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Classroom versus workbench: Labour market effects of firm-based learning

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Abstract

This study assesses the labour market effects of firm-based (or dual) vocational education and training (VET), i.e. when training takes place in a firm rather than in a school. Using Swiss administrative data, I compare the school-to-work transition between graduates of dual and school-based VET, both of whom have the same curriculum and diploma. To identify the causal effect, I rely on an instrumental variable strategy, using the distance to the nearest full-time VET school as instrument. The empirical analysis shows that dual VET is more effective in securing first employment, especially in occupations with loose labour market conditions as well as for men. However, dual VET graduates are less likely to progress to higher education, suggesting that both forms of VET have a comparative advantage. As for causal channels, heterogeneous results indicate that dual VET is particularly effective in developing noncognitive skills.

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1 Introduction

In many developed countries, young people are struggling to enter the labour market, and the Great Recession of 2008 certainly did not help. Youth unemployment rates and NEET rates are more than twice the corresponding adult rates in most countries (Biavaschi et al., 2012; Eichhorst et al., 2015; Quintini & Martin, 2006; Ripamonti, 2023). Moreover, the transition from education to work is one of the most important phases in a person's career, and difficulties can have a profound and lasting impact not only on future employment and wages (Arulampalam, 2001; Filomena, 2023; Schmillen & Umkehrer, 2017) but also on other outcomes such as health or substance use (Gariépy et al., 2022). Policymakers are therefore becoming increasingly concerned, warning that almost one-third of young people aged 15–29 are at risk of poverty or social exclusion (European Commission, 2016). In addition to this already challenging situation, there is growing concern that technological advances such as automation and, more recently, artificial intelligence, are profoundly changing labour markets and labour demand (e.g. Autor et al., 2003; Lane & Saint-Martin, 2021; Webb, 2019). Such changes are already visible today: For instance, social or noncognitive skills have become increasingly important in recent decades (Deming, 2017; Edin et al., 2022).

This raises the question of whether certain institutional differences in education systems are more effective for today's challenges. In German-speaking countries, for example, the youth unemployment rate is relatively low, which has led to the assumption that a well-developed vocational education and training (VET) system facilitates the transition into the labour market. While cross-national evidence supports such an association (e.g. Barbieri et al., 2018; Bolli et al., 2021), VET systems differ across countries (Kis, 2020), and not all forms may be equally effective. In particular, the venue where learning takes place could be important: firm-based or dual VET, where apprentices are mostly trained in firms, appears to be more effective in ensuring a smooth transition to work (Quintini & Martin, 2006). Moreover, on-the-job training enhances noncognitive skills such as teamwork, motivation, and conscientiousness (Adhvaryu et al., 2023; Birkelund, 2022; Halpern, 2008). Dual VET could therefore contribute to meeting the rising demand for these skills.

In this context, this study aims to determine the effects of firm-based training by comparing dual VET with school-based VET in Switzerland. At the Swiss upper secondary level, both forms of VET are available with the same structure and curriculum, and graduates of both forms receive the same diploma. This makes it possible to isolate the effects of the learning venue on various postgraduate outcomes, such as the number of days in employment, the number of NEET (not in education, employment, or training) days, and the likelihood of entering higher education. To identify causal effects, I rely on an instrumental variable approach and employ the commonly used distance to the nearest school as a source of exogenous variance.

I argue that Switzerland provides an ideal setting for studying the school-to-work transition. Several recent studies compare school-based and dual VET. To identify causal effects, most studies rely on a reform that introduced or promoted dual VET. Consequently, these estimations capture the outcomes of the reform, which may differ from the causal effects of the VET form in an established system. Schools that are the first to adapt to the reform may be the most successful and innovative. Indeed, while reform-based studies all report positive outcomes for dual VET, descriptive studies or those based on other identification strategies have produced mixed results (see Section 2.1). In most countries, school-based VET is the norm, whereas dual apprenticeships are the exception. In Switzerland, the opposite is true: Dual VET is far more widespread, and only approximately one in ten VET students attends a school-based programme. This allows me to examine the effects of dual VET in a country where VET is well established and well known to both employers and young people.

Furthermore, this study contributes to the literature by considering cognitive and, to some extent, noncognitive skills. To do so, I link the administrative register data to the PISA (Programme for International Student Assessment) 2012 sample, which enables me to control for these skills and, more importantly, to analyse heterogeneous effects across skill levels. Finally, I explore not only labour market outcomes but also the transition to higher education.

The results show a comparative rather than an absolute advantage: School-based VET graduates are more likely to remain in education and progress to higher education, whereas (dual) apprentices are more likely to be employed after graduation and have higher incomes. NEET periods are also more frequent among graduates of school-based VET, suggesting that some of them enter higher education due to a lack of employment opportunities. This reduced risk of NEET days among apprentices is heterogeneous and depends on the labour market and gender. The effect is more pronounced in occupations with loose labour market conditions, where firms can choose from many candidates. Under tight labour market conditions, firms cannot choose between candidates and therefore must employ both dual- and school-based VET graduates equally. Furthermore, although there is no descriptive heterogeneity, the causal effects are more pronounced for men than for women. Dual VET therefore appears to be most effective for young men who have little motivation to stay in school and who are at risk of not completing their upper secondary education.

I then examine the two main causal channels discussed in the literature and find that both play a role. In the first year after graduation, stayers—those who remain in their training company after completing their training—have a lower risk of experiencing NEET days. While this "signalling" effect diminishes in subsequent years, dual VET graduates still have a smoother transition from school to work and experience fewer NEET periods for up to three years after graduation. At the same time, additional regressions indicate that they are more successful during their training and graduate faster, suggesting that firm-based training is more effective at building skills (i.e. the human capital channel). My interpretation of these results is that firm-based learning is indeed effective in developing professional competencies and noncognitive skills in particular. This interpretation is supported by the observed heterogeneity: Poorly motivated VET students experience more NEET days if they graduated from a school-based VET programme, but not if they graduated from a dual VET programme.

2 Related literature

2.1 Dual vs. school-based VET

Many studies compare the labour market outcomes and returns of different types of secondary education, often VET and general education (for a discussion, see e.g. Eichhorst et al., 2015). However, such comparisons are difficult; for example, due to endogeneity, differences in objectives (general education typically prepares students for higher education, whereas VET prepares students for the labour market), or because estimating linear models may not capture general equilibrium effects (Bolli et al., 2021). In turn, several studies directly compare the labour market transition[1] between dual apprenticeship and school-based VET, thus isolating

[1]Several studies also look at other outcomes, particularly success in VET. For instance, Alet and Bonnal (2011) compare dual and school-based VET in France, focusing on the likelihood of dropping out, graduating, and participating in further education. They use regional differences in the availability of apprenticeships to identify the causal effects of dual VET and find that dual apprentices are more successful in their exams and more likely to continue their education. Bertrand et al. (2021) study Reform 94 in Norway, which expanded the firm-based training component in the Norwegian VET system by increasing the duration of in-company training, providing wage subsidies, and partnering with firms and trade unions. In addition, the reform streamlined the first year of VET programmes, integrated more general education, and introduced a pathway to universities. Bertrand et al. (2021) examine the impact of this reform via a

the effects of the two different types of training, as both lead to the same qualifications. These studies can be divided into two groups. First, recent studies use reform to identify the effect of the VET form, revealing that dual VET improves the transition to employment. Second, studies that do not rely on reforms yield more mixed results. In the first group, Noelke and Horn (2014) use a difference-in-differences framework to measure the effects of the Hungarian transformation from socialism to capitalism, which led to a shift in training provision from employers to vocational schools. This transformation had the opposite effect to that intended by most reforms: It shifted training from firms to schools, thereby reducing dual VET. The transformation increased the unemployment rate of males by 10 percentage points in the first two years after graduation, but the effect weakened thereafter. Corseuil et al. (2019) study the transition to work in Brazil after a reform passed in 2000 that greatly increased the number of dual apprentices. Their identification strategy exploits the initial age limit of 17 years to be eligible for the programme, which allows them to use age as an instrument in a regression discontinuity framework. They find that dual graduates are more likely to be in permanent employment in the short and medium term but are also more likely to return to education and complete their secondary education. Albanese et al. (2021) study the impact of a VET reform in Italy in 2003, which introduced on-the-job training instead of school-based training, a minimum wage, and an extension of the duration of the programme. Students in these reformed apprenticeships are less likely to drop out and more likely to be hired by the training firm after graduation. The authors argue that the introduction of dual elements drives these results. Finally, Bentolila et al. (2023) examine a reform in Madrid, Spain, which expanded dual VET at the tertiary level. They used a very similar identification strategy to that employed in this study: using the distance to the nearest school in the field of choice as a source of exogenous variance. The reform improved both employment and earnings but not the probability of being employed full-time or permanently.

Among the studies that do not rely on reforms, three support the finding of positive effects of the dual VET form. First, Winkelmann (1996) compare the transition to work of apprentices, university graduates, school-based VET graduates, and unskilled individuals and find that apprentices are more likely to be employed, especially those trained in large firms. Looking at the French system, Bonnal et al. (2002) compare dual and school-based VET and find that dual graduates are more likely to move directly into employment. Part of this effect is due to graduates staying in their training firm, but for men, among those who left the training firm, dual graduates also have an advantage over school-based VET graduates. Third, Parey (2016) reports lower unemployment probability for dual VET graduates in Germany but no differences in their earnings. He relies on an IV strategy using the regional supply of dual VET as an instrument.

Several articles present less positive conclusions about dual VET. Using Dutch data, Groot and Plug (1998) estimate structural equations for both apprentices and those in school-based VET. They then look at the long-term evolution of earnings and employment rates but find no significant differences between the two estimations. Horn (2016) rely on a selection-on-observables strategy to identify the effects of dual VET in Hungary and find no significant effect. Subsample analyses show that apprentices who organized their VET training are more likely to be employed immediately after graduation than those whose school organized the training. He asserts that the latter effect is due to signalling: Firms use self-organized apprentices as a signal of ability and are therefore more likely to hire them. Riphahn and Zibrowius (2016) estimate the

difference-indiscontinuity research design and find increased access and graduation probabilities due to the reform. Wages also increased slightly, particularly for disadvantaged men. de Amesti and Claro (2021) analyse whether dual and school-based VET differ in terms of the likelihood of receiving further education, as improved entry into the labour market may come at the cost of fewer transitions to tertiary education. Notwithstanding, they find the opposite: Apprentices are 3.3 percentage points more likely to enter tertiary education.

earnings and employment probability of VET graduates compared to those without VET and revealed positive effects. However, they do not observe significant differences between dual- and school-based VET graduates. Using a dynamic discrete choice model, Neyt et al. (2020) study three types of VET in Flanders: school-based dual programmes with an apprenticeship; school-based dual programmes without an apprenticeship; and training centre-based dual programmes with an apprenticeship. In the first two, the students spend two days in vocational schools; in the last two, they spend only one day at a training centre. The remaining days they are employed in firms, except in the second programme, where they follow a preliminary phase in a Centre for Part-time Training (PTE). They find that only the last programme increased the likelihood of being employed after graduation.

2.2 Causal mechanisms and hypotheses

Why might there be differences in the school-to-work transition between dual and school-based VET? The literature discusses two main channels—human capital development and signalling, the same channels that are explored as drivers of the return to education (Aryal et al., 2022).

Based on Becker (1962), the *human capital* channel suggests that dual and school-based training may differ in the resulting skills and abilities of the training and thus lead to different levels of productivity. For example, firm-based, hands-on training may be better at cultivating practical and problem-solving skills, which may then be rewarded by employers. The opportunity to apply theoretical knowledge in the workplace might add relevance to learning and increase the scope for learning and the apprentice's motivation, especially for those who are struggling (Alet & Bonnal, 2011; Ryan, 1998). On the other hand, there are also arguments in favour of school-based VET. For example, apprentices spend a considerable portion of their training doing unskilled work, leaving more time for school-based students to improve their skills.

In contrast, Spence (1973) suggests that educational attainment acts as a *signal* of individual productivity. Employers may thus retain their most suitable apprentices because they already have information about their productivity and can thus save on screening costs. Cahuc and Hervelin (2024) provide experimental evidence of this channel by sending similar fictitious applications for job offers as a bricklayer and a cook, varying only the VET pathway: either a school-based VET (with internships) or a dual apprenticeship. Comparing the probability of recall, they find no statistically significant difference, except in regions with high unemployment rates. Comparing empirical retention rates and wages, they argue that the lower unemployment rate of apprentices than of school-based VET graduates is almost entirely due to apprentices staying in their training firms (i.e. the signalling channel), whereas there is little difference in productivity.

In the context of returns to schooling, the signalling mechanism is inefficient as additional years of schooling do not translate into higher productivity (Aryal et al., 2022). In our context, this claim is less valid as both dual and school-based VET have the same duration. Nevertheless, the human capital channel would establish a stronger advantage as the form of training would affect not only transaction costs (for screening) but also productivity (Horn, 2016). If so, how might the form of VET affect an individual's productivity? Considering the literature, it seems unlikely that the type of VET affects cognitive skills but rather noncognitive or occupation-specific skills. While cognitive skills are formed early in life and remain relatively stable, noncognitive skills are more malleable and more likely to be affected during secondary education (Brunello & Schlotter, 2011; Heckman & Carneiro, 2003; Hoeschler et al., 2018; Kautz et al., 2014).

Indeed, there is evidence from developing countries that on-the-job soft skills training increases productivity (Adhvaryu et al., 2023). Studies on VET systems have shown that firm-

based VET permanently reduces emotion-centred coping strategies (Bolli & Hof, 2018) and significantly increases conscientiousness (Birkelund, 2022). There is also qualitative evidence in favour of dual vocational training. For example, Halpern (2008) shows that US apprenticeship programmes are suitable for learning both noncognitive and occupational skills, such as expertise in an occupation, problem-solving, self-confidence, teamwork, discipline, and the ability to take direction and initiative. In Switzerland, Zulauf and Gentinetta (2008) interviewed 10 experts, 90 adolescents, and 31 firms about the form of VET. They suggested that employers prefer dual graduates (29 firms) over school-based graduates (2 firms), whereas many also have no particular preference (20 firms). Firms expect dual apprentices to have acquired greater innovation abilities. The important criteria for hiring apprentices are personal, occupational, and social skills, while firms do not pay much attention to grades. Likewise, Wehner et al. (2022) also show that employers value noncognitive skills, especially conscientiousness and agreeableness.

3 Institutions

In Switzerland, compulsory education lasts for 11 years, usually[2] divided into 2 years of kindergarten, 6 years of primary school, and 3 years of secondary school. In most cantons, lower secondary schools are divided into basic and advanced tracks. In addition, many cantons have a baccalaureate track that prepares students for general education baccalaureates, and some cantons have introduced mixed tracks. Most graduates from the basic track go on to VET, whereas graduates from the advanced track are eligible for the baccalaureate under certain conditions.

3.1 VET and apprenticeships

After completing compulsory education, more than half of the cohorts start a VET programme.[3] More than four out of five started a dual apprenticeship.[4] They must first decide which of the 240 or so occupations they are interested in. Then, they search for and apply for apprenticeships offered by eligible firms. The application process is very similar to a normal job application and usually includes an application letter, interviews, job shadowing, and sometimes an aptitude test. Once the most suitable candidate has been selected, the training firm and the apprentice sign a special apprenticeship contract that protects the latter. All data on VET are collected by the government from apprenticeship contracts, which makes the data highly reliable.

Dual apprentices spend 1–2 days a week in vocational schools, where they receive both general education and occupation-specific courses. For the remaining 3–4 days, the apprentices work in the firm and receive hands-on training. Apprenticeships last 3–4 years[5], depending on occupation. Apprentices start out doing unskilled work and gradually take on more skilled tasks as they improve their abilities.

[2]As education is governed by the cantonal authorities and not at the national level, there are some differences between the cantons. For the same reason, the criteria for admission to the lower secondary tracks and baccalaureates also vary.

[3]The exact proportions depend on how many years after leaving school are considered, as many who end up in a VET programme do not move on directly from compulsory schooling but first attend a so-called bridge year programme or skip one or more years. For example, among the cohort that graduated in 2018, 63% attended a VET programme by 2021, and 26% attended a GE school.

[4]Since I have omitted occupations with only dual VET students, the school-based share is 14.4% and thus higher in the empirical sample.

[5]There are also 2-year programmes called EBA, which are designed for cognitively less abled people. However, as these are special programmes and there are few school-based students, I excluded them from the sample

School-based VET, on the other hand, is organized in cantonal learning centres or commercial schools. Consequently, students usually sign VET contracts with these institutions and not with firms. Likewise, the costs of practical training are borne by the state, whereas for apprenticeships, these costs are borne by companies (which primarily consist of trainers' salaries). Since apprentices perform various tasks for firms, most of these costs are recovered. For the public sector, apprenticeships are therefore much less costly and more efficient.

Apart from these differences implied by the learning venue, the two forms are very similar. Students in both forms take the same exams and receive the same diploma upon graduating. School-based VET students often attend some form of internship where they also receive practical training. If demand exceeds the number of spots available, applicants for school-based VET are often selected based on their performance. However, some institutions reserve a proportion of all vacancies for students from the catchment area who cannot find an apprenticeship. School-based VET is far more common in the French-speaking part of Switzerland for historical reasons. The watchmaking industry, for example, set up facilities early on to recruit and train future employees.

In the main sample, 58 out of 223 occupations have both school-based and dual VET offerings, covering 58% of all VET students. The most common occupations without school-based VET are closely related to customer service, such as retail professionals, licenced electricians, chefs, or hairdressers. To avoid bias due to the effects of these pure dual training occupations, I exclude them. There are a few occupations in which more than half of all students are in a school-based programme, such as clothing designers, graphic designers, or watchmakers. In the most popular occupation—commercial employee—, approximately 21% are in school-based training.

Not every student who starts a VET programme successfully completes it. Approximately one in five terminates the contract, usually due to moving on to another occupation. Who moves within the VET system and who drops out is complex and involves many factors, including the quality of training, grades, motivation and satisfaction with the programme, and noncognitive skills (Bessey & Backes-Gellner, 2015; Krötz & Deutscher, 2022; Lüthi & Wolter, 2023; Müller & Schweri, 2009).

3.2 Transitioning after graduation

Most VET graduates find jobs quickly: For example, 6 months after graduation, almost 70% of the 2011 cohort were working, 14% were studying, and 12 % were unemployed or NEET. Some graduates, mostly males, enter compulsory military service. Few graduates pursue tertiary education, but this share expands sharply in the following years. Five years after leaving VET, 44% of the main sample has been in tertiary education at some point[6]. Of these, most enter either a university of applied science (UAS, in German *Fachhochschule*) or professional education and training (PET, in German *Höhere Berufsbildung, HBB*). To be admitted to a UAS, VET graduates must complete a vocational baccalaureate, which can be done either during the apprenticeship (in which case the students spend one day a week in school) or afterwards. Few VET graduates (<5% of the sample) enrol at university or a university of teacher education. Attending a university requires passing an additional exam called *Passerelle*. Attending a PET, on the other hand, does not require an additional degree but does require some work experience. As a result, most PET students are already employed during or before their studies, and VET graduates typically do not attend directly a PET program but do so later in their careers.

[6]This includes students who did not graduate but dropped out of tertiary education

4 Data and methods

4.1 Data sources and sample

Several data sources are used for the analysis. The main database contains Swiss administrative data; it is called *Longitudinal Analysis in Education* (LABB). Since 2011, all educational pathways have been available for every individual in a formal education programme in Switzerland. These data thus include all apprentices, their transition through education, and their degree attainment. I match these individuals with spell data from the social security system, which indicate their labour market status, whether they are employed, studying, serving in the military, receive disability insurance, are registered as unemployed, or are NEET. Each spell also contains a company account number, which allows me to identify whether a VET student remained in the same firm after graduation or moved to another firm. In chapter 5.4, I make additional use of the PISA 2012 dataset, which I link to the LABB data. This provides data on cognitive (and to some extent noncognitive) skills, allowing me to increase the robustness of the results and for interaction effects. In addition, income data are available for this PISA subsample, indicating the annual net income as declared to the social security authorities. Unfortunately, no information on working hours is available, so it is not possible to calculate full-time equivalent incomes.

The main analysis is based on the entire cohort that completed compulsory education in 2011. This is the first cohort available in the LABB dataset and thus includes the longest period after graduating from VET. This allows me to examine the labour market status for up to five years after graduation (depending on the actual year of graduation). In addition, the PISA data mentioned above are available for a subsample of this cohort.

The total cohort consists of 84,798 students. A total of 4,216 left Switzerland during the observation period, whereas 35,441 did not choose a VET programme as their initial post-compulsory education, leaving 45,133 individuals in the sample. Of these, 12,990 individuals chose an occupation in which all trainees were in a dual programme. Since this study compares dual with school-based VET, I exclude these dual-only occupations. A total of 2,708 individuals did not complete their VET; hence, I also exclude them. For a further 1,790 people, some data are missing, mostly the spell data or the municipality of residence. Appendix C shows a balance test for missing data. Excluding those cases with missing data left a main sample of 28,066 individuals. Because some individuals graduated later due to repetitions or programme changes, the sample size decreased for outcomes with longer observation periods (i.e. the third or fifth year after the year of graduation).

4.2 Identification strategy

Compared with other school choices, the choice between school-based and dual VET does not seem to be strongly influenced by personal factors (see chapter 4.4). Nevertheless, some selection may still take place, for example, based on noncognitive skills that are not observed. Therefore, I rely on an instrumental variable strategy to identify and isolate the causal effect of the VET form, using as instrumental variable the distance between the residence of the individual in the last year of compulsory education and the nearest full-time vocational school offering programmes in the field of choice. Since its introduction by Card (1993), the distance to an educational institution has often been used as instrument (e.g. Kramer & Tamm, 2018), also in the context of VET (Andersson et al., 2014), and there is evidence that the distance does indeed affect the likelihood of participation (Frenette, 2006; Spiess & Wrohlich, 2010). Figure 3 in the appendix shows the locations of all the schools, which are spread across the country, with fewer schools in the mountainous parts of southern Switzerland. Many offer dual and

school-based VET, but especially in German-speaking areas, there are often dual schools in rural areas and those offering both forms in urban centres.

In a similar paper, Bentolila et al. (2023) used proximity to the nearest dual VET school as instrument to identify the effects of dual VET compared with school-based VET. In contrast to their IV, I do not use the distance to dual VET schools but rather to school-based VET institutions, which is more appropriate in the Swiss context. The crucial feature here—which distinguishes the VET systems found mostly in German-speaking countries from school-based forms of VET—is that the supply of dual VET is driven entirely by firms and professional associations and not by public authorities. Firms are free to offer training places for occupations in their sector. The cantons, on the other hand, are obliged to provide vocational schooling for all occupations in which the firms train. During their training, dual apprentices spend most of their time at the employer's premises rather than in vocational schools. As a result, school leavers do not choose a particular vocational school but apply directly for apprenticeships offered by companies. If they are hired by these companies, they are automatically enrolled in the corresponding vocational school. For this reason, the largest online platform for VET vacancies (https://www.berufsberatung.ch) shows the location of the company but not the location of the school.

In the case of school-based VET, the incentive stemming from proximity to schools is different: Here, school leavers apply directly to schools. Candidates living in the vicinity therefore tend to have more information about these schools and programmes, for example, through their peers, teachers, career advisers, or parents. VET students tend to live with their parents and are unlikely to move to another location to pursue their education. Since firms can be located anywhere, providing dormitories or shared accommodations for VET students is less feasible as it is common in the university context. As a result, VET students are more likely to be restricted to programmes that are accessible from their parents' place of residence, and consequently, proximity is likely to be a stronger instrument in a VET context than at the tertiary level. Like Bentolila et al. (2023), I do not consider the proximity to any school-based VET institution but only to institutions that offer VET programmes in the same occupational field as the one that the individual has finally chosen. If an individual is interested in technology, for example, a nearby school that only offers VET in healthcare will not be an incentive to attend that school.

The exclusion restriction in this setting is that proximity is not correlated with the outcomes—tertiary enrolment, the number of working days, and NEET days—in any way other than through the form of VET. This restriction would be violated if the school locations were endogenous, i.e. if the schools were systematically placed in strategic locations. There are several reasons why this might be the case. First, as mentioned above, school-based VET is more common in the French part of Switzerland, and distances to schools are thus lower there. This difference is due primarily to historically different policy choices and is unlikely to be correlated with local labour market outcomes. Nevertheless, I use control variables that capture regional labour market conditions and, most importantly, a dummy for each of the three language regions. Thus, all estimates capture effects only within the language regions. Second, schools are often (but not always) located in urban areas. Hence, labour market conditions may differ from those in rural areas. For this reason, I include dummies that capture the type of residence (urban, agglomeration, or rural). Moreover, I include the population number at the municipal level to control for its size.

The chief concern regarding the exogeneity of the instrument is that certain schools may have been deliberately opened in certain strategic locations. The flourishing watchmaking industry in some regions of French-speaking Switzerland, for instance, was responsible for the opening of training centres at the beginning of the 19th century (Imdorf et al., 2016). Today, however, such strategically located schools are the exception. Most school-based VET programmes are

in the commercial sector and are therefore the same as their dual counterparts. The resulting bias is thus likely to be small, if any. In contrast to most of the other studies mentioned in the literature section, dual VET in Switzerland is predominant, and school-based VET is the exception. In turn, we would expect a bias in favour of school-based institutions. If schools are opened strategically, they will be in places where there is a high demand for workers in this field and a correspondingly low unemployment rate. As such, the estimates would capture better labour market outcomes for school graduates. Thus, the regressions can be interpreted as lower bound estimates, and the causal part may be slightly less favourable for school-based VET. For example, school-based VET graduates are approximately one month more NEET than their dual VET counterparts are. Since strategically located full-time VET schools would reduce this estimate, the true effect could be even greater.

Formally, I apply the following 2SLS estimates:

$$Y_i = \beta_0 + \beta_1 \widehat{sb}_i + X_i'\beta + \gamma_j + \delta_r + \epsilon_i \tag{1}$$

where Y_i is the outcome for individual i, X_i is a matrix with regional and individual controls, γ_j represents the sector fixed effects in field j, δ_r denotes the language region fixed effects, and ϵ_i embodies the error term. $\widehat{sb}_i$ is a binary variable referring to school-based VET derived from the first-stage regression:

$$sb_i = \pi_0 + \pi_1 dist_{is} + \pi X + \gamma_j + \delta_r + \varepsilon_i \tag{2}$$

where $dist_{is}$ indicates the distance between the residence of individual i at the end of compulsory schooling and the nearest school-based VET institution in the field of choice. As this indicator is skewed to the right, I transformed the variable by taking its root. Compliers are individuals who attend a school-based programme due to the proximity of the VET school, which offers a programme in their chosen field; and would otherwise attend a dual VET programme. School leavers typically choose their preferred type of education and occupation first, and only then may it matter whether the programme is offered at a school or a company. In other words, they do not have a strong preference regarding the form of VET, which is why the selection effect is comparatively weak (see chapter 4.4). We can therefore expect a large group of compliers. Indeed, if I dichotomize the distance variable at the mean distance ($dist = 1$ if the distance is < 71 km) and assuming that there are no defiers, the size of the complier group would be $E[sb_i|dist_i = 1] - E[sb_i|dist_i = 0] = 0.239$, i.e. almost a quarter.

4.3 Variables and descriptive statistics

In all analyses, this study follows the cohort that completed compulsory education in 2011. For each individual, I examine the first post-compulsory education at the ISCED 3 level. Not all school leavers enter upper secondary education directly: Some take a gap year or attend a transitional programme, the latter being quite common. All individuals who started immediately (in the school year 2012/13) and one year later (in the school year 2013/14) are considered.

4.3.1 Independent variables

The main variable of interest is whether the students choose a school-based VET programme *(School-based = 1)* or a dual apprenticeship *(School-based = 0)* as their first educational experience at ISCED level 3. School-based programmes are defined by the Federal Statistical Office (FSO) as "training in a school or purpose-analogue institution which organizes the training course (the totality of theoretical and possibly practical subjects) in such a way that it is in principle

the main occupation of the students." I excluded all individuals who chose general education or a two-year VET programme as their first educational experience.

I use several control variables to describe the labour market as well as individual and occupational characteristics. Regarding the labour market, I employ four variables: First, the labour force participation rate in each region *(LFP rate in the region)*, which corresponds to the share of the employed population of working age in the region and year in which the student lived at the time of leaving VET. Second, *Regional unemployment* is the unemployment rate (registered unemployed as a share of the labour force) in the region and year in which the student was living at the time of leaving VET. Third, I include a dummy for each type of residence in the year of graduation: urban, agglomeration, and rural areas. Finally, I include a variable that measures the population of each municipality (*Population in munip.*).

The transition to work depends not only on regional labour market conditions but also largely on the situation in the different industrial or commercial sectors. As such, I include control variables describing the chosen programme for each individual. First, I include a dummy for each 3-digit ISCED occupation field (19 fields in total). I argue that the occupational field depends purely on the preferences of the subjects. The specific occupational choice, on the other hand, may be affected by what offerings are available nearby and is not exogenous to the treatment (the form of VET). Hence, I include fixed effects for the occupational fields only but not for the occupations, as the latter would constitute a mediator rather than a confounder. Second, I include the *employment rate in occupation* as a control to ensure that it would not be the occupation-specific unemployment likelihood that drives the results (see chapter 5.3.1 for a description of this variable).

For individual characteristics, I include five control variables. *Female* is a dummy for female individuals. *Age* is the age of the individual in 2021. *Basic track*, *Advanced track*, and *Mixed track* are dummies indicating the individual's track at the lower secondary level. As mentioned in Chapter 3, students in Switzerland are usually tracked into either the basic or advanced track. Some cantons have mixed classes instead. *Started in 2013* is a dummy indicating students who took a gap year or transitional year after compulsory education. In addition, I include a dummy referring to foreign residents, called *Foreigner*. Finally, I include a dummy for the French- and Italian-speaking parts of Switzerland.

4.3.2 Outcomes

In addition to the school-to-work transition, I also examine whether the form of VET affects the likelihood of advancing to higher education (mostly universities of applied sciences [UAS]). Although the tertiary level also includes PET students, I do not take them into account and look specifically at those in higher education.[7] First, PET students are usually already employed. Consequently, dual VET graduates may be more likely to start a PET programme as they are more likely to be employed. Second, employees typically enter a PET programme after a few years of employment, whereas I am mostly interested in the transition immediately after VET graduation. Finally, the inclusion of PET students may bias the results. PET courses can be offered by any institution as the programmes are certified by the authorities and not the institutions. As such, some schools offering school-based VET also offer PET courses. This could lead to an omitted variable bias if students attend these PET schools due to proximity rather than because of being in school-based VET. To offer UAS programmes, however, the institutions must be certified. As a result, there are far fewer UAS institutions.

I estimate the effects on three main outcomes. The first outcome, *in higher education*, is a

[7]Higher education includes universities, universities of teacher education, and UAS. The first two are usually attended by GE graduates, so there are few such cases in the sample.

binary variable indicating whether individuals have enrolled in higher education, usually in a UAS. I consider three time periods: those who enrolled in a UAS in the first year after leaving VET, those who enrolled in the first three years, and those who enrolled in the first five years.

Second, I calculate the total number of days of employment after graduation *(employed days)*. Again, I look at three periods: the number of days in employment in the first year after graduation, in the third year (excluding the first and second years), and in the fifth year (excluding years 1–4).

Third, I calculate the number of *NEET days* on which the individual was neither employed nor in education. I calculate these days for the same 3 one-year periods as above. As I am interested in differences in NEET days among graduates in the labour market, I exclude individuals who were in any form of tertiary education (higher education and PET) during the period considered.

Some VET graduates go on to military service, which is compulsory for men and usually lasts 18 weeks. Those in the military are not NEET, which could affect the results, especially the interaction effects with gender. To correct for this, I extend the corresponding one-year periods by the length of service for those who were in the military.

In Section 5.2.2, I use four additional outcomes to examine the channels that drive the results. First, I examine whether the VET student failed the final exam (called *Failed exam*). This is not that common; in my sample, only 4.7% failed the exam at least once. These individuals usually try to pass a year later. Second, I use a dummy to indicate who changed their VET programme (called *Changed programme*). This dummy is equal to 1 if the occupation in which the individual graduated is not the same as the occupation in which he/she started. Third, I calculate the *Time to graduation*, defined as the number of days between the start of the first upper secondary educational experience and the date of first graduation from upper secondary graduation. While apprenticeships usually last three or four years, the actual duration is often considerably longer. Many VET students change their training occupation, whereas some only change employers and continue in the same occupation. Some students also repeat a year. Fourth, I use a proxy for *mobility* after graduation. This variable indicates the number of different companies in which the individual was employed in the first three years after leaving VET.

4.3.3 Descriptive statistics

The descriptive statistics for all the variables are presented in Table 9. In Table 1, I contrast the means of the main outcome variables between dual- and school-based VET graduates. This descriptive evidence already shows large differences between the two. While more than half of school-based VET graduates attend higher education in the first five years after graduation, fewer than a quarter of dual VET graduates do so. On the other hand, dual VET graduates have almost twice as many working days as do school-based VET graduates in their first year after graduation. In the first, third, and fifth years after leaving school, they have only approximately half as many NEET days.

4.4 Selection into apprenticeships

Do certain students systematically select into dual or school-based VET programmes? Previous studies have reported little or no systematic selection (e.g. Fersterer et al., 2008; Groot & Plug, 1998). Bonnal et al. (2002) found that those who did not obtain their first qualification in general education and those whose father was self-employed or a manual worker were more likely to be in apprenticeships.

Table 1: Descriptive differences

	Dual		School-based			
	Mean	StDev	Mean	StDev	Diff	P-value
In higher edu. 1st-5th year	0.219	0.414	0.538	0.499	-0.319	0.000
Employed days 1st year	248.391	144.496	141.230	149.780	107.161	0.000
NEET days 1st year	37.771	73.377	91.028	119.313	-53.258	0.000
NEET days 3rd year	28.940	72.256	68.087	115.651	-39.146	0.000
NEET days 5th year	23.129	70.137	49.373	107.481	-26.244	0.000

To provide evidence for the Swiss case, Table 2 presents the first-stage regressions from Table 3 (Specification B2) and 7 (Specification 2). As stated above, the availability of VET forms differs in Switzerland, as French regions have historically provided more school-based VET. Moreover, the supply of dual apprenticeships is likely to depend on labour market conditions (Muehlemann & Wolter, 2011). Indeed, the corresponding coefficients (*LFP rate in the region* and *regional unemployment*) are highly significant.

Table 2: Selection into school-based VET

	Entire cohort		PISA subsample	
	(1)		(2)	
School-based VET = 1; dual VET = 0				
Distance to school	-0.023***	(0.001)	-0.031***	(0.002)
Cognitive skills			0.004	(0.004)
Low motivation			0.002	(0.004)
LFP rate in region	-0.037***	(0.001)	-0.043***	(0.003)
Regional unemployment	-0.013***	(0.002)	-0.030***	(0.009)
Female	-0.067***	(0.005)	-0.043***	(0.016)
Age	-0.027***	(0.003)	-0.036***	(0.009)
Advanced track	0.005	(0.004)	-0.018	(0.015)
Mixed track	0.025***	(0.010)	-0.010	(0.023)
Agglomeration	0.008	(0.005)	0.029*	(0.015)
Rural	0.015***	(0.006)	-0.007	(0.018)
Started in 2013	-0.055***	(0.005)	-0.089***	(0.015)
Foreigner	0.010*	(0.006)	0.035**	(0.018)
Unemployment rate in occupation	0.097	(0.107)	0.183	(0.490)
Population in munip.	-0.000	(0.002)	-0.001	(0.006)
French Switzerland	0.128***	(0.009)	0.144***	(0.024)
Italian Switzerland	0.055***	(0.017)	-0.028	(0.040)
Constant	4.057***	(0.122)	4.804***	(0.342)
Observations	28066		3456	

First stage regressions from Table 3 (Specification B2) and Table 7 (Specification 2). Language region FE and occupational fields FE are included, but their coefficients are omitted. * p <0.1, ** p <0.05, *** p <0.01.

On the demand side, the potential selection effect is a priori less clear. As the degree and the curriculum are the same for both forms, there is less incentive for a strong preference than, for example, the choice between VET and general education. The correlations suggest that

female students (who are generally underrepresented in VET), older students, and those who delay their entry into the upper secondary level are more likely to start an apprenticeship. Specification (2) shows the first stage of a subsample regression, in which I matched the PISA data. However, cognitive skills and motivation do not play a role, and both coefficients are essentially zero.

5 Results

In this chapter, I first present the main result—the different transitions into employment or further education—depending on the form of VET. I then discuss the causal mechanisms of the main results and the heterogeneity of the effects. In Section 5.4, I re-estimated the main finding via the PISA 2012 subsample, which allows for the addition of controls for individual ability, thereby increasing robustness.

5.1 Transition after graduating

One advantage of the Swiss VET system is its permeability to tertiary education: Graduates of the vocational baccalaureate (VBac) have direct access to a UAS, and even those who have obtained a VET diploma without a VBac can attend PET. As such, there are three primary postgraduate activities: entering higher education, starting employment, or neither. Some graduates also remain at the secondary level and start another educational programme, often a second apprenticeship in a different occupation, or the GE baccalaureate. I discuss these issues at the end of this section.

Table 3 shows the extent to which these activities are pursued, comparing school-based and dual graduates. As already seen in the descriptive evidence, attending a school-based VET programme involves a trade-off. On the one hand, school-based graduates are between 9 (in the first year after graduation) and 19 percentage points (in the first five years) more likely than apprenticeship graduates to enter higher education (Panel A). The average marginal effect (OLS) is greater than the local average treatment effect (IV), suggesting that there is some selection effect driving the OLS coefficient (see the next section).

On the other hand, school-based VET graduates are less likely to be employed (Panel B). In the first postgraduate year, they spend 104 days (almost a third of the year) less in employment. The causal effect is considerably larger than the OLS coefficient in the first year, but the difference shrinks in the third year. This implies that the early OLS coefficient is downwards biased by an unobserved factor. By the fifth year after leaving VET, the causal effect is no longer significantly different from zero, indicating that the relationship weakens over the years.

The results thus far hint at a comparative advantage: School-based VET induces graduates to remain in education, whereas dual VET prepares them more effectively for employment. Staying in education, however, may not always be voluntary: School-based VET graduates might enrol in higher education because they cannot find a job. If this is the case, we would also expect them to more often be NEET. Panel C shows that this is indeed the case. In the first two of the three periods considered, school-based VET graduates are over a month longer NEET. This is a strong effect, given that the effect size is roughly the same as the average number of NEET days (see Table 9). Dual VET is therefore more effective in terms of the transition from school to work, but the advantage is present only in the short term: no difference in the fifth year after graduation is observable. This implies that school-based VET graduates have more difficulty finding their first job, but once they (also) have some work experience (or have opted for tertiary education), the form of their initial VET programme no longer matters. Moreover, the number of NEET days declined over time for the whole sample.

Table 3: Main results

	First year		Third year		Fifth year	
	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV
A) In higher education						
School-based	0.141***	0.089***	0.251***	0.154***	0.258***	0.194***
	(0.007)	(0.024)	(0.009)	(0.040)	(0.011)	(0.054)
Observations	28066	28066	27567	27567	23872	23872
F-Statistic (first stage)		762.3		738.0		561.6
B) Work days						
School-based	-67.016***	-104.211***	-75.305***	-88.562***	-40.059***	-19.572
	(3.040)	(15.940)	(3.315)	(17.496)	(4.048)	(21.780)
Observations	28066	28066	27567	27567	23872	23872
F-Statistic (first stage)		762.3		738.0		561.6
C) NEET days (excluding individuals on tertiary level)						
School-based	33.972***	35.265***	25.152***	35.837**	20.243***	-12.164
	(2.416)	(10.829)	(2.962)	(14.099)	(3.946)	(18.139)
Observations	24489	24489	18460	18460	12496	12496
F-Statistic (first stage)		583.6		383.2		220.8

OLS and 2SLS estimators with robust SE in parentheses. Dependent variables: (A) In tertiary education up to the first, third, or fifth post-graduation year = 1, if otherwise = 0; (B) Number of days in employment during each one-year period; (C) Number of NEET days during each one-year period. In (C), individuals who started tertiary education are excluded from the sample. Included controls: LFP rate in region; regional unemployment; gender; age; lower secondary track; urbanity; late entry; foreigners; language region dummies; population in municipality; occupation field dummies, unemployment rate per occupation. The instrument is the distance between the residential municipality during the lower secondary level and the nearest full-time VET school in the field of choice. * p <0.1, ** p <0.05, *** p <0.01.

Some VET graduates remain in school but do not advance to higher education and instead start a second programme at the upper secondary level. However, this is rare: Only approximately 5% in the sample did so (Table 9). In Table 11 in the Appendix, I estimate whether the probability of remaining in secondary education would be affected by the form of VET. In the first and fifth years after leaving school, no difference is observable. Only in the third postgraduate year are graduates of school-based programmes more likely to continue in upper secondary education, with the IV coefficient being significant at the 5% level. This effect could again be caused by a lack of employment opportunities for graduates of school-based programmes, who then decide to change their career path.

5.2 Causal mechanisms

5.2.1 Attending higher education

Why are school-based VET graduates more likely to attend higher education institutions? There are several possibilities.

(1) First, the choice of a particular VET programme may affect the transition to higher education. For example, adolescents who plan to do so might specifically choose a school-based VET programme (Zulauf & Gentinetta, 2008). Similarly, full-time VET schools may offer

spots for training in more popular occupations, for which there are often few dual apprenticeship positions. This could lead to an oversupply of workers in these occupations, forcing them into higher education. However, this channel would only be captured by the OLS estimator and not by the IV estimator, and could thus explain the larger OLS coefficients above.

(2) Second, graduates from school-based VET may not find any employment opportunities, not because of the chosen occupation but because firms prefer graduates from dual VET. In turn, they may have no other option but to remain in education.

(3) Third, the form of VET may affect preferences. Having already worked in a firm during an apprenticeship might increase the motivation to obtain a permanent job. Conversely, being in a school-based VET programme might increase the preference to remain in school for a few more years.

(4) Fourth, in the Swiss case, access to higher education may differ: To enter a UAS, a vocational baccalaureate (vBac) is needed. Although companies should, in principle, allow their apprentices to attend the vBac during their apprenticeship, those who do so will be away from work half a day to one day more per week. Firms therefore have an incentive to take on apprentices who do not plan to attend the VBac at the same time as they will have more time to carry out productive tasks in the firm.

Indeed, Table 12 in the Appendix shows that school-based VET graduates are more likely to have completed a VBac during VET (Panel A). The OLS coefficient is significantly larger than the IV coefficient, indicating that VET graduates who intend to enrol in higher education are more inclined to opt for a school-based programme from the outset. However, this selection effect does not explain the entire difference, and the LATE of school-based VET programmes is over 24 percentage points. There are probably multiple reasons for this effect; for example, some firms prefer hiring apprentices who do not plan to attend a VBac as they are less absent from work and therefore more productive. School-based VET programmes, on the other hand, are sometimes offered with mandatory VBac participation. Since schools cannot recoup parts of the training costs via productive work, their incentive is to have as many students in VBac as possible since this lowers the costs.

In Panel B, I estimate the probability of attending higher education among those who graduated with a VBac1 and thus had direct access to a UAS. Within this subgroup, no (causal) effect is observable. Hence, at least a large part of the observed effect is due to Channel (4).

However, while there is no descriptive difference (Column 3 in Table 12) between school-based graduates and dual graduates attending a VBac *after* leaving VET, the causal effect (Column 4) is highly significant. Thus, school-based VET graduates are more likely to attend a VBac not only during but also after their VET programme. At the same time, they are more likely to encounter NEET days and start secondary-level education. This suggests that Channel (4) is not the sole driver of outcomes and that channels (2) and (3) may also influence the transition to higher education.

5.2.2 School-to-work transition

As mentioned in Section 2.2, there are two primary channels discussed in the literature to explain why the school-to-work transition may differ between graduates of school-based and dual VET. Both channels are addressed in this section.

Screening

First, the *screening* or *signalling* channel assumes that firm-based VET could help firms gain information about the ability of their apprentices and in turn retain the most suitable ones. In this way, firms save on the costs of screening when hiring their employees. To determine whether this is the case, I consider such stayers as intermediary variable. I examine who stayed and who left the training firm using the account number in the spell data. This account number identifies the firm unit that provided the data to the Social Security Administration, thus allowing me to determine who stayed in the same firm after completing their apprenticeship. I define a VET graduate as a stayer if he/she spent more than 31 days after graduation in the same firm in which he/she was employed during the VET programme. This measure excludes individuals who stay for only 1 or 2 weeks, such as before starting a new job or military service.

Table 4: Screening effect

	First year		Third year		Fifth year	
	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV
A) NEET days, controlling for stayers						
School-based	29.101***	26.656**	22.113***	29.935**	18.202***	-17.387
	(2.418)	(11.298)	(2.964)	(14.780)	(3.936)	(18.866)
Stay in training firm	-16.392***	-16.632***	-10.157***	-9.517***	-6.360***	-8.812***
	(1.023)	(1.475)	(1.165)	(1.658)	(1.358)	(1.856)
Observations	24489	24489	18460	18460	12496	12496
F-Statistic (first stage)		550.1		362.3		212.7
B) NEET days, sample without stayers						
School-based	35.060***	42.686***	25.847***	36.710**	24.031***	8.242
	(2.894)	(12.040)	(3.512)	(15.047)	(4.616)	(17.440)
Observations	12350	12350	8936	8936	5821	5821
F-Statistic (first stage)		495.7		336.3		207.8

OLS and 2SLS estimators with robust SE in parentheses. Dependent variable: Number of NEET days during each one-year period. Individuals who started tertiary education are excluded from the sample. Included controls: LFP rate in region; regional unemployment; gender; age; lower secondary track; urbanity; late entry; foreigners; language region dummies; population in municipality; occupation field dummies, unemployment rate per occupation; in A) stayers. * p <0.1, ** p <0.05, *** p <0.01.

Panel A of Table 4, shows the same regressions of the number of NEET days as in the table with the main results, but also includes the variable *Stay in training firm* as an intermediary variable. Its highly significant coefficients show that, as expected, those who stay are less likely to experience NEET days. This effect is most pronounced in the first year after graduation (specifications 1 and 2) and diminishes in subsequent years.

The inclusion of this intermediate variable does not impact the coefficients for the form of VET much. On average, those who have completed school-based VET still spend approximately one month longer in the first and third years after graduation as NEET. In Panel B, all stayers are excluded, which greatly reduces the sample size and thus increases the standard errors. Even in this subsample of movers, school-based VET graduates are, on average, over a month more NEET. Again, the effect becomes insignificant in the fifth year.

Including stayers as a control variable or excluding them might not fully capture and eliminate a potential signalling effect. Employers who receive applications from dual VET graduates

might call the former training company and ask about the applicant's skills and aptitude, thus saving on screening costs. Nevertheless, it is unlikely that such a mechanism will fully drive the remaining coefficients of school-based VET. As such, it is not only the screening channel that causes these differences in NEET days.

Human capital development

The second explanation for the transitional differences is that the development of human capital—or the quality of training—differs between school-based and dual VET. If this is the case, we might expect dual apprentices to be more successful, not only in terms of their employment probability but also during VET training itself. I test this assumption in Table 5 based on four outcomes: whether the individuals failed their final exam, whether they changed their programmes at least once, the time between starting VET programmes and graduating, and their postgraduate mobility.

Table 5: Success during VET and mobility

	A) Failed exam		**B) Changed programme**	
	(1) OLS	(2) IV	(3) OLS	(4) IV
School-based	-0.006	0.070***	0.025***	0.057**
	(0.005)	(0.025)	(0.005)	(0.027)
Observations	28066	28066	28066	28066
F-Statistic (first stage)		763.1		763.1
	C) Time to graduation		**D) Mobility**	
	(5) OLS	(6) IV	(7) OLS	(8) IV
School-based	235.926***	241.893***	0.109***	0.348**
	(6.134)	(28.631)	(0.025)	(0.136)
Observations	28066	28066	27379	27379
F-Statistic (first stage)		763.1		700.6

OLS and 2SLS estimators with robust SE in parentheses. Dependent variables: A) Failed final VET exam = 1, if otherwise = 0; B) Graduated with a different occupation than the one chosen when starting VET = 1, if otherwise = 0; C) Number of days between VET entry and graduation; D) Number of distinct employments in the first 3 years after graduation. Included controls: LFP rate in region; regional unemployment; gender; age; lower secondary track; urbanity; late entry; foreigners; language region dummies; population in municipality; occupation field dummies, unemployment rate per occupation. * p <0.1, ** p <0.05, *** p <0.01.

School-based VET graduates are approximately 7 percentage points more likely to fail the final exam and approximately 6 percentage points more likely to change their programme. The third outcome in Panel C—time to graduation—indicates that apprentices take less time to complete their training, namely, about 8 months less on average than those in school-based VET. This is partly due to effects A and B: Those who fail usually retake the exam a year later, thus extending their time to graduation. Changing the programme usually involves retaking one or more years of courses. In addition, VET students in full-time schools are more likely to repeat a year. This finding confirms the results of Alet and Bonnal (2011), who also reported no effect on dropout rates but found that apprentices are more successful on their final exams,

and de Amesti and Claro (2021), who also indicated that dual apprentices are more likely to graduate on time and with better grades.

Moreover, dual VET graduates appear to be more often in long-term employment, as suggested by the last outcome in Table 5. This outcome measures interfirm mobility, i.e. the number of different firms in which VET graduates were employed in the three years after graduation. The positive coefficients suggest that graduates of school-based VET programmes are more likely to change employers. A likely explanation is that they are more often employed on a fixed-term contract, whereas dual VET graduates start with a permanent contract.

Although the data do not provide direct evidence of the human capital channel, these results support the interpretation that dual VET is a more effective form of vocational learning. Compared with school-based programmes, firm-based training is advantageous in terms of preparing for the final exam, involves fewer repetitions or changes within occupations, and leads to faster progression.

5.3 Heterogeneity

5.3.1 Labour demand

As Cahuc and Hervelin (2024) indicated, the impact of dual training can vary depending on labour market conditions. In regions (and occupations) with a low supply of labour, employers cannot choose from among many applicants for their vacancies and must hire applicants regardless of the type of VET they attended. In regions or occupations with high supply and low demand, on the other hand, employers can choose from among applicants and are therefore better able to take their preferences into account. Hence, we might expect a more pronounced effect of the type of training when supply tends to be high and labour markets are loose.

To test this hypothesis, I calculate a variable to proxy labour market tightness using the average unemployment share per occupation, named the *Unemployment rate in occupation*. I define the unemployment share as the average number of unemployed days per individual, divided by the average number of days in the labour market in the first year after graduating from VET. I define being in the labour market as being employed, unemployed, or NEET but excluded months spent in military service or receiving disability insurance. I calculate this rate for each occupation using the population that graduated between 2015 and 2020. The occupations with the lowest unemployment rates are carpenters, building service technicians, and licenced electricians. The highest rates are for building and ground custodians, hairdressers, and media technologists. This variable is also included in the main regressions as a confounder.

Figure 1 portrays the predicted number of NEET days against the employment rates, based on a regression where the VET form is interacted with the unemployment rate. For dual apprenticeship graduates, the unemployment rate per occupation does not affect the probability of NEET: The curve is flat. For graduates from school-based VET, however, those in occupations with loose labour market conditions (and high unemployment rates) are far more likely to be NEET than those in occupations with tight labour market conditions. Thus, the advantage of dual VET is driven by occupations with loose labour market conditions where employers can choose from among several candidates, confirming the above hypothesis. This observation is consistent with the human capital channel; employers prefer to hire dual VET graduates because they expect such graduates to be more productive, but they can only hire these candidates if they have a choice of graduates from both forms. If the screening channel were dominant, we would expect the opposite, as it is unlikely that firms would retain their apprentices more often under loose conditions where they have more external options.

Next, I estimate the same heterogeneity with respect to regional unemployment to provide evidence for whether the effect of the form of VET is more pronounced in regions with a high

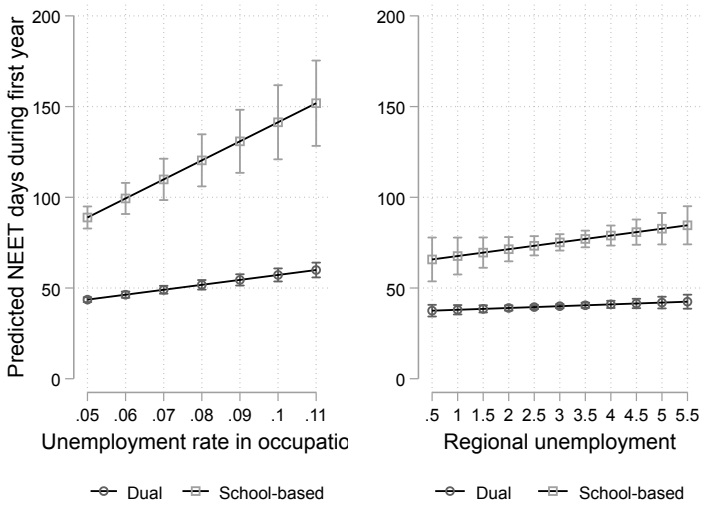

Figure 1: Interaction with labour market conditions

unemployment rate. The results are depicted in the right-hand panel of Figure 1. While graduates in such regions are more likely to experience difficulties in their transition to employment, there is no significant difference between school-based and dual VET observations: both lines are parallel, indicating that the variance in supply and demand between occupations is more decisive than regional differences.

Figure 1 is based on an interacted OLS regression and therefore also captures the effect due to the selection of the form of VET. To test whether omitted variables drive the resulting interaction effect, I divide the full sample into three subsamples, each with one tertile of the unemployment rate. To make the interaction more dichotomous, I exclude those in the middle tertile, with average unemployment ratios, and compare only those in occupations with high unemployment ratios to those with low ratios. I then estimate the OLS and IV regressions where I interact the high unemployment tertile dummy with the VET form. For this interaction term, I use the interaction between the high unemployment variable and the distance variable as instrument.

The coefficients in Table 6, Panel A, show that school-based VET has an adverse effect, particularly in occupations with loose labour market conditions. In the third year after graduation, there is no significant relationship in occupations with a low unemployment rate but only in occupations with many applicants.

5.3.2 Gender differences

In recent years, women have overtaken men in educational attainment in high-income countries (see, for example, Goldin et al., 2006, for the US or Buchmann and Kriesi, 2011, for Europe). Girls tend to perform better because of higher expectations (Fortin et al., 2015), better noncognitive skills (Cornwell et al., 2013; Jacob, 2002), or because the school environment is less suitable for boys and firm-based education may be more appropriate (Bonnal et al., 2002; Van Houtte, 2004). Apprenticeships may therefore be particularly effective for males, who tend to be less study-oriented and less motivated to remain in a school environment and are more interested

Table 6: Number of NEET days — heterogeneity

	First year		Third year	
	(1) OLS	(2) IV	(3) OLS	(4) IV
A) Labour market				
School-based	24.188***	29.289**	16.642***	10.765
	(5.110)	(13.062)	(6.280)	(18.384)
SB × High unemployment	35.531***	72.858***	30.359***	96.463***
	(9.460)	(21.337)	(11.783)	(28.264)
Observations	11490	11490	8759	8759
F-Statistic (first stage)		165.8		95.9
B) Gender				
School-based	35.555***	43.847***	30.116***	61.133***
	(3.263)	(11.246)	(4.338)	(15.552)
SB × Female	-3.323	-19.195	-9.913*	-54.068***
	(4.499)	(12.134)	(5.672)	(17.098)
Observations	24489	24489	18460	18460
F-Statistic (first stage)		273.5		183.2
C) Ability				
School-based	41.833***	51.989***	23.485***	41.039**
	(5.966)	(15.152)	(6.306)	(18.018)
SB × Advanced track	-8.333	-25.511**	1.272	-16.554
	(6.370)	(12.968)	(7.106)	(16.561)
Observations	23104	23104	17395	17395
F-Statistic (first stage)		248.9		149.7

OLS and 2SLS estimators with robust SE in parentheses. Dependent variable: Number of NEET days during each one-year period. SB × High unemployment is the interaction between school and a dummy, indicating the tertile of occupations with the highest post-graduation unemployment rates. Individuals who started tertiary education are excluded from the sample. Included controls: LFP rate in region; regional unemployment; gender; age; lower secondary track; urbanity; late entry; foreigners; language region dummies; population in municipality; occupation field dummies, unemployment rate per occupation. The instrument is the distance between the residential municipality during the lower secondary level and the nearest full-time VET school in the field of choice. The interaction term is instrumented by the interaction between the distance and the interaction variable. * p <0.1, ** p <0.05, *** p <0.01.

in practical tasks.

Table 6, Panel B, estimates the impact of school-based VET on the number of NEET days and includes an interaction term with gender. In the OLS specifications, the interaction terms are small and insignificant. However, this could be due to the negative selection of females (see section 4.4). Indeed, the IV specification suggests that dual VET is less beneficial for women than for men, but only in the third year. As such, the whole effect is driven by males.

5.3.3 Ability

VET is often seen as particularly effective among cognitively less abled young people, thus providing "a 'safety net' for less-capable and less-academically oriented students by preparing them for well-established and recognised working-class occupations" (Barbieri et al., 2018, p. 165). Especially in its dual form, VET could motivate more practically oriented school leavers to continue their education, reduce segregation by socioeconomic status, and increase social mobility (Eichhorst et al., 2015). In Switzerland, such a dichotomy—VET for practically oriented, general education for academically oriented youth—is less pronounced, and many of the most cognitively able students opt for VET (SCCRE, 2018).

To test this, I again interact the VET form variable, this time with the tracks of the lower secondary level. As described in Section 3, this level is divided in most Swiss cantons into a track with basic requirements and a track with advanced requirements. In the former, the vast majority opt for VET, and only a few opt for general education (mostly upper secondary specialized schools), whereas in the latter, approximately one-third attend a general education baccalaureate. There are several cantons with mixed levels, and I exclude them.

The results in Table 6, Panel C suggest that VET is more efficient for graduates on the basic requirements track, but only in the very short term. Their point estimate in the IV specification is about twice as large as the combined coefficients for graduates of the advanced requirements track. However, there are fewer than 7,000 students from the basic track, which increases the standard error. The interaction effect is significant only at the 5% level. In the third year after graduation, no heterogeneity is observable.

5.4 Cognitive and noncognitive skills

In this section, I introduce the PISA measures of cognitive ability. This is possible because a subsample of the 2011 cohort participated in the PISA 2012 study, where their scores in math, reading, and science were assessed, among other variables.

In Table 7, I estimate the same regression as in the main results but add two more control variables. First, *cognitive skills* captures the principal component of the three PISA scores (math, reading, science). Second, I define a proxy variable available in the PISA dataset to measure noncognitive skills. Specifically, I estimate the principal component of four variables: (1) whether the individuals knew at the time of the PISA survey what education they would pursue after compulsory schooling; (2) whether the individual was punctual; (3) whether they skipped school lessons; and 4) whether they skipped an entire school day.

Panel A of Table 7, however, shows that these skills do not correlate with the number of NEET days. At the same time, the positive effect of being in a school-based VET program remain: Their graduates are over one month more NEET than graduates from dual VET. This finding shows that skills—at least those measured here—do not bias the main effect due to skills-based selection.

They might, however, interact with the effect of the VET form. The estimation of interaction effects along the lower secondary track has already suggested that dual VET may be particularly effective for students who struggle at school (Section 5.3.3). Dual VET may be a more appropriate alternative for students who are not motivated to stay in a traditional school setting. In the words of Ryan (1998, p. 291), "It is often claimed that a curriculum which contextualises knowledge to the workplace increases the scope for learning as well as student motivation, relative their counterparts under a purely schoolbased approach. Similarly, a pedagogy which involves problemsolving and workplace activity may produce more learning, particularly amongst less academically oriented students."

Table 7: Interaction with cognitive skills

	A) No interaction		B) Cognitive		C) noncognitive	
	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV
NEET days (first year)						
School-based	37.044***	50.707**	36.779***	50.501**	36.998***	50.656**
	(5.287)	(20.606)	(5.268)	(20.697)	(5.298)	(20.626)
Cognitive skills	-0.869	-0.885	-2.101*	0.197	-0.873	-1.009
	(1.136)	(1.131)	(1.124)	(1.605)	(1.136)	(1.132)
Low motivation	1.377	1.363	1.324	1.410	1.285	-1.241
	(1.280)	(1.275)	(1.281)	(1.279)	(1.336)	(1.380)
SB × Cognitive			6.912**	-6.067		
			(3.278)	(7.532)		
SB × Low motivation					0.428	12.241**
					(3.578)	(4.951)
Observations	3456	3456	3456	3456	3456	3456
F-Statistic (first stage)		155.9		79.5		78.3

OLS and 2SLS estimators with robust SE in parentheses. Dependent variable: Number of NEET days during the first year after graduation. Included controls: LFP rate in region; regional unemployment; gender; age; lower secondary track; urbanity; late entry; foreigners; language region dummies; population in municipality; occupation field dummies, unemployment rate per occupation. * p <0.1, ** p <0.05, *** p <0.01.

The results in Table 7, Panel B indicate that the effectiveness of the form of training does not vary according to cognitive ability. However, the IV coefficient (6) implies that noncognitive skills matter: For school leavers with a low level of motivation, it seems advantageous to participate in dual VET. Those in a school-based VET programme have more difficulty finding employment and are more often NEET. This result remains similar in the third year after graduating from VET (Table 13 in the Appendix), although the standard errors increase significantly in the smaller sample.

5.5 Income

While income data are unfortunately not available for the main sample, the PISA subsample includes income as reported to the tax authorities. These data consist of annual net earnings converted into monthly wages via information on labour market status. The advantage of the data is that they are very reliable as they are official figures and not self-reported income. The key drawback is that we do not have information on part-time work; therefore, it is not possible to calculate full-time equivalent incomes. Indeed, the wage distribution is negatively skewed (-2.168), with a higher density for low-income workers, suggesting that a considerable number of VET graduates are employed in some form of part-time work.

In Table 8, I regress log income on the VET form and the control variables. To calculate income, I identified the first spell of the following year after leaving VET. From there, I identified the first spell in which the individual was employed and use the corresponding income. This ensures that income is not considered for periods when individuals are in training or unemployed. Furthermore, I dropped the bottom and top 1% percentiles to exclude outliers.

Table 8: Effect on log(income)

	All		Without tertiary	
	(1) OLS	(2) IV	(3) OLS	(4) IV
School-based	-0.308***	-0.252*	-0.273***	-0.389**
	(0.037)	(0.143)	(0.045)	(0.168)
Observations	3594	3594	2139	2139
F-Statistic (first stage)		175.6		124.4

OLS and 2SLS estimators with robust SE in parentheses. Dependent variable: First effective income in the year after graduating from VET, in log. Columns (3) and (4) exclude all persons that attended the tertiary level during the first five years after VET graduation. Included controls: LFP rate in region; regional unemployment; gender; age; lower secondary track; urbanity; late entry; foreigners; language region dummies; population in municipality; occupation field dummies, unemployment rate per occupation; duration of the VET program. * p <0.1, ** p <0.05, *** p <0.01.

The findings suggest that dual VET graduates earn about a quarter more. This is quite a large difference, which indicates that part of the difference is due to part-time work: School-based VET graduates, who have more difficulty finding a job, are more likely to work part-time, in temporary employment, or to participate in work placements. This is consistent with the observation of greater postgraduate mobility for school-based VET graduates (Table 5). Figure 2 depicts the density distributions of both school-based and dual VET graduates. Among the former, low-income workers are noticeably more common.

Such low-wage employment may be more common among those who plan to attend higher education. In columns (3) and (4), I therefore exclude all individuals who studied at the tertiary level at any point after graduating from VET. This, however, has little effect on the coefficients: Graduates from dual VET still earn over 25% more, indicating that even among those who remain in the labour market, dual graduates earn more.

6 Conclusion

This study highlights the relevance of institutions or forms of training in education. Although the formal qualifications are the same, the outcomes of school-based VET graduates and dual apprenticeship graduates indicate that the form of training has an impact on young people's further education and careers. However, there is no absolute advantage for one form over the other; rather, there is a trade-off. While dual VET students are more likely to be employed after graduation (especially in well-paid, permanent positions), school-based VET graduates are more likely to enter higher education but are also more likely to be neither employed nor in education.

The findings are consistent with the interpretation that school-based VET graduates enter higher education more often because they complete a vocational baccalaureate during their VET training, which provides them with direct access to UAS. This finding may thus depend on the institutional setting, which would limit the external validity of this particular result, and the effect may differ in other settings, as observed by de Amesti and Claro (2021). At the same time, there may be some degree of "path dependency" in the sense that for school-based VET graduates, it may be easier to stay in education because they are accustomed to the school environment and their training centres may provide better information about higher education

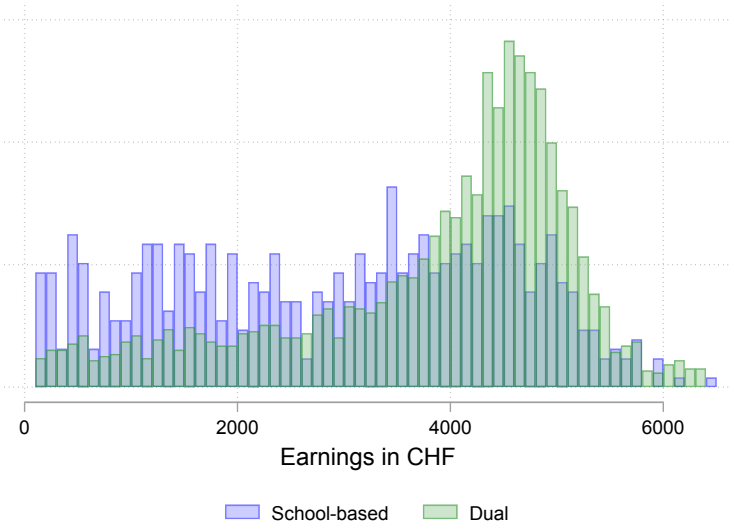

Figure 2: Earnings distribution

opportunities than training firms do. On the other hand, apprentices are accustomed to the world of work, and returning to education might be perceived as less favourable. Moreover, as the results show, it is easier for dual VET graduates to find employers; thus, the opportunity costs of the application process are greater for school-based VET graduates. In particular, dual VET graduates, with the possibility of staying in their training firm, might prefer to start working instead of attending higher education institutions.

As for the causal channels of the school-to-work transition, the study confirms that such stayers have a smoother transition into employment, but the advantage of dual graduates persists when these stayers are controlled for or omitted. Thus, both screening and human capital channels play a role. VET graduates who remain in their training firm have a lower risk of NEET phases, but the coefficient is smaller than the remaining coefficient of school-based VET. Hence, former apprentices are more likely to be hired because employers expect them to be more productive, which also leads to greater earnings for dual VET graduates. I find suggestive evidence that firm-based training is especially effective in developing noncognitive skills, but it is also conceivable that there are differences in occupation-specific skills, and more research is needed to provide robust evidence on this mechanism.

In addition, this study shows that the effects of firm-based training are not homogenous across different groups of people. First, labour market conditions impact the size of the effect. In occupations with a large labour supply and weak demand, the effects are more pronounced than those in occupations with tight conditions. In the latter, employers cannot choose from a number of applicants and are thus forced to hire candidates regardless of their form of VET. In terms of individual characteristics, the results show that dual VET is most effective for men (and less so for women) and for less academically oriented students (as opposed to cognitively, highly skilled students). This underscores the importance of dual VET as a means of increasing social mobility while providing firms with skilled workers.

There are several implications for policymakers. The results support the claim that dual VET facilitates the transition to work, not only by providing signalling information to employers but also by improving the skills of trainees. In addition, the results suggest that dual VET is

most effective for males, who often struggle in a purely school-based system. For policymakers, therefore, dual VET could also be an effective tool to improve social mobility and provide an alternative for students who are otherwise at risk of not completing upper secondary education, especially in regions with high youth unemployment rates or in male-dominated occupations. Notwithstanding, the lower likelihood of higher education among graduates of dual VET shows the importance of high permeability and a well-developed higher education system. A direct school-to-work transition after VET may come at the price of lower earnings later in one's career (Hanushek et al., 2017); policymakers should therefore promote higher education and continuing education, especially for VET graduates.

Moreover, school-based VET can be an effective form of training if it is implemented carefully. In particular, policymakers should promote school-based programmes in occupations with high demand for skilled workers. While the supply of dual training places by firms ensures that young people are not trained in occupations with low labour demand, there is no such mechanism for school-based VET, and schools may oversupply certain popular occupations. If permeability to higher education is ensured, school-based VET also appears to be an effective stepping stone to higher education.

This study raises several issues for further research. The effectiveness of dual VET may vary across countries, depending on how VET is perceived by young people and firms. If firms do not perceive VET to be beneficial, they will not invest in high-quality training and will stop offering training places. If high-achieving students do not believe that VET will enhance their careers, they will not choose this route. In turn, a potential advantage of firm-based learning could be cancelled out by the negative selection effect. Such interdependencies could explain the differences in the relevant literature. It is also conceivable that a low-quality, school-based VET system could impact the perception of dual VET and therefore reduce the incentive for firms to provide high-quality training. In addition, dual VET is effective for developing noncognitive skills. Given the growing importance of such skills, direct evidence of the skill formation process of firm-based training—especially in light of recent trends and the potential impact of further technological advances on the demand for skills—is important.

Appendices

A VET schools

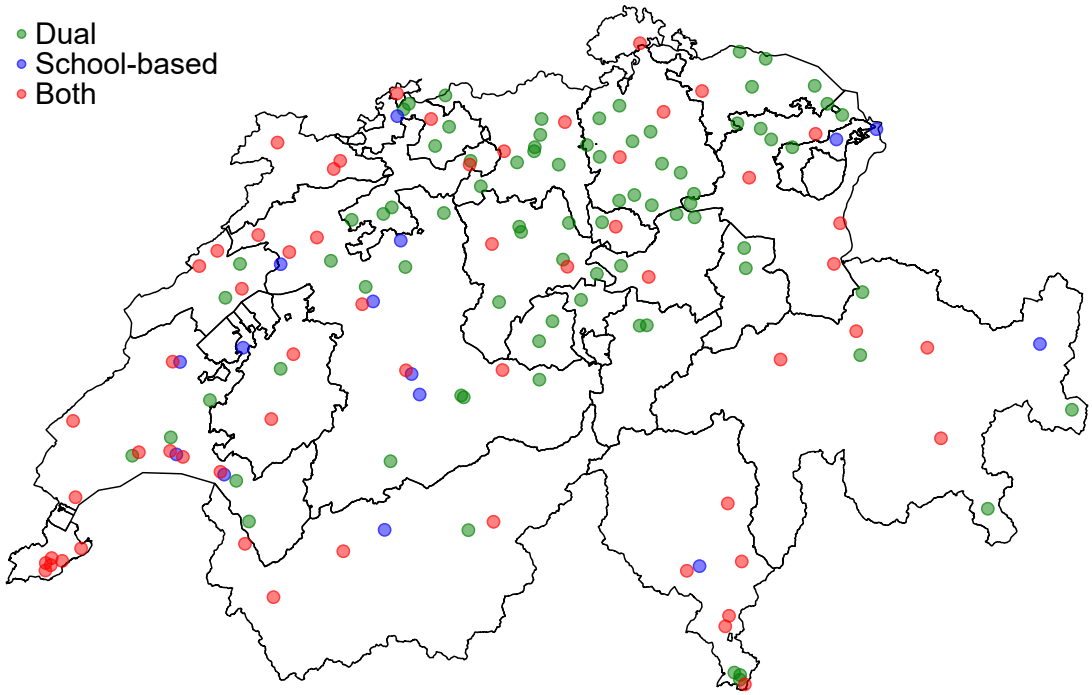

Figure 3: Map of all Swiss VET school locations

B Descriptive statistics

Table 9: Descriptive statistics

	Mean	StDev	Min	Max
School-based	0.141	0.348	0	1
LFP rate in region	81.469	3.043	67	88
Regional unemployment	2.800	0.968	0	6
Female	0.443	0.497	0	1
LFP rate in occupation	0.821	0.071	0	1
Age	24.927	0.650	23	28
Advanced track	0.685	0.464	0	1
Mixed track	0.059	0.236	0	1
Agglomeration	0.262	0.439	0	1
Rural	0.212	0.409	0	1
Started in 2013	0.206	0.404	0	1
Foreigner	0.133	0.339	0	1
Unemployment rate in occupation	0.036	0.019	0	0
Population in munip.	8.886	1.404	4	13
Stay in training firm	0.467	0.499	0	1
In higher edu. 1st year	0.050	0.217	0	1
In higher edu. 1st-3rd year	0.175	0.380	0	1
In higher edu. 1st-5th year	0.251	0.434	0	1
In secondary edu. 1st year	0.046	0.209	0	1
In secondary edu. 3rd year	0.053	0.225	0	1
In secondary edu. 5th year	0.033	0.179	0	1
Employed days 1st year	233.325	149.948	0	365
Employed days 3rd year	227.943	161.977	0	365
Employed days 5th year	225.230	167.332	0	365
NEET days 1st year	44.110	82.065	0	365
NEET days 3rd year	32.515	78.052	0	365
NEET days 5th year	24.828	73.413	0	365
Failed final exam	0.048	0.215	0	1
Changed program	0.058	0.234	0	1
Time to graduation	1267.647	299.225	684	2968
Distinct firms	2.095	1.177	1	11

C Balance test for missing data

In the main sample, 1,368 persons had missing data, among which 819 had missing data. Unfortunately, the Federal Statistical Office (FSO) only attaches these spells if the individual meets certain criteria, such as graduating from the upper secondary level and a 'hierarchical' transition, i.e. not changing to a less advanced education level. As such, there are more missing data among students in a 4-year VET programme or from the advanced lower secondary track. These missing data, in any case, are very unlikely to affect the results because there is no correlation with the main variable of interest: whether the VET programme is school-based or dual.

Table 10: Balance test

School-based	0.004	(0.004)
LFP rate in region	-0.005***	(0.001)
Regional unemployment	0.001	(0.001)
Female	-0.001	(0.003)
Age	0.009***	(0.002)
Advanced track	-0.029***	(0.003)
Mixed track	-0.005	(0.006)
4-year VET	0.052***	(0.003)
Agglomeration	-0.002	(0.003)
Rural	0.006*	(0.003)
Started in 2013	-0.009***	(0.003)
Foreigner	0.003	(0.004)
Constant	0.217***	(0.062)
Observations	29434	

OLS estimator with robust SE in parentheses. Dependent variable: missing data = 1; if otherwise = 0. * p <0.1, ** p <0.05, *** p <0.01.

D Further education at the secondary level

Table 11: Likelihood of attending another upper secondary school after graduating

	A) First year		B) Third year		C) Fifth year	
	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV
Being in upper-secondary education						
School-based	-0.005	0.031	0.006	0.055**	0.006*	0.012
	(0.004)	(0.023)	(0.004)	(0.025)	(0.003)	(0.020)
Observations	28066	28066	28066	28066	28066	28066
F-Statistic (first stage)		762.3		762.3		762.3

OLS and 2SLS estimators with robust SE in parentheses. Dependent variable: attending an upper secondary education during each period after graduating from VET = 1, if otherwise = 0. Included controls: LFP rate in region; regional unemployment; gender; age; lower secondary track; urbanity; late entry; foreigners; language region dummies; population in municipality; occupation field dummies, unemployment rate per occupation. * p <0.1, ** p <0.05, *** p <0.01.

E The transition to higher education

Table 12: Vocational baccalaureates

	A) VBac1		**B) In tertiary (5th year)**		**C) VBac2**	
	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV
School-based	0.367***	0.244***	0.101***	0.047	-0.006	0.129***
	(0.009)	(0.038)	(0.017)	(0.082)	(0.005)	(0.026)
Observations	28066	28066	4466	4466	28066	28066
F-Statistic (first stage)		762.3		191.7		762.3

OLS and 2SLS estimators with robust SE in parentheses. Dependent variables: Attending a vocational baccalaureate *during* VET = 1, if otherwise = 0 (VBac1); or *after* graduating from VET (VBac2); attending a higher education programme in the first three years after graduation = 1, if otherwise = 0. In (3) and (4), only individuals with a VBac1 degree are included. Included controls: LFP rate in region; regional unemployment; gender; age; lower secondary track; urbanity; late entry; foreigners; language region dummies; population in municipality; occupation field dummies, unemployment rate per occupation. * p <0.1, ** p <0.05, *** p <0.01.

F Skills interaction in the third postgraduate year

Table 13: Interaction with cognitive skills, third year after graduation

	A) No interaction		B) Cognitive		C) Noncognitive	
	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV
NEET days (third year)						
School-based	35.277***	43.229**	35.603***	42.159*	35.070***	45.776**
	(6.412)	(21.942)	(6.446)	(22.331)	(6.407)	(21.934)
Cognitive skills	1.858	1.833	1.309	2.950*	1.830	1.704
	(1.261)	(1.254)	(1.227)	(1.747)	(1.259)	(1.251)
Low motivation	2.883**	2.897**	2.834*	2.996**	2.336	0.550
	(1.452)	(1.442)	(1.455)	(1.434)	(1.458)	(1.663)
SB × Cognitive			3.786	-7.697		
			(4.400)	(10.124)		
SB × Low motivation					3.424	14.733**
					(4.624)	(6.822)
Observations	2577	2577	2577	2577	2577	2577
F-Statistic (first stage)		135.6		69.0		62.3

OLS and 2SLS estimators with robust SE in parentheses. Dependent variable: Number of NEET days during the third year after graduation. Included controls: LFP rate in region; regional unemployment; gender; age; lower secondary track; urbanity; late entry; foreigners; language region dummies; population in municipality; occupation field dummies, unemployment rate per occupation. * p <0.1, ** p <0.05, *** p <0.01.

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