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Abstract

In this paper, we investigate how student outcomes are impacted by the accessibility of apprenticeships, a characteristic of dual vocational systems that is sparsely researched. We apply a novel measure of access to dual vocational education, exploiting variation across specialization, county, and school year. The analysis benefits from full-population data, a rich set of control variables, and information on student preferences. Our results show that access to apprenticeship has a strong effect on the dropout risk for students at age 21. We also find statistically significant but smaller favourable effects on employment and on neither being in employment nor post-secondary education at age 23. The impact of access on dropout rates was favourable for most categories of immigrant background. However, students with an Asian or African background, who exhibit the highest dropout rate in the sample, do not appear to benefit from better access to apprenticeship.

Keywords: vocational education, apprenticeship, transitions in youth, employment, dropout, NEET

JEL codes: I21, I26, J24

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1. Introduction

Vocational degrees are often considered valuable in order to smooth the transition from school to working life. Yet, while there are several recent analyses that investigate the returns to vocational education and training (VET) relative to general education programmes (Hanushek *et al.*, 2017; Dougherty, 2018; Brunner *et al.,* 2023; Bertrand *et al*., 2021; Silliman and Virtanen, 2022), less is known about the success criteria of VET programmes, in their own right (Wolters and Ryan, 2011; Riphahn and Zibrovius, 2016). In this paper, we investigate how student outcomes are impacted by the accessibility of apprenticeships, a crucial feature of dual VET programmes.

In dual VET programmes, school-based education is combined with an apprenticeship, either concurrently or in alternating periods, as opposed to vocational education that is predominately school-based (Eichhorst *et al.*, 2015). Dual VET is intended to improve employability by providing the student with "ready-to-use" skills, and the students may also benefit from social networks acquired in the apprenticeship period. A completed apprenticeship may also have a positive signalling effect or be used as a screening device (Wolters and Ryan, 2011). Signalling is especially valuable in contexts where employment protection is high (Bäckman *et al.*, 2015), such as in Norway, according to OECD Indicators of Employment Protection.

We apply administrative register data from Norway, where about 50% of a birth cohort enrol in VET after completing compulsory schooling. Our study population includes four cohorts of students who enrolled in VET programmes 2010-2013, and we observe labour market and education outcomes at age 21-23. Importantly, we have data on students' preferred programme when they apply for VET specialization. The measure of access to apprenticeship is the ratio of the number of contracts signed to the number of applicants prioritizing an apprenticeship within

each vocational specialization, county, and year. A well-known challenge in the literature on the effect of access to education is self-selection in students' educational choices. This concern is addressed by including fixed effects for specialization, county, and year, as well as interaction terms between specialization and year or specialization and county, and a wide array of control variables that represent student background characteristics.

The next section provides some general background and an overview of relevant institutional details. We then describe the data sources and the selected sample and present the estimation strategy. Our main results, heterogeneity analysis, and robustness/specification tests are reported in section 4, followed by a discussion in section 5 which concludes the paper. We find that, indeed, access to apprenticeship has a strong effect on the dropout risk for this student group: In our main regressions, increasing the ratio of number of contracts signed to the number of applicants has an implied elasticity of -1 with respect to the probability of not completing upper secondary by age 21. We also find effects, albeit smaller, on employment and on neither being in employment nor education. The results are robust to several specification and sensitivity checks.

2. Background and institutional framework

2.1. Background

In modern societies, all occupations require some general human capital that is provided by formal education. On the other hand, workers also need skills that are more or less transferable between jobs and occupations. To what extent learning job-specific skills is a part of the formal education system varies considerably among countries (Wolter and Ryan, 2011). In particular, the German-speaking countries are traditionally associated with apprenticeship systems.

Countries employing dual systems include Germany, Austria, Switzerland, Latvia, Denmark, and Norway, while school-based vocational programmes are found in Australia, the United States, France, the Netherlands, Sweden, and Finland (OECD, 2018; Bäckman *et al*., 2015).

The discussion on merits and demerits of VET programmes is summarized in Bertrand *et al.* (2021). The argument against such programs is that they may lock in students at an early age to non-academic careers and low paid jobs. Moreover, vocational programs may be of poor quality, aimed at students with low abilities.

Conversely, an overly academic approach to education potentially results in fewer years of completed schooling. In such cases, the alternative to schooling may be inactivity rather than participating in the labor force. Bertrand *et al.* (ibid) evaluate the Norwegian educational reform in 1994 that streamlined the vocational upper secondary school track and improved apprenticeship access, but also facilitated transitions from the vocational to the academic track. They find that the reform increased college enrolment and improved social mobility.

Silliman and Virtanen (2022), exploiting quasi-experimental variation created by the Finnish admission system, find that admission to the vocational track increases initial annual income, and this benefit persists at least through the mid-thirties. Using a "fuzzy" regression discontinuity design on data from Connecticut, Brunner *et al.* (2023) find that for men, being admitted to technical high school substantially improved students' likelihood of completing high school, and increased earnings. Positive income effects persisted past the age of 23, with no difference in the propensity to attend college. Dougherty (2018) focuses on educational outcomes, using administrative data from Massachusetts. His main result is that vocational education noticeably increased the likelihood of on-time graduation from high school. Studying

graduates from higher education in Switzerland, Oswald-Egg and Renold (2021) find that graduates with work experience from dual VET got their first job quicker and obtained better wages one year after graduation from higher education.

Our analysis focuses on students demonstrating a clear preference for the vocational track. Somewhat related is a study by Fersterer *et al.* (2008), who estimate the returns to length of apprenticeship training in Austrian firms that close. They find positive returns, which they argue cannot be explained by selection. Neyt *et al.* (2020) examine the impact of enrolling into dual apprenticeship programmes on early employment outcomes, finding evidence for short-term labour market advantages only for the programme with the most days of on-the-job training.

VET systems are frequently classified as either 'knowledge-based' or 'skill-based' (Brockmann *et al*., 2008), emphasizing either general human capital accumulation or the acquisition of skills specific to tasks or firms. In the Norwegian context, VET is distinctly characterized as knowledge-based (see Betrand *et al.,* 2021), and the details of the system are explained below.

2.2 The Norwegian upper secondary school system.

In Norway, students complete 10 years of compulsory schooling by the age of 16, and almost all proceed to upper secondary school (OECD, 2018). Upper secondary schools are administered and to a large extent governed by the counties, which numbered 19 during our observational period. Students are entitled to three years of upper secondary schooling, with an additional year available for those who opt to change their chosen education programme or programme area (The Norwegian Directorate for Education and

Training, a).[1] This stage of education is categorized into the academic track and the vocational track, and is structured into three levels named Vg1, Vg2, and Vg3. At each level, students can apply to multiple schools and programmes, and must rank-order their choices.

Within VET, mandatory core subjects encompass Norwegian, English, Mathematics, Natural Science, Social Science, and Physical Education, while each programme area also incorporates subjects specific to its focus. Notably, these core subjects prepare VET graduates for post-secondary education, and undertaking Supplementary studies after VET completion may qualify them for higher education. The flexibility of switching from vocational to academic track is large, as described in Bertrand *et al. (*2021), and Norway stands out as the OECD country where the largest share of VET students switches and completes a degree at the academic track (OECD, 2023). Still, dropout from upper secondary schooling remains a significant concern, and is dominated by VET enrolees (OECD, 2018; p88).

[1] Up until 2017, the entitlement to upper secondary schooling was restricted to 5 years from the start of Vg1. This time limit was removed in 2021.

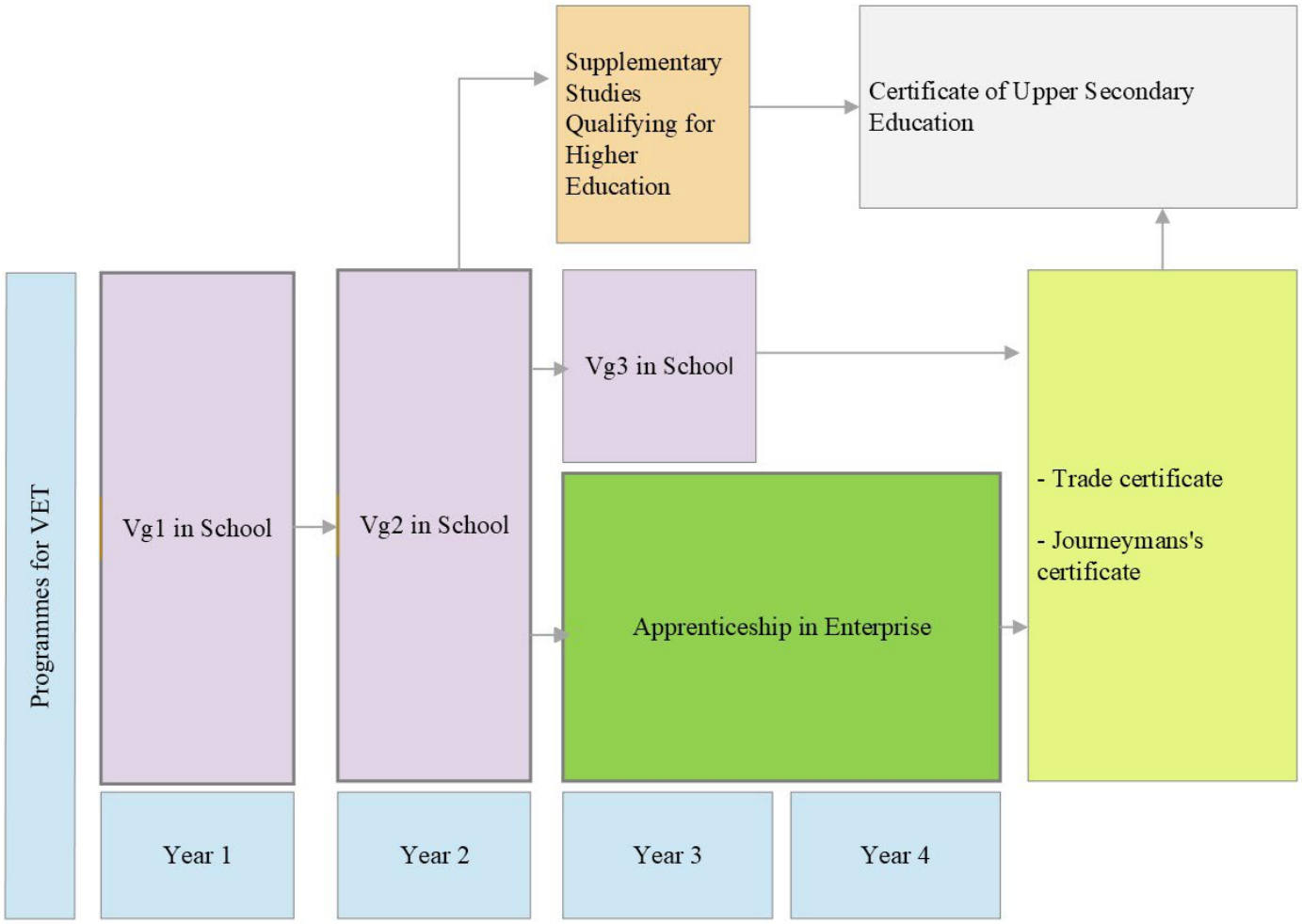

Figure 1. The dominant model within Vocational upper secondary education in Norway, see marked rectangles. Alternative trajectories after Vg2 are also presented.

The dominant model in VET is two years of school-based education, followed by two years as an apprentice, see Figure 1[2]. However, students are not guaranteed an apprenticeship contract, and for instance in 2011, one third of the applicants did not obtain a training place despite giving this alternative top priority in their application. The Office of the Auditor General argues that "because of the lack of available training places, teen-agers do not complete their vocational training, and this is considered a major cause of the large dropout rate in upper secondary

[2] The structure within VET depends on specialization, for instance, some programs require 1 year of classroom education and 3 years as an apprentice. In some counties, there is a limited number of spots where classroom teaching and work-place training are combined throughout all four years ("vekslingsmodellar").

education» (Office of the Auditor General of Norway, 2013). The proportion of rejected applicants varies considerably across different education programmes and counties. In cases where apprenticeship placements are not obtained, counties bear the responsibility of providing an alternative pathway to attain a trade/journeyman's certificate, known as "Vg3 in school." However, this pathway is viewed as less favourable due to its shorter duration and lack of work-based training (see references in The Norwegian Directorate for Education and Training, 2019)[3]. Alternatively, students have the option to transition out of VET and instead pursue a third year of classroom-based education, referred to as "supplementary studies" in Figure 1. It is crucial to acknowledge that this option, intended to prepare for higher education, is demanding due to its intensive nature and emphasis on academic subjects.

In order to specialize in a particular field at the Vg3 level, students are required to follow a specific course trajectory at preceding levels. At the Vg1 level, there are a total of nine education programs available. During the academic years 2011 to 2014, there were 47 Vg2 programme areas within VET, which potentially lead to 182 Vg3 programme areas. This structure is exemplified and commented upon in Online Appendix A figure 1.

Students who are unable to secure an apprenticeship, have several options. Aside from choosing to pursue Vg3 in school or supplementary studies aimed at qualifying for higher education, these students may decide to restart their upper secondary education within a different education programme or Vg2 programme area. They also have the option to repeat their current Vg2 programme area, seek employment, or temporarily disengage from both education and employment. Notably, finding employment may be more feasible upon reaching the age of 18,

[3] Aspøy and Nyen (2017) briefly describe how different countries address the shortage of apprenticeship contracts.

as regulations regarding occupational safety and working hours become less stringent, and obtaining a driver's license becomes possible. In summary, is worth noting that there is no predetermined relationship between the attainment of an apprenticeship contract and the outcomes examined in this analysis.

2.3. The process of securing an apprenticeship

While the registration and remuneration of apprenticeship contracts are centralized, the matching of applicants to potential employers is highly decentralized. Students enrolled at Vg2 in August in a given school year apply electronically for further education by March 1 in the same school year, signalling their three prioritized alternatives. If they apply for an apprenticeship, an administrative body within the county informs potential employers, i.e., firms, Apprenticeship Training Agencies, municipalities, or public enterprises certified as training companies, about the students' interest[4]. Additionally, students are encouraged to get in touch with employers on their own, and seek information through personal networks, advertisements or lists of potential employers on public websites. However, no source of information offers an initial or updated overview of the number of available spots within each Vg3 programme during this matching process. By March 1, for instance, potential employers would not be able or willing to state a fixed number of spots, since they prefer to assess candidates through interviews later in the spring. A large proportion of contracts are signed between March and May (The Norwegian Directorate of Education and Training, 2019). In cases where applicants have not secured a contract by then, the county intervenes to match

[4] Many Norwegian firms and municipalities are small and 80 % of them have joined as members of Apprenticeship Training Agencies ("opplæringskontor"). These agencies help potential employers recruit apprentices, often sign apprenticeship contracts, and supervise the training (The Norwegian Directorate of Education and Training (2019); Kuczera (2017).

individual applicants with potential employers (ibid). Thus, although students are expected to actively pursue an apprenticeship contract, it is ultimately the county's responsibility to offer them further options for upper secondary education if an apprenticeship is not obtained.

During the apprenticeship period, apprentices are employed by approved firms or organizations that are responsible for delivering high-quality training. Employers are compensated based on nationally determined fees. The county where the signing firm is situated, oversees the compliance with the conditions outlined in the apprenticeship contract. It is possible for students to commence their apprenticeship even if they have not passed all their Vg2 exams. However, any pending exams will be noted on the contract, and students must successfully complete these exams before they become eligible for a trade or journeyman's certificate.

3. Data and empirical approach

3.1 Data and variables

Our sample comprises VET students who enrolled in Vg2 at age 17 for the school years 2010/2011 to 2013/2014, that is, the birth cohorts from 1993 to 1996. From a total of 72247 individuals, we focus on the 38401 students who applied for an apprenticeship as their top priority wish for Vg3. All individual data are extracted from population data registers and merged using personal identifiers. For a full account of data sources and sample selection, see the Online Appendix B.

The accessibility of apprenticeship was assessed using annual reports published by the Norwegian Directorate for Education and Training, providing information on the number of

applicants whose top priority is to obtain an apprenticeship and the number of signed contracts, aggregated by Vg3 programme area and county.

In the main analysis, we focus on three dichotomous outcomes:

- *dropout*: not having completed upper secondary schooling at age 21
- *employed*: contracted working hours > 0 at age 23
- *NEE* (Not in Employment or Education): neither employed nor pursuing post-secondary education at age 23

We also investigate two supplementary outcomes: (*Income>G*), which denotes having income from wages and self-employment exceeding the basic amount set by the National Insurance scheme ("G"), approximately 10,000 Euros in 2016. Accordingly, *NEE2* indicates having income below G and not pursuing any post-secondary educational activity.

The key explanatory variable of our study, *access rate,* represents the individual student's level of access to the specific type of apprenticeship aligned with their revealed preference. This variable reflects the degree of competition for apprenticeship opportunities and is calculated as the ratio of the number of contracts signed to the number of applicants for the student's preferred Vg3 programme area and their selected county in the year they initially apply, i.e., at the age of 18. The denominator of this ratio encompasses all students whose top priority for Vg3 is an apprenticeship, regardless of whether they applied through the public application system or secured a contract independently. Online Appendix A Figure 3 provides a visual representation of the distribution of *access rate* at the student level, and the median value is 0.73. To demonstrate the geographical variation, Online Appendix A Figure 4 displays the distribution by county, across Vg3 programme areas in a specific year (2011). The median values of the

variable range from 0.5 to 0.8, indicating significant disparities in access to apprenticeship opportunities.

In a robustness test, we employ an alternative but less precise proxy to measure accessibility. We utilize the fact that Vg2 students can only qualify for an apprenticeship within their chosen Vg2 programme area. Hence, for each Vg3 applicant, we define a variable called *access rate Vg2*. This variable aggregates the number of signed contracts to the number of applicants within the student's Vg2 programme area.

As control variables, we include indicators for sex (male), immigrant background, GPA, quarter of birth, each parent's highest level of completed education (compulsory, intermediate, higher, missing), income (under G, above G, missing), type of occupation (blue/white collar job, missing), centrality class, and separate indicators for Vg3 programme area, school year, and county. See Online Appendix A Table 1 for more details.

3.2 Descriptive statistics

Table 1 presents the average values of the variables for the main sample, split by quartiles based on *access rate*. We see that the average dropout rate (at age 21) is 25%, the average employment rate (at age 23) is 79% and the average NEE rate (at age 23) is 15%.

These mean values demonstrate a clear gradient across the quartiles of *access rate* for all the outcomes. As the rate increases (indicating a higher probability of obtaining an apprenticeship contract), there is a noticeable decrease in the dropout rate, an increase in the employment rate, and a decline in the NEE rate. It's worth noting that these patterns emerge without considering the impact of background characteristics.

Furthermore, the mean values exhibit a consistent gradient across the quartiles for the explanatory variables, as well. Higher values on *access rate* correspond to a higher proportion of males, a lower prevalence of individuals with an immigrant background, higher GPAs, and a parental background characterized by higher levels of education and income and higher prevalence of white-collar occupations. Given these associations, it is essential to control for these background characteristics in order to isolate the effects of apprenticeship accessibility.

Table 1 about here

The relationship between *access rate* and the outcomes is visualized in Figure 2.

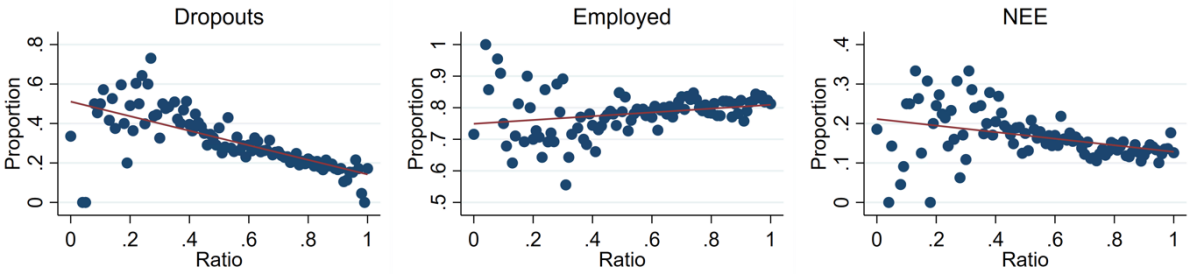

Figure 2. Relationship between *access rate* and outcomes. The ratio is the number of signed apprenticeship contracts to the number of Vg3 applicants whose top priority wish was apprenticeship, defined for each combination of Vg3 programme area, county, and year (birth cohort). The vertical axis shows the proportion that are dropouts/employed/NEE of all students who applied for Vg3 programme areas with a given ratio (rounded to two decimal places).

Indeed, we see that higher levels of *access rate* are linked to more favourable outcomes. Lower values of the ratio exhibit greater variability, which is expected given the left-skewed distribution of the variable, as indicated by Table 1 and Online Appendix, Figure 3. The skewness implies that the data points in Figure 2 represent a smaller number of Vg3 programme areas/students at low levels of *access rate* compared to higher levels.

3.3. Empirical approach

We consider how the accessibility of apprenticeships (*access rate*) affects dropout from upper secondary education at age 21 and the early labour market outcomes employment, NEE, and income at age 23. We consider the effect of *access rate* a direct effect, while the effects on employment, NEE, and income are reduced form effects. This distinction arises because obtaining an apprenticeship contract can influence early labour market outcomes through various pathways, as explained in the introduction.

Our analysis focuses on individual students, denoted as *i*, belonging to birth cohort *j,* who applied for an apprenticeship within a specific programme area *p*, located in county *c*. These individual students serve as the unit of observation in our estimations. Therefore, the estimated equation is

$$Y_{ipcj} = \alpha + \beta access\ rate_{pcj} + \gamma X_i + \theta_p + \theta_c + \theta_j + \varepsilon_{ipcj}, \quad (1)$$

where Y_{ipcj} denotes either dropout, employment, NEE, NEE2, or income. We include programme area, county, and cohort fixed effects, θ_p, θ_c, and θ_j, respectively. As noted in Section 3.1, outcomes are measured at age 21 (dropout) or age 23 (employment, NEE, NEE2, income), whereas the access rate is experienced at age 18. Thus, θ_j captures the overall demand for labour in the year when outcomes are measured, as well as other relevant time-varying conditions at the national level. The fixed effects θ_c and θ_p account for unobservable but potentially important characteristics. For example, counties may differ in terms of industry structures and the extent of collaboration between school administrations and potential employers. Similarly, programme areas exhibit systematic variations, such as differing traditions in utilizing apprenticeships and the varying significance of a trade certificate for

employment across occupations. We also include exogenous control variables, denoted as X_i, which are detailed in the previous section. To account for potential correlations within the programme area level, we cluster the standard errors accordingly.[5] By incorporating these fixed effects and control variables, we aim to mitigate omitted variable bias and enhance the robustness of our estimations.

Equation (1) is our main specification, but we also report results from specifications augmented by *i*) an interaction between Vg3 programme area and county or *ii*) an interaction between Vg3 programme area and year. The first extension allows supply and demand of contracts within a programme to be correlated across counties, while the second allows for national correlations within a given year.

4. Results

4.1 Main results

Table 2 about here

Table 2 presents the main results of the analysis. For each outcome, we have estimated three different regression models, and find that the estimates of the effect of *access rate* are consistent and with overlapping confidence intervals across these specifications. Columns 1, 4, and 7 report results for the main specification, which includes programme, birth cohort, and county fixed effects plus the control variables listed in Online Appendix, Table 1.[6] Combining the

[5] Since *access rate* is assigned at a cluster level (Vg3 programme area × county × year), we would like to cluster by that level (Abadie *et al.,*2023). However, within some clusters, that would imply a small number of observations. We therefore cluster standard errors by Vg3 programme area.

[6] Estimated coefficients for the control variables are reported in the online Appendix Table 2.

programme fixed effect with county (columns 2, 5, and 8) allows supply and demand of contracts within a programme area to be correlated across counties. Columns 3, 6, and 9 allow for national correlations within a period by interacting the programme and year fixed effects. Neither of these extensions alters our conclusions with respect to the access rate - the results are only moderately affected. The effect of the *access rate* variable is precisely estimated in all specifications.

Since the outcomes being analysed are dichotomous variables, the coefficients can be directly interpreted as marginal effects in these linear probability models. The results show that the effect on the probability of dropout is consistently negative across all specifications, meaning that an increase in the accessibility of apprenticeships (the variable *access rate*) reduces the likelihood of dropping out. The specific coefficient of -0.25 in column (1) indicates that a 10% increase in *access rate* decreases the probability of dropping out by 2.5 percentage points. In other words, at the average dropout risk of 0.25, the risk is reduced by 10%. This translates to an implied elasticity of -1, suggesting a strong impact of accessibility on individual dropout. When including county by programme area fixed effects in the analysis, the magnitude of the effect increases to 0.3 (with an elasticity at the means of -1.2). However, in the third column where programme area is interacted with year, the effect estimate remains unchanged.

The analysis shows that the effect of *access rate* on employment outcomes is smaller compared to its effect on dropout. The implied elasticities for employment range from 0.08 to 0.09 across the three specifications in Table 2. This suggests that increasing access to apprenticeships has a modest positive effect on employment prospects for students within the VET system.

Conversely, the analysis reveals that an increase in accessibilityte significantly reduces the risk of being not in employment nor in post-secondary education (NEE), with elasticities ranging from -0.28 to -0.41. This implies that students with limited access to apprenticeships are at a higher risk of dropping out of education and not being engaged in employment or post-secondary education.

It is also worth noting that male students in the sample demonstrated better outcomes overall compared to their female counterparts. They had lower dropout rates, were less likely to be not in post-secondary education nor employment (NEE) and had a higher likelihood of being employed. This suggests that there may be underlying gender differences in the factors influencing educational and employment outcomes within the VET system. Moreover, students with an immigrant background faced a higher risk of dropout from upper secondary school. Taken together, these results call for a heterogeneity analysis. In addition to sex and immigrant background, we also perform an analysis by parents' type of job.

Overall, the regression results reported in table 2 are consistent with the broad picture depicted by the aggregated graphs in Figure 2. In addition to the outcomes reported in table 2, we also estimated alternative, income-based, specifications of employment (Income >G) and inactivity (NEE2), as defined in Section 3.3. Results for these alternative outcome definitions are reported in Online Appendix, Table 3 and align well with our main results, but with somewhat larger coefficient estimates on *access rate*. The elasticities at means are 0.09 for Income>G and -0.47 for NEE2.

4.2 Heterogeneity

In our heterogeneity analysis, we apply the specification presented in equation (1), i.e., with programme, year (birth cohort), and county fixed effects without interaction terms.

Table 3 about here

In many countries, there are strong gender patterns in enrolment in VET programs and in the labour market (see for instance Brunner *et al*., 2023). This is true for Norway, as well, with male VET students overrepresented in programmes for Technical and Industrial Production and Building and Construction, and females in Healthcare, Childhood and Youth Development. We have inspected whether the impact of access to apprenticeship varies in Norway by splitting the sample by sex.

Panel A of Table 3 shows that the estimated effects of the access rate on dropout and NEE are very similar across sex. Because the dropout rate is slightly smaller for male students, the elasticity of *access rate* is somewhat larger than for females, -1.01 vs – 0.85. The effects on employment and NEE are imprecisely estimated for female students but, for male students, quite similar to the main results.

Panel B shows results from the sample split by immigrant background, where the category "Native Norwegians" are Norwegian born with two Norwegian born parents. The sub-sample with immigrant background (foreign born or Norwegian born with at least one foreign born parent) constitutes 5.9% of the full sample, and is further divided in three by national background. We focus on reporting the estimate of the *access rate* coefficient.

As expected, the results for the native Norwegian group are very similar to the main results. The sample sizes for student groups with immigrant backgrounds are smaller, leading to imprecise results that only reach statistical significance for the dropout outcome in Group 2 (EU/EEA plus the Anglo-American countries) and Group 4 (Europe outside EU/EEA etc.), with the expected negative sign. Group 2 shows a larger implied elasticity of -1.53 compared to natives, while the value for Group 4 is almost the same as for natives (-0.95 versus -1.0). In contrast, students with Asian or African background have the highest dropout rate in the sample (0.44), yet their dropout rates appear to be unaffected by the accessibility of apprenticeships. Thus, they are extra vulnerable by having higher risk of dropping out from upper secondary, and the accessibility of apprenticeship contracts reduces this risk to a lesser extent compared to other student groups. For employment and NEE, the results are too imprecise to draw any conclusions regarding heterogeneity by immigrant background.

We saw in Table 1 that there appeared to be gradients in parents' education, income, and occupation. We chose to perform a heterogeneity analysis by occupation for students whose parents were both employed in the application year (54% of the full sample). Panel C of Table 3 shows the results. When one or both parents are blue-collar workers, the effect of *access rate* on dropout is -0.25 as in the main results. But because the mean dropout risk is smaller in the one-parent-blue-collar group, the implied elasticity is larger, -1.25 versus -0.96. When both parents are white collar, the dropout risk is smaller at 0.16 but the implied elasticity of -1 is almost the same as in the blue-collar group. However, in the blue-collar group, the effect on employment also reaches statistical significance, with an elasticity of 0.07. The estimated effects in the other two groups are very close, but imprecisely estimated.

In summary, the heterogeneity analysis shows some, although moderate differences by sex and parents' occupation, but the most striking gradient is by students' immigrant background. Access to apprenticeship has a large impact on groups of students with a high risk of dropout from upper secondary, with an estimated elasticity regarding dropout of -1,53 (students with a background from EU/EEA or the Anglo-American countries) or - 0,95 (background from Europe except EU/EEA, mostly). An exception to this picture is students with a background from Asia or Africa, for whom there is no estimated effect of access on any of the outcomes. At the same time, this group has the largest risk of dropping out from upper secondary school.

4.3 Robustness/specification tests

Our main results, as presented in Table 2, could be sensitive to outliers in the distribution of the access measure. Figure 3 reveals significant variation in outcomes for low values of *access rate*. These low values are generally associated with smaller programs, where even a small change in the number of signed contracts can have a substantial impact on the calculated ratio. To address this concern, we conducted a sensitivity analysis by excluding programs with fewer than 6 students. This resulted in a sample reduction of 5.4%, leaving us with 36,312 students. The results, reported in Online Appendix, Table 4 and estimated using the main specification, indicate a slightly larger impact on the probability of dropout, a virtually unchanged effect on employment, and a smaller and less precisely estimated effect on NEE. Specifically, the elasticities at means are -1.29, 0.08, and -0.22, respectively. In summary, while the exclusion of these smaller programs does affect the magnitude of the effects, our main conclusions remain largely unchanged.

We also investigate the impact of a less precise measure of access on two samples. While our primary analysis involves calculating access at the Vg3 level, we also examine an alternative measure that aggregates the number of contracts to the number of applicants at the Vg2 programme level. This alternative measure is less precise, as Vg2 programs are divided into sub-programs at the Vg3 level. As expected, the alternative accessibility measure yielded less precise estimates when applied to the main sample, as reported in Online Appendix A Table 5, columns 1-3. When applied to an extended sample of all Vg2-level students who potentially apply for an apprenticeship at Vg3 level, the results deviated even more from our main findings. This could be due to the inclusion of students who did not actually apply for an apprenticeship at Vg3 level.

5. Discussion

The focus of this study is how young adults enrolled in dual vocational education programmes are impacted by a contextual factor essential to many VET students, namely the accessibility of apprenticeship. Early labour market and education outcomes represent important aspects of the life and well-being of these students and may have large repercussions for later employment and earnings and other aspects of life (Oreopoulos and Salvanes, 2011). Our results show that access to apprenticeship has a strong effect on the dropout risk for VET students, with an implied elasticity of -1 with respect to the probability of not completing upper secondary by age 21. We also find statistically significant but smaller favourable effects on employment and on neither being in employment nor education at age 23. The heterogeneity analysis revealed a significant and favourable impact on dropout rates for most categories of immigrant background. However, it is concerning that students with an Asian or African background, who exhibit the highest dropout rate in the sample, do not appear to benefit from higher access rates.

The outcomes studied are clearly interrelated, for instance, education and employment may to some extent be mutually exclusive activities, therefore, we include the NEE outcome. Although NEE can be voluntary (for instance due to voluntary work or travelling), it is often associated with inactivity and poor mental health (Rahmani and Groot, 2023)[7]. From the perspective of young adults' welfare, NEE can be considered the most unfavourable among the outcomes studied. As much as 15 % of the sample are in this state at age 23, our descriptive statistics show. This highlights the importance of our results on the effect of access on dropout since numerous studies have found dropout to be a very strong predictor of NEE (*ibid*).

The stronger effect on NEE relative to employment suggests that students with poor access to apprenticeship are more vulnerable to dropping out of education: it is conceivable that students who could not obtain an apprenticeship switch to completing Vg3 in school or supplementary studies qualifying for higher education and then go on to post-secondary education, however, that does not seem to be the case. The analysis suggests that the educational system's options for completing Vg3 in school or enrolling in supplementary studies to qualify for higher education are unappealing or unsuitable to them.

We expect the effect of apprenticeship accessibility on employment and NEE to go mainly through the risk of dropping out of upper secondary school. However, the access rate may also be correlated with labour market outcomes for other reasons such as sector-specific labour demand that also affects the number of apprentice contracts. Furthermore, better access to apprenticeships may increase students' chances of making long-term connections with firm managers, which may affect their longer-term employment *per se*.

[7] In this context, we use the terms NEE and NEET interchangeably.

This analysis is complementary to a strand of literature that assesses the effects of access to school-based vocational education, compared either to admission to a general programme (Silliman and Virtanen, 2022) or to traditional, comprehensive high schools (Brunner *et al.*, 2023). In contrast, we consider an institutional aspect of dual VET systems, which constitutes a distinct setting and treatment. Nonetheless, we observe some noticeable similarities with their findings. Silliman and Virtanen (2022) find that students with a comparative advantage in vocational education benefit from being admitted to a VET programme. Our general results show that increased access to an apprenticeship contract is positively associated with school completion and favourable labour market outcomes. Brunner *et al.* (2023) find that male VET students benefit, but that is not the case for females, who have similar outcomes to non-admitted students. They suggest that one explanation may be that females pursue other programmes than males. With some caution, we may argue that a similar gender difference appears in our results. The accessibility of apprenticeships affects school dropout rate for both sexes but is less associated with labour market outcomes for women than for men. A plausible explanation is that women select programmes where a completed apprenticeship is less important for getting a job.

From a policy perspective, the student group in this analysis is of particular interest, since they have revealed a clear preference for VET and the supply of apprenticeship contracts should be responsive to policy measures. Such measures could be monetary compensation to employers to bridge the gap between wages and the employer's training costs versus the value of the apprentice's production. Furthermore, in public procurement, a requirement can be imposed for contracting firms to employ apprentices. Presently, the government mandates that all state

enterprises with over 75 employees must have at least one apprentice employed at any given time (dfo.no).

Two caveats are in place. The analysis considers short run outcomes: dropout from upper secondary (at age 21) and employment and NEE at age 23, while it is often claimed that VET provides occupation-specific skills that may become obsolete. Although recent research points to favourable effects of vocational education in the longer run (Silliman and Virtanen, 2022; Brunner *et al*., 2023), we cannot rule out that favourable effects of access to apprenticeship on employment and NEE fade out. Furthermore, unobserved individual heterogeneity may bias our results. Our identification strategy hinges on including a rich set of control variables on student background including each parent's characteristics, indicators for birth cohort, specialization, county, etc., and we estimate alternative specifications and perform sensitivity checks.

We claim several contributions to the literature on vocational education: First, we investigate the importance of a characteristic that is specific to vocational education in dual systems, namely access to apprenticeship. This research question is of high policy relevance, yet sparsely researched. Second, the analysis benefits from full population data on recent birth cohorts (1993-1996), which adds relevance given the large labour market changes caused by fiercer international competition and technological change. Finally, we apply a novel measure of access to VET, exploiting variation in access to apprenticeship across specialization, county, and year.

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TABLES

Table 1. Descriptive statistics

	Sample	Ratio			
		Quartile 1 (0 - .61)	**Quartile 2 (.62 - .73)**	**Quartile 3 (.74 - .83)**	**Quartile 4 (.84 - 1)**
N	38 401 (100%)	10 188 (27%)	9 182 (24%)	10 168 (27%)	8 863 (23%)
Outcomes					
Dropout	.25	.34	.26	.21	.17
Employed	.79	.77	.80	.80	.81
NEE	.15	.18	.15	.13	.12
Income>G	.83	.79	.84	.84	.85
NEE2	.11	.16	.11	.10	.08
Explanatory variables:					
Male	73 %	68 %	70 %	76 %	80 %
Immigrant background	5.9 %	6.2 %	5.9 %	5.8 %	5.7 %
GPA (s.d.)	34.4 (6.2)	33.4 (6.2)	33.9 (6.1)	34.8 (6.2)	35.8 (6.2)
Quarter of birth					
1	24 %	25 %	24 %	24 %	25 %
2	26 %	26 %	26 %	26 %	27 %
3	26 %	27 %	26 %	26 %	25 %
4	24 %	23 %	25 %	24 %	23 %
Mother's education					
Compulsory	28 %	30 %	30 %	27 %	25 %
Intermediate	50 %	49 %	50 %	51 %	51 %
Higher	21 %	19 %	19 %	21 %	23 %
Missing	1.6 %	1.8 %	1.5 %	1.5 %	1.6 %
Father's education					
Compulsory	26 %	30 %	28 %	25 %	23 %
Intermediate	58 %	56 %	57 %	59 %	61 %
Higher	12 %	11 %	11 %	13 %	14 %
Missing	3 %	3.3 %	3.3 %	2.9 %	2.7 %
Mother's income					
Below G	18 %	21 %	18 %	16 %	14 %
Above G	81 %	78 %	81 %	83 %	84 %
Missing	1.3 %	1.3 %	1.3 %	1.1 %	1.1 %
Father's income					
Below G	11 %	14 %	12 %	10 %	9 %
Above G	84 %	81 %	83 %	86 %	87 %
Missing	4.6 %	5 %	4.6 %	4.4 %	4.3 %
Mother's occupation					
Blue collar	44 %	45 %	45 %	44 %	42 %
White collar	31 %	27 %	29 %	32 %	35 %
Missing	25 %	28 %	26 %	24 %	23 %
Father's occupation					
Blue collar	43 %	43 %	43 %	43 %	42 %
White collar	27 %	24 %	26 %	28 %	29 %

Missing	30 %	32 %	31 %	30 %	29 %

Note: For variable definitions, see Online Appendix A table 1.

Table 2. Main results

	Dropout			Employed			NEE		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
access rate	-.25***	-.3***	-.25***	.067***	.065**	.072***	-.042***	-.061**	-.043***
	(.025)	(.028)	(.027)	(.017)	(.028)	(.018)	(.015)	(.026)	(.015)
male	-.044***	-.047***	-.044***	.016**	.019**	.017**	-.026***	-.027***	-.026***
	(.014)	(.015)	(.014)	(.0082)	(.0083)	(.0081)	(.0084)	(.0087)	(.0084)
Immigrant backgr	.037***	.043***	.037***	-.012	-.014	-.013	.0044	.0082	.0046
	(.014)	(.015)	(.014)	(.016)	(.017)	(.016)	(.014)	(.014)	(.014)
Program area Vg3 x county dummies	no	yes	no	no	yes	no	no	yes	no
Program area Vg3 x year dummies	no	no	yes	no	no	yes	no	no	yes
n	*38 401*	*38 401*	*38 401*	*38 401*	*38 401*	*38 401*	*38 401*	*38 401*	*38 401*
Mean of Y		*.25*			*.79*			*.15*	

Standard errors in parentheses clustered at Vg3 programme area (specialization at 3rd level of vocational upper secondary education). * p < 0.1, ** p < 0.05, *** p < 0.01
All specifications include indicators for each parent's level of education, level of income, and white/blue collar job, as well as indicators for year (i.e., birth cohort), quarter of birth, centrality, Vg3 programme area, and county.

Table 3. Heterogeneity. Estimated effect of *access rate*.

			n	Dropout	Employed	NEE
(A)		**Females**	*10194*	-.23***	.051	-.045
		Mean of Y		*.27*	*.78*	*.17*
		Males	*28207*	-.25***	.077***	-.045***
		Mean of Y		*.24*	*.80*	*.14*
(B)	1	**Native Norwegian**	*36139*	-.24***	.068***	-.039***
		Mean of Y		*.24*	*.80*	*.14*
	2	**EU, EEA, US, Canada,Australia, NZ**	*537*	-.52**	.013	-.017
		Mean of Y		*.34*	*.73*	*.23*
	3	**Africa, Asia**	*510*	-.15	-.25	.16
		Mean of Y		*.44*	*.72*	*.22*
	4	**Europe except EU/EEA, mostly[1]**	*1215*	-.36***	.05	-.057
		Mean of Y		*.38*	*.77*	*.18*
(C)		**Both parents blue collar job**	*8153*	-.25***	.059**	-.045
		Mean of Y		*.26*	*.84*	*.12*
		Both parents white collar job	*4299*	-.16***	.061	-.021
		Mean of Y		*.16*	*.78*	*.12*
		One white collar, one blue collar	*8360*	-.25***	.06	.0043
		Mean of Y		*.20*	*.82*	*.12*

Standard errors in parentheses clustered at Vg3 programme area (specialization at 3rd level of vocational upper secondary education). * p < 0.1, ** p < 0.05, *** p < 0.01.

The table report coefficient estimates of *access rate* from separate estimations of equation (1), i.e., including controls for sex, GPA, each parent's level of education, income, and occupation, as well as indicators for year (i.e., birth cohort), quarter of birth, centrality, Vg3 programme area, and county.

Panels A, B, and C show results from dividing the sample by sex, immigrant background, and parents' type of job, respectively.

[1] This subsample includes students with background from either Europe except EU/EEA or Latin America or Oceania except Australia/New Zealand.

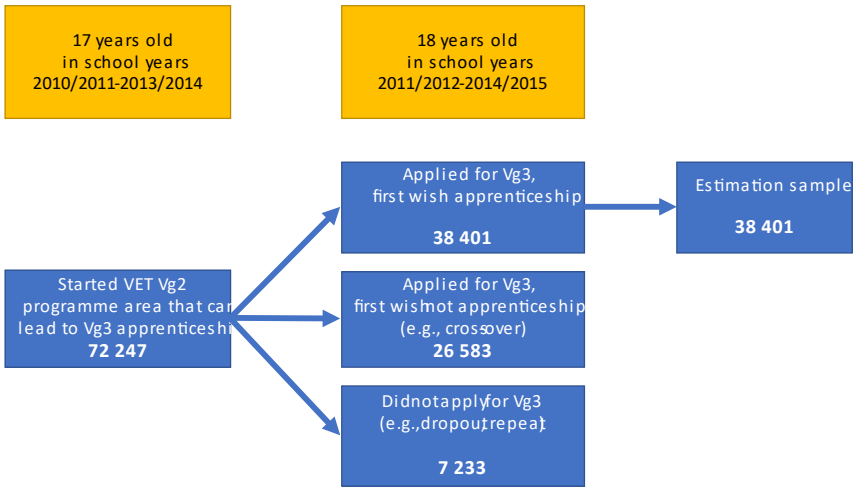
Online Appendix A

APPENDIX FIGURES

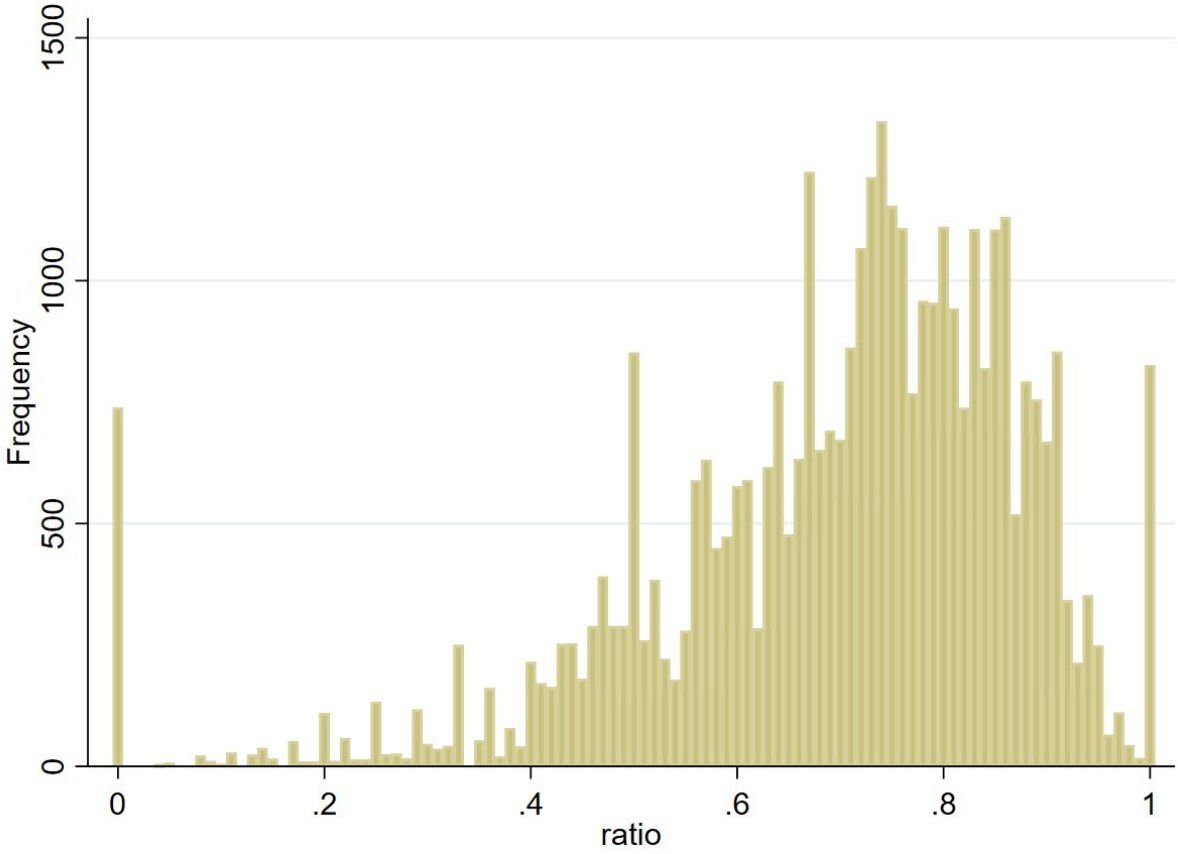
Year 1 Vg1 - Upper sec. level 1 *Education programme*	Year 2 Vg2 - Upper sec. level 2 *Vg2 programme area*	Year 3 Vg3 - Upper sec. level 3 *Vg3 programme area*	Year 4	Trade certificate
Sales, service, and transport	IT services	IT services	Cont.	IT service worker
	Tourism	Tourism	Cont.	Travel agent
		Receptionist	Cont.	Receptionist
	Sales, service, and safety	Office and administration	Cont.	Service and adm. worker
		Sales	Cont.	Sales representative
		Safety	Cont.	Security guard
	Transport and logistics	Logistics	Cont.	Logistics operator
		Professional driver	Cont.	Professional driver

App. Figure 1. The VET structure, exemplified by the education programme Sales, service and transport. Shaded areas represent classroom teaching, unshaded areas represent the apprenticeship period (our translation from Norwegian web site vilbli.no).

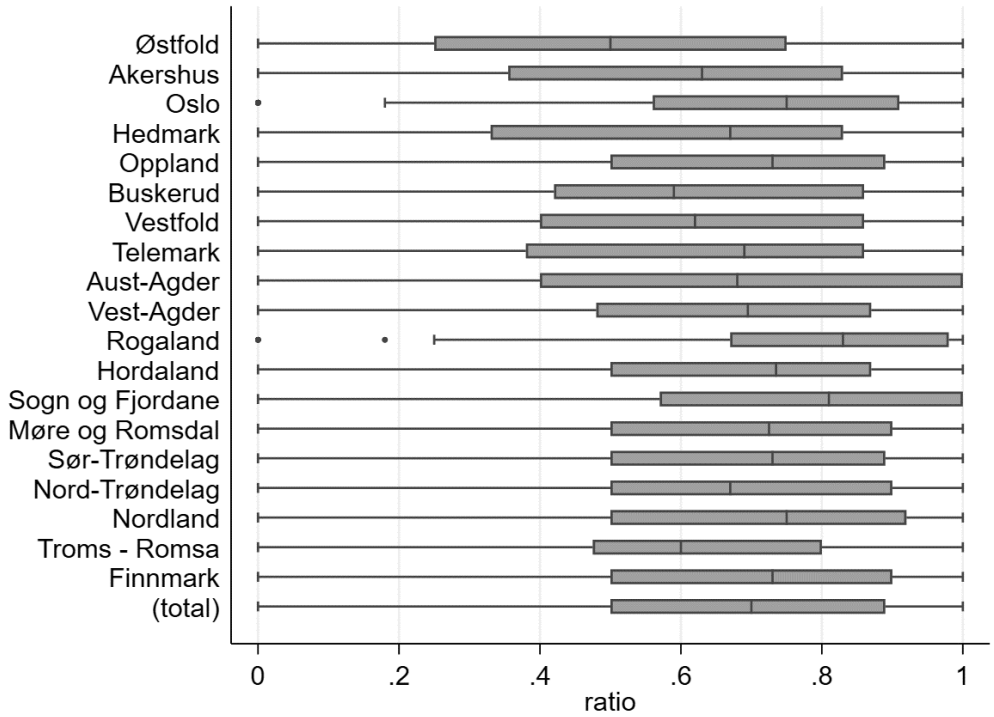
In the first year of VET, all students within a given education programme are required to take the same set of classes. In order to proceed to the Vg2 level, students must submit their applications in March and successfully complete their Vg1 coursework. Furthermore, their enrolment in a specific Vg2 programme area determines the available Vg3 programme area(s) in which they can specialize. For instance, students enrolled in the Vg2 Transport and Logistics programme area would not be eligible to apply for an apprenticeship in receptionist training unless they firsti transition to the Vg2 programme area of Tourism.



App. Figure 2. Sample selection.
VET = Vocational education and training, Vg2 (Vg3) is the 2nd (3rd) level of VET.



App. Figure 3. Distribution of *access rate* among students in the sample. The ratio is calculated by year (birth cohort), specialization, and county. Mean 0.70, standard deviation 0.19, median 0.73.



App. Figure 4. Distribution of *access rate*, by county in 2011.
The boxes are bordered at the 25th and 75th percentiles of the ratio with a median line at the 50th percentile. Whiskers extend from the box to the lowest and highest values (after excluding outliers).

APPENDIX TABLES

Appendix Table 1. Variables

Variable	Description
Outcomes at age 21:	
Dropout	1 if upper secondary is not completed by the calendar year when the student reaches age 21
Outcomes at age 23:	
Employed	1 if registered in Aa/A-registry in Oct.(contracted hours worked > 0)
NEE	1 if not employed (in Aa/A-registry) nor in post-secondary education by Oct 1st
Income > G	1 if income from employment or self-employment exceeds G (*grunnbeløp,* NOK 92 576 in 2016)
NEE2	1 if income from employment or self-employment is below G and not in post-secondary education by Oct 1st
Explanatory variables:	
Access rate	Ratio of signed apprenticeship contracts to number of Vg3 applicants whose top priority wish was apprenticeship. Per calendar year, county, and Vg3 programme area (0<=ratio<=1).
Access rate Vg2	Ratio – assigned to Vg2 students - of signed apprenticeship contracts to number of Vg3 applicants whose top priority wish was apprenticeship. Per calendar year, county, and Vg2 programme area (0<=ratio<=1).
Male	1 if male
Immigrant backgr	1 if student is immigrant or Norwegian-born to immigrant parents
GPA	Grade point average ("grunnskulepoeng") from lower secondary school
Quarter of birth	Four separate indicators for each quarter of birth, base category first quarter
Indicators for highest level of mother's and father's education when the pupil is 16 years old:	
Compulsory	1 if compulsory education, base category
Intermediate	1 if upper secondary education or post-secondary, but not higher education
Higher	1 if higher education
Missing	1 if information on education is missing
Indicators for mother's and father's income when the pupil is 16 years old:	
Income <= G	1 if income from employment or self-employment is below G ("grunnbeløp", NOK 92 576 in 2016), base category
Income > G	1 if income exceeds G
Missing	1 if income information is missing
Indicators for mother's and father's occupation type when the pupil is 16 years old:	
Blue collar	1 if blue collar occupation based on occupational code, base category
White collar	1 if white collar occupation based on occupational code
Missing	1 if occupation information is missing (the parent is not employed or we cannot link the parent to the pupil)
Centrality	Six separate indicators for each centrality class of municipality of residence based on SSB centrality index (Høydahl 2017).

Appendix Table 2. Main results, reporting a richer set of estimated coefficients

	Dropout			Employed			NEE		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
access rate	-.25***	-.3***	-.25***	.067***	.065**	.072***	-.042***	-.061**	-.043***
	(.025)	(.028)	(.027)	(.017)	(.028)	(.018)	(.015)	(.026)	(.015)
male	-.044***	-.047***	-.044***	.016**	.019**	.017**	-.026***	-.027***	-.026***
	(.014)	(.015)	(.014)	(.0082)	(.0083)	(.0081)	(.0084)	(.0087)	(.0084)
Immigrant backgr	.037***	.043***	.037***	-.012	-.014	-.013	.0044	.0082	.0046
	(.014)	(.015)	(.014)	(.016)	(.017)	(.016)	(.014)	(.014)	(.014)
GPA	-.022***	-.022***	-.022***	.0036***	.0036***	.0036***	-.0076***	-.0076***	-.0077***
	(.00082)	(.0008)	(.00083)	(.00079)	(.00085)	(.00081)	(.00054)	(.00056)	(.00054)
Mother's education:									
Intermediate	-.037***	-.036***	-.038***	.0089**	.0084*	.0092**	-.012***	-.011***	-.012***
	(.0056)	(.0056)	(.0057)	(.0043)	(.0044)	(.0044)	(.0035)	(.0037)	(.0036)
Higher	-.026***	-.024***	-.027***	-.025***	-.028***	-.025***	.0018	.0044	.0019
	(.0085)	(.0083)	(.0086)	(.0064)	(.0071)	(.0064)	(.0051)	(.0053)	(.0052)
Missing	.006	.0042	.0057	-.0022	.0048	-.002	.0031	-.0019	.0037
	(.017)	(.016)	(.017)	(.024)	(.024)	(.024)	(.022)	(.022)	(.022)
Father's education:									
Intermediate	-.034***	-.033***	-.034***	.0094**	.0089**	.0085**	-.0092**	-.0085**	-.0086**
	(.0049)	(.0049)	(.005)	(.0039)	(.0042)	(.004)	(.0037)	(.0039)	(.0038)
Higher	-.02**	-.019**	-.02**	-.048***	-.045***	-.047***	.011*	.0084	.011*
	(.0081)	(.0087)	(.0081)	(.0087)	(.0091)	(.0088)	(.0057)	(.0056)	(.0058)
Missing	-.029	-.031*	-.031*	-.019	-.021	-.019	.017	.02	.016
	(.018)	(.018)	(.018)	(.015)	(.016)	(.015)	(.016)	(.016)	(.016)
Mother's income:									
Income > G	-.055***	-.053***	-.055***	.045***	.044***	.045***	-.049***	-.048***	-.05***
	(.0071)	(.0073)	(.0071)	(.0071)	(.0074)	(.0071)	(.0076)	(.008)	(.0077)
Missing	-.0099	-.0058	-.0055	.019	.016	.018	-.025	-.023	-.025
	(.019)	(.02)	(.02)	(.023)	(.024)	(.023)	(.023)	(.023)	(.023)
Father's income:									
Income > G	-.049***	-.051***	-.05***	.023***	.027***	.023***	-.031***	-.034***	-.032***

	(.0068)	(.0069)	(.0067)	(.0074)	(.0077)	(.0075)	(.0077)	(.008)	(.0078)
Missing	.03***	.028**	.029***	.0084	.012	.0083	-.0075	-.011	-.0073
	(.011)	(.012)	(.011)	(.01)	(.011)	(.01)	(.01)	(.011)	(.01)
Mother's occupation:									
White collar	-.017***	-.017***	-.017***	-.015***	-.013**	-.015***	.0041	.0027	.004
	(.0062)	(.0062)	(.0061)	(.0056)	(.0059)	(.0056)	(.0056)	(.0058)	(.0056)
Missing/unspec.	-.011**	-.0096**	-.011**	-.014*	-.013*	-.014*	.006	.005	.0053
	(.0043)	(.0043)	(.0044)	(.0071)	(.0074)	(.0071)	(.0076)	(.008)	(.0075)
Father's occupation:									
White collar	-.013**	-.012**	-.012**	-.0024	-.0032	-.0021	-.0086**	-.0073*	-.0084*
	(.0054)	(.0054)	(.0054)	(.005)	(.0051)	(.005)	(.0042)	(.0041)	(.0043)
Missing/unspec.	-.0038	-.0051	-.0045	-.027***	-.026***	-.026***	.016**	.015**	.015**
	(.0068)	(.007)	(.0069)	(.0067)	(.007)	(.0069)	(.0071)	(.0075)	(.0073)
Program area Vg3 x county dummies	no	Yes	no	no	Yes	no	no	Yes	no
Program area Vg3 x year dummies	no	no	Yes	no	no	Yes	no	no	Yes
Constant	1.3***	1.4***	1.3***	.65***	.61***	.66***	.49***	.55***	.48***
	(.045)	(.04)	(.045)	(.034)	(.034)	(.037)	(.029)	(.03)	(.03)
n	*38 401*	*38 401*	*38 401*	*38 401*	*38 401*	*38 401*	*38 401*	*38 401*	*38 401*
Mean of Y		*.25*			*.79*			*.15*	

Standard errors in parentheses clustered at Vg3 programme area (specialization at 3rd level of vocational upper secondary education). * p < 0.1, ** p < 0.05, *** p < 0.01
All specifications include indicators for year (i.e., birth cohort), quarter of birth, centrality, Vg3 programme area, and county.
Base categories are compulsory schooling, income below G (NOK 92 576 by May 2016), blue collar occupation.

Appendix Table 3. Alternative outcomes reflecting activity

	(1) Income > G	(2) NEE2
access rate	.077***	-.052***
	(.017)	(.016)
male	.024***	-.022**
	(.0091)	(.0098)
Immigrant background	-.012	-.0018
	(.021)	(.017)
GPA	.0035***	-.0075***
	(.00061)	(.00056)
n	*28017*	*28017*
Mean of Y	*.83*	*.11*

Standard errors in parentheses clustered at Vg3 programme area (specialization at 3rd level of vocational upper secondary education). * p < 0.1, ** p < 0.05, *** p < 0.01.
Estimations include controls for sex, GPA, each parent's level of education, income, and occupation, as well as indicators for year (i.e., birth cohort), quarter of birth, centrality, Vg3 programme area, and county.

Appendix Table 4. Robustness, small programme areas excluded

	(1) Dropout	(2) Employed	(3) NEE
access rate	-.31***	.064***	-.031
	(.027)	(.021)	(.019)
male	-.046***	.02**	-.029***
	(.015)	(.0084)	(.0089)
immigrant background	.039***	-.017	.0091
	(.014)	(.016)	(.014)
GPA	-.022***	.0035***	-.0076***
	(.00086)	(.00083)	(.00055)
n	*36312*	*36312*	*36312*
Mean of Y	*.24*	*.80*	*.14*

Standard errors in parentheses clustered at Vg3 programme area (specialization at 3rd level of vocational upper secondary education). * p < 0.1, ** p < 0.05, *** p < 0.01.
Estimations include controls for sex, GPA, each parent's education, income, and occupation, as well as indicators for year (i.e., birth cohort), quarter of birth, centrality, Vg3 programme area, and county.

Appendix Table 5. Robustness, *access rate* at Vg2 level

	Sample Vg3			Sample Vg2		
	Dropout	Employed	NEE	Dropout	Employed	NEE
	(1)	(2)	(3)	(4)	(5)	(6)
access rate Vg2	-.23***	.042**	-.024	-.076***	.015*	-.012
	(.038)	(.021)	(.019)	(.027)	(.0078)	(.0081)
male	-.042**	.018**	-.025***	-.031	-.0077	-.01
	(.017)	(.0086)	(.0083)	(.02)	(.01)	(.0076)
Immigrant backgr	.034**	-.014	.0049	.012	-.0072	-.0083
	(.013)	(.018)	(.015)	(.0097)	(.015)	(.013)
GPA	-.023***	.0038***	-.0078***	-.026***	.0037***	-.0094***
	(.001)	(.00085)	(.0006)	(.00089)	(.00075)	(.00046)
n	*38401*	*38401*	*38401*	*71246*	*71246*	*71246*
Mean of Y	*.25*	*.79*	*.15*	*.28*	*.77*	*.15*

Standard errors in parentheses clustered at Vg3 programme area (specialization at 3rd level of vocational upper secondary education). * p < 0.1, ** p < 0.05, *** p < 0.01.
Estimations include controls for sex, GPA, each parent's education, income, and occupation, as well as indicators for year (i.e., birth cohort), quarter of birth, centrality, Vg2 programme area, and county.

Online Appendix B

Data sources

The sample we analyse is constructed using data obtained from the Vigo database. This database offers comprehensive individual-level information on students' preferred choices when applying for admission to upper secondary education at different levels. This includes details regarding the school and Vg1 education program, as well as the Vg2 and Vg3 programme areas selected by the students. Similar data has been used in one report (Aspøy and Nyen, 2015), otherwise, this data source is underutilized in research. The Vigo database contains data starting from the academic year 2011/2012.

The accessibility of apprenticeships can be assessed using the data published by the Norwegian Directorate for Education and Training. This data is reported annually and provides information on the number of applicants whose top priority is to obtain an apprenticeship and the number of signed contracts, aggregated by Vg3 programme area and county (The Norwegian Directorate for Education and Training, b). [1]

The dropout indicator used in the analysis is based on annual information from the national education database (NUDB), regarding an individual's highest level of completed education. Additionally, the NUDB includes information on education activity, updated annually by 1 October. This information is represented by a 6-digit code that denotes the level and field of study. The NUDB also includes data on final grades from lower secondary school, measured by GPA (Grade Point Average). Furthermore, information on the highest level of education completed by both the mother and father of the individual is available in the database.

[1] For a few programme areas, admission is at the national level ("landslinje").

The State Register of Employers and Employees ("Aa or A-registeret") is managed by the Norwegian Labour and Welfare Administration and serves as a comprehensive source of information on employment. Reporting to it is mandatory. For information on annual income, the analysis relies on Statistics Norway's database for income and wealth statistics for households. Furthermore, Statistics Norway has provided data on students' background characteristics (e.g., sex, birth cohort, immigrant background, family relations, and centrality).

We have merged information extracted from these sources using the personal identifier. Data is available up until 2019, with income data available until 2018.

Sample selection

The analysis focuses on students who prefer following the dominant model within VET, which entails two years of classroom instructions followed by two years of apprenticeship. To capture this specific group of students, the sample is restricted to students who enrol in a Vg2 programme area that may qualify them for an apprenticeship the subsequent year [2]. Furthermore, the sample includes students whose schooling is without delay, meaning they are 17 years old in the calendar year when enrolled in Vg2.[3] To identify students meeting these criteria, information on Vg2 enrolment in VET is taken from the NUDB data on educational activity. Because of data availability, the sample is based on VET students enrolled for the school years 2010/2011 to 2013/2014, that is, the birth cohorts from 1993 to 1996. Applying these selection criteria results in a sample of 72247 students, as illustrated in Online Appendix

[2] Thus, we exclude students who enrol in VET Vg2 programme areas which do not involve an apprenticeship but lead to Certificate of Upper Secondary Education instead ("yrkeskompetanse med vitnemål"), or where the apprenticeship starts at Vg2 level already ("særløp") or starts the fourth year of upper secondary school.
[3] Students are excluded from the sample if they drop out of upper secondary schooling altogether during the first year or experience delays due to programme switches. By excluding students whose schooling is delayed, we avoid a potential endogeneity problem.

A Figure 2. In our main analysis, we will apply a subsample, namely 38401 students who apply for an apprenticeship as their top priority wish for Vg3[4]. [5]

[4] This subsample includes students who aim at or end up with "certificate of competence" (3-4 % of all Vg3 applicants), which is regarded basic education.

[5] As shown in Appendix Figure 1, we exclude students who were enrolled in Vg2 but did not apply for Vg3 altogether, for example dropouts, students who repeat their current Vg2 programme area or switch to another (7233 students), and students who prefer another Vg3 option to apprenticeship, for example cross-over to academic track (26583 students).