Working Paper No. 154

Rising tide effect or crowding out — does tertiary education expansion lift the tasks of workers without tertiary degree?

Tobias Schultheiss, Curdin Pfister and Uschi Backes-Gellner

Universität Zürich
IBW – Institut für Betriebswirtschaftslehre

UNIVERSITÄT BERN

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First draft. Preliminary results.

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Rising tide effect or crowding out—does tertiary education expansion lift the tasks of workers without tertiary degree?[1]

Tobias Schultheiss[2], Curdin Pfister[3], and Uschi Backes-Gellner[4]

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Abstract

An extensive literature examines the effects of tertiary education expansion on wages of workers with and without tertiary degree. However, the question how tertiary education expansion affects the tasks of these workers remains unexplored. We examine whether such an expansion crowds out sophisticated tasks such as R&D in jobs of workers without tertiary degree or elevates the content of their tasks via a rising tide effect. In particular, we analyze the effects of the establishment of Universities of Applied Sciences (UAS), a large tertiary education expansion in Switzerland, on R&D tasks of workers with apprenticeship training. Job ads provide us with information about the demand for R&D tasks. To estimate causal effects, we exploit the quasi-natural variation in time and location of the establishment of UAS campuses and perform difference-in-differences estimations. We find that firms demand more R&D tasks of workers with apprenticeship training after a tertiary education expansion. Our results therefore show that instead of crowding out, tertiary education expansion lifts the tasks of workers with apprenticeship training via a rising tide effect.

Keywords: higher education expansion, labor demand, job advertisements, crowding out
JEL Classification: I23, J23, M51

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[2] University of Zurich, Switzerland. E-mail: tobias.schultheiss@business.uzh.ch. Address: Plattenstrasse 14, CH-8032 Zurich, Switzerland.
[3] University of Zurich, Switzerland. E-mail: curdin.pfister@business.uzh.ch. Address: Plattenstrasse 14, CH-8032 Zurich, Switzerland.
[4] University of Zurich, Switzerland. E-mail: backes-gellner@business.uzh.ch. Address: Plattenstrasse 14, CH-8032 Zurich, Switzerland.

1 Introduction

In many countries more and more students attend college and obtain a tertiary education degree. In the OECD countries the average of individuals holding a tertiary education degree in recent cohorts compared to cohorts 16 years ago increased by 50 percent (OECD, 2017a). The increase in tertiary degree holders is in line with the expansion of tertiary education as an official policy goal of many OECD countries (OECD, 2017b). To support this goal and serve the increasing numbers of students that strive for a tertiary education degree, new colleges have been founded in many countries. However, this expansion not only affects tertiary graduates but also workers without tertiary degree.

A growing literature examines the effects of expansion of tertiary education expansion on the labor market outcomes of workers without tertiary degree. Previous studies find that an increase in the share of college graduates raises the wages of workers without tertiary degree in the same area (Morreti, 2004, and Kantor and Whalley, 2014), with the effect being particularly strong for STEM graduates (Winters, 2014). Furthermore, a higher share of college graduates is associated with lower unemployment for workers with upper-secondary education (Hansson, 2007).

However, whether the increase in number of college graduates crowds out sophisticated tasks such as R&D in jobs of workers without tertiary degree or whether it elevates the content of their tasks due to a rising tide effect remains unexplored. Addressing this question contributes to the literature in two ways: First, it sheds some light on the interaction between task bundles of workers from different educational levels, i.e., whether this interaction entails any spill-overs or complementarities (linked to a rising tide effect). Moreover, addressing this question can inform policy makers on how to adjust education and training for non-tertiary types of education, so that the skills of these workers best match the task demand by firms. We address this question by examining the tasks that firms are searching workers for.

In our study, we examine whether tertiary expansion crowds out sophisticated tasks such as R&D in jobs of workers with upper-secondary diploma or elevates the content of their tasks via a rising tide effect. Specifically, we investigate whether the increase in R&D tasks on the tertiary level—as one type of sophisticated task—spills over to the upper-secondary level. In our empirical approach we follow the increasingly popular method of analyzing job ads to capture tasks and skill requirements (Sahin et al, 2014, Hershbein and Kahn, 2017, and Atalay et al., 2018). Job ads are particularly well-suited to analyze the short and medium run changes in tasks: First, job ads react fast to changes in the economic environment (in contrast to occupational curricula whose adaption takes years). Second, while skill databases and occupational curricula are country-wide and do not allow for a control group, job ads, however, are local and allow for a control group.

To estimate the effect of tertiary education expansion on tasks of workers on the upper-secondary level, we use these two properties of job ads and exploit the quasi-experimental setting of a large educational intervention in the tertiary education sector of Switzerland, the establishment of UAS in the late 90s. Location and timing of the establishment of UAS and their campuses was subject to a political process which was unrelated to the economic environment in those regions (for more details on the process of the UAS establishment see Pfister et al., 2017). We focus us on UAS campuses that specialize on chemistry, life sciences, as well as engineering and IT as these campuses conduct applied research and development (R&D) and provide their students with the respective applied R&D skills. The establishment of UAS thus led to a substantial change of the skills in the labor market on the tertiary level. Taking a difference-in-differences (DiD) approach, we investigate whether this increase in R&D on the tertiary level leads to spill-over effects.

In our analysis, we focus on spill-over effects to workers with a vocational training and education (VET) diploma as these workers have an upper-secondary education and likely work in R&D. VET programs follow a formal structure with three to four years of training in the

workplace and education at vocational schools according to a binding and well-defined curriculum. For brevity, in this paper we call these workers "workers with VET diploma". Dual VET system exists in Switzerland, Germany, Austria or Denmark and introducing such a system is the goal of an increasing number of countries around the globe. UAS combine vocational and academic elements on the tertiary level, therefore their graduates have a particular strong link with workers on the VET level.

For our analysis we draw on data from the Swiss Job Market Monitor (SJMM), which contains a large representative sample of job ads from Switzerland for the last 60 years (Buchmann et al, 2017). To ensure that the establishment of UAS is the only relevant educational intervention in our observational period, we restrict our analysis on job ads from 1995 to 2011. For our analysis the SJMM provides us with the necessary information on the education requirements, occupation and whether the firm is searching a worker for R&D as main task. Finally, the Job Market Monitor contains the geographic location of the future workplace on the municipality level which allows for a well-defined control and treatment group of job ads for the establishment of UAS.

We find that after the establishment of UAS firms search more often workers with VET diploma for R&D tasks. Our results therefore show that the establishment of UAS does not crowd out sophisticated tasks in jobs of workers without tertiary education degree but elevates the content of their tasks via a rising tide effect. Additionally, we find that the establishment of UAS does not reduce the number of job ads for workers with VET diploma. Thus, the establishment of UAS does not change the quantity of jobs for workers with VET diploma, but affects the quality of jobs. As the UAS campuses focus on engineering, life sciences and IT, we complement our full sample analysis of VET occupations with a subsample analysis of technical and IT occupations on the VET level. For this subsample, we find that the treatment effect of the establishment of UAS is even stronger.

2 Conceptual Background

To formalize the effects of a rising number of college graduates on local economies, Moretti (2004) proposes a model for spill-overs between workers with different levels of education. In the model two types of workers (educated and uneducated) are employed in a local production process, which possesses the properties of a Cobb-Douglas function and combines these two types of workers with capital to produce output. In the production process the two types of workers act as imperfect substitutes. Therefore, increasing the number of educated workers also increases the productivity of uneducated workers via imperfect substitutability, which some empirical evidence supports as an assumption (Katz and Murphy, 1992, and Freeman, 1986). This is the first channel by which educated workers affect productivity and thereby also the labor market outcomes such as wages of other workers.

In addition, the model also allows for spill-overs between the two types of workers which increase the productivity of each type. Spill-overs (or complementarities) therefore pose the second channel by which educated workers may influence productivity and wages of other workers. However, the model restricts itself on spill-overs from the educated workers to the uneducated workers, with the strength of the spill-over effect increasing in the share of educated workers.

While Moretti (2004) derives predictions for the effect of increasing numbers of college graduates on wages of workers without tertiary degree and includes imperfect substitutability and spill-overs as channel, the empirical analysis cannot distinguish between these two potential channels and, in particular, cannot identify whether spill-overs actually occur for workers without tertiary degree. Both channels predict positive wage effects of tertiary education expansion, therefore the finding of a positive effect means that either one of these channels, but not which one, or a combination of both is relevant.

Building on the theoretical framework by Moretti and examining the interaction of tasks by workers on the tertiary level and VET level, we try to shed some shed light on the existence

of spill-overs versus the prevalence imperfect substitutability. Spill-overs as described in the model may take the form of task spill-overs. In response to a local labor-supply shock caused by an influx of tertiary graduates, the demand by firms for sophisticated tasks may increase for workers on the tertiary level and VET level alike, as both workers fulfil complementary roles in these tasks. However, if imperfect substitutability plays the major role, we would expect UAS graduates to crowd-out the sophisticated tasks of workers on the VET level. UAS graduates take over these sophisticated tasks in the task bundles of workers on the VET level. In our analysis we examine whether UAS graduates crowd out sophisticated tasks such as R&D on the VET level or whether demand for sophisticated tasks such as R&D by firms spills over to the VET level after a tertiary education expansion.

3 Data and variables

For our analysis, we draw on data from the Swiss Job Market Monitor (SJMM). The SJMM is based on a representative sample of job ads for the German-speaking part of Switzerland. The sample of job ads is drawn on a yearly basis and stratified over regions, ad channels and characteristics of the ad media within the channel. The SJMM covers job ads from the last decades. Job ads share a common information structure. Rafaeli and Oliver (1998) dub this information structure a "skeleton" that all job ads share: every job ad contains information about the identity of the firm, its human resource needs, requirements how to fulfill these needs and information on how to contact the firm. The fact that job ads follow a similar structure enables categorization and comparison of job ads.

The SJMM contains the characteristics that are comparable between different job ads. For each job ad the SJMM includes information on the firm that is advertising, its industry affiliation, the geographic location of the workplace at the municipality level, the occupation according to ISCO-08 classification, formal educational requirements, and specific demands such as experience, special knowledge or specific training, and the main task. As the SJMM comprises information on tasks, occupation according to the ISCO-08 and geographic location of the workplace, the database is particularly appropriate to investigate changes in local task demand by firms and allows for digging deeper by examining a subsample of technical and IT occupations. The main task is the central component of our empirical analysis.

The SJMM staff manually coded and categorized the main task in job ads depending on the explicit or implicit description of tasks. For example, a job ad specifying "your experience and knowledge is needed for repairs and the maintenance of equipment" would be put into the category of repairing and restore. Buchs and Müller (2014) find a good reliability of the main task encoding with an Krippendorff's alpha of 0.76 as measure of encoding quality.

We look at the main task of job ads to construct our dependent variable. The main task is defined as the kind of task that is mostly performed at the advertised job position and is

categorized according to 21 distinct main tasks. The categorization of the main task follows and augments a categorization of tasks that was also used in the socio-economic panel (Stoss et al., 1990). Main tasks belong to 21 distinct categories, ranging from agricultural tasks, over sales and customer service to publishing and creative work. In each category of main tasks, several activities are bundled. For our empirical analysis, we concentrate on the main task of "analyzing, researching and controlling", which is the R&D task category. Table 1 lists the subset of activities as defined by the SJMM that belong into this category. Our dependent variable is thus a dummy indicating whether a job ad requires R&D as main task.

[Table 1]

We use to the ISCO-08 classification to identify technical and IT occupations for our subsample analysis. For a more conservative selection we pick technical and IT occupations on the two-digit level of the ISCO-08 classification: Science and engineering associate professionals (ISCO-08: 31); information and communications technicians (ISCO-08: 35); metal and related trades workers (ISCO-08: 71); and electrical and electronics trades workers (ISCO-08: 74) form the group of technical and IT occupations. Subject-wise this group is similar to the UAS graduates in engineering, life sciences and IT. Furthermore, this group consists of occupations that are in general R&D intensive. We use this group to investigate in a second stage whether and how the establishment of the UAS affected R&D intensive VET-occupations.

To define whether a firm (that publishes a job ad) was treated by the tertiary education expansion, we use information on the geographic location of the workplace at the municipality level. We argue that the effect of the tertiary education expansion limits to firms located close to a UAS, thereby following the argument of Pfister et al. (2017). The authors exploit the low mobility of individuals living in Switzerland and the temporal and regional variation of the

establishment of UAS campuses to estimate the effect of UAS on regional patenting activities. In line with Pfister et al., we assume that all firms (that publish job ads) within a radius of 25 km around a UAS campus are affected by the intervention (treatment group). Firms without a newly established UAS constitute the control group (control group). We furthermore use the information provided by Pfister et al. (2017) on when and where each UAS campuses opened its doors. This spatial and regional variation allows us to determine the exact year in which we expect to observe an effect.

The SJMM also includes information on (economic) characteristics that potentially affect the job ads. The SJMM comprises information on the industry affiliation of the advertising firm, following the aggregated NOGA-classification of the SWISS Federal Office of Statistics. The aggregated NOGA-classifications divides the economy into 10 industry categories. With the rise of internet technology there might have been a fundamental change in the prominence of certain industries during the 90s and 2000s and a fundamental shift in labor demand (Black and Lynch, 2004). To control for such confounding factors and obtain a more robust estimation, we generate a set of dummy variables for the industry category.

Furthermore, the SJMM includes information on the ad channel. Before 2001 the SJMM sample contains only job ads from newspapers. From 2001 on the SJMM includes job ads that firms announce on their business websites and from 2006 on the SJMM also considers those job ads that firms post on online job boards. According to Sacchi (2014), not considering online channels before 2001 does not lower the representativeness of the sample in a relevant manner. Before 2001 the majority of job ads posted online still also appeared as newspaper job ad. The sampling process therefore captured these job ads. To ensure that the choice of ad channels remains valid and the SJMM sample design fits recruitment practice, the SJMM is complemented by a firm questionnaire that asks firms on how they recruit their personnel.

To construct our sample, we use information on the formal educational requirements and identify the job ads that aim at workers with VET diploma. Job ads that require a VET

diploma—either as the minimum educational degree required for the job or as the maximum degree required for the job or as degree in between—constitute our sample. We restrict our sample on these jobs ads, because we want to examine the spill-overs in R&D tasks on workers with VET diploma.

4 Descriptive Evidence

Table 2 displays the five most frequent main tasks that firms search UAS graduates for and shows that R&D is the fourth most frequent main task as around 12% of all job ads specify it as main task. Furthermore, as the tasks of the remaining 88% job ads R&D may also contain some R&D, just not as most performed task, and are therefore not captured by the definition of main task, the frequency is a lower bound for the actual R&D activity of UAS graduates. This descriptive evidence shows that UAS graduates bring R&D skills to the labor market and firms search them for R&D tasks. Therefore, we expect the establishment of UAS to bring a substantial increase in R&D activity to the tertiary level and affect other educational groups via spill-overs.

[Table 2]

To complement the descriptive statistics and illustrate the trends of job ads with R&D as main task, Figure 1 reports the number of job ads with R&D as main task for the control and treatment group. We set the number of job ads in 1995 to a base level of 100 and present changes in absolute relation to the base level of 100. Before the year 2000, which is before the first graduates from the first new UAS campuses entered the labor market, treatment and control group follow the same trend. From 2000 on, which is roughly when the first graduates from the UAS entered the labor market, the treatment and control group diverge. The steep increase in job ads with R&D as main tasks only for the treatment group shows that the availability of UAS graduates for firms had a substantial effect on labor demand and the required tasks.

[Figure 1]

5 Estimation strategy

To estimate the effect of the tertiary education expansion on tasks of workers with VET diploma, we exploit the temporal and regional variation of the tertiary education expansion, i.e., the establishment of UAS. We thereby follow the empirical identification strategy by Pfister et al (2017) and take the difference-in-differences (DiD) approach:

$$P(task)_{it+3} = \alpha + \beta Treatment_{it} + \gamma Year_t + \delta TG_i + \lambda X_{it} + \varepsilon_{it}$$

The dependent variable is a dummy indicating whether the main task of a job ad is R&D. We estimate a linear probability model, meaning that $P(task)$ denotes the probability of a job ad specifying analyzing, researching and controlling as its main task. The probability captures the importance that firms place on a certain task in their recruitment of new workers. Specifically, looking the probability allows to investigate the focus of firms in their task assignment. Subscript *i* indicates our level of observation, the individual job ad, and *t* indicates the year in which the job ad appears. As our first year of observation we use 1995 as from 1995 onwards the variable 'main task' is coded. Given that students need a minimum of three years to graduate from a Bachelor's program at a UAS, we assume a time lag of three years for the effects of UAS establishment on firms and labor market.

TG is a dummy variable indicating that the job ad (and the firm publishing the ad) belongs to the treatment group. $Year$ comprises year dummies that show the common time trend of the treatment and control groups. X_{it} is a set of control variables: First, we control for the ad channel. As the SJMM data started including job ads of business websites in 2001 and from online job boards in 2006, these job ads may be different from the typical newspaper ad. Second, we also control for industry affiliation because the industry structure might undergo some changes on the local level and at the same time affect task assignment.

In a next step we first estimate our DiD-equation for the subsample of jobs in technical and IT occupations that require a VET diploma. With the subsample analysis we want to investigate which and if the establishment of UAS affected a particular subset of occupations. Many occupations requiring a VET diploma such as cooks or hairdressers will never be involved in any R&D. Including such occupations in our analysis dilutes the treatment effect and makes it difficult to draw conclusions on the level of occupations. Workers in technical and IT occupations are similar to the UAS graduates in engineering, life sciences and IT. Additionally, these occupations are in general R&D intensive. We therefore focus on jobs in technical and IT occupations.

Identification in a DiD setup as ours rests upon the assumption that treatment and control regions would have followed a common trend for the share of job ads with R&D as main task in absence of treatment[5]. It is not possible to test this assumption directly. Examining carefully the trends before the establishment of UAS, however, indicates whether the common trend assumption might hold.

[Table 3]

We test whether control and treatment regions follow a common trend in the years before the establishment of the UAS. The SJMM contains ads for the years before the establishment of the UAS. The first UAS campuses had been established from 1997 onwards. Combined with a time lag of three years that it takes for students to graduate, the pre-treatment period spans over at least over 5 years. Table 3 reports the results from testing for common trends in the pre-treatment period by regressing our variable of interest on belonging to the

[5] Contamination might also be a problem as UAS graduates migrate from the control to the treatment regions. However, Switzerland is a country with low labor migration. Using graduate survey data, Pfister et al. (2017) showed by that 75% of all graduates still live in the same treatment region five years after graduation.

treatment group, year dummies and the interactions of both. Significant coefficients of interaction terms would indicate a violation of common trend in that year. However, as table 3 shows we cannot find a violation of common trends before 2001. All coefficients of interaction terms are not significant. In addition, we employ an F-test for the interaction terms and cannot reject the null that any interaction term differs significantly from 0 (p-value of 0.65).

6 Results

To capture the effect from the establishment of a nearby UAS campus on the demand for R&D tasks in job ads for workers with VET diploma, we perform DiD estimations. We use two samples. The results of our first estimation with a full sample of VET job ads show whether firms increase their demand for R&D tasks generally after the tertiary education expansion. The results of our second estimation for a subsample of technical and IT occupations show how firms adapt their demand for tasks within this subset of occupations that have a strong link to the UAS level.

[Table 4]

Table 4 reports the results of our DiD - estimation. Our dependent variable is a dummy variable, indicating if the job ad from our sample of job ads for workers with VET diploma specifies R&D as main task. The first two columns report the results for the full sample of VET occupations. In the first column no control variables are included. The coefficient of the treatment variable equals 0.78 and is statistically significant at the 5%-level. The establishment of the UAS thus increases the probability of a job ad specifying R&D as main task by 0.78%. In the SJMM data-set main tasks are divided into 21 categories. As only 2.31% of job ads in our sample specify R&D as their main task (and the remaining job ads indicate one of the other 20 categories as main task), the effect is substantial. Furthermore, in the second column we control for ad channel and industry. Changes in the sampling procedures by the SJMM and a general shift in industry in the 90s could have confounded our results. However, the results in the second column indicate the opposite. We find only small changes in the effect size and level of significance. The treatment coefficient remains significant at the 5% level.

In a second step we restrict our sample on technical and IT occupations. Columns three to four report on the results: in the third column we use our specification with no additional controls and find a strong treatment effect. The coefficient of the treatment variable equals 2.77

and is statistically significant at the 5%-level. The establishment of the UAS thus increases the probability of a job ad specifying R&D as main task by 2.77%. This effect is three and a half times as strong as the treatment effect of the full sample, highlighting that including occupations without any R&D intensity in the full sample dilutes the treatment effect. Moreover, the size of the treatment effect also suggests that mostly changes within technical and IT occupations drive our results[6]. Including industry and channel as additional controls in the fourth column, we only find that a marginal decrease in the effect size.

Our results show that firms react to the establishment of UAS by demanding more often R&D as main task in job ads for workers with VET diploma. When we restrict our sample to technical and IT occupations on the VET-level, we find a stronger treatment effect which shows that the increased focus on R&D concentrates on a certain subset of occupations. In addition to analysis of the quality dimension of jobs such as the tasks, we also examine whether the absolute number of job ads for workers with VET diploma changed. We do not find any evidence that the establishment of UAS reduced the number of jobs for workers with VET diploma[7]. In summary, the establishment of UAS changed the qualitative dimension of jobs for workers with VET diploma, but did not reduce the quantity.

[6] We performed DiD-estimations for the remaining occupations that are non-IT and non-technical. For this complementary subsample we find no treatment effect.
[7] We performed DiD-estimations with the absolute number of job ads (for worker with VET diploma) as dependent variable and find an insignificant effect by the establishment of UAS.

7 Conclusion

In this study, we examine how firms change their demand for tasks from workers with VET diploma in response to an expansion of tertiary education. To answer this question, we exploit the quasi-natural variation in the establishment of UAS, a large scale tertiary education expansion in Switzerland in the late 90s. UAS produce a novel type of graduate on the tertiary level that possesses a skill-set with a strong focus on applied R&D. Employing difference-in-differences estimations, we find that the increase in R&D activity on the tertiary level— induced by the influx of UAS graduates—also changed the tasks that firms demand from workers with VET diploma. The establishment of the UAS increased the probability that job ads for workers with VET diploma include R&D as main-task substantially. Our results therefore show that the establishment of UAS did not crowd out sophisticated tasks such as R&D in jobs of workers without tertiary education degree, but elevated the content of their tasks via a rising tide effect. Moreover, this change in the quality of tasks did not occur at the cost of reducing the total number of jobs for workers with VET diplomas.

To further investigate whether the increased focus of a particular subset of occupations on more sophisticated tasks drives our result, we restrict the sample on the occupations that conduct R&D, i.e., technical and IT occupations. These occupations on the VET level have a strong link to the work of UAS graduates. For the subsample of technical and IT occupations we find an even stronger treatment effect. The size of the treatment effect suggest that mostly changes within technical and IT occupations drive our results.

Finally, our results show that tertiary education expansion has positive effects on R&D activity for workers without tertiary education. This has implications for studies on tertiary education expansion and its effect on innovation. These studies focus mostly on the graduates of newly established tertiary education institutions and therefore might underestimate the total effect on R&D activity and innovation. Accounting for tasks spill-overs effects and including workers without tertiary degree in the analysis is important.

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Tables & Figures:

- Table 1 -

Main task: Analyzing, researching and controlling			
Activities			
Researching	Measuring	Controlling	Inspecting
Analyzing	Recording	Monitoring	Testing

- Table 2 –

Main tasks of UAS graduates

	UAS graduates	Rel. frequency
1.	Organizing & Leading	25.51
2.	Planning & Engineering	17.55
3.	Programming & IT	12.32
4.	Researching & Controlling	11.47
5.	Educating & Advising	9.38

- Table 3 -

	Dependent Variable
	$Prob(R\&D\ Task)$
TG	2.162
	(2.098)
1996*TG	-3.549
	(2.775)
1997*TG	-0.658
	(3.141)
1998*TG	-3.650
	(2.954)
1999*TG	-0.467
	(2.863)
2000*TG	-1.157
	(2.700)
Constant	0
	(1.928)
Observations	1,257
R-squared	0.004

Notes: Authors' calculations with data from the Swiss Job Market Monitor. Clustered Standard errors on the municipality level are reported in parentheses. Coefficients, standard errors, and sample means of dep. var. in columns are multiplied by 100 to represent percentage point changes. * p<0.10, ** p<0.05, *** p<0.01.

- Table 4-

	Dependent Variable			
	R&D Task			
	Full sample		Subsample: Technical & IT occupations	
Treatment	0.786**	0.777**	2.774**	2.410**
	(0.381)	(0.360)	(1.273)	(1.451)
TG	0.154	0.067	0.003	-0.828
	(0.419)	(0.421)	(1.553)	(1,451)
Constant	1.42	2.77	3.268	-0.547
	(0.999)	(1.305)	(3.413)	(3.510)
Years	YES	YES	YES	YES
Channel	NO	YES	NO	YES
Industry	NO	YES	NO	YES
Observations	9,123	9,123	1,886	1,886
R-squared	0.005	0.034	0.020	0.127

Notes: Authors‘ calculations with data from the Swiss Job Market Monitor. Clustered Standard errors on the municipality level are reported in parentheses. Coefficients, standard errors, and sample means of dep. var. are multiplied by 100 to represent percentage point changes. * p<0.10, ** p<0.05, *** p<0.01.

Figure 1: Trends in number of jobs with R&D as main task (1995=100)