

$$\ln H_i \quad \text{on} \quad x_{i1}, \hat{u}_{3i}, \tag{5}$$

yielding consistent estimates of β_1 and allowing us to test for selectivity. Similarly, using observations of training firms that do not hire externally, we regress

$$C_i \quad \text{on} \quad x_{i2}, \hat{u}_{3i}, \tag{6}$$

yielding consistent estimates of β_2 and again allowing us to test for selectivity.

Having obtained consistent estimates $\hat{\beta}_1$, $\hat{\beta}_2$ for β_1, β_2, we can estimate β_3, α and δ using the reduced form of L in terms of the following structural parameters:

$$L = \max[0, x_3\beta_3 + \alpha(x_1\beta_1) + \delta(x_2\beta_2) + u_3]$$

Using our consistent estimates $\hat{\beta}_1$, $\hat{\beta}_2$, we can estimate the following Tobit equation to obtain consistent estimates $\hat{\beta}_3$, $\hat{\alpha}$, and $\hat{\delta}$:

$$L = \max[0, x_3\beta_3 + \alpha(x_1\hat{\beta}_1) + \delta(x_2\hat{\beta}_2) + error_i] \qquad (7)$$

5.2 Results

Before turning to estimates of the structural coefficients of interest, we discuss the results of the reduced form Tobit equation, the hiring costs, and the net training costs regression.

First, we estimate a reduced form Tobit regression to obtain the generalized residual (table A4), which we need to obtain consistent estimates in the hiring costs and net training costs equation.

Second, we estimate equation (5), i.e., we regress hiring costs on x_1 and the generalized residual (table A5). The number of recruits has a positive and significant effect on average hiring costs, a finding that implies a convex cost structure. The hiring costs' elasticity with respect to the number of recruits is 1.19. We further find that hiring costs increase with firm size, and strongly depend on skilled workers' pay. In addition, firms facing difficulties in hiring skilled labor externally exhibit hiring costs 20.4% above average. The coefficient on the generalized residual is not significantly different from zero. Thus we find no evidence for a self-selection bias in the hiring costs equation.

Third, we estimate equation (6), i.e., we regress the net costs of training C on x_2 and the generalized residual (table A6). In contrast to hiring costs, we find that the structure of net training costs is concave. Hiring an additional trainee decreases average net training costs by CHF 180. This results is mainly due to economies of scale in instruction time (training several trainees at the same time requires less time per trainee). Furthermore, the result show that a 1 percentage point increase in the local share of potential trainees decreases the net costs of training by CHF 4355. The explanation for this result is that firms are more likely to find a good match if the supply of suitable young people is high. Therefore, firms with a good match quality can save on training costs compared to firms with a poorer match quality. The coefficient on the generalized residual is negative and significantly different from zero, meaning that the expected net costs of training for firms with $L = 0$ are significantly higher than those for firms with $L > 0$.

Having obtained consistent estimates of hiring costs and net training costs, we estimate the structural effects of hiring costs H and net training costs C on the firm's supply of training positions L.

The results show that both variables have significant effects on the number of training positions L (table 1). A look at the entire sample reveals that an increase in average hiring costs H by CHF 1000 increases the number of training positions by 0.13, implying that an increase in average hiring costs by CHF 8,000 induces a firm to hire one additional trainee. This effect is economically substantial, as an increase of H by one standard deviation (CHF 7174) increases a firm's supply of training by 0.52 standard deviations (0.93 training positions).

We then estimate the supply of training positions using only firms with positive net costs ($\hat{C} > 0$). We expect a stronger effect of hiring costs on training supply for this sub-sample, as post-training benefits are crucial for firms that made a net investment in training (table 1). We find that an increase in average hiring costs H of CHF 1000 increases the supply of training positions by 0.17 (third column, table 1). Put differently, an increase in H by one standard deviation leads to a 0.6 standard deviations (1.4 training positions) increase in the supply of training for firms with $\hat{C} > 0$. Including an interaction term of hiring costs and net training costs (multiplied by (-1)), we find that the effect of hiring costs is inversely related to the level of net training costs (last column, table 1). The coefficients on the individual variables remain significant. Our results show that the marginal effect of average hiring costs evaluated at the average of net training costs (i.e., $\partial L/\partial H = 0.236 - 0.00321 \times \bar{\hat{C}}_i$)) on the firm's supply of training

Table 1: Determinants of the firm's supply of training positions L

Dependent variable:	Number of training positions L		
	all firms	if $\hat{C} > 0$	
Hiring costs $\hat{H}$ (in 1000 CHF)	0.1265	0.1700	0.236
	(0.0132)	(0.0339)	(0.0493)
Net training costs $\hat{C}$ (in 1000 CHF)	-0.1341	-0.2338	-0.194
	(0.0403)	(0.0694)	(0.0716)
$\hat{H} \times (-1)\hat{C}$ (in 1,000,000 CHF)			3.210
			(1.040)
New hires (internal + external)	0.0705	0.2518	0.2474
	(0.0386)	(0.0959)	(0.0883))
Number of skilled workers N_s	0.0554	0.0196	0.0185
	(0.0078)	(0.0087)	(0.008)
Number of other workers N_o	0.0086	0.0086	0.0087
	(0.0015)	(0.0015)	(0.0016)
Wage of skilled workers w (in CHF)	-0.0058	-0.0011	-0.0011
	(0.0001)	(0.0002)	(0.0002)
Foreign firm ownership	-1.8801	-2.0506	-2.0616
	(0.2526)	(0.6222)	(0.6309)
Aggregate cantonal (i.e., state) income	0.0142	0.001	0.0105
(in 1000 CHF)	(0.0102)	(0.0148)	(0.0105)
Industry controls	Yes	Yes	Yes
Job controls	Yes	Yes	Yes
Constant	-0.3487	2.348	2.0799
	(0.4544)	(1.0661)	1.0693
Log pseudolikelihood	-427,207.90	-114,744.93	-114,457.59
Observations	6739	2114	2114

Cluster-robust standard errors in parentheses.

is 0.204. Thus an increase in H by one standard deviation leads to a 0.72 standard deviations (1.7 training positions) increase in the supply of training for firms with $\hat{C} > 0$.[16]

As expected, the net costs of training have a negative effect on a firm's supply of training. If the net costs C increase by CHF 1000, the number of training positions L decreases by 0.13. Put differently, if C decreases by one standard deviation (CHF 13,251), a firm's number of internal training positions will decrease by 0.93 standard deviations (1.8 training positions). Considering only firms with $\hat{C} > 0$, the coefficient on C is -0.23. Accounting for the interdependence of hiring costs and net training costs, an in increase in average net training costs (evaluated at average hiring costs) by CHF 1000 decreases a firm's supply of training positions by 0.22, implying that a one standard deviation increase in average net training costs leads to a 1.3 standard deviations decrease in training positions.

Furthermore, both the number of skilled workers and the number of other employees within the firm have a positive effect on the supply of training L. The wage of skilled workers w has a negative effect on L, possibly because the wage is negatively related to the separation rate of trainees. Therefore, a firm needs to train fewer apprentices to fill a given number of vacancies. Finally, foreign-owned firms have a significantly lower supply of training. A possible explanation for this result is that these firms might be less familiar with the vocational training system or too small and specialized to provide an entire training program.

[16] As a robustness check we re-estimate our model by excluding firms that offer internal training but did not retain any trainees in the preceding three years. Our main results remain qualitatively unchanged, although the effect of hiring costs becomes stronger. Accounting for the interdependence of hiring costs and net training costs, we find that a one standard deviation increase in average hiring costs increases a firm's supply of training positions by 1.1 standard deviations (last column, table A7).

6 Conclusions

Firm-sponsored training is an alternative hiring strategy, as opposed to hiring skilled workers solely from the external labor market. A profit-maximizing firm will offer internal training and subsequently retain some workers if the corresponding costs are lower than the costs of external hiring.

Using representative firm-level data that contains detailed measures of hiring and training costs, we find that a one standard deviation increase in average hiring costs is associated with a 0.7 standard deviation increase in training positions. Conversely, we find that a one standard deviation increase in average net training costs reduces a firm's supply of training by 1.3 standard deviations. In monetary terms, a 10,000 Swiss franc increase in average hiring costs increases a firm's supply by two training positions, whereas a 10,000 Swiss franc increase in average net training costs reduces a firms supply by two training positions.

Our analysis contributes to the understanding of why firms are frequently willing to make substantial investments in general training. The results have important implications, as demographic change is expected to lead to a shortage of skilled workers in the Swiss and many other Western labor markets. As external hiring becomes increasingly expensive, our results suggest that firms will offer more internal training positions to satisfy their demand for skilled workers. However, demographic change will also reduce the number of school leavers and thus a firm's pool of potential trainees. Consequently, firms that are confronted with less suitable training candidates will have to invest more resources so that trainees still achieve the desired skill level. Our results show that net training costs will increase if the match quality decreases, which in turn has an adverse effect on a firm's supply of training. The challenge for policy makers is therefore to design training regulations so that firms can provide training cost-efficiently to ensure the young people's future skill formation in firm-based training programs.

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A Tables

Table A1: Hiring and training costs

	External hiring		No external hiring	
	Training	No training	Training	No training
Hiring costs H	11,888.160	14,286.190	–	–
	(11,906.010)	(14,561.400)		
Number of recruits R	3.511	2.557	–	–
	(4.369)	(2.919)		
Separation rate δ	10.173	14.680	–	–
	(16.629)	(19.907)		
Net training costs C	-7304.728	–	-9958.906	–
	(34,908.28)		(33,170)	
Number of trainees L	2.584	–	1.883	–
	(3.205)		(1.864)	
Number of trainees retained	0.991	–	0.518	–
	(4.078)		(1.386)	
Trainee separation rate γ	68.33	–	74.0542	–
	(32.8435)		32.0286	
Number of skilled workers N_s	11.235	4.1910	4.4994	2.3643
	(29.6258)	(6.6944)	(9.7787)	(2.7852)
Number of other workers N_o	26.03	8.674	10.82	4.484
	(115.4)	(37.62)	(59.41)	(15.04)
Monthly skilled worker pay w	6340.3	6459.6	6256.3	6229.0
	(1417.5)	(1460.8)	(1281.0)	(514.6)
Observations	2381	1671	1263	1424

Standard deviation in parentheses.

Table A2: Descriptive statistics

Variable	Mean	Std.Err.	Minimum	Maximum	Obs.
Costs for job postings v (in CHF)	1103	1889	0	50000	4052
Costs for interview per applicant c_a (in CHF)	395	495	0	8844	4052
Number of interviewed applicants J per vacancy	5	4	1	30	4052
Personnel costs for interviews $J * c_a$	2009	3877	0	83586	4052
Costs for external advisors/headhunters e (in CHF)	414	1881	0	30000	4052
Recruitment costs $r = v + J * c_a + e$ (in CHF)	3878	5894	0	116117	4052
Duration of adaption period in days d_a	80	60	0	756	4052
Average decline in productivity $(1 - p)$ during adaption period (in %)	29	14	0	90	4052
Daily wage w of a skilled worker with vocational degree (in CHF)	349	79	125	784	4052
Duration of training courses in days d_t	2	4	0	90	4052
Direct training costs c_t (in CHF)	550	1805	0	60000	4052
Adaption costs $a = d_a * (1 - p)w + d_t * w + c_t$ (in CHF)	9688	11005	0	147779	4052
Average hiring costs $H = r + a$ to fill a vacancy (in CHF)	13570	13862	320	170575	4052

Table A3: Summary statistics by hiring and training decision

	External hiring		No external hiring		Total
	Training	No training	Training	No training	
Construction sector	0.172	0.0999	0.165	0.115	0.125
	(0.377)	(0.300)	(0.371)	(0.319)	(0.331)
Industry sector	0.162	0.118	0.162	0.117	0.130
	(0.368)	(0.322)	(0.369)	(0.322)	(0.337)
Foreign-owned firm	0.0762	0.148	0.0346	0.114	0.111
	(0.265)	(0.356)	(0.183)	(0.317)	(0.314)
Aggregate cantonal (i.e., state) income	48072.4	49638.7	46613.2	48434.4	48593.1
	(9964.6)	(10554.6)	(8898.6)	(10594.4)	(10322.7)
Population share of 15-19-year-olds	0.0578	0.0568	0.0582	0.0573	0.0573
	(0.00525)	(0.00504)	(0.00549)	(0.00499)	(0.00514)
Lagged share of youth in grammar school	0.163	0.187	0.170	0.167	0.174
	(0.0644)	(0.0796)	(0.0675)	(0.0693)	(0.0730)
Population share of potential trainees (in %)	0.0485	0.0463	0.0485	0.0479	0.0475
	(0.00689)	(0.00717)	(0.00714)	(0.00690)	(0.00709)
Difficulties in finding skilled workers	0.493	0.358	0.305	0.188	0.315
	(0.500)	(0.480)	(0.461)	(0.391)	(0.465)
Observations	2381	1671	1263	1424	6739

Note: Mean of each variable with standard deviation in parentheses.

Table A4: Reduced form Tobit

Dependent variable:	Supply of training positions L	
	Full sample	Firms with internal or external hiring
Skilled workers N_s	0.0578	0.0533
	(0.0094)	(0.0091)
Other workers N_o	0.0082	0.0082
	(0.0015)	(0.0016)
Wage of skilled workers w	-0.0001	-0.0001
	(0.0001)	(0.0001)
New hires (internal + external)	0.1289	0.1262
	(0.0461)	(0.0450)
Foreign firm ownership	-1.7814	-1.7990
	(0.2179)	(0.2799)
Aggregate cantonal income (in 1'000 CHF)	-0.0254	-0.0286
	(0.00254)	(0.00875)
Industry controls	Yes	Yes
Job controls	Yes	Yes
Constant	-1.0925	-0.8662
	(0.4487)	(0.5558)
Log pseudolikelihood	-432778.13	-292386.89
Observations	6739	4486

Cluster-robust standard errors in parentheses.

Table A5: Hiring cost regression

Dependent variable:	ln Hiring costs H
ln(Number of hires R)	0.1856
	(0.0729)
ln(Skilled workers N_s)	-0.0021
	(0.0530)
ln(Other workers N_o)	0.0209
	(0.0067)
ln(Wage of skilled workers w)	1.4692
	(0.1214)
Foreign firm ownership	0.0211
	(0.0783)
Aggregate cantonal income (in 1'000 CHF)	0.0042
	(0.0024)
Difficulties to find skilled workers	0.2040
	(0.0558)
Generalized residual	0.0091
	(0.0329)
Industry controls	Yes
Job controls	Yes
Constant	-4.0717
	(1.1153)
R^2	0.290
Observations	1671

Cluster-robust standard errors in parentheses.

Table A6: Net cost regression

Dependent variable:	Net training costs C
Number of trainees L	-181.5957
	(67.7274)
Skilled workers N_s	18.0259
	(21.5736)
Number of other workers N_o	10.5812
	(4.7449)
Wage of skilled workers w	-1.8450
	(1.0646)
Foreign firm ownership	-264.1512
	(3605.03)
Aggregate cantonal income (in 1'000 CHF)	133.7377
	(83.1494)
Population share of potential trainees (in %)	-4355.1560
	(1403.5560)
Generalized residual	-709.9584
	(322.3683)
Industry controls	Yes
Job controls	Yes
Constant	18,963.62
	(10114.16)
R^2	0.1332
Observations	2381

Cluster-robust standard errors in parentheses.

Table A7: Determinants of the firm's supply of training

Dependent variable:	Number of training positions L		
	all firms	if $\hat{C} > 0$	
Hiring costs $\hat{H}$ (in 1000 CHF)	0.1641	0.2304	0.4208
	(0.0245)	(0.0490)	(0.0749)
Net training costs $\hat{C}$ (in 1000 CHF)	-0.1852	-0.2573	-0.1607
	(0.0508)	(0.1063)	(0.1063)
$\hat{H} \times (-1)\hat{C}$ (in 1,000,000 CHF)			5.510
			(1.140)
Number of hires (internal + external)	0.0534	0.2107	0.1681
	(0.0392)	(0.0996)	(0.0931)
Number of skilled workers N_s	0.0534	0.0222	0.0212
	(0.0074)	(0.0100)	(0.0095)
Number of other workers N_o	0.0091	0.0088	0.0085
	(0.0017)	(0.0018)	(0.0020)
Wage of skilled workers w (in CHF)	-0.0008	-0.0010	-0.0014
	(0.0002)	(0.0004)	(0.0004)
Foreign firm ownership	-1.906	-1.8629	-1.9507
	(0.3453)	(0.7111)	(0.7363)
Aggregate cantonal (i.e., state) income	0.0066	0.0180	0.0112
(in 1000 CHF)	(0.0132)	(0.0201)	(0.027))
Industry controls	Yes	Yes	Yes
Job controls	Yes	Yes	Yes
Constant	-0.2114	0.5192	1.1581
	(0.5659)	(1.4591)	(1.4630))
Log pseudolikelihood	-289563.87	-71685.45	-77,303.29
Observations	4486	1451	1451

Cluster-robust standard errors in parentheses. 1424 Firms with no external and no internal hiring are excluded from the estimation sample.