I Z A Institute
of Labor Economics
Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 16474

Can Vocational Education Improve Schooling and Labour Outcomes? Evidence from a Large Expansion

João R. Ferreira
Pedro S. Martins

SEPTEMBER 2023

I Z A Institute
of Labor Economics

Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 16474

Can Vocational Education Improve Schooling and Labour Outcomes? Evidence from a Large Expansion

João R. Ferreira
Nova School of Business and Economics

Pedro S. Martins
Nova School of Business and Economics and IZA

SEPTEMBER 2023

Any opinions expressed in this paper are those of the author(s) and not those of IZA. Research published in this series may include views on policy, but IZA takes no institutional policy positions. The IZA research network is committed to the IZA Guiding Principles of Research Integrity.

The IZA Institute of Labor Economics is an independent economic research institute that conducts research in labor economics and offers evidence-based policy advice on labor market issues. Supported by the Deutsche Post Foundation, IZA runs the world's largest network of economists, whose research aims to provide answers to the global labor market challenges of our time. Our key objective is to build bridges between academic research, policymakers and society.

IZA Discussion Papers often represent preliminary work and are circulated to encourage discussion. Citation of such a paper should account for its provisional character. A revised version may be available directly from the author.

ISSN: 2365-9793

IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Can Vocational Education Improve Schooling and Labour Outcomes? Evidence from a Large Expansion*

We evaluate the education and labour impact of vocational education and training (VET). Identification draws on different IVs from the large-scale, staggered introduction of VET courses in public schools in Portugal from 2005. We also exploit the large gender differences in VET, with many courses selected almost only by either boys or girls. Drawing on rich student-school matched panel data, we find that VET increased upper-secondary graduation rates dramatically: our LATE estimates typically exceed 50 percentage points. These effects are even stronger for low-achieving students and welfare recipients. Moreover, we find evidence of regional youth employment growth following VET expansions. VET graduates also benefit from higher wages and other positive outcomes over several years, compared to both academic-track and lower-secondary graduates.

JEL Classification: I21, I26, I28, J24

Keywords: educational attainment, vocational education, matched student-teacher-school data, VET wage differentials

Corresponding author:
Pedro S. Martins
Nova School of Business and Economics
Universidade NOVA de Lisboa
Campus de Carcavelos
2775-405 Carcavelos
Portugal
E-mail: pedro.martins@novasbe.pt

* The authors thank comments from Alex Armand, Federico Biagi, Luis Catela Nunes, Nuno Crato, Ying Cui, Li Dai, Giorgio Di Pietro, Pedro Freitas, Judite Gonçalves, Eric Hanushek, David Justino, Zbigniew Karpinski, Isabel Leite, Miguel Baião Santos, and seminar and workshop participants at ISEG (Lisbon Micro Group), Nova SBE, and the European Commission Joint Research Center (Seville). We thank support fromDGEEC (Ministry of Education), Fundação para a Ciência e a Tecnologia (UIDB/00124/2020, UIDP/00124/2020 and Social Sciences DataLab - PINFRA/22209/2016), POR Lisboa and POR Norte (Social Sciences DataLab, PINFRA/22209/2016). All errors are our own.

1 Introduction

Vocational education and training (henceforth VET) can offer important school-to-work pathways to youngsters (OECD 2023). By providing a combination of academic and practical skills, VET can smooth their transitions to the labour market. Moreover, VET's focus on particular occupations can motivate some students to stay longer in school, thus increasing their educational achievement before they join the labour market. Furthermore, these features of VET courses may be particularly appealing to students from lower socio-economic backgrounds. This can generate important contributions from VET not only on efficiency but also equity grounds.

While the effects of VET on schooling achievement and labour outcomes are major questions, of significant academic and policy relevance, we know of few studies that investigate them from a causal perspective (Brunner et al. 2023, Dougherty 2018). Our analysis is based on exploiting causally a large VET reform in Portugal. As we show below in more detail, the share of upper secondary students enrolled in VET increased by as much as 20 percentage points over a period of only five years. Given its large size, this expansion was carried out at different times in different schools, creating discontinuities in VET availability that we exploit.

Moreover, we draw on comprehensive student-school matched panel data, covering all students in each year during and after the reform. We can thus compare the outcomes of two consecutive cohorts of students at the same school, typically separated simply by having been born one year apart, but that faced greatly different circumstances in VET availability. We use this information to construct instrumental variables based on the availability of VET in each school district and academic year, exploiting both the extensive and the intensive margins. We also highlight and exploit the large gender differences in VET, with many courses selected (almost) only by boys or girls. Furthermore, we use the detailed longitudinal information on each student, including several socio-economic variables, to assess the equity implications of VET. The nature and richness of the data set also allows us to conduct several heterogeneity analysis and robustness checks.

We find that VET increased significantly the upper secondary graduation rate of lower secondary students. Our LATE estimates of VET takeup effects on three-year graduation (the shortest time possible to graduate and the Education Ministry's preferred measure of student success) are typically higher than 50 percentage points. These dramatic effects follow partly from the context of large dropout rates when the reform was implemented, particularly for low socio-economic

background students. Interestingly, when considering longer graduation times (typically involving grade retention), our VET effects are smaller. This difference indicates that VET is more effective for faster, no-retention graduation outcomes. From an equity perspective, we find that the above-mentioned VET effects on graduation are even larger for (lower-secondary) low-achieving students, students whose parents have lower levels of schooling, and welfare recipients. In other words, VET availability tends to support more the educational achievement of individuals that otherwise are more likely to drop out from (lower or upper) secondary school (and face weaker labour market prospects).

Finally, we analyse the labour effects of VET again drawing on the same policy reform. We ask if better VET graduation rates come at the cost of weaker labour market prospects of those individuals. This could arise if the new VET courses add little human capital to graduates and thus lack labour-market appeal. First, we analyse region-industry-year labour data (from a comprehensive matched employer-employee panel) linked with VET availability information (from our education data above). Our evidence is not supportive of this view as we find positive and generally statistically significant effects on regional industry employment rates. Second, when estimating VET wage premiums across the targeted cohorts using individual-level data, we find that VET graduates earn higher wages than both lower-secondary graduates and academic-stream upper-secondary graduates. We find similar positive VET effects in other outcomes not explored so far in the literature, including open-ended employment contracts, firm-provided training, and employment time.

Overall, our results indicate that VET provision may be an important policy to increase both efficiency and equity. Our evidence indicates that VET graduates tend to benefit from fast upper secondary graduation and good labour-market opportunities. Moreover, the VET graduates that tend to benefit the most from these opportunities come from low socio-economic backgrounds.

Related literature. As indicated above, we know of very few other causal studies regarding the impact of VET on both graduation and labour market outcomes. An important and recent study is Brunner et al. (2023), which considers oversubscribed technical schools in Connecticut in a regression discontinuity analysis, finding large positive effects on graduation and earnings for male students. Another example is Dougherty (2018), which considers oversubscribed technical schools in Massachussets, also finding positive graduation effects. Several other papers also contrast outcomes of VET and academic programs.[1] We note that our context contrasts and complements

[1] Kugler et al. (2022) finds long-term and family spillover effects from VET in Colombia. Polidano & Tabasso (2014) and

the contexts of these two studies: given the excess demand these Connecticut and Massachussets schools face, these schools presumably have a strong reputation with students. Such strong reputation (and its underpinning high quality levels) may explain the positive graduation and labour market effects in Brunner et al. (2023) and Dougherty (2018) which may not extend to broader VET expansions, including when new courses are launched. The gender dimension of these U.S. results (with effects found only for boys) may also stem from the particular courses in these schools, which may be less appealing to girls.

Our contribution to this small literature is the analysis of the policy-relevant case in which a VET stream is made available for the first time for many students. In this context, in contrast to Brunner et al. (2023) and Dougherty (2018), VET does neither have a strong reputation nor is subject to excess demand. Our findings may thus be particularly important for countries that are considering to introduce VET but may be concerned about its effects, especially in the early stages of VET development, when its reputation is not yet established. In this context, our results highlight the limited comparability of students under VET and academic tracks, as the former tend to come from lower socio-economic backgrounds. Such selection can also be very important in subsequent labour market comparisons of the two groups of graduates.

We also contribute to three additional literatures. First, the VET employment and wage differentials literature (Hanushek et al. 2017, Brunello & Rocco 2017, Silliman & Virtanen 2022, Chakravarty et al. 2019, Kemper & Renold 2024). We find that graduates from VET courses earn higher wages both compared to academic-track graduates or lower secondary graduates of the same age. Moreover, we do not find evidence of employment or wage premiums declining over the 13-year period analysed. This suggests that the returns from VET exceeded those from the labour market experience of early school leavers. Moreover, the added value of these VET courses appears to be resilient over time, which supports the value of their human capital. We also consider a number of additional labour market outcomes besides wages, namely contract type and firm-provided training, finding positive VET effects in all cases.

Second, the literature on gender and labour: we find considerable scope for VET availability to shape gender segmentation in occupations. This follows from large gender imbalances in VET

Mora et al. (2022) find that VET is associated with higher school completion rates and better employment transitions in Australia and Spain, respectively. Other studies focus on higher levels of instruction: Jepsen et al. (2014) find that community college certificates have positive labour market returns in Kentucky and Böckerman et al. (2019) estimate positive wage effects from attending vocational master's programmes in Finland. See also Stevens et al. (2019) for an analysis of returns to career technical education in community colleges.

course composition, in striking contrast to the case of academic courses. These results support earlier findings on large gender differences in occupations and industries (Blau & Kahn 2017) and their role in driving the gender wage gap.

Third, the educational tracking literature, which studies the merits of splitting students across classes depending on their achievement (Hanushek & Woessmann 2006, Meghir & Palme 2005, Card & Giuliano 2016, De Groote forthcoming). In contrast to some earlier studies, our evidence indicates that upper secondary tracking, through VET students' self-selection, can be both efficient and equitable.

Outline. The structure of the remaining of the paper is as follows: Section 2 presents the policy reform that led to the expansion of upper secondary vocational education in Portugal. Section 3 describes our data and Section 4 presents our methodology, namely the three instrumental variable strategies we follow to study educational outcomes. The main results focusing on educational achievement and a series of heterogeneity and robustness analyses are presented in Section 5. Section 6 presents our results on labour market outcomes. Finally, Section 7 concludes.

2 Institutional context and the VET reform

VET is conducted very differently across countries and to some extent also over time. Considering the share of VET students in upper secondary education across the OECD, in 2005 and in 2016, one finds a great deal of diversity (Figure A.1), from around 10% in Canada to around 70% in Czechia. In some countries, these shares have changed considerably, such as in Mexico, Portugal, and the UK (where they have increased) and Sweden and Germany (where they have declined).[2] Before zooming on the VET reform we study here, we provide below a brief summary of the Portuguese education system.

2.1 The Portuguese education system

Students start compulsory education in lower primary school (grades 1 to 4) around the age of 6. They then proceed to upper primary (grades 5-6) and lower secondary education (grades 7-9). After

[2] International differences in VET systems can include several other dimensions: the breakdown between vocational education and vocational training (including apprenticeships); the involvement of social partners (in particular employers' associations) in the design, implementation, and updating of the courses; and the flexibility offered for further study, including in higher education.

graduating from lower secondary school (at about 15 years old, if not retained before), continuing students have to select either the academic or the vocational track (grades 10-12) and one course option in each track. The latter choice creates significant variation in modules and training among students even if they select the same track. The transition from lower to upper secondary education may entail a change in school, but generally within the same school district (*agrupamento*).[3] Most students attend public schools, which do not charge tuition fees.

The compulsory school leaving age was 15 years of age during the first part of the period we cover, increasing later to 18. This change (Law 85/2009) mandated pupils to remain attending school until they either turn 18 years old or complete upper secondary education. The first cohort affected by this reform were students aged 14 or less and enrolled in 7^{th} grade or lower in 2009/10.[4]

Students sit national exams (in Portuguese and Maths) at the end of 9^{th} and 12^{th} grades. 9^{th} grade exam scores account for 30% of students' final grade and can be used as a measure of student achievement prior to upper secondary enrollment, as we show below. 12^{th} grade exams are used for university applications and available to pupils of both academic and VET streams. Indeed, we use below the 12^{th} grade exam of Portuguese as a measure of student achievement upon upper secondary graduation.

2.2 The VET reform

Portugal lagged behind OECD upper secondary graduation rates for decades. In 2004, for instance, the country's early school leaving rate of 39.3% was more than 20 percentage points above the EU average at the time, 16% (see Figure 1). This motivated the introduction, in that year, of VET courses (*cursos profissionais*) in public schools. Until then, only private schools offered vocational courses but they did so in relatively low numbers. All VET courses, both before and after the reform, were subsidised by the Ministry of Education, implying that students did not have to pay any tuition fees to attend them.

The new VET courses offered by public schools provided general skills (in maths, languages, and other subjects) as well as practical skills towards a specific occupation. Indeed, these VET courses

[3] Since 2013/14, there are 713 school districts. To be consistent, we consider the most recent map of school districts in our analyses (even for older, pre-2013/14 cohorts). Most school districts include several primary schools (and kindergartens), at least one lower secondary school, and an upper secondary school. Many students thus complete their entire education in the same school district.

[4] Our study includes cohorts before and after this reform, an issue that we discuss further below. See Leme (2023) for an impact evaluation of this reform drawing on the same data set used in this paper and Harmon (2017) for a review of the effects of compulsory schooling laws. We also note that the use of grade retention (Borghesan et al. 2022) for remedial purposes has been reduced in recent years.

are 'double certified', as they award both an academic diploma (completion of upper secondary education) and a technical diploma (regarding a specific occupation).[5]

The range of VET subjects offered in the new VET courses delivered by public schools is very wide. These subjects covered virtually all main skilled occupations that do not require higher education. For instance, as of the 2013/14 academic year, there were a total of 156 different courses running.[6] Moreover, students attending VET courses were entitled to (non-means-tested) financial support for food, transportation, and (during the internship stage) a small scholarship. In total, this financial support was equivalent to about one third of the minimum wage.

An important driver of the VET expansion was the availability of financial support from the European Union's European Social Fund.[7] Indeed, 69.7% of the total expenditure of 1.26 billion euros on VET between 2007 and 2011 was funded by the ESF. Given the dual priorities for the Ministry of Education of making use of EU funds and reducing early school leaving, the introduction of VET courses took place rapidly, without detailed studies of local labour market needs for specific occupations.

Figure 1 shows how the number and composition of upper secondary enrollments evolved in Portugal between 1995 and 2021. Just between 2006 and 2010, the proportion of upper secondary students that enrolled in VET courses increased from 13.1% to 31.4%. This period coincided with increasing upper secondary school enrollments, inverting a decade-long trend of decline.

Note that the extension of compulsory schooling in 2009 increased the transition rate between lower and upper secondary school. This raised the demand for upper secondary school places, thereby requiring a rapid supply response from schools. Considering this 'demand shock', the availability of ESF funds being conditional on their use for VET programmes, and the weaker academic profile of those students who would have dropped out at the end of 9^{th} grade if not due to the compulsory schooling age reform, the incentives for schools to create VET courses were significant. This situation may have led to a rushed implementation of the VET reform, with negative effects on course quality.[8]

[5] In contrast, until 2004, the most practical courses offered by public schools, 'technological courses', were mostly scientific (rather than vocational), with little focus on specific occupations. See DGERT (2019) and Barbosa et al. (2020) for additional background on the VET system in Portugal.

[6] The ten most popular courses enrolled between 860 and 2,600 12^{th} grade students in that academic year. These courses were (in decreasing order of enrollments): sports management, information system management and programming, IT management, multimedia, health support, catering, tourism, childcare, socio-cultural animation, and management.

[7] See Martins (2021) for an evaluation of another policy supported by the ESF over the same period.

[8] According to views collected from our interviews of policy-makers over the period studied, the Ministry of Education did not strategically plan the creation of VET courses: the approval of new courses was typically a bureaucratic process.

3 Data and descriptive statistics

3.1 Data

We use a comprehensive longitudinal administrative data set, MISI, containing extensive information about all non-higher-education students in mainland Portugal between and including the 2006/7 and 2016/7 academic years. The data is compiled by the Ministry of Education and includes both public and private schools (see Catela Nunes et al. (2018) and Borghesan et al. (2022) for earlier studies drawing on this data set). We draw on variables such as students' sex, date of birth, Portuguese or foreign nationality, exam scores, welfare support status (full or partial, if applicable), and a range of parental (guardian) characteristics. The data set also includes unique time-invariant identifiers for each student, allowing us to track them over time and establish if and when they attend and graduate from upper secondary school (a key outcome variable in this study).

3.2 Descriptive statistics

Table 1 presents descriptive statistics for our main sample, covering all 650,000 students enrolled in 9^{th} grade in mainland Portugal's public schools between 2006/7 and 2013/4. We focus on public school students because the VET expansion from 2005 was essentially in the public sector. These individuals account for 86.6% of the full data set of all (non-adult) pupils, with little changes over the period covered. We also focus on the 9^{th} grade because this is when students decide whether or not to attend upper secondary education and, if so, whether to follow the academic or VET streams. (In our main analyses, we consider only the last observation of each student in 9^{th} grade: because of retention practices, students may enrol in the 9^{th} grade more than once.)

51.7% of our sample are girls, the average age is 15.5 years, and approximately 3.2% of students are foreigners. 54.8% of all students were still bound by compulsory schooling (i.e., required to register in school for at least one more year). Average Portuguese and Maths national exam scores are 55.6 and 48.6, respectively. 34.1% are welfare recipients. On average, the parents and *guardians* of public school students had completed fewer than nine years of formal schooling (i.e., less than lower secondary education). 8.8% of guardians were unemployed and 3.7% inactive.[9]

Moreover, teachers generally did not have experience in the private sector (or in vocational training). These conditions led many schools to open VET streams that had a lower technical load, without much regard to the labour market needs of their regions.

[9]The 'guardian' is the individual that is legally responsible for the child before the school: in most cases, these are mothers (76%), followed by fathers (17%), and non-parent guardians (typically grand-parents or elder siblings; 6.3%).

The second panel of Table 1 focuses on multiple outcomes of interest related to educational achievement. First, we present a key indicator of academic success by the Ministry of Education: the percentage of students that graduates from upper secondary school in the three years following initial enrollment (the standard duration of that cycle). This is only 42.5% in our sample. Over 70% of these graduates were enrolled in academic courses (Sciences and Technologies, Socio-Economic Sciences, Languages and Humanities, and Visual Arts) while 28% graduated from VET (and a small minority was enrolled in 'specialized artistic courses'). Graduation rates in up to four or five years (thus also including the set above of graduations up to three years) were approximately 10 percentage points larger than the three-year figure.[10] We also present statistics for 12^{th} grade exam scores even if these are only available for a subset of VET students.

Finally, our main explanatory variables are summarized in Table 1's third panel. $VETavailability$ is a dummy variable equal to one if the school district where and when the student was enrolled in 9^{th} grade offered at least one VET option in the following academic year, and zero otherwise.[11] We find that nearly 60% of 9^{th} grade students had the opportunity to enrol in VET courses in their school district. As discussed above, this global average masks considerable differences across time periods (Figure 3) and regions.

For robustness purposes, we also constructed and present two VET availability measures taking into account gender preferences. This follows from large gender imbalances in the takeup of several VET courses, in contrast to the case of academic courses (Figure 2). Finally, we also consider a measure of the relative availability of VET opportunities, considering the number of students at the 9^{th} grade (in school year $t-1$) and the number of VET classes at the 10^{th} grade (in year t). This measure, $VETsupply$, is primarily defined at the municipality level. We discuss these three complementary explanatory variables in greater detail below in Section 4.1 and Appendix B.

Finally, Table A.1 presents the 9^{th} grade statistics of the variables above separately between students who subsequently enrol in VET and academic upper secondary tracks. We find that there are large differences between both groups of students. For instance, VET pupils are older (thus are more likely to have been retained), have lower prior academic achievement (as measured by national exams in Portuguese and Maths), have a higher probability of being males, immigrants, and

[10] Note that the sample size used to compute graduation rates over longer periods is naturally smaller, as we do not have data over longer periods for the more recent cohorts.

[11] This implies that a student enrolled in 9^{th} grade in year t would be able to enrol in a VET course in the same school district in year $t+1$. Note that the introduction of a VET track in many public schools was not necessarily 'permanent': due to changes in demand, schools may open slots in specific courses, for instance, every other year instead of each year. This creates an additional source of variation in VET availability.

receiving welfare support and of having guardians with lower levels of schooling and employment. These striking differences highlight the so far relatively unexplored class tracking (Card & Giuliano 2016, De Groote forthcoming) dimension of VET.

4 Methodology

We seek to estimate the effect of VET enrollment at the end of lower secondary education on upper secondary graduation rates. Naturally, the choice between academic and VET instruction may be endogenous and partly determined by unobserved student or household characteristics that can also influence graduation outcomes. Therefore, we use the large-scale, staggered expansion of upper secondary VET across the country for identification. Specifically, we use the availability (or not) of a VET track for 9^{th} grade students in the school district they were attending (i.e., the opportunity or not to start a VET course in the following year) as a first instrumental variable for VET takeup.

Our graduation models are specified as follows:

$$Graduation_{ij,t+\Delta t} = \alpha + \beta VETtakeup_{ijt} + \gamma X_i + \lambda_j + \tau_{tr} + u_{ij,t+\Delta t}, \tag{1}$$

in which $Graduation_{ij,t+\Delta t}$ is a dummy variable equal to one if 9^{th} grade student i in school j at time t graduates in Δt (3, 4, or 5) years. $VETtakeup_{ijt}$ is a dummy variable equal to one if the same student registers in a VET course in the following year. X_i is composed of individual-level controls; λ_j and τ_{tr} are, respectively, school district and region-by-year fixed effects (we consider 28 different, NUTS3 regions), and $u_{ij,t+\Delta t}$ is the error term. The school-district and region-year fixed effects seek to capture systematic differences in graduation rates across schools, regions, and time that may be correlated with VET takeup decisions and also influence graduation outcomes. In our baseline specification, X_i includes sex, age, socio-economic status (proxied by full or partial welfare support), and compulsory school age bite (which varies by age and academic year). We also consider an extended specification in which X_i further includes 9^{th} grade Maths and Portuguese national exam scores, in addition to controls for (foreign) nationality and guardian's education and employment status. Again, these variables may also be correlated with VET takeup decisions and influence graduation outcomes. Standard errors are clustered at the school district level.

We use data for all school years between and including 2006/7 and 2016/7. Hence, when a three-year graduation rate is considered as the outcome of interest, the sample is composed of

students in Portugal who were last enrolled in 9^{th} grade between the 2006/7 and 2013/4 school years, in the public school system. (As indicated above, the 2012/3 and later cohorts are removed from the sample when the five-year completion rate is used; and the 2013/4 cohort is removed when considering graduation within four years.)

4.1 Gender and VET availability

As previously shown, VET enrollment varies greatly on account of the interaction between gender and course profiles (Figure 2). In fact, the decision to launch courses in traditionally female- or male-dominated courses can lead to different enrollment outcomes on account of the gender of each student (Bonilla 2020). We therefore exploit this heterogeneity in a complementary IV strategy.

Specifically, first, we identify each course as being either 'male-friendly', 'gender-neutral', or 'female-friendly' if the proportion of female students who enrolled (throughout the entire period considered) is lower than 1/3, between 1/3 and 2/3, or higher than 2/3, respectively. Then, we define two new instruments (presented in Table 1's third panel): 'Same-gender-friendly VET' takes value one if student i has at least one available VET option associated with their gender, as defined above, in their school district when preparing to enrol in 10^{th} grade, and zero otherwise. 'Gender-neutral VET' takes value one if student i has at least one available 'gender-neutral' VET option in their school district at the end of 9^{th} grade, and zero otherwise. (Note that the 'at least one course' definition here explains why the descriptive statistics for the main instrument and for the two new instruments are somewhat similar - Table 1.) For instance, we find that the most female-friendly VET courses include 'Infant support' and 'Health technician', while male-friendly courses include IT, Multimedia, and Sports management. Neutral courses include Tourism, Restaurant hospitality training, and Management.

4.2 VET supply

We are interested in measuring how the increased supply of VET course offerings affected a range of student outcomes. However, we have only focused on the 'extensive margin' of VET expansion thus far. In our third IV strategy, we build a continuous instrumental variable to capture the effective capacity of public schools to provide upper-secondary VET for each cohort and region of mainland Portugal and exploit the intensive margin as well.

We note that the 'supply-side' of VET expansion should be distinguished from fluctuations in

pupils' demand for such courses. Moreover, a good metric of supply should consider the size of the student population in each region (for instance, a single new 10^{th} grade VET class in year t may represent very different effective supply when there are 30 or 300 9^{th} grade students in the same region in year $t-1$). Therefore, our measure of the supply of upper-secondary VET (hereafter, $VETsupply$) is defined in the following way:

$$VETsupply_{ct} \equiv \frac{30 \times VETclasses_{ct}}{Number\ of\ 9^{th}\ grade\ students_{c,t-1}}, \tag{2}$$

where $VETclasses_{ct}$ is the number of 10^{th} grade VET classes (in the public sector) that were opened in *concelho* c and school year t, while the denominator is the number of 9^{th} grade public-school students that lived in the same *concelho* in the previous school year. $VETclasses_{ct}$ is multiplied by 30 (the maximum class size for most upper secondary VET courses) so that the numerator may provide an estimate for the VET capacity of region c in school year t.

Our preferred approach involves defining $VETsupply$ at the municipal level, of which there are 278 in continental Portugal (these regions may overlap with a school district, but are often served by several school districts). Overall, due to its denominator, our measure of VET density accounts for variation across municipalities and over time in the number of potential 10^{th} grade students in each *concelho*. For descriptive statistics concerning $VETsupply$, see the last row of Table 1's third panel.

Furthermore, Figures 3 and A.3 show the absolute, municipal-level variation of our measure of $VETsupply$ between 2006 and 2011 and from 2006 to 2014, respectively. They highlight the scattered and diverse implementation of public upper-secondary VET in Portugal, while revealing some regional disparities.

5 Education results

5.1 Takeup

We start by showing how enrollment in the two main (academic and VET) upper-secondary tracks evolved following the creation of the first VET course(s) in a given school district. We consider, as dependent variables, two binary indicators for whether students were enrolled in a VET or academic 10^{th} grade course after their final 9^{th} grade enrollment (Table 2). Note that, when the de-

pendent variable is $VETtakeup$ (in the first three columns of the Table), the estimated equation is essentially the first stage of the IV model described above. The specifications include the same explanatory variables as equation (1). Note also that, besides enrolling in academic or VET courses, 9^{th} grade students may also drop out. Standard errors are once again clustered at the school district level.

We find that VET availability has the predicted positive effect upon VET takeup. The coefficients range between 4.5 (with the full set of controls) and 5.6 percentage points (without controls, other than school district and region-by-year fixed effects), and are always significant at the 1% level. The results of the remaining explanatory variables in terms of enrollment in VET courses are also of interest (and in line with Table A.1). For instance, we find that females are less likely to enrol in VET (which is consistent with the significant gender differences in course choice mentioned above - Figure 2), that older students are more likely to enrol (these will be students subject to retention in previous years), and that students under welfare support are more likely to enrol. Better students (in their 9^{th} grade exam scores), and students with guardians with more schooling are less likely to enrol in VET courses. Students whose guardians are unemployed are more likely to enrol in VET.

Interestingly, we find evidence of a displacement effect, as the availability of 10^{th} grade VET classes reduces the enrollment in academic courses (last three columns of Table 2; see also Table A.2). The coefficients here are about less than half of those regarding VET takeup, ranging between -1.7 and -2.7 percentage points. These results highlight different margins of VET takeup: about two thirds of the increase in VET enrollment is driven by students who otherwise would not enrol in upper secondary education and the remaining one third is driven by students who otherwise would enrol in academic courses. (As before, the analysis of the remaining coefficients is also interesting. We find that virtually all coefficients have the opposite sign compared to the case of VET takeup.)

5.2 Main results

Our main estimates are in Tables 3 (OLS) and 4 (IV/2SLS). In the first case, ignoring the endogeneity of VET takeup, we find that VET enrollment increases the probability of graduation in three years by up to 15.7 percentage points, but only when including control variables. In a specification without control variables (other than school district and region-year fixed effects), we find a negative coefficient (-0.042). When considering longer graduation time ranges (up to four years), estimates vary between 0.6 (and not significant) and 20.1 percentage points.

We now move to our main IV results, in which we instrument VET takeup using VET availability, in the context of the reform described above. This analysis focuses on students whose decision to enrol in VET was driven by newly-established VET course options (LATE parameter). In contrast to the LPM/OLS results, we now find that the probability of graduating in (not more than) three years was increased by 42 to 59 percentage points. Four-year graduation rates were 26 to 39 p.p. higher. These results indicate that students that gain the opportunity to attend VET courses in their schools benefit greatly in terms of faster completions of upper secondary education. Considering a longer time-to-graduation (5 years) leads to similar effects to those obtained for four-year graduation rates (see columns (3) and (4) of Table A.4).[12]

As robustness checks, we consider different sub-samples and additional controls. First, we focus exclusively on students that enrol in upper secondary education by removing from the sample all students who dropped out by the end of 9^{th} grade. We find that our main estimates are robust to the exclusion from the sample of this sizeable group of students - Tables A.5 (OLS) and A.6 (IV).

Second, we restrict initially the sample to all students from school districts in which VET courses were either always or never available (Table A.7). We then also include in the sub-sample all observations up to and including the first introduction (or closing) of VET in school district j (columns 1-3). Alternatively, we include in the sub-sample the last observations before the opening of VET and the first observations after VET was implemented (or before and after VET closing) (columns 4-6). Estimates lose statistical precision, but remain uniformly positive and mostly significant.

Third, while there are mixed findings in the literature about the effect of class size on student achievement, the fact that VET classes are (on average) smaller than academic-track classes (see Figure A.2) could potentially bias our estimates and explain at least in part the large positive effects documented above. However, as shown in Table A.8, our main estimates are robust to the inclusion of a linear control for 10^{th} grade class size. Fourth, our results are also robust to the exclusion of the three more recent cohorts (i.e., those affected by the 2009 increase in the compulsory school leaving age) from the sample (Table A.9).

For our gender-related IV strategy (Subsection 4.1), we re-estimate equation (1) using the 'Same-gender-friendly VET' dummy variable as a single instrument (Table A.10) and then in conjunction

[12] While descriptive in nature, the coefficients on control variables provide interesting insights about the drivers or predictors of schooling achievement in our context. All else equal, female students are over 10 percentage points more likely to graduate than their male peers. The student's grades and their guardian's education and employment status also predict an increased probability of graduation. In contrast, welfare support strongly predicts a lower graduation probability.

with 'Gender-neutral VET' (Table A.11). As to the first stages, we find similar coefficients to those in our main results. When considering the two gender IVs, we find as expected that 'Same-gender friendly VET' has a stronger effect on VET takeup. As to the second-stage results, they are in line with our main findings in Table 4. Moreover, in the estimation with two instruments, the Sargan-Hansen tests for over-identifying restrictions do not cast doubt on instrument validity. The only difference of note is that the coefficients of interest are larger when graduation in four or five years is the dependent variable.

When considering instead our $VETsupply$ instrumental variable, we again obtain very similar results: see Table 5. First-stage F-statistics are around 150 and the second-stage coefficients on VET takeup are at least 0.64 when considering three-year graduations (dropping to not more than 0.56 when considering graduations within four years).

Overall, our results indicate strong VET effects on upper secondary graduation. Graduation rates increase by over 50 percentage points in most specifications. These effects are most likely driven by academically marginal students. These students would have likely dropped out of (or never enrolled in) upper-secondary academic courses if a VET stream were not available in their schools. These results hold under different sets of control variables, different samples, different time periods, and different IV strategies. Moreover, the size of the effects tends to decline when longer periods for graduation are considered, which again supports the advantages of VET courses in improving faster (no-retention) graduation rates.

5.3 Performance in 12^{th} grade national exams

As mentioned before, we have limited ability to compare the educational outcomes of academic and VET students beyond (time to) graduation: the two tracks (and the multitude of course options within each stream) expose students to vastly different modules and assessment. However, around 29,000 VET students (15% of the VET sub-sample and 9.2% of all exam takers) decided to take the 12^{th} grade Portuguese national exam. This high-stakes exam was mandatory for all academic-track students in our sample but optional for VET students. While the sub-sample of VET exam takers should naturally be self-selected (namely in favour of pupils who wanted to enrol in higher education), and thus not necessarily representative of the population of interest, we also study how students' results in this assessment may have been affected by VET enrollment.

Results can be found in Table A.12. Columns (1) - (3) present OLS results, while columns (4) -

(6) display the second-stage results of IV regressions. The dependent variable in all estimations is student i's standardized score in the Portuguese national exam. As expected, the large 'descriptive' difference in exam scores between academic and VET students (in favour of the former) is reflected in negative OLS coefficients, even after the inclusion of a broad range of controls. However, the IV estimates (using VET availability as an instrument for takeup) are not statistically significant and the point estimates are even positive.

We interpret these findings as suggesting that VET-track courses may not provide systematically weaker support to students on the academic components of their courses, such as the national language, compared to strictly academic courses. This view also follows from taking into account that VET modules, unlike academic-track programmes, do not directly prepare students to sit this exam. Despite caveats following from potential self-selection, we note that we control in some specifications for the student's national exam scores in 9^{th} grade, when selection does not apply.

5.4 Graduation rates: Intent-to-treat analysis

We have established, using the increased availability of VET courses in public schools as an IV, that the effect of *choosing* the VET track on students' probability of graduating was positive and economically significant. This result can be complemented by an analysis of how changes in VET *availability* affected students' educational attainment, again measured by upper secondary school graduation, in an 'intent-to-treat' estimate. To that effect, we estimate equations of the form:

$$Graduation_{ij,t+\Delta t} = \alpha + \beta VETavailability_{jt} + \gamma X_i + \lambda_j + \tau_{tr} + u_{ij,t+\Delta t}, \tag{3}$$

where the binary dependent variables considered assume value one if student *i* completed upper secondary education within either three, four, or five years of their final 9^{th} grade enrollment, and zero otherwise. The specifications include the same explanatory variables as equation (1). Once again, standard errors are clustered at the school district level.

Results can be found in Table A.13. We estimate that graduation in 3 years (i.e., 'timely' upper-secondary completion) was 2.4-2.7 percentage points more likely for students exposed to a newly-opened VET track in their school district. Four-year graduation rates were 1.4-1.8 percentage points larger in those school districts, controlling again for a range of individual characteristics, besides school district and time-regional fixed effects. These results again suggest that expanding VET

increased graduation rates across the board, but that it was especially relevant in improving the 'timely' completion of upper-secondary instruction. Estimates are robust to the inclusion of a linear control for 10^{th} grade class size (Table A.14) and to a series of restrictions to the sample (Table A.15).[13]

5.5 Heterogeneity

We have seen before that VET takeup is highly heterogeneous. Moreover, VET itself may also lead to heterogeneous effects, given the diversity of covered subjects and the scope for interactions between student and course profiles. For instance, Heinesen & Lange (2023) find that VET effects may be negative for students with advanced math skills. We adjust equation (1) to test for heterogeneous effects of VET expansion across four dimensions: gender, previous academic achievement, guardian education, and welfare support status.

We present results from heterogeneity analyses using our IV approach in Tables 6 and A.16. We separately estimate equation (1) for eight different sub-samples: females and males, students above and below the median exam performance in their cohort, pupils with guardians with more or fewer years of schooling than the cohort's median guardian, and students who do (or do not) receive school welfare support. First, focusing on the specifications with a larger set of controls, we find that the effect of VET takeup on graduation rates is larger for girls than for boys. Despite the fact that the upper-secondary VET track was mostly selected by—and associated with—male students (Table A.3), the positive effects from VET takeup on (3-year) graduation are actually stronger for their female peers.

VET enrollment benefited more students with lower prior achievement (defined herein as having scored below their cohort's median 9^{th} grade national exam score), having a statistically insignificant effect for high-achievers. This result is consistent with the findings in Heinesen & Lange (2023). Moreover, despite the similarity of the coefficients, we find that VET takeup improved the graduation prospects of welfare beneficiaries and students with less-educated guardians at a higher rate than for their peers (Table 6).[14] In general, these results point to a strong, positive impact of VET expansion on educational equity. These results suggest that a broader availability

[13] Besides using $VETsupply$ as an instrument for selection into the VET track, we also performed an intent-to-treat robustness analysis in which $VETsupply$ is used as the explanatory variable of interest, finding consistent results - Appendix B.

[14] Results from a specification with fewer controls are qualitatively similar, with the exception of the estimates in columns (5) and (6), which would suggest a stronger effect among students with *more*-educated guardians (Table A.16). Results from OLS estimations can be found in Table A.17 and are consistent with IV estimations.

and takeup of vocational education opportunities may lead to a substantial reduction in socio-economic achievement gaps.

6 Labour results

In this section, we investigate the effects of VET on the labour market. Besides the general question of understanding the individual labour market payoff of VET courses, we also seek to understand potential drivers of the large effects documented above. For instance, while VET expansion has increased graduation rates, this may have been driven by low standards *vis-à-vis* academic courses. If that were the case, it could be expected that VET degrees would not be valued in the labour market, leading to worse employment and or wage outcomes for their graduates.

To investigate this question, we turn to a different data set, *Quadros de Pessoal* (QP). This is a matched employer-employee-job title data set covering all private sector employees in Portugal. Data is provided by the Ministry of Employment and comes from an annual survey which all firms with at least one employee are mandated to fill. QP contains individual information on all employees as of October of each year (including variables such as gender, age, schooling, and salary) and all establishments of each firm. Critically, QP provides information on whether workers have completed upper secondary VET or not.[15]

6.1 Region-industry analysis

We then match QP labour data concerning the 2007-2013 period to the VET reform information described earlier using the location and industry of each establishment and the location and VET courses of each school. We match establishment and school locations using a common variable in the education and QP data sets (unfortunately, this more detailed geographical information is not available in QP after 2013); we also match establishment industry and course contents using a correspondence that we developed between the two variables. Along the time dimension, we match QP data concerning (October of) year t with education data concerning 10^{th} grade students in academic year $t-3/t-2$. This allows us to understand the potential effects from a new VET course in a given school on employment and wages in the region of that school and or in the industry to

[15] See Hartog et al. (2022) for a recent study of VET in Portugal over several decades also using the QP data set. Here we focus exclusively on VET graduates following the 2004 reform studied in the paper. Note also that despite the richness of QP, it does not cover the self-employed, a potentially important labour format for VET graduates.

which the course corresponds.

Table 7 presents summary statistics of our QP sample. These concern up to over 36,000 observations, corresponding to region-industry-year combinations. For instance, we find that in 8% of these cells, a VET course in the same area of the industry was available for students. The average total number of employees per (region-industry-year) cell was 590 while in the case of employees with a completed VET course the average is 26. If we consider younger (less than 23 years old) VET employees, their average drops to only 2.8. We also consider the cases of female employees, employment in new establishments or new firms, and average compensation (see Garin & Silvério (2023) for a recent study of wage determination in Portugal also using QP data).

Using municipality-industry-year QP data, we test if and how the availability of VET courses affected a number of local labour market metrics. Given the large numbers of zeros in labour-market outcomes (in particular municipality-industry-year cells) and the large number of fixed effects, we estimate Poisson models by pseudo-maximum-likelihood (Correia et al. 2020). These models are specified as follows:

$$Y_{sct} = \exp\left(\alpha_0 + \alpha_1 VET_{sct} + \lambda_{sc} + \tau_{tr} + u_{sct}\right), \tag{4}$$

in which Y_{sct} is the outcome of interest (e.g., number of employees in municipality c, industry s and year t; number of employed VET graduates in different age ranges; employees in new firms or new firm establishments). VET_{sct} is a binary indicator equal to one if a VET course *associated with industry* s is available in year $t-3$ in municipality c, and zero otherwise. Finally, λ_{sc} and τ_{tr} represent municipality-by-industry and NUTS3-by-year fixed effects, respectively. Standard errors are clustered at the municipality level.

Note that a potential threat to the identification of causal effects in this context would be the nonrandom nature of VET expansions: for instance, if new VET courses were opened according to local labour market conditions (more courses in specific subjects of increasing regional labour market demand), then estimates could suffer from omitted variable bias. However, as we discussed above, the focus on the fast deployment of these courses and the nature of their funding make us believe that this concern is not important. In any case, we control for systematic differences across region-industry pairs and differential time trends across (aggregated) regions.

We find consistently positive effects from VET courses on the private sector employment of VET degree holders, measured three years onward, in the same municipality and related industry - Table 8. Effects on the employment of VET workers below 23 years of age and of all VET workers are

statistically significant: we estimate that the former increased by 6.9% ($= e^{0.067} - 1$) and the latter by 3.4%. Employment of young female VET graduates appears to be unaffected.

However, when the outcome of interest shifts to the employment level of *all* workers, effects become consistently positive and statistically significant: see Table 9. We estimate that the impact on total employment of individuals below 19 years of age was of approximately 9.9%, with slightly lower effects (9.2% and 8.9%) among workers younger than 21 and 23, respectively. (Our main estimates are also robust to the exclusion of the five largest NUTS3 regions in Portugal from the sample - Table C.1). Employment in new establishments and in new firms also increases strongly and significantly with VET availability, which hints at potential positive effects from VET on entrepreneurship.

Several possible factors may explain why we find stronger effects for all young employees than specifically for young VET employees. For instance, firms may fail to correctly report the upper secondary track of their employees in QP ('general' instead of 'vocational'); VET students may drop out before graduating (especially if they receive a job offer, e.g., after their VET curricular internship); VET graduates may work in industries other than that associated with their course, or our correspondence between courses and industries may have errors in some cases; finally, as indicated above, QP does not include self-employed workers.[16]

6.2 Worker-level analysis

Under the hypothesis that VET enhances human capital similarly to the academic stream — and is not merely an easy, low-quality course —, we expect that VET graduates would enjoy similar labour earnings than their academic peers and higher earnings than their peers that dropped out upon graduating from lower secondary school. We investigate this hypothesis by examining QP data again but now at the individual level. We pay particular attention to age controls, in order to compare the wages of individuals of the same age but that have presumably different levels of labour market experience. Those that dropped out earlier (without completing upper secondary schooling) will have more labour experience but less VET or academic human capital. As both groups are in the labour market, which profile type is paid higher wages?

[16] Furthermore, the estimation of similar models by OLS — using average (unconditional) wages at the municipality-industry-year level, for different age brackets, as the dependent variables — does not yield statistically significant effects of VET course availability - see Table C.2. This may follow from composition effects, as new VET graduates may tend to be paid lower wages than more experienced workers. See also Cui & Martins (2023) which finds positive effects from VET recruitment on firm performance drawing on the same reform considered in this paper.

Specifically, we restrict our 2007-2013 QP sample to individuals of 18 to 23 years of age that completed at least a lower secondary degree and at most an upper secondary degree. Then, we estimate log hourly wage equations by pooled OLS with the goal of identifying the wage premia of upper secondary (VET and academic) degrees, compared to private-sector employees who only completed lower secondary school.[17] Table C.3 presents summary statistics regarding our sample, which covers over 800,000 worker-years. We find that 10.2% (35.4%) of these individuals have completed VET (academic) upper secondary courses, indicating that over 50% of these cohorts (i.e., among those who did not proceed to tertiary education) have not completed upper secondary education; average monthly pay was 611 euros.

Our results are in Table 10. In the first three specifications (without firm fixed effects), we find that VET graduates enjoyed a wage premium of around 9% compared to upper secondary dropouts. Academic graduates experience a slightly lower premium of around 8%. When we include firm fixed effects, our estimated coefficients drop but remain positive and significant. The ranking between VET and academic graduates remains as well. Moreover, the results are similar when we use monthly wages (Table C.4).

Consistent with earlier evidence of a short-run VET wage premium, we also find that the VET wage effects up to 13 years after graduation are systematically higher than those of completing the upper-secondary academic track. More important from our specific angle, our wages analysis indicates that employers value the skills provided by VET courses more than the experience that dropouts may gain during the period required for VET course completion.

Finally, we consider a number of additional labour outcomes, regarding different working conditions that can also be monitored in our data set. Table C.5 presents our analysis of the incidence of fixed-term contracts (as opposed to open-ended contracts (Cahuc et al. 2023)). As before, we consider both the initial period (2007-2013) and the latter period (2014-2020). We find in most specifications and samples that VET graduates are less likely to be under fixed-term contracts, both when compared to lower-secondary graduates and when considering upper-secondary academic graduates. This is particularly the case in the second period.[18]

[17] Since we are not able to determine whether individuals ever attended upper secondary school unless they graduated, our estimates may be downward biased. For instance, a VET student who performs well in a curricular internship or on-the-job training may receive a job offer and thus drop out before graduating.

[18] On collective bargaining coverage, Table C.6 indicates that VET graduates tend to be less covered than the two comparison groups. In principle, this would translate into weaker working conditions although this is at odds with our findings regarding wages. This result may, however, reflect the greater incidence of coverage in older, more established sectors, and is therefore not conclusive.

Another outcome considered is that of firm-provided training. This information is available only for 2010 and 2011 (Martins 2021). Table C.7 presents our results, considering first (Panel A) the extensive margin — if the worker receives or not any training in a given year — and then (Panel B) the intensive margin — how many hours of training. We find across virtually all specifications that VET graduates receive more training from their firms than similar workers with lower-secondary education or academic upper-secondary education. Such differentials can explain the positive wage differentials presented above.

Finally, we consider employment resilience measured in terms of the number of years that the worker is employed over the 2014-2020 period. This analysis is conducted only for workers that are observed in at least one year over the earlier period (2007-2013). Table C.8 indicates that VET graduates experience longer spells of employment, again with respect to both comparison groups. When comparing to lower-secondary graduates, the increased years of employment range between 0.18 and 0.35, depending on the specification.

7 Conclusions

Can vocational education and training be an important education policy tool both on efficiency and equity grounds? We contribute to this question by evaluating the impact of a reform in Portugal that greatly increased the availability of upper-secondary VET.

Earlier research on the graduation and labour market causal effects of VET (Brunner et al. 2023, Dougherty 2018) covered oversubscribed established schools in different U.S. states. Such excess VET demand may follow from a strong reputation of these schools and explain the positive effects on graduation and labour outcomes of these earlier studies. In contrast, we analyse a large-scale introduction of entirely new VET courses. Most schools in our study were introducing VET for the first time and experienced limited demand at first, which could lead to small or even negative VET graduation and labour market effects.

However, drawing on the staggered regional and time expansion of VET and comprehensive student-school matched panel data (and, in some cases, the large gender differences in VET), we find that VET takeup increased significantly upper secondary graduation rates. Students that enrol in VET following increased VET availability in their schools increase dramatically their graduation prospects: our LATE estimates of VET effects on upper-secondary graduation are as large as 50 per-

centage points. Such large effects follow from a context of large early school leaving rates. In other words, VET appears to be a very important upper secondary track to increase schooling attainment among those that otherwise tend to leave earlier.

We also find that graduation effects are even larger for low-achieving students, children of low-schooling parents, and welfare recipients, who tend to be at greater risk of early school leaving. Overall, these heterogeneity results also highlight the equity-enhancing scope of VET. In this sense, VET-related tracking through self-selection may be an interesting policy. In contrast to earlier literature, VET effects apply also to females and not only or mostly to males. This latter result may again follow from our analysis of all VET schools in a country and not a subset of schools facing excess demand (which may happen to be preferred by boys), as in earlier research.

Finally, we conduct an analysis based on employer-employee data. When linking this data at the regional-industry level with our main education data set, we find generally significantly positive effects on regional-industry employment levels over the years following VET expansions. This result suggests that VET courses supported school-to-work transitions. When focusing on the worker-level data, we find that the new cohorts of VET graduates enjoy a large wage premium when compared to upper-secondary dropouts of the same age (and presumably longer labour market experience). This wage premium indicates that the much-improved graduation results from VET are not driven by easier requirements and modest human capital contributions that could potentially be features of some VET courses. Moreover, we also find a VET wage premium with respect to academic graduates. While this premium may be reverted later in the individual's life-cycle (Hanushek et al. 2017, Heinesen & Lange 2023), this does not arise over the 13-year period covered. We also uncover additional positive aspects along several other dimensions not analysed so far in this literature, such as employment contract type and firm-provided training. All these results again support the significance of VET human capital contributions.

Overall, our results indicate that VET expansions may be an important policy to increase both efficiency and equity. Their positive effects may apply across the board, and not exclusively with VET schools that are in high demand in the U.S.. VET may help youngsters that otherwise (in the absence of VET opportunities) would leave school early and miss out on the benefits from higher levels of education. These results indicate that countries that are struggling with high dropout rates or difficult school-to-work transitions may want to pay more attention to the enhancement of their VET systems. Our results may also suggest that, as schooling levels increase and attention turns to

higher education, the role of VET in tertiary instruction could have to increase proportionally.

A number of areas are left for future research. One involves analysing the role of VET courses upon gender segregation in the labour market. Another concerns extending our evidence of VET effects on entrepreneurship, as proxied by new establishments or firms in the regions where VET courses are launched. A related area is assessing the scope for VET as a tool of industrial policy, by shaping the creation of new firms and the development of existing ones.

References

Barbosa, B., Melo, A., Dias, G. P., Rodrigues, C., Santos, C., Costa, F. & Filipe, S. (2020), Oferta de Ensino Profissional Secundário [VET upper-secondary supply], Portugal, 2018-21, Technical report, EDULOG.

Blau, F. D. & Kahn, L. M. (2017), 'The gender wage gap: Extent, trends, and explanations', *Journal of Economic Literature* **55**(3), 789–865.

Bonilla, S. (2020), 'The dropout effects of career pathways: Evidence from California', *Economics of Education Review* **75**, 101972.

Borghesan, E., Reis, H. & Todd, P. E. (2022), Learning through repetition? A dynamic evaluation of grade retention in Portugal, Working paper, Penn Institute for Economic Research, University of Pennsylvania.

Brunello, G. & Rocco, L. (2017), 'The labor market effects of academic and vocational education over the life cycle: Evidence based on a British cohort', *Journal of Human Capital* **11**(1), 106–166.

Brunner, E. J., Dougherty, S. M. & Ross, S. L. (2023), 'The effects of career and technical education: Evidence from the Connecticut technical high school system', *Review of Economics and Statistics* **105**(4), 867–882.

Böckerman, P., Haapanen, M. & Jepsen, C. (2019), 'Back to school: Labor-market returns to higher vocational schooling', *Labour Economics* **61**, 101758.

Cahuc, P., Carry, P., Malherbet, F. & Martins, P. S. (2023), Spillover effects of employment protection, Nova SBE Working Paper 655.

Card, D. & Giuliano, L. (2016), 'Can tracking raise the test scores of high-ability minority students?', *American Economic Review* **106**(10), 2783–2816.

Catela Nunes, L., Balcão Reis, A. & Seabra, C. (2018), 'Is retention beneficial to low-achieving students? Evidence from Portugal', *Applied Economics* **50**(40), 4306–4317.

Chakravarty, S., Lundberg, M., Nikolov, P. & Zenker, J. (2019), 'Vocational training programs and youth labor market outcomes: Evidence from Nepal', *Journal of Development Economics* **136**, 71–110.

Correia, S., Guimarães, P. & Zylkin, T. (2020), 'Fast poisson estimation with high-dimensional fixed effects', *The Stata Journal* **20**(1), 95–115.

Cui, Y. & Martins, P. (2023), Firm-level returns to vocational education: Evidence from a policy reform, Mimeo, Queen Mary University of London.

De Groote, O. (forthcoming), 'Dynamic effort choice in high school: Costs and benefits of an academic track', *Journal of Labor Economics* .

DGERT (2019), Vocational education and training in Europe – Portugal. Cedefop Refernet VET in Europe reports 2018, Technical report.

Dougherty, S. M. (2018), 'The effect of career and technical education on human capital accumulation: Causal evidence from Massachusetts', *Education Finance and Policy* **13**(2), 119–148.

Garin, A. & Silvério, F. (2023), 'How responsive are wages to firm-specific changes in labor demand? Evidence from idiosyncratic export demand shocks', *Review of Economic Studies* .

Hanushek, E. A., Schwerdt, G., Woessmann, L. & Zhang, L. (2017), 'General education, vocational education, and labor-market outcomes over the lifecycle', *Journal of Human Resources* **52**(1), 48–87.

Hanushek, E. A. & Woessmann, L. (2006), 'Does educational tracking affect performance and inequality? Differences-in-differences evidence across countries', *Economic Journal* **116**(510), C63–C76.

Harmon, C. (2017), 'How effective is compulsory schooling as a policy instrument?', *IZA World of Labor* .

Hartog, J., Raposo, P. & Reis, H. (2022), 'Fluctuations in the wage gap between vocational and general secondary education: lessons from Portugal', *Journal of Population Economics* **35**(2), 643–675.

Heinesen, E. & Lange, E. S. (2023), 'Vocational versus general upper secondary education and earnings', *Journal of Human Resources* .

Jepsen, C., Troske, K. & Coomes, P. (2014), 'The labor-market returns to community college degrees, diplomas, and certificates', *Journal of Labor Economics* **32**(1), 95–121.

Kemper, J. & Renold, U. (2024), 'Evaluating the impact of general versus vocational education on labor market outcomes in Egypt by means of a regression discontinuity design', *Journal of Development Economics* **166**, 103172.

Kugler, A., Kugler, M., Saavedra, J. E. & Herrera-Prada, L. O. (2022), 'Long-term educational consequences of vocational training in Colombia: Impacts on young trainees and their relatives', *Journal of Human Resources* **57**(1), 178–216.

Leme, A. C. (2023), Too young to quit school? Increasing the compulsory schooling leaving age and students' educational paths, Mimeo, Nova School of Business and Economics.

Martins, P. S. (2021), 'Employee training and firm performance: Evidence from ESF grant applications', *Labour Economics* **72**(C).

Meghir, C. & Palme, M. (2005), 'Educational reform, ability, and family background', *American Economic Review* **95**(1), 414–424.

Mora, T., Escardíbul, J.-O. & Pineda-Herrero, P. (2022), 'The effect of dual vocational education and training on grades and graduation in Catalonia, Spain', *Educational Review* pp. 1–21.

OECD (2023), *Education at a Glance 2023*.
URL: *https://www.oecd-ilibrary.org/content/publication/e13bef63-en*

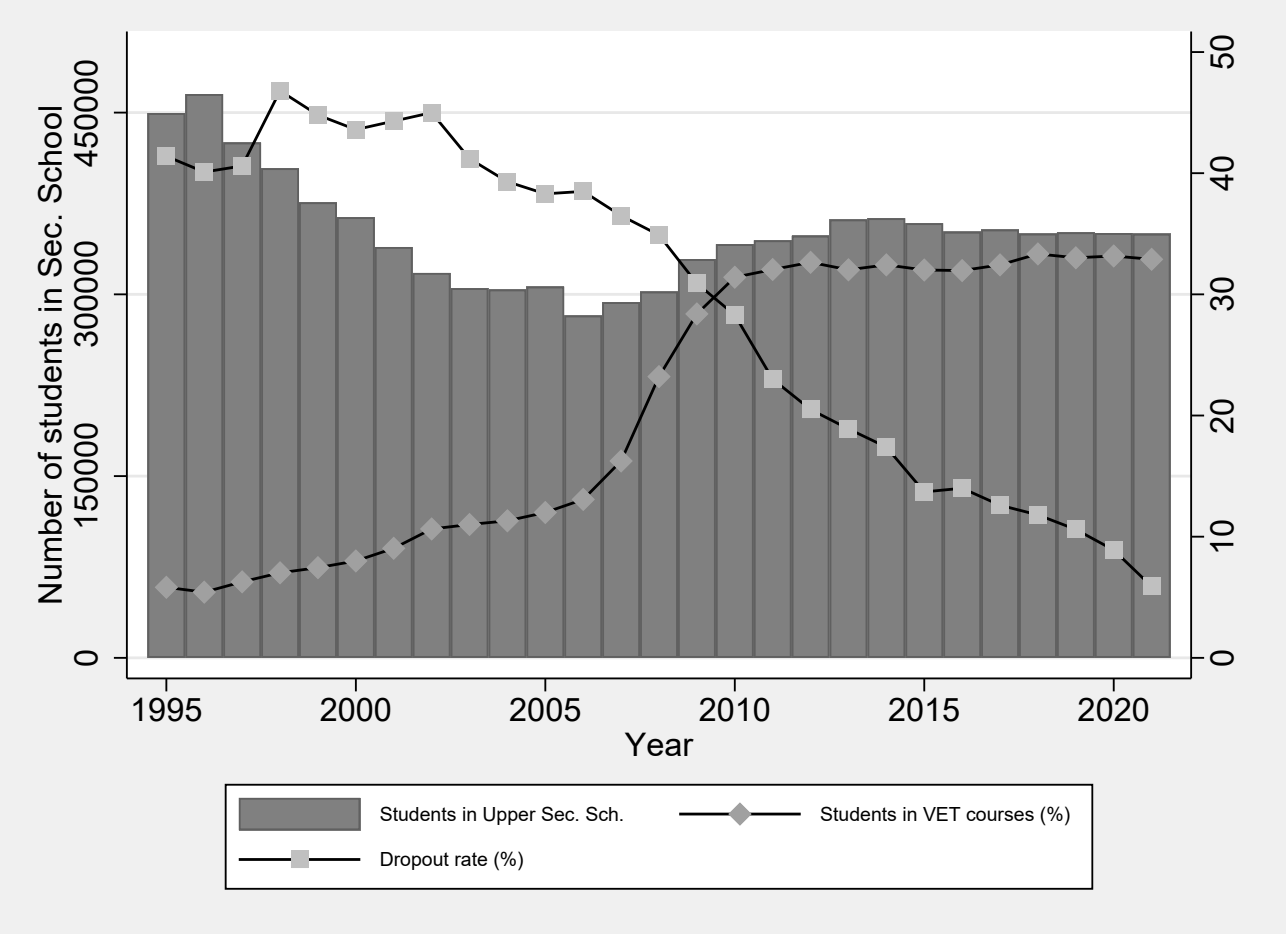
Polidano, C. & Tabasso, D. (2014), 'Making it real: The benefits of workplace learning in upper-secondary vocational education and training courses', *Economics of Education Review* **42**, 130–146.

Silliman, M. & Virtanen, H. (2022), 'Labor market returns to vocational secondary education', *American Economic Journal: Applied Economics* **14**(1), 197–224.

Stevens, A. H., Kurlaender, M. & Grosz, M. (2019), 'Career technical education and labor market outcomes', *Journal of Human Resources* **54**(4), 986–1036.

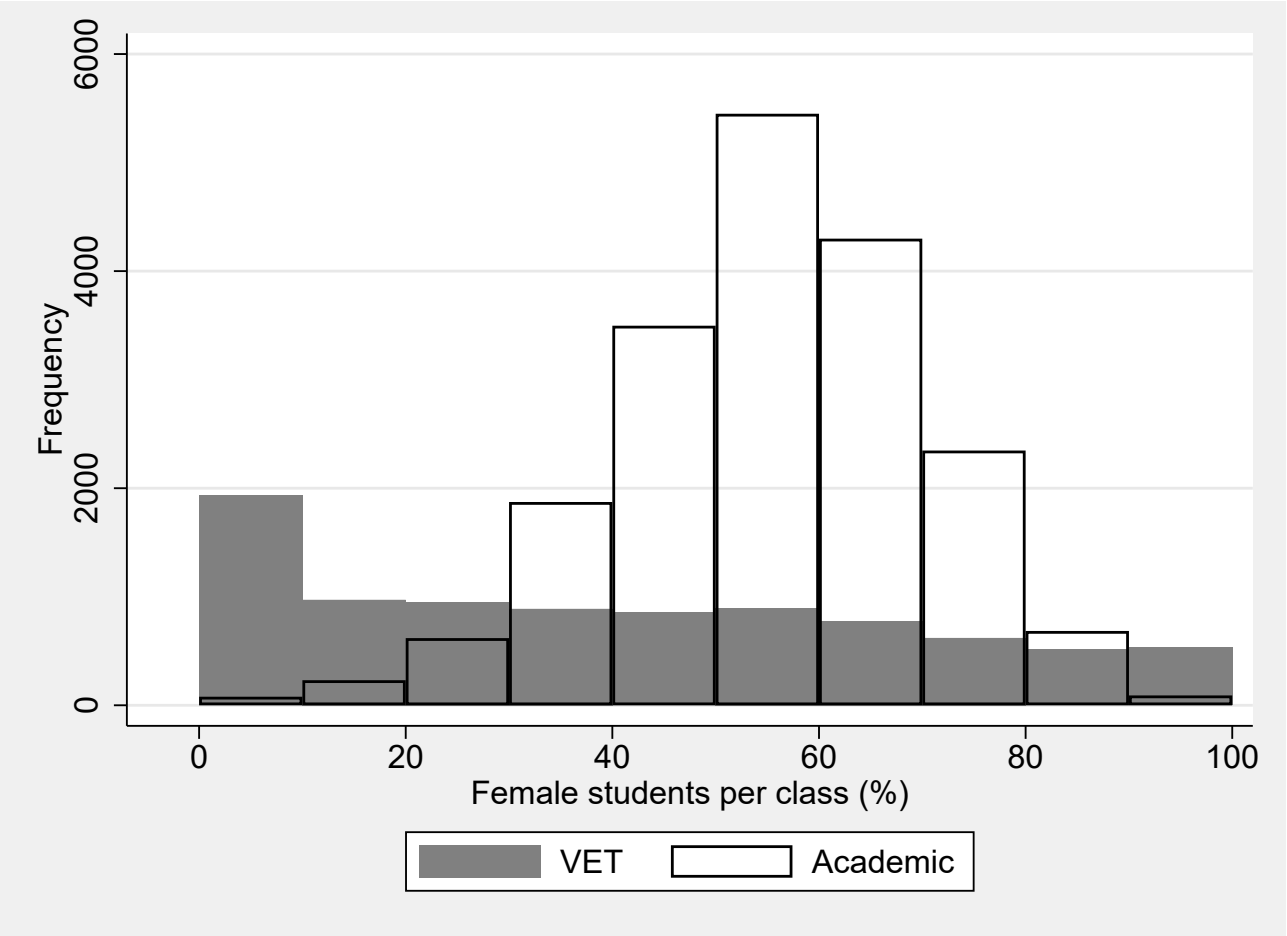
Figures

Figure 1: **Upper secondary indicators, Portugal, 1995-2021**



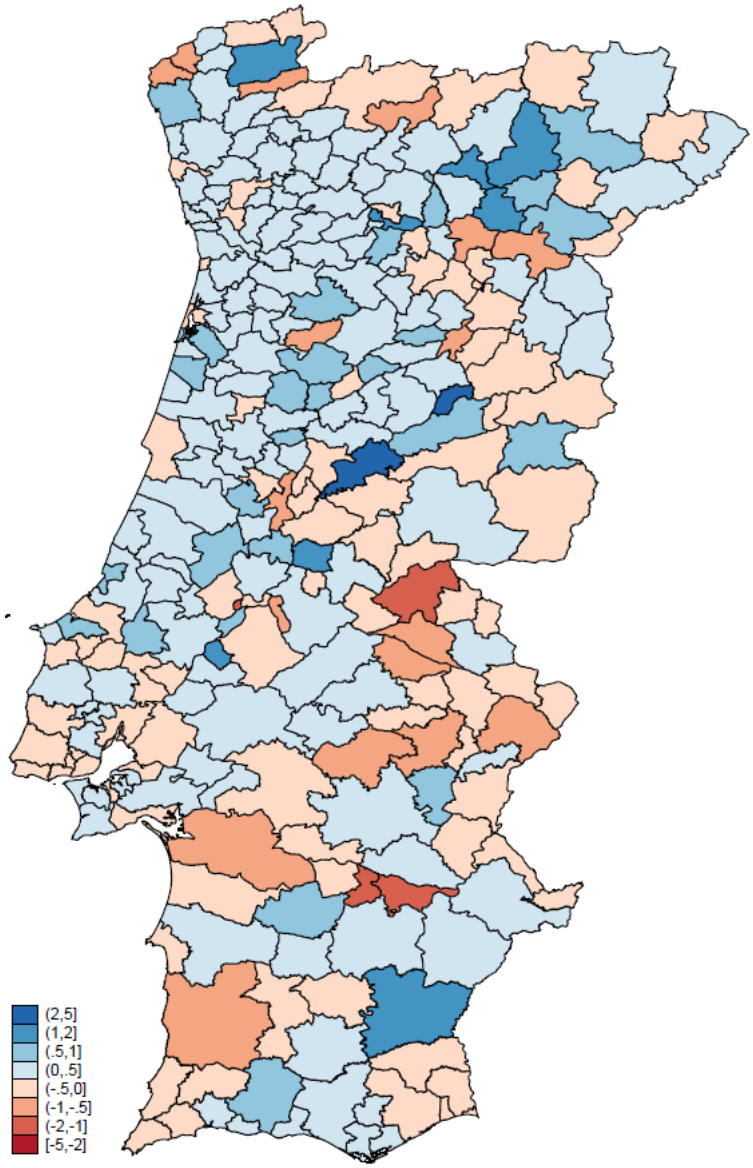
Notes: This Figure presents the total number of students enrolled in upper secondary education in Portugal over 1995 - 2021, the proportion of upper-secondary VET students , and the dropout rate (defined as the percentage of 18- to 24-year-olds who have left school without completing upper secondary education). **Source:** Authors' analysis of Ministry of Education data.

Figure 2: **Proportion of female students per class, by track**



Notes: This Figure shows the proportion of female students in 10^{th} grade public school VET and academic classes with more than 10 students. Pooled analysis covering 2007/08 to 2014/15. Therefore, we consider 8,931 VET classes and 19,171 academic stream classes. **Source:** Authors' analysis of Ministry of Education (MISI) data.

Figure 3: **Variation in 'VET supply', 2006-2011**



Notes: This Figure shows the difference, measured at the *concelho* (municipality) level, between the values of $VETsupply$ experienced by the 2006/07 and 2010/11 9^{th} grade cohorts (positive values indicate that $VETsupply$ increased). The expansion of upper secondary VET in Portugal was faster between 2005 and 2010. **Source:** Authors' analysis of Ministry of Education (MISI) data.

Tables

Table 1: **Descriptive Statistics: Full sample**

Variable	Mean	Std. Dev.	Min.	Max.	N
Individual characteristics					
Female	0.517	0.5	0	1	650561
Age at the end of 9^{th} grade (June 30)	15.542	0.914	10.027	19.998	650561
Welfare support (Full)	0.194	0.395	0	1	650561
Welfare support (Partial)	0.147	0.354	0	1	650561
Compulsory schooling bite	0.548	0.498	0	1	650561
Foreign nationality	0.032	0.176	0	1	639261
PT national exam score, 9^{th} grade (0-100)	55.643	16.003	0	100	580288
Math national exam score, 9^{th} grade (0-100)	48.468	23.617	0	100	584052
Mother's education (in years)	8.786	3.984	0	21	596985
Father's education (in years)	8.292	3.896	0	21	575684
Guardian's education (in years)	8.911	4.01	0	21	604876
Employed guardian	0.875	0.331	0	1	614989
Unemployed guardian	0.088	0.283	0	1	614989
Inactive guardian	0.037	0.189	0	1	614989
Educational achievement					
Graduated within 3 years	0.425	0.494	0	1	645491
Graduated within 3 years (Academic track)	0.302	0.459	0	1	649512
Graduated within 3 years (VET track)	0.12	0.325	0	1	646542
Graduated within 4 years	0.52	0.5	0	1	559063
Graduated within 4 years (Academic track)	0.357	0.479	0	1	564355
Graduated within 4 years (VET track)	0.158	0.365	0	1	560820
Graduated within 5 years	0.534	0.499	0	1	477493
PT national exam score, 12^{th} grade (0-200)	104.316	33.961	0	200	313826
Regional characteristics					
VET availability	0.594	0.491	0	1	647046
Same-gender-friendly VET	0.459	0.498	0	1	647046
Gender-neutral VET	0.481	0.500	0	1	647046
VET supply	0.436	0.234	0	4.091	629359

Notes: Each observation corresponds to a student registered in 9^{th} grade over the academic years ranging from 2006/07 and 2013/14. (If the student is observed more than once in 9^{th} grade, only the last observation is considered.) 'Individual characteristics' describes the student (or their parents or guardians) at that time. 'Educational achievement' variables concern the outcomes of the student over the following years. For instance, 'Graduated within 3 years' is a dummy variable equal to one if the student graduates from upper secondary school over the following 3 years. 'Graduated within 4 years (VET track)' is a dummy variable equal to one if the student graduates from upper secondary school in the VET track over the following 4 years. 'Regional characteristics' refers to the VET availability or supply measurement for the student in 9^{th} grade. **Source:** Authors' analysis of MISI data set.

Table 2: **VET availability and upper secondary track takeup (LPM estimates)**

	(1) VET Takeup	(2) VET Takeup	(3) VET Takeup	(4) Acad. Takeup	(5) Acad. Takeup	(6) Acad. Takeup
VET availability	0.056	0.052	0.045	-0.027	-0.023	-0.017
	(0.005)***	(0.005)***	(0.005)***	(0.006)***	(0.006)***	(0.006)**
Female		-0.081	-0.069		0.086	0.073
		(0.002)***	(0.002)***		(0.002)***	(0.002)***
Age		0.086	0.062		-0.213	-0.126
		(0.002)***	(0.002)***		(0.002)***	(0.002)***
Welfare support (Full)		0.114	0.048		-0.118	-0.054
		(0.002)***	(0.002)***		(0.002)***	(0.002)***
Welfare support (Partial)		0.101	0.035		-0.090	-0.038
		(0.002)***	(0.002)***		(0.002)***	(0.002)***
Compulsory schooling bite		-0.027	-0.001		-0.009	-0.016
		(0.002)***	(0.002)		(0.002)***	(0.002)***
Foreign nationality			-0.111			0.033
			(0.005)***			(0.006)***
PT exam score, 9^{th} grade			-0.005			0.006
			(0.000)***			(0.000)***
Math exam score, 9^{th} grade			-0.004			0.004
			(0.000)***			(0.000)***
Guardian's education			-0.009			0.009
			(0.000)***			(0.000)***
Unemployed guardian			0.005			-0.004
			(0.002)**			(0.002)*
Inactive guardian			-0.005			0.026
			(0.004)			(0.004)***
Observations	647046	647046	535216	647046	647046	535216
R^2	0.041	0.101	0.223	0.064	0.240	0.306

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'VET Takeup [Acad.]' is a binary variable that takes value 1 if the student enrolled in a VET ["regular"] course right after their final 9^{th} grade enrollment, and 0 otherwise. 'Age' is a continuous variable, measured as of June 30^{th} of the civil year in which the student was last enrolled in 9^{th} grade. 'Foreign nationality' is a dummy variable equal to 1 if the student is a citizen of any other country (even if they are also Portuguese nationals), and 0 otherwise. All regressions include school district and NUTS III-by-year fixed effects. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table 3: **VET takeup and upper secondary graduation rates (OLS estimates)**

	(1)	(2)	(3)	(4)	(5)	(6)
	Grad. 3 years	Grad. 3 years	Grad. 3 years	Grad. 4 years	Grad. 4 years	Grad. 4 years
VET takeup	-0.042	0.033	0.157	0.006	0.095	0.201
	(0.005)***	(0.004)***	(0.004)***	(0.005)	(0.004)***	(0.005)***
Female		0.088	0.086		0.091	0.091
		(0.002)***	(0.002)***		(0.002)***	(0.002)***
Age		-0.136	-0.047		-0.169	-0.087
		(0.001)***	(0.001)***		(0.002)***	(0.001)***
Welfare support (Full)		-0.078	-0.021		-0.088	-0.034
		(0.002)***	(0.002)***		(0.002)***	(0.002)***
Welfare support (Partial)		-0.043	-0.003		-0.047	-0.010
		(0.002)***	(0.002)		(0.002)***	(0.002)***
Compulsory schooling bite		-0.003	0.007		-0.005	0.001
		(0.002)	(0.002)***		(0.002)**	(0.002)
Foreign nationality			-0.041			-0.068
			(0.006)***			(0.007)***
PT exam score, 9^{th} grade			0.006			0.005
			(0.000)***			(0.000)***
Math exam score, 9^{th} grade			0.006			0.005
			(0.000)***			(0.000)***
Guardian's education			0.003			0.004
			(0.000)***			(0.000)***
Unemployed guardian			-0.021			-0.022
			(0.002)***			(0.003)***
Inactive guardian			-0.042			-0.031
			(0.004)***			(0.004)***
Observations	642306	642306	531945	556917	556917	461268
R^2	0.055	0.127	0.212	0.057	0.162	0.215

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'Grad. 3 [4] years' is a dependent variable that takes value 1 if the student graduated from upper secondary school within 3 [4] years of completing lower secondary education (9^{th} grade), and 0 otherwise. 'Age' is a continuous variable, measured as of June 30^{th} of the civil year in which the student was last enrolled in 9^{th} grade. 'Foreign nationality' is a dummy variable equal to 1 if the student is a citizen of any other country (even if they are also Portuguese nationals), and 0 otherwise. All regressions include school district and NUTS III-by-year fixed effects. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table 4: **VET takeup and upper secondary graduation rates (IV estimates)**

	(1) Grad. 3 years	(2) Grad. 3 years	(3) Grad. 3 years	(4) Grad. 4 years	(5) Grad. 4 years	(6) Grad. 4 years
VET takeup	0.422	0.506	0.588	0.255	0.355	0.393
	(0.102)***	(0.100)***	(0.124)***	(0.115)**	(0.112)***	(0.125)***
Female		0.126	0.116		0.113	0.105
		(0.008)***	(0.009)***		(0.009)***	(0.009)***
Age		-0.177	-0.073		-0.191	-0.099
		(0.009)***	(0.008)***		(0.009)***	(0.007)***
Welfare support (Full)		-0.131	-0.041		-0.117	-0.044
		(0.012)***	(0.006)***		(0.013)***	(0.006)***
Welfare support (Partial)		-0.091	-0.018		-0.073	-0.017
		(0.010)***	(0.005)***		(0.011)***	(0.005)***
Compulsory schooling bite		0.009	0.008		0.003	0.001
		(0.003)**	(0.002)***		(0.004)	(0.002)
Foreign nationality			0.006			-0.048
			(0.015)			(0.015)***
PT exam score, 9^{th} grade			0.008			0.006
			(0.001)***			(0.001)***
Math exam score, 9^{th} grade			0.008			0.006
			(0.000)***			(0.000)***
Guardian's education			0.007			0.006
			(0.001)***			(0.001)***
Unemployed guardian			-0.023			-0.023
			(0.003)***			(0.003)***
Inactive guardian			-0.040			-0.031
			(0.004)***			(0.004)***
Observations	641514	641514	531251	556128	556128	460577
F (first stage)	110	99.19	74.26	81.39	73.16	58.05
Kleibergen-Paap rk LM statistic	73.94	70.91	58.37	63.17	60.07	50.98
Kleibergen-Paap rk LM p-value	8.063e-18	3.742e-17	2.177e-14	1.896e-15	9.147e-15	9.309e-13

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'Grad. 3 [4] years' is a dependent variable that takes value 1 if the student graduated from upper secondary school within 3 [4] years of completing lower secondary education (9^{th} grade), and 0 otherwise. 'Age' is a continuous variable, measured as of June 30^{th} of the civil year in which the student was last enrolled in 9^{th} grade. 'Foreign nationality' is a dummy variable equal to 1 if the student is a citizen of any other country (even if they are also Portuguese nationals), and 0 otherwise. 'Compulsory schooling bite' is a binary variable that takes value 1 if the student was, at the end of 9^{th} grade, below the age of 15 (before the 2010/2011 school year, inclusive) or 18 (from 2011/2012 onwards). All regressions include school district and NUTS III-by-year fixed effects. 'VET availability' is used as an instrument for 'VET takeup'. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table 5: **VET takeup and upper secondary graduation rates ('VET supply' IV estimates)**

	(1)	(2)	(3)	(4)	(5)	(6)
	Grad. 3 years	Grad. 3 years	Grad. 3 years	Grad. 4 years	Grad. 4 years	Grad. 4 years
VET takeup	0.664	0.639	0.726	0.543	0.537	0.564
	(0.082)***	(0.072)***	(0.081)***	(0.086)***	(0.074)***	(0.079)***
Female		0.140	0.127		0.131	0.118
		(0.006)***	(0.006)***		(0.006)***	(0.006)***
Age		-0.193	-0.083		-0.210	-0.110
		(0.007)***	(0.005)***		(0.007)***	(0.005)***
Welfare support (Full)		-0.149	-0.049		-0.143	-0.053
		(0.008)***	(0.004)***		(0.008)***	(0.004)***
Welfare support (Partial)		-0.107	-0.023		-0.096	-0.024
		(0.008)***	(0.004)***		(0.008)***	(0.004)***
Compulsory schooling bite		0.010	0.008		0.006	0.002
		(0.003)***	(0.002)***		(0.003)*	(0.002)
Foreign nationality			0.024			-0.028
			(0.011)**			(0.011)**
PT exam score, 9^{th} grade			0.009			0.007
			(0.000)***			(0.000)***
Math exam score, 9^{th} grade			0.008			0.007
			(0.000)***			(0.000)***
Guardian's education			0.008			0.007
			(0.001)***			(0.001)***
Unemployed guardian			-0.023			-0.025
			(0.003)***			(0.003)***
Inactive guardian			-0.040			-0.031
			(0.004)***			(0.004)***
Observations	624075	624075	524074	541173	541173	454366
'VET supply' IV	0.095	0.095	0.084	0.093	0.092	0.084
	(0.008)***	(0.007)***	(0.007)***	(0.008)***	(0.008)***	(0.007)***
F (first stage)	158	169.9	145.1	141.5	150	146
Kleibergen-Paap rk LM statistic	110.6	111.8	105.6	96.39	101	96.73
Kleibergen-Paap rk LM p-value	7.260e-26	3.980e-26	9.133e-25	9.448e-23	9.164e-24	7.955e-23

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'Grad. 3 [4] years' is a dependent variable that takes value 1 if the student graduated from upper secondary school within 3 [4] years of completing lower secondary education (9^{th} grade), and 0 otherwise. See Table 4 for more information regarding the covariates. All regressions include school district and NUTS III-by-year fixed effects. 'VET supply' is used as an instrument for 'VET takeup'. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table 6: **VET takeup and upper secondary graduation rates (IV estimates; Heterogeneity)**

	Sex		9^{th} Grade Exam Scores		Guardian Education		Social Support	
	Female	Male	Above Median	Below Median	High	Low	No Welfare	Welfare
VET takeup	0.704	0.454	0.492	0.565	0.536	0.595	0.559	0.573
	(0.147)***	(0.152)***	(0.540)	(0.087)***	(0.205)***	(0.111)***	(0.187)***	(0.111)***
Female			0.112	0.141	0.105	0.124	0.111	0.119
			(0.033)***	(0.009)***	(0.014)***	(0.008)***	(0.013)***	(0.009)***
PT exam score, 9^{th} grade	0.009	0.007			0.008	0.008	0.008	0.008
	(0.001)***	(0.001)***			(0.001)***	(0.001)***	(0.001)***	(0.001)***
Math exam score, 9^{th} grade	0.009	0.007			0.008	0.007	0.008	0.007
	(0.001)***	(0.001)***			(0.001)***	(0.001)***	(0.001)***	(0.001)***
Guardian's education	0.009	0.005	0.017	0.005			0.007	0.003
	(0.002)***	(0.001)***	(0.006)***	(0.001)***			(0.002)***	(0.001)**
Welfare support (Full)	-0.042	-0.039	-0.082	-0.037	-0.054	-0.038		
	(0.007)***	(0.008)***	(0.032)**	(0.005)***	(0.011)***	(0.007)***		
Welfare support (Partial)	-0.021	-0.015	-0.046	-0.011	-0.031	-0.010		
	(0.007)***	(0.006)***	(0.021)**	(0.005)**	(0.010)***	(0.005)**		
Age	-0.067	-0.073	-0.195	-0.089	-0.083	-0.064	-0.079	-0.064
	(0.007)***	(0.012)***	(0.068)***	(0.006)***	(0.017)***	(0.004)***	(0.014)***	(0.005)***
Compulsory schooling bite	0.021	-0.001	-0.056	0.012	0.002	0.012	0.002	0.015
	(0.004)***	(0.003)	(0.023)**	(0.004)***	(0.003)	(0.004)***	(0.003)	(0.004)***
Foreign nationality	0.038	-0.023	-0.090	0.038	-0.007	0.063	-0.007	0.025
	(0.018)**	(0.018)	(0.044)**	(0.011)***	(0.024)	(0.016)***	(0.022)	(0.013)*
Unemployed guardian	-0.021	-0.024	-0.038	-0.015	-0.026	-0.020	-0.024	-0.022
	(0.004)***	(0.003)***	(0.007)***	(0.003)***	(0.004)***	(0.004)***	(0.004)***	(0.003)***
Inactive guardian	-0.036	-0.044	-0.061	-0.023	-0.052	-0.028	-0.046	-0.027
	(0.006)***	(0.005)***	(0.007)***	(0.005)***	(0.006)***	(0.006)***	(0.005)***	(0.007)***
Observations	250737	280510	273355	257891	329668	201574	356347	174901
F (first stage)	58.98	45.51	8.961	103.3	31.2	93.77	42.08	88.65
Kleibergen-Paap rk LM statistic	48.63	39.39	8.52	69.97	29.25	58	37.41	55.97
Kleibergen-Paap rk LM p-value	3.087e-12	3.474e-10	.003512	6.035e-17	6.349e-08	2.627e-14	9.551e-10	7.365e-14

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'Grad. 3 years' is the dependent variable in all regressions: it takes value 1 if the student graduated from upper secondary school within 3 years of completing lower secondary education (9^{th} grade), and 0 otherwise. The header of each column identifies the sub-sample used in each estimation. 'Above [Below] Median' identify students that had a combined 9^{th} grade national exam score (sum of marks obtained in Portuguese and Mathematics) above [below] their cohort's median score. 'High [Low]' Guardian Education identify pupils whose guardian's schooling was above [below] the median level among that cohort's guardians. 'Welfare' refers to students who received either full or partial welfare support. See Table 2 for details regarding the covariates. All regressions include school district and NUTS III-by-year fixed effects. 'VET availability' is used as an instrument for 'VET takeup'. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table 7: **Descriptive Statistics (Region-industry analysis)**

Variable	Mean	Std. Dev.	Min.	Max.	N
VET course available	0.083	0.275	0	1	36316
Any VET course available	0.71	0.454	0	1	32955
VET takeup	0.265	0.112	0	0.62	32442
Graduated within 3 years	0.387	0.131	0	0.745	32442
Graduated within 4 years	0.481	0.15	0	0.851	32442
Employees with VET $<$ 19 YO	0.405	2.966	0	337	33677
Employees with VET $<$ 21 YO	1.429	9.468	0	1093	33677
Employees with VET $<$ 23 YO	2.845	18.207	0	2230	33677
Employees with VET	26.153	120.615	0	9182	33677
Female employees with VET $<$ 21 YO	0.649	4.964	0	609	33677
Employees $<$ 19 YO	7.732	43.604	0	2587	33677
Employees $<$ 21 YO	20.804	113.598	0	7003	33677
Employees $<$ 23 YO	39.687	210.346	0	12747	33677
Number of employees	589.789	2415.961	1	96046	33677
Female employees $<$ 21 YO	9.138	58.97	0	3397	33677
Employed in new establishments	33.344	215.076	0	10089	23971
Employed in new firms	8.409	56.579	0	4170	23971
Average compensation, $<$ 19 YO	516.784	419.083	100	12000	12664
Average compensation, $<$ 21 YO	535.658	335.094	100	12991.215	17824
Average compensation, $<$ 23 YO	574.503	384.714	100	21477.735	21301
Average compensation	794.409	513.408	100	22307.284	28601
Average compensation, Female $<$ 21 YO	496.898	308.568	100	16600	13186

Notes: Each observation is a municipality-by-industry-by-year cell. Average compensation is measured in Euros per month. **Source:** Authors' analysis of the *Quadros de Pessoal* data set.

Table 8: **VET course availability and graduates' employment (Poisson estimates)**

	(1) Emp. w/ VET < 19	(2) Emp. w/ VET < 21	(3) Emp. w/ VET < 23	(4) Emp. w/ VET	(5) Female Emp. w/ VET < 21
VET course available	0.047	0.060	0.067	0.033	-0.002
	(0.063)	(0.042)	(0.029)**	(0.013)***	(0.055)
Constant	1.512	2.552	3.125	5.152	1.917
	(0.017)***	(0.012)***	(0.008)***	(0.004)***	(0.013)***
Observations	10389	16606	20186	28553	12417
Pseudo R^2	0.612	0.756	0.818	0.949	0.669

Notes: Standard errors clustered at the *concelho* (municipality) level in parentheses. 'Emp. w/ VET < 19 [< 21] [< 23]' is the number of upper secondary VET graduates employed in municipality c, in industry s, in year t, below 19 [21] [23] years of age. 'VET course available' is a binary indicator equal to 1 if a VET course *associated with industry* s is available in year $t-3$ in municipality c, and zero otherwise. All regressions include municipality-by-industry and NUTS III-by-year fixed effects. Own calculations based on the *Quadros de Pessoal* data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table 9: **VET course availability and local employment (Poisson estimates)**

	(1) Emp. < 19	(2) Emp. < 21	(3) Emp. < 23	(4) Total Emp.	(5) Emp. new estab.	(6) Emp. new firms
VET course available	0.094	0.088	0.085	0.056	0.154	0.358
	(0.019)***	(0.015)***	(0.012)***	(0.005)***	(0.059)***	(0.206)*
Constant	4.348	5.226	5.773	8.141	6.041	4.705
	(0.004)***	(0.004)***	(0.003)***	(0.001)***	(0.010)***	(0.030)***
Observations	23220	27232	29275	32373	15992	13264
Pseudo R^2	0.926	0.956	0.968	0.991	0.935	0.915

Notes: Standard errors clustered at the *concelho* (municipality) level in parentheses. 'Emp. < 19 [< 21] [< 23]' is the number of workers (with any level of schooling) employed in municipality c, in industry s, in year t, below 19 [21] [23] years of age. 'Emp. new establish.' is the number of workers employed by new firm establishments in municipality c. 'VET course available' is a binary indicator equal to 1 if a VET course *associated with industry* s is available in year $t-3$ in municipality c, and zero otherwise. All regressions include municipality-by-industry and NUTS III-by-year fixed effects. Own calculations based on the *Quadros de Pessoal* data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

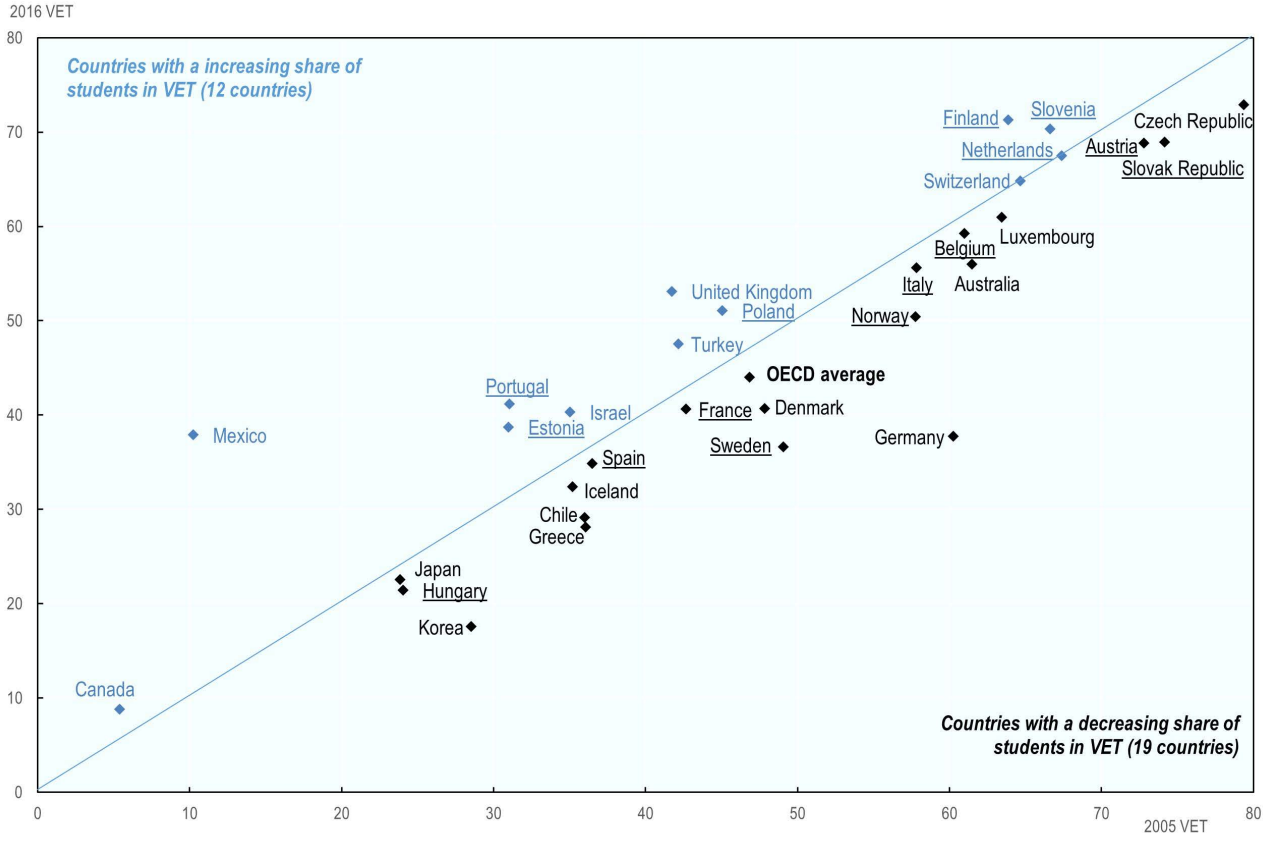
Table 10: **Schooling and hourly wages for young workers (OLS estimates)**

	(1)	(2)	(3)	(4)	(5)
	Log hourly wage	Log hourly wage	Log hourly wage	Log hourly wage	Log hourly wage
A. 2007-2013					
(Upper secondary) VET graduate	0.086	0.081	0.082	0.029	0.029
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
(Upper secondary) Academic graduate	0.083	0.077	0.078	0.019	0.019
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Female	-0.089	-0.091	-0.091	-0.034	-0.034
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Tenure			0.003	0.017	0.017
			(0.000)***	(0.000)***	(0.000)***
N	848,064	848,064	848,064	804,783	804,783
R^2	0.072	0.092	0.093	0.625	0.626
B. Same workers, 2014-2020					
(Upper secondary) VET graduate	0.105	0.108	0.109	0.040	0.040
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
(Upper secondary) Academic graduate	0.098	0.098	0.100	0.033	0.034
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Female	-0.126	-0.127	-0.127	-0.061	-0.061
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Tenure			0.008	0.012	0.012
			(0.000)***	(0.000)***	(0.000)***
N	803,887	803,887	803,803	775,871	775,871
R^2	0.128	0.138	0.145	0.666	0.666
Additional controls					
Year FE	Yes	Yes	No	Yes	No
Age FE	No	Yes	No	Yes	No
Firm FE	No	No	No	Yes	Yes
Year x Age FE	No	No	Yes	No	Yes

Notes: Robust standard errors in parentheses. The dependent variable is the natural logarithm of hourly wages. N is the total number of worker-year observations. In panel A, we restrict our sample to individuals with 18 to 23 years of age, inclusive, without a post-secondary degree. Panel B is composed of worker-year observations for the same individuals from 2014 to 2020, inclusive. Own calculations based on the *Quadros de Pessoal* data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

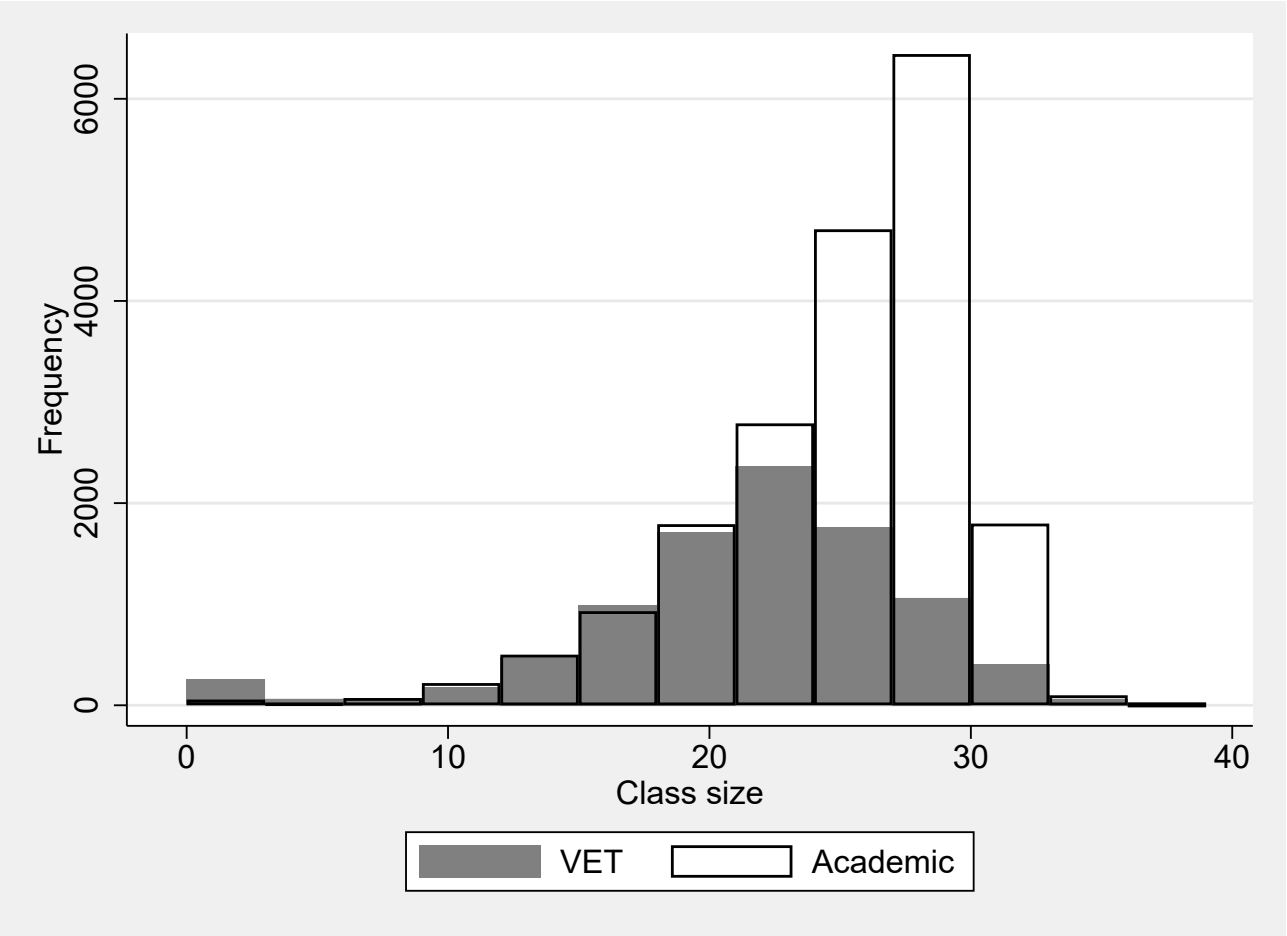
A Supplementary figures and tables: Educational outcomes

Figure A.1: **Share of students in VET, International comparison, 2005 vs 2016**



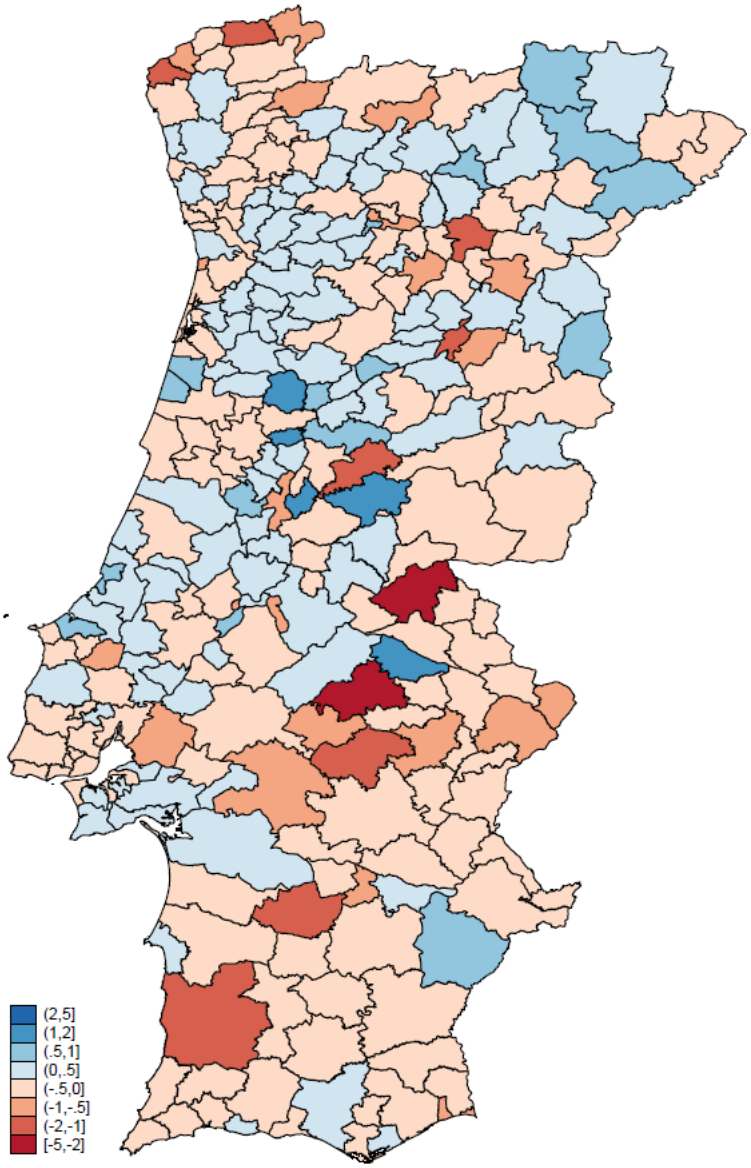
Notes: This Figure presents the percentage of upper secondary students enrolled in VET courses in 2005 and 2016. The OECD definition of upper secondary VET includes the discontinued 'technological' courses, unlike Portugal's. This explains why the variation between 2005 and 2016 in the share of VET students is larger in Figure 1 than in Figure A.1. However, 'technological' courses were much closer to academic, 'regular' courses than to the current VET track. In particular, the closer relationship with the labour market observed in current VET courses (e.g., through internships, training outside of school) was not a feature in the old 'technological' track. **Source:** OECD.

Figure A.2: **Class size and upper secondary track**



Notes: This Figure shows the distribution of (10^{th} grade, public school) class sizes for the two major upper secondary tracks, for all cohorts from 2007/08 to 2014/15. We exclude a very small number of 'classes' with more than 40 students.
Source: Authors' treatment of MISI data.

Figure A.3: **Variation in 'VET supply', 2006-2014**



Notes: This Figure shows the difference, measured at the *concelho* (municipality) level, between the values of $VETsupply_{ct}$ for the 2006/07 and 2013/14 9^{th} grade cohorts (positive values indicate that $VETsupply$ increased).
Source: Authors' treatment of MISI data.

Table A.1: **Descriptive Statistics: VET vs Academic track**

	(1) VET		(2) Academic	
	Mean	SD	Mean	SD
Individual characteristics				
Female	0.44	0.50	0.57	0.50
Age at the end of 9^{th} grade (June 30)	15.84	0.94	15.21	0.60
Welfare support (Full)	0.27	0.44	0.14	0.35
Welfare support (Partial)	0.18	0.39	0.13	0.34
Compulsory schooling bite	0.47	0.50	0.62	0.48
Foreign nationality	0.03	0.16	0.02	0.14
PT national exam score, 9^{th} grade (0-100)	46.99	13.54	60.63	14.93
Math national exam score, 9^{th} grade (0-100)	35.46	18.01	55.91	22.99
Mother's education (in years)	7.28	3.34	9.78	4.01
Father's education (in years)	6.84	3.18	9.23	3.98
Guardian's education (in years)	7.44	3.43	9.89	4.02
Employed guardian	0.85	0.36	0.90	0.31
Unemployed guardian	0.11	0.31	0.08	0.26
Inactive guardian	0.05	0.21	0.03	0.17
Educational achievement				
Graduated within 3 years	0.40	0.49	0.54	0.50
Graduated within 4 years	0.53	0.50	0.64	0.48
Graduated within 5 years	0.55	0.50	0.66	0.47
PT national exam score, 12^{th} grade (0-200)	69.45	28.56	107.89	32.42
Regional characteristics				
VET availability	0.61	0.49	0.61	0.49
Same-gender-friendly VET	0.49	0.50	0.46	0.50
Gender-neutral VET	0.50	0.50	0.49	0.50
VET supply	0.45	0.23	0.44	0.23
Observations	186392		362977	

Notes: Each observation corresponds to a student registered in the 9^{th} grade over the academic years ranging from 2006/07 and 2013/14. The left (right) columns refer to students that will enrol in the VET (academic) track in the following year. The reported average '[Portuguese] national exam score, 12^{th} grade' for the VET sub-sample was computed from 28,979 students' results, as it is not a mandatory assessment for VET pupils. Both mean scores for that exam were calculated based on sub-samples of students who were enrolled in 12^{th} grade in the respective track. **Source:** MISI data set. See the notes to Table 1 for more details.

Table A.2: **VET availability and upper secondary track takeup (LPM estimates; Robustness)**

	(1) VET Takeup	(2) VET Takeup	(3) Acad. Takeup	(4) VET Takeup	(5) VET Takeup	(6) Acad. Takeup
VET availability	0.054	0.049	-0.018	0.041	0.039	-0.011
	(0.007)***	(0.007)***	(0.013)	(0.008)***	(0.009)***	(0.013)
Female	-0.082	-0.072	0.075	-0.082	-0.072	0.075
	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***
Age	0.082	0.060	-0.126	0.082	0.060	-0.125
	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***
Welfare support (Full)	0.111	0.046	-0.053	0.111	0.046	-0.053
	(0.003)***	(0.002)***	(0.002)***	(0.003)***	(0.002)***	(0.002)***
Welfare support (Partial)	0.101	0.036	-0.038	0.101	0.036	-0.037
	(0.002)***	(0.002)***	(0.002)***	(0.003)***	(0.002)***	(0.002)***
Compulsory schooling bite	-0.030	-0.003	-0.016	-0.031	-0.004	-0.014
	(0.002)***	(0.002)*	(0.002)***	(0.002)***	(0.002)**	(0.002)***
Foreign nationality		-0.113	0.027		-0.114	0.027
		(0.006)***	(0.007)***		(0.006)***	(0.007)***
PT exam score, 9^{th} grade		-0.005	0.006		-0.005	0.006
		(0.000)***	(0.000)***		(0.000)***	(0.000)***
Math exam score, 9^{th} grade		-0.004	0.004		-0.004	0.004
		(0.000)***	(0.000)***		(0.000)***	(0.000)***
Guardian's education		-0.010	0.009		-0.010	0.009
		(0.000)***	(0.000)***		(0.000)***	(0.000)***
Unemployed guardian		0.003	-0.003		0.002	-0.002
		(0.002)	(0.002)		(0.002)	(0.002)
Inactive guardian		-0.002	0.025		-0.004	0.025
		(0.005)	(0.005)***		(0.005)	(0.005)***
Observations	514860	424257	424257	489619	403492	403492
R^2	0.098	0.221	0.306	0.098	0.222	0.307

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'VET Takeup [Acad.]' is a binary variable that takes value 1 if the student enrolled in a VET ["regular"] course right after their final 9^{th} grade enrollment, and 0 otherwise. More information about the covariates can be found in Table A.13. The sample is restricted to school districts in which there was no variation in 'VET availability', as well as (for the other school districts) those cohorts up to and including the first school year in which 'VET availability' changed (columns (1) - (3)). In columns (4) - (6) we consider all school districts in which there is no variation in 'VET availability', as well as (for the other school districts) the cohorts immediately "before and after" the first change in 'VET availability'. All regressions include school district and NUTS III-by-year fixed effects. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table A.3: **VET availability and takeup (LPM estimates; Heterogeneity)**

	(1) VET Takeup	(2) VET Takeup	(3) VET Takeup	(4) VET Takeup	(5) VET Takeup	(6) VET Takeup	(7) VET Takeup	(8) VET Takeup
VET availability	0.057	0.047	0.029	0.032	0.041	0.039	0.042	0.039
	(0.006)***	(0.006)***	(0.006)***	(0.006)***	(0.005)***	(0.005)***	(0.005)***	(0.005)***
Female	-0.075	-0.067	✓	✓	✓	✓	✓	✓
	(0.003)***	(0.003)***						
VET x Female	-0.009	-0.004						
	(0.004)***	(0.004)						
Below median			0.242	0.231				
			(0.005)***	(0.005)***				
VET x Below median			0.036	0.030				
			(0.006)***	(0.006)***				
Low G.E.					0.096	0.054		
					(0.004)***	(0.003)***		
VET x Low G.E.					0.028	0.016		
					(0.005)***	(0.004)***		
Welfare support							0.090	0.032
							(0.003)***	(0.003)***
VET x Welfare							0.031	0.017
							(0.004)***	(0.004)***
Full/Partial support	✓	✓	✓	✓	✓	✓		
Exam scores		✓				✓		✓
Guardian's education		✓		✓				✓
Other controls		✓		✓		✓		✓
Observations	647046	535216	574782	535216	604138	535216	647046	535216
R^2	0.101	0.223	0.192	0.207	0.119	0.222	0.101	0.223

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'VET takeup' is a binary variable that takes value 1 if the student enrolled in a VET course right after their final 9^{th} grade enrollment, and 0 otherwise. (1) 'Below median', (2) 'Low G. E.', and (3) 'Welfare support' are binary variables that are equal to 1 if, respectively, (1) the student had a combined 9^{th} grade national exam score (sum of marks obtained in Portuguese and Mathematics) below their cohort's median score; (2) their guardian's schooling was below the median level among that cohort's guardians; or (3) they received either full or partial welfare support. "Exam scores" includes the two linear controls for Portuguese and Mathematics 9^{th} grade national exam scores; "Full/Partial support" refers to the 'Welfare support (Full)' and 'Welfare support (Partial)' dummies, as presented in Table 2. Finally, "Other controls" include 'Foreign nationality', 'Unemployed guardian', and 'Inactive guardian'. All regressions include 'Age', 'Compulsory schooling bite', and school district and NUTS III-by-year fixed effects. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table A.4: **VET availability, takeup, and 5-year upper secondary graduation rates (LPM/IV estimates)**

	(1)	(2)	(3)	(4)
	Grad. 5 years	Grad. 5 years	Grad. 5 years	Grad. 5 years
VET availability	0.018	0.018		
	(0.006)***	(0.006)***		
VET takeup			0.347	0.396
			(0.125)***	(0.137)***
Female	0.079	0.072	0.107	0.099
	(0.002)***	(0.002)***	(0.010)***	(0.010)***
Age	-0.169	-0.088	-0.196	-0.109
	(0.002)***	(0.002)***	(0.010)***	(0.008)***
Welfare support (Full)	-0.075	-0.025	-0.113	-0.045
	(0.002)***	(0.002)***	(0.014)***	(0.007)***
Welfare support (Partial)	-0.036	-0.004	-0.070	-0.019
	(0.003)***	(0.002)*	(0.013)***	(0.005)***
Compulsory schooling bite	-0.009	-0.004	0.004	-0.001
	(0.002)***	(0.002)**	(0.006)	(0.003)
Foreign nationality		-0.094		-0.053
		(0.007)***		(0.016)***
PT exam score, 9^{th} grade		0.004		0.006
		(0.000)***		(0.001)***
Math exam score, 9^{th} grade		0.004		0.006
		(0.000)***		(0.001)***
Guardian's education		0.002		0.006
		(0.000)***		(0.001)***
Unemployed guardian		-0.022		-0.025
		(0.003)***		(0.003)***
Inactive guardian		-0.027		-0.027
		(0.005)***		(0.005)***
Observations	475496	393169	475496	393167
R^2	0.161	0.188		
F (first stage)			63.01	48.81
Kleibergen-Paap rk LM statistic			52.44	43.28
Kleibergen-Paap rk LM p-value			4.435e-13	4.755e-11

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'Grad. 5 years' takes value 1 if the student graduated from upper secondary school within 5 years of completing lower secondary education (9^{th} grade), and 0 otherwise. See Table 4 for additional information regarding the covariates. All regressions include school district and NUTS III-by-year fixed effects. Columns (1) and (2) present the output of equations estimated by OLS. 'VET availability' is used as an instrument for 'VET takeup' in columns (3) and (4). Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table A.5: **VET takeup and upper secondary graduation rates (LPM estimates; Robustness)**

	(1)	(2)	(3)	(4)	(5)	(6)
	Grad. 3 years	Grad. 3 years	Grad. 3 years	Grad. 4 years	Grad. 4 years	Grad. 4 years
VET takeup	-0.139	-0.047	0.124	-0.112	0.001	0.150
	(0.004)***	(0.004)***	(0.004)***	(0.004)***	(0.004)	(0.004)***
Female		0.089	0.089		0.092	0.093
		(0.002)***	(0.002)***		(0.002)***	(0.002)***
Age		-0.112	-0.039		-0.146	-0.080
		(0.001)***	(0.001)***		(0.002)***	(0.002)***
Welfare support (Full)		-0.075	-0.018		-0.083	-0.032
		(0.002)***	(0.002)***		(0.002)***	(0.002)***
Welfare support (Partial)		-0.042	-0.000		-0.045	-0.007
		(0.002)***	(0.002)		(0.002)***	(0.002)***
Compulsory schooling bite		-0.008	0.008		-0.014	-0.001
		(0.002)***	(0.002)***		(0.002)***	(0.002)
Foreign nationality			-0.016			-0.037
			(0.006)**			(0.007)***
PT exam score, 9^{th} grade			0.006			0.005
			(0.000)***			(0.000)***
Math exam score, 9^{th} grade			0.006			0.005
			(0.000)***			(0.000)***
Guardian's education			0.002			0.003
			(0.000)***			(0.000)***
Unemployed guardian			-0.022			-0.023
			(0.003)***			(0.003)***
Inactive guardian			-0.050			-0.041
			(0.004)***			(0.005)***
Observations	544644	544644	481493	470533	470533	416499
R^2	0.058	0.095	0.197	0.049	0.108	0.183

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'Grad. 3 [4] years' is a dependent variable that takes value 1 if the student graduated from upper secondary school within 3 [4] years of completing lower secondary education (9^{th} grade), and 0 otherwise. More information about the covariates can be found in Table A.13. All regressions include school district and NUTS III-by-year fixed effects. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table A.6: **VET takeup and upper secondary graduation rates (IV estimates; Robustness)**

	(1) Grad. 3 years	(2) Grad. 3 years	(3) Grad. 3 years	(4) Grad. 4 years	(5) Grad. 4 years	(6) Grad. 4 years
VET takeup	0.340	0.593	0.669	0.088	0.320	0.336
	(0.114)***	(0.142)***	(0.166)***	(0.120)	(0.150)**	(0.156)**
Female		0.151	0.131		0.123	0.107
		(0.014)***	(0.013)***		(0.015)***	(0.013)***
Age		-0.252	-0.106		-0.216	-0.102
		(0.031)***	(0.020)***		(0.033)***	(0.019)***
Welfare support (Full)		-0.158	-0.049		-0.125	-0.042
		(0.019)***	(0.010)***		(0.020)***	(0.009)***
Welfare support (Partial)		-0.107	-0.021		-0.078	-0.015
		(0.015)***	(0.007)***		(0.016)***	(0.006)**
Compulsory schooling bite		-0.027	-0.004		-0.024	-0.005
		(0.005)***	(0.004)		(0.005)***	(0.004)
Foreign nationality			0.043			-0.019
			(0.019)**			(0.018)
PT exam score, 9^{th} grade			0.009			0.006
			(0.001)***			(0.001)***
Math exam score, 9^{th} grade			0.008			0.006
			(0.001)***			(0.001)***
Guardian's education			0.008			0.005
			(0.002)***			(0.002)***
Unemployed guardian			-0.024			-0.024
			(0.003)***			(0.003)***
Inactive guardian			-0.039			-0.038
			(0.006)***			(0.005)***
Observations	543979	543979	480874	469871	469871	415883
F (first stage)	89.09	65.93	49.03	64.61	45.14	37.25
Kleibergen-Paap rk LM statistic	66.12	54.02	42.33	54.89	41.94	35.62
Kleibergen-Paap rk LM p-value	4.238e-16	1.980e-13	7.724e-11	1.273e-13	9.422e-11	2.396e-09

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'Grad. 3 [4] years' is a dependent variable that takes value 1 if the student graduated from upper secondary school within 3 [4] years of completing lower secondary education (9^{th} grade), and 0 otherwise. More information about the covariates can be found in Table A.13. 'VET availability' is used as an instrument for 'VET takeup'. All regressions include school district and NUTS III-by-year fixed effects. The sample is restricted to students who enrolled in either the VET or academic tracks following their last observation in 9^{th} grade. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table A.7: **VET takeup and upper secondary graduation rates (IV estimates; Robustness)**

	All observations of schools always with or without VET; plus...					
	All obs. up to and including the introduction of VET			Last obs. without VET and first obs. with VET		
	(1)	(2)	(3)	(4)	(5)	(6)
	Grad. 3 years	Grad. 3 years	Grad. 4 years	Grad. 3 years	Grad. 3 years	Grad. 4 years
VET takeup	0.464	0.399	0.281	0.722	0.604	0.268
	(0.154)***	(0.165)**	(0.166)*	(0.272)***	(0.244)**	(0.213)
Female	0.122	0.105	0.107	0.143	0.120	0.106
	(0.013)***	(0.012)***	(0.014)***	(0.022)***	(0.018)***	(0.017)***
Age	-0.170	-0.062	-0.183	-0.192	-0.074	-0.182
	(0.013)***	(0.010)***	(0.013)***	(0.023)***	(0.015)***	(0.017)***
Welfare support (Full)	-0.125	-0.033	-0.108	-0.153	-0.042	-0.107
	(0.017)***	(0.008)***	(0.018)***	(0.030)***	(0.011)***	(0.023)***
Welfare support (Partial)	-0.085	-0.011	-0.065	-0.111	-0.018	-0.064
	(0.016)***	(0.006)*	(0.017)***	(0.027)***	(0.009)**	(0.021)***
Compulsory schooling bite	0.011	0.009	0.003	0.019	0.010	0.003
	(0.005)**	(0.002)***	(0.006)	(0.008)**	(0.003)***	(0.008)
Foreign nationality		-0.012			0.013	
		(0.020)			(0.029)	
PT exam score, 9^{th} grade		0.007			0.008	
		(0.001)***			(0.001)***	
Math exam score, 9^{th} grade		0.007			0.008	
		(0.001)***			(0.001)***	
Guardian's education		0.005			0.007	
		(0.002)***			(0.002)***	
Unemployed guardian		-0.022			-0.022	
		(0.003)***			(0.003)***	
Inactive guardian		-0.042			-0.040	
		(0.004)***			(0.005)***	
Observations	510274	420975	448570	485209	400336	423646
F (first stage)	56.83	44.26	51.45	26.42	19.51	31.18
Kleibergen-Paap rk LM statistic	39.56	33.46	35.18	22.3	17.09	24.63
Kleibergen-Paap rk LM p-value	3.187e-10	7.258e-09	3.005e-09	2.334e-06	.0000357	6.951e-07

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'Grad. 3 [4] years' is a dependent variable that takes value 1 if the student graduated from upper secondary school within 3 [4] years of completing lower secondary education (9^{th} grade), and 0 otherwise. More information about the covariates can be found in Table A.13. 'VET availability' is used as an instrument for 'VET takeup'. All regressions include school district and NUTS III-by-year fixed effects. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table A.8: **VET takeup, class size, and upper secondary graduation rates (IV estimates)**

	(1)	(2)	(3)	(4)	(5)	(6)
	Grad. 3 years	Grad. 3 years	Grad. 3 years	Grad. 4 years	Grad. 4 years	Grad. 4 years
VET takeup	0.474	0.670	0.714	0.263	0.464	0.438
	(0.129)***	(0.144)***	(0.167)***	(0.143)*	(0.158)***	(0.162)***
Class size (10^{th} grade)	0.014	0.011	0.007	0.012	0.010	0.005
	(0.003)***	(0.002)***	(0.002)***	(0.003)***	(0.003)***	(0.002)**
Female		0.148	0.126		0.128	0.109
		(0.013)***	(0.012)***		(0.014)***	(0.012)***
Age		-0.244	-0.098		-0.228	-0.106
		(0.026)***	(0.016)***		(0.028)***	(0.015)***
Welfare support (Full)		-0.157	-0.048		-0.134	-0.045
		(0.017)***	(0.009)***		(0.019)***	(0.009)***
Welfare support (Partial)		-0.108	-0.021		-0.088	-0.018
		(0.013)***	(0.006)***		(0.015)***	(0.006)***
Compulsory schooling bite		-0.023	-0.002		-0.021	-0.004
		(0.004)***	(0.004)		(0.004)***	(0.003)
Foreign nationality			0.039			-0.009
			(0.017)**			(0.016)
PT exam score, 9^{th} grade			0.009			0.006
			(0.001)***			(0.001)***
Math exam score, 9^{th} grade			0.008			0.006
			(0.001)***			(0.001)***
Guardian's education			0.008			0.006
			(0.002)***			(0.001)***
Unemployed guardian			-0.024			-0.024
			(0.003)***			(0.003)***
Inactive guardian			-0.039			-0.033
			(0.005)***			(0.005)***
Observations	576252	576252	507192	498386	498386	439114
F (first stage)	71.48	60.59	47.03	48.29	39.79	33.39
Kleibergen-Paap rk LM statistic	52.78	48.13	39.3	39.4	34.8	30.26
Kleibergen-Paap rk LM p-value	3.733e-13	3.985e-12	3.636e-10	3.460e-10	3.645e-09	3.782e-08

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'Grad. 3 [4] years' is a dependent variable that takes value 1 if the student graduated from upper secondary school within 3 [4] years of completing lower secondary education (9^{th} grade), and 0 otherwise. More information about the covariates can be found in Table A.13. 'VET availability' is used as an instrument for 'VET takeup'. All regressions include school district and NUTS III-by-year fixed effects. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table A.9: **VET takeup and graduation rates before the compulsory school leaving age reform**

	(1)	(2)	(3)	(4)
	Grad. 3 years	Grad. 3 years	Grad. 3 years	Grad. 3 years
VET takeup	0.030	0.152	0.572	0.557
	(0.005)***	(0.005)***	(0.153)***	(0.162)***
Female	0.089	0.089	0.133	0.118
	(0.002)***	(0.002)***	(0.012)***	(0.012)***
Age	-0.135	-0.047	-0.182	-0.069
	(0.001)***	(0.001)***	(0.014)***	(0.009)***
Welfare support (Full)	-0.074	-0.018	-0.133	-0.038
	(0.002)***	(0.002)***	(0.017)***	(0.008)***
Welfare support (Partial)	-0.046	-0.006	-0.100	-0.021
	(0.003)***	(0.003)**	(0.016)***	(0.007)***
Foreign nationality		-0.042		-0.001
		(0.007)***		(0.019)
PT exam score, 9^{th} grade		0.006		0.008
		(0.000)***		(0.001)***
Math exam score, 9^{th} grade		0.006		0.008
		(0.000)***		(0.001)***
Guardian's education		0.004		0.007
		(0.000)***		(0.002)***
Unemployed guardian		-0.025		-0.028
		(0.003)***		(0.004)***
Inactive guardian		-0.042		-0.043
		(0.005)***		(0.005)***
Observations	400951	331473	400159	330782
R^2	0.125	0.218		
F (first stage)			47.06	40.17
Kleibergen-Paap rk LM statistic			39.63	35.4
Kleibergen-Paap rk LM p-value			3.072e-10	2.688e-09

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'Grad. 3 years' takes value 1 if the student graduated from upper secondary school within 3 years of completing lower secondary education (9^{th} grade), and 0 otherwise. More information about the covariates can be found in Table A.13; we exclude from the estimated regressions the 'Compulsory schooling bite' dummy. 'VET availability' is used as an instrument for 'VET takeup' in columns (3) and (4). All regressions include school district and NUTS III-by-year fixed effects. Cohorts that were affected by the compulsory school leaving age increase (i.e., the three latter cohorts in the period we consider) were excluded from the sample. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table A.10: **VET takeup, gender, and upper secondary graduation rates (IV estimates)**

	(1) Grad. 3 years	(2) Grad. 3 years	(3) Grad. 4 years	(4) Grad. 4 years	(5) Grad. 5 years	(6) Grad. 5 years
VET takeup	0.376	0.538	0.609	0.761	0.664	0.860
	(0.113)***	(0.135)***	(0.131)***	(0.150)***	(0.144)***	(0.169)***
Female	0.115	0.112	0.133	0.130	0.133	0.131
	(0.009)***	(0.010)***	(0.011)***	(0.011)***	(0.012)***	(0.012)***
Age	-0.165	-0.070	-0.212	-0.120	-0.221	-0.134
	(0.010)***	(0.008)***	(0.011)***	(0.009)***	(0.012)***	(0.009)***
Welfare support (Full)	-0.116	-0.039	-0.145	-0.062	-0.149	-0.068
	(0.013)***	(0.007)***	(0.015)***	(0.008)***	(0.016)***	(0.009)***
Welfare support (Partial)	-0.077	-0.016	-0.098	-0.030	-0.102	-0.036
	(0.012)***	(0.005)***	(0.013)***	(0.006)***	(0.015)***	(0.007)***
Compulsory schooling bite	0.005	0.008	0.011	0.003	0.017	0.003
	(0.004)	(0.002)***	(0.005)**	(0.002)	(0.006)***	(0.003)
Foreign nationality		0.001		-0.008		-0.004
		(0.016)		(0.018)		(0.019)
PT exam score, 9^{th} grade		0.008		0.008		0.008
		(0.001)***		(0.001)***		(0.001)***
Math exam score, 9^{th} grade		0.007		0.008		0.008
		(0.001)***		(0.001)***		(0.001)***
Guardian's education		0.006		0.009		0.010
		(0.001)***		(0.001)***		(0.002)***
Unemployed guardian		-0.022		-0.026		-0.030
		(0.003)***		(0.003)***		(0.004)***
Inactive guardian		-0.040		-0.030		-0.028
		(0.004)***		(0.005)***		(0.005)***
Observations	642306	531942	556917	461265	476285	393855
'Same-gender-friendly VET' IV	0.028	0.024	0.026	0.023	0.025	0.021
	(0.003)***	(0.003)***	(0.003)***	(0.003)***	(0.003)***	(0.003)***
F (first stage)	88.25	65.55	72.55	57.78	56.64	42.87
Kleibergen-Paap rk LM statistic	71.37	54.94	61.21	49.11	48.23	36.94
Kleibergen-Paap rk LM p-value	2.965e-17	1.244e-13	5.118e-15	2.421e-12	3.799e-12	1.218e-09

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'Grad. 3 [4] [5] years' is a dependent variable that takes value 1 if the student graduated from upper secondary school within 3 [4] [5] years of completing lower secondary education (9^{th} grade), and 0 otherwise. More information about the covariates can be found in Table A.13. 'Same-gender-friendly VET' is used as an instrument for 'VET takeup'. All regressions include school district and NUTS III-by-year fixed effects. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table A.11: **VET takeup, gender, and upper secondary graduation rates (IV estimates)**

	(1)	(2)	(3)	(4)	(5)	(6)
	Grad. 3 years	Grad. 3 years	Grad. 4 years	Grad. 4 years	Grad. 5 years	Grad. 5 years
VET takeup	0.364	0.520	0.579	0.719	0.617	0.775
	(0.096)***	(0.116)***	(0.112)***	(0.129)***	(0.125)***	(0.145)***
Female	0.114	0.111	0.131	0.127	0.129	0.125
	(0.008)***	(0.008)***	(0.009)***	(0.009)***	(0.010)***	(0.010)***
Age	-0.164	-0.069	-0.209	-0.117	-0.217	-0.130
	(0.009)***	(0.007)***	(0.010)***	(0.008)***	(0.010)***	(0.008)***
Welfare support (Full)	-0.115	-0.038	-0.142	-0.060	-0.143	-0.064
	(0.011)***	(0.006)***	(0.013)***	(0.007)***	(0.014)***	(0.008)***
Welfare support (Partial)	-0.076	-0.016	-0.095	-0.029	-0.097	-0.033
	(0.010)***	(0.005)***	(0.011)***	(0.005)***	(0.013)***	(0.006)***
Compulsory schooling bite	0.005	0.008	0.010	0.003	0.015	0.003
	(0.003)	(0.002)***	(0.004)**	(0.002)	(0.005)***	(0.003)
Foreign nationality		-0.001		-0.012		-0.013
		(0.014)		(0.015)		(0.017)
PT exam score, 9^{th} grade		0.008		0.008		0.008
		(0.001)***		(0.001)***		(0.001)***
Math exam score, 9^{th} grade		0.007		0.007		0.007
		(0.000)***		(0.001)***		(0.001)***
Guardian's education		0.006		0.009		0.009
		(0.001)***		(0.001)***		(0.001)***
Unemployed guardian		-0.022		-0.026		-0.029
		(0.003)***		(0.003)***		(0.003)***
Inactive guardian		-0.040		-0.031		-0.028
		(0.004)***		(0.005)***		(0.005)***
Observations	642306	531942	556917	461265	476285	393855
'Same-gender-friendly VET' IV	0.028	0.024	0.027	0.023	0.026	0.022
	(0.003)***	(0.003)***	(0.003)***	(0.003)***	(0.003)***	(0.003)***
'Gender-neutral VET' IV	0.020	0.015	0.018	0.015	0.018	0.016
	(0.004)***	(0.004)***	(0.004)***	(0.004)***	(0.005)***	(0.004)***
F (first stage)	52.35	38.26	42.28	34.43	33.51	26.9
Kleibergen-Paap rk LM statistic	81.17	62.08	69.41	56.9	55.91	45.18
Kleibergen-Paap rk LM p-value	2.364e-18	3.300e-14	8.461e-16	4.398e-13	7.243e-13	1.550e-10
Hansen's J statistic	.04517	.08479	.205	.3486	.4343	1.032
J-statistic p-value	.8317	.7709	.6507	.5549	.5099	.3098

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'Grad. 3 [4] [5] years' is a dependent variable that takes value 1 if the student graduated from upper secondary school within 3 [4] [5] years of completing lower secondary education (9^{th} grade), and 0 otherwise. More information about the covariates can be found in Table A.13. 'Same-gender-friendly VET' and 'Gender-neutral VET' are used as instruments for 'VET takeup'. All regressions include school district and NUTS III-by-year fixed effects. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table A.12: **VET takeup and standardized national exam performance (OLS/IV estimates)**

	(1)	(2)	(3)	(4)	(5)	(6)
	Exam score (σ)	Exam score (σ)	Exam score (σ)	Exam score (σ)	Exam score (σ)	Exam score (σ)
VET takeup	-1.138	-0.995	-0.562	0.612	0.860	0.308
	(0.008)***	(0.008)***	(0.007)***	(1.038)	(1.025)	(0.820)
Female		0.276	0.224		0.299	0.233
		(0.004)***	(0.003)***		(0.013)***	(0.009)***
Age		-0.388	-0.148		-0.576	-0.199
		(0.004)***	(0.004)***		(0.104)***	(0.049)***
Welfare support (Full)		-0.198	-0.013		-0.280	-0.028
		(0.006)***	(0.005)***		(0.045)***	(0.015)*
Welfare support (Partial)		-0.168	-0.017		-0.228	-0.028
		(0.006)***	(0.004)***		(0.034)***	(0.011)***
Compulsory schooling bite		-0.100	-0.011		-0.159	-0.026
		(0.005)***	(0.004)**		(0.033)***	(0.015)*
Foreign nationality			0.042			0.073
			(0.015)***			(0.033)**
PT exam score, 9^{th} grade			0.029			0.031
			(0.000)***			(0.002)***
Math exam score, 9^{th} grade			0.009			0.011
			(0.000)***			(0.001)***
Guardian's education			0.011			0.013
			(0.000)***			(0.001)***
Unemployed guardian			-0.001			-0.001
			(0.005)			(0.006)
Inactive guardian			0.003			0.008
			(0.009)			(0.011)
Observations	313692	313692	296224	313361	313361	295907
R^2	0.139	0.197	0.446			
F (first stage)				20.33	19.64	18.03
Kleibergen-Paap rk LM statistic				18.92	18.45	16.77
Kleibergen-Paap rk LM p-value				.00001366	.00001748	.00004212

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. The dependent variable, 'Exam score (σ)', is the standardized score of student i in their cohort's assessment. More information about the covariates can be found in Table A.13. 'VET availability' is used as an instrument for 'VET takeup' in columns (4) - (6). All regressions include school district and NUTS III-by-year fixed effects. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table A.13: **VET availability and upper secondary graduation rates (LPM estimates)**

	(1)	(2)	(3)	(4)	(5)	(6)
	Grad. 3 years	Grad. 3 years	Grad. 3 years	Grad. 4 years	Grad. 4 years	Grad. 4 years
VET availability	0.024	0.027	0.027	0.014	0.018	0.018
	(0.006)***	(0.005)***	(0.005)***	(0.006)**	(0.006)***	(0.006)***
Female		0.085	0.075		0.084	0.077
		(0.002)***	(0.002)***		(0.002)***	(0.002)***
Age		-0.133	-0.037		-0.161	-0.076
		(0.002)***	(0.001)***		(0.002)***	(0.001)***
Welfare support (Full)		-0.074	-0.013		-0.077	-0.024
		(0.002)***	(0.002)***		(0.002)***	(0.002)***
Welfare support (Partial)		-0.040	0.003		-0.037	-0.003
		(0.002)***	(0.002)		(0.002)***	(0.002)
Compulsory schooling bite		-0.004	0.007		-0.008	-0.000
		(0.002)**	(0.002)***		(0.002)***	(0.002)
Foreign nationality			-0.059			-0.090
			(0.006)***			(0.007)***
PT exam score, 9^{th} grade			0.005			0.004
			(0.000)***			(0.000)***
Math exam score, 9^{th} grade			0.005			0.005
			(0.000)***			(0.000)***
Guardian's education			0.001			0.002
			(0.000)***			(0.000)***
Unemployed guardian			-0.020			-0.020
			(0.002)***			(0.003)***
Inactive guardian			-0.043			-0.031
			(0.004)***			(0.004)***
Observations	641651	641651	531288	556174	556174	460595
R^2	0.053	0.127	0.197	0.057	0.156	0.189

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'Grad. 3 [4] years' is a dependent variable that takes value 1 if the student graduated from upper secondary school within 3 [4] years of completing lower secondary education (9^{th} grade), and 0 otherwise. 'Age' is a continuous variable, measured as of June 30^{th} of the civil year in which the student was last enrolled in 9^{th} grade. 'Foreign nationality' is a dummy variable equal to 1 if the student is a citizen of any other country (even if they are also Portuguese nationals), and 0 otherwise. All regressions include school district and NUTS III-by-year fixed effects. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table A.14: **VET availability, class size, and upper secondary graduation rates (LPM estimates)**

	(1)	(2)	(3)	(4)	(5)	(6)
	Grad. 3 years	Grad. 3 years	Grad. 3 years	Grad. 4 years	Grad. 4 years	Grad. 4 years
VET availability	0.024	0.029	0.026	0.013	0.018	0.015
	(0.006)***	(0.006)***	(0.005)***	(0.006)*	(0.006)***	(0.006)***
Class size (10^{th} grade)	0.004	0.000	-0.003	0.006	0.001	-0.001
	(0.000)***	(0.000)	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Female		0.090	0.076		0.088	0.077
		(0.002)***	(0.002)***		(0.002)***	(0.002)***
Age		-0.122	-0.028		-0.145	-0.064
		(0.002)***	(0.001)***		(0.002)***	(0.002)***
Welfare support (Full)		-0.078	-0.012		-0.080	-0.022
		(0.002)***	(0.002)***		(0.002)***	(0.002)***
Welfare support (Partial)		-0.047	0.003		-0.045	-0.002
		(0.002)***	(0.002)		(0.002)***	(0.002)
Compulsory schooling bite		-0.006	0.011		-0.011	0.003
		(0.002)***	(0.002)***		(0.002)***	(0.002)*
Foreign nationality			-0.026			-0.047
			(0.006)***			(0.007)***
PT exam score, 9^{th} grade			0.005			0.004
			(0.000)***			(0.000)***
Math exam score, 9^{th} grade			0.005			0.005
			(0.000)***			(0.000)***
Guardian's education			0.001			0.002
			(0.000)***			(0.000)***
Unemployed guardian			-0.020			-0.021
			(0.003)***			(0.003)***
Inactive guardian			-0.048			-0.038
			(0.004)***			(0.005)***
Observations	576317	576317	507218	498424	498424	439129
R^2	0.050	0.102	0.193	0.052	0.120	0.179

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'Grad. 3 years' is a dependent variable that takes value 1 if the student graduated from upper secondary school within 3 years of completing lower secondary education (9^{th} grade), and 0 otherwise. More information about the covariates can be found in Table A.13. All regressions include school district and NUTS III-by-year fixed effects. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table A.15: **VET availability and upper secondary graduation rates (LPM estimates; Robustness)**

	All observations of schools always with or without VET; plus...					
	All obs. up to and including the introduction of VET			Last obs. without VET and first obs. with VET		
	(1)	(2)	(3)	(4)	(5)	(6)
	Grad. 3 years	Grad. 3 years	Grad. 4 years	Grad. 3 years	Grad. 3 years	Grad. 4 years
VET availability	0.025	0.020	0.016	0.029	0.023	0.012
	(0.008)***	(0.008)**	(0.009)*	(0.010)***	(0.010)**	(0.010)
Female	0.085	0.076	0.084	0.085	0.076	0.084
	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***
Age	-0.131	-0.038	-0.161	-0.131	-0.038	-0.160
	(0.002)***	(0.001)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***
Welfare support (Full)	-0.074	-0.015	-0.078	-0.074	-0.014	-0.078
	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.003)***
Welfare support (Partial)	-0.039	0.003	-0.037	-0.039	0.003	-0.037
	(0.003)***	(0.002)	(0.003)***	(0.003)***	(0.002)	(0.003)***
Compulsory schooling bite	-0.002	0.008	-0.007	-0.001	0.008	-0.006
	(0.002)	(0.002)***	(0.002)***	(0.002)	(0.002)***	(0.003)**
Foreign nationality		-0.057			-0.055	
		(0.006)***			(0.007)***	
PT exam score, 9^{th} grade		0.005			0.005	
		(0.000)***			(0.000)***	
Math exam score, 9^{th} grade		0.005			0.005	
		(0.000)***			(0.000)***	
Guardian's education		0.001			0.001	
		(0.000)***			(0.000)***	
Unemployed guardian		-0.021			-0.021	
		(0.003)***			(0.003)***	
Inactive guardian		-0.043			-0.041	
		(0.004)***			(0.005)***	
Observations	510378	421003	448609	485313	400364	423685
R^2	0.130	0.198	0.159	0.130	0.198	0.159

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'Grad. 3 [4] years' is a dependent variable that takes value 1 if the student graduated from upper secondary school within 3 [4] years of completing lower secondary education (9^{th} grade), and 0 otherwise. 'Age' is a continuous variable, measured as of June 30^{th} of the civil year in which the student was last enrolled in 9^{th} grade. 'Foreign nationality' is a dummy variable equal to 1 if the student is a citizen of any other country (even if they are also Portuguese nationals), and 0 otherwise. 'Compulsory schooling bite' is a binary variable that takes value 1 if the student was, at the end of 9^{th} grade, below the age of 15 (before the 2010/2011 school year, inclusive) or 18 (from 2011/2012 onwards). All regressions include school district and NUTS III-by-year fixed effects. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table A.16: **VET takeup and upper secondary graduation rates (IV estimates; Heterogeneity)**

	Sex		9^{th} Grade Exam Scores		Guardian Education		Social Support	
	Female	Male	Above Median	Below Median	High	Low	No Welfare	Welfare
VET takeup	0.574	0.422	0.654	0.547	0.596	0.488	0.429	0.538
	(0.117)***	(0.127)***	(0.572)	(0.086)***	(0.208)***	(0.079)***	(0.152)***	(0.088)***
Female			0.114	0.134	0.137	0.134	0.118	0.131
			(0.033)***	(0.008)***	(0.017)***	(0.007)***	(0.012)***	(0.008)***
Age	-0.171	-0.181	-0.241	-0.086	-0.218	-0.141	-0.192	-0.144
	(0.009)***	(0.013)***	(0.073)***	(0.005)***	(0.025)***	(0.005)***	(0.016)***	(0.006)***
Compulsory schooling bite	0.027	-0.009	-0.068	0.015	-0.018	0.018	-0.005	0.022
	(0.006)***	(0.003)***	(0.023)***	(0.004)***	(0.003)***	(0.005)***	(0.004)	(0.005)***
Welfare support (Full)	-0.131	-0.126	-0.143	-0.043	-0.162	-0.067		
	(0.013)***	(0.015)***	(0.051)***	(0.007)***	(0.020)***	(0.006)***		
Welfare support (Partial)	-0.102	-0.079	-0.094	-0.015	-0.120	-0.023		
	(0.013)***	(0.012)***	(0.037)**	(0.006)**	(0.019)***	(0.005)***		
Observations	309520	331990	289415	280902	361499	237669	422416	219096
F (first stage)	93.1	51.38	8.559	103	39.26	149.4	52.75	126.3
Kleibergen-Paap rk LM statistic	66.11	43.53	8.296	69.32	36.71	72.75	46.7	68.68
Kleibergen-Paap rk LM p-value	4.271e-16	4.166e-11	.003974	8.379e-17	1.368e-09	1.475e-17	8.267e-12	1.158e-16

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'Grad. 3 years' is the dependent variable in all regressions: it takes value 1 if the student graduated from upper secondary school within 3 years of completing lower secondary education (9^{th} grade), and 0 otherwise. The header of each column identifies the sub-sample used in each estimation. 'Above [Below] Median' identify students that had a combined 9^{th} grade national exam score (sum of marks obtained in Portuguese and Mathematics) above [below] their cohort's median score. 'High [Low]' Guardian Education identify pupils whose guardian's schooling was above [below] the median level among that cohort's guardians. 'Welfare' refers to students who received either full or partial welfare support. See Table 2 for details regarding the covariates. All regressions include school district and NUTS III-by-year fixed effects. 'VET availability' is used as an instrument for 'VET takeup'. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table A.17: **VET takeup and upper secondary graduation rates (LPM estimates; Heterogeneity)**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Grad. 3 years	Grad. 3 years	Grad. 3 years	Grad. 3 years	Grad. 3 years	Grad. 3 years	Grad. 3 years	Grad. 3 years
VET takeup	0.023	0.141	-0.081	-0.077	-0.054	0.089	-0.018	0.118
	(0.004)***	(0.005)***	(0.006)***	(0.006)***	(0.004)***	(0.004)***	(0.005)***	(0.004)***
Female	0.082	0.077	✓	✓	✓	✓	✓	✓
	(0.002)***	(0.002)***						
VET x Female	0.022	0.034						
	(0.003)***	(0.004)***						
Below median			-0.339	-0.335				
			(0.003)***	(0.003)***				
VET x Below med.			0.274	0.271				
			(0.005)***	(0.005)***				
Low G. E.					-0.103	-0.040		
					(0.002)***	(0.002)***		
VET x Low G. E.					0.174	0.137		
					(0.004)***	(0.004)***		
Welfare support							-0.103	-0.043
							(0.002)***	(0.002)***
VET x Welfare							0.123	0.094
							(0.004)***	(0.004)***
Full/Partial sup.	✓	✓	✓	✓	✓	✓		
Exam scores		✓				✓		✓
Guardian's educ.		✓		✓				✓
Other controls		✓		✓		✓		✓
Observations	642306	531942	571040	531942	599940	531942	642306	531942
R^2	0.128	0.212	0.175	0.174	0.128	0.215	0.130	0.214

Notes: Standard errors clustered at the *agrupamento* (school district) level in parentheses. 'Grad. 3 years' is the dependent variable in all regressions: it takes value 1 if the student graduated from upper secondary school within 3 years of completing lower secondary education (9^{th} grade), and 0 otherwise. (1) 'Below median', (2) 'Low G. E.', and (3) 'Welfare support' are binary variables that are equal to 1 if, respectively, (1) the student had a combined 9^{th} grade national exam score (sum of marks obtained in Portuguese and Mathematics) below their cohort's median score; (2) their guardian's schooling was below the median level among that cohort's guardians; or (3) they received either full or partial welfare support. "Exam scores" includes the two linear controls for Portuguese and Mathematics 9^{th} grade national exam scores; "Full/Partial support" refers to the 'Welfare support (Full)' and 'Welfare support (Partial)' dummies, as presented in Table 2. Finally, "Other controls" include 'Foreign nationality', 'Unemployed guardian', and 'Inactive guardian'. All regressions include 'Age', 'Compulsory schooling bite', and school district and NUTS III-by-year fixed effects. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

B VET supply

We check the robustness of our estimates using the continuous measure of VET *supply* introduced in Section 4. This allows us to conduct an intent-to-treat analysis focusing on the intensive margin of VET expansions, in contrast with the focus on an extensive margin of VET in our preferred specifications.

We estimate models in which the dependent variable is upper-secondary graduation (within three, four, or five years of lower-secondary graduation), considering again a broad range of covariates. Moreover, as a complement to the estimation of linear probability models by OLS, we use a leave-one-out IV. This instrument, Z_{ct}, is defined as

$$Z_{ct} \equiv \frac{30 \times (VETclasses_{-c,t} \; - \; VETclasses_{ct})}{Number\ of\ 9^{th}\ grade\ students_{-c,t-1} \; - \; Number\ of\ 9^{th}\ grade\ students_{c,t-1}}, \tag{B.1}$$

where $VETclasses_{-c,t}$ is the number of 10^{th} grade VET classes (again, only in the public sector) that were opened in year t all municipalities except 'concelho' c. Standard errors are now clustered at the municipality level.

Table B.1 shows how enrollment in the VET (columns 1-3) and academic (columns 4-6) tracks was affected by exposure to a higher 'density' of upper-secondary VET courses. The analysis yields similar conclusions as to those in Subsection 5.1.

B.1 Results

The main LPM estimates can be found in Table B.2. We find positive and statistically significant effects from being exposed to higher VET capacity and opportunities on both three- and four-year graduation rates. This impact on attainment is robust to the inclusion of a large set of controls in the estimated models. In the case of a change from 0% to 100% VET supply (when all 9^{th} grade students gain the opportunity to attend VET in 10^{th} grade, for instance through the introduction of a VET class for a 9^{th} grade of up to 30 students), graduation in three (four) years is predicted to increase by 5.7 to 6.2 (3.6 to 4.5) percentage points. Estimated coefficients are slightly higher when the leave-one-out IV strategy is implemented (Table B.3). Note that these results cannot be compared with our main findings above, as we are regressing outcomes on an equivalent measure of VET availability and not takeup itself, as in Subsection 5.4.

The main conclusion regarding the policy's effect on upper secondary completion is unchanged even when graduation within five years is the outcome of interest (Table B.4) or when students' *first* 9^{th} grade enrollment is used as the reference year for our analysis (results available from the authors).

B.2 Additional robustness analyses

The use of leave-one-out instruments has been criticised. In order to mitigate these concerns, we re-defined the instrument so that the potentially-endogenous variable, $VETsupply_{ct}$, was instrumented by either $VETsupply_{-n,t}$ or $VETsupply_{-d,t}$ — that is, by the contemporaneous average $VETsupply$ in all intermunicipal communities ($-n$) or districts ($-d$) apart from those in which municipality c is located. Note that the use of these alternative instruments requires an adjustment in the estimated equations: namely, the use of NUTS II x Year (instead of NUTS III x Year) fixed effects.[19] Estimates are about twice as large as OLS coefficients when the leave-one-out instrument is defined at the NUTS III level, and even larger when districts are used to build the IV, although their precision is lower (results available upon request).

Furthermore, our main results are robust to the inclusion of a measure of academic courses' supply (defined in the same way as $VETsupply$) as a control in the estimated models (Table B.5). As shown in Table B.6, the estimates of interest are also robust to the exclusion from the sample of the largest metropolitan areas and intermunicipal communities in Portugal.

[19] With the same adjustment, we are also able to go beyond 'concelho'-level exposure to upper-secondary VET courses and redefine $VETsupply$ at the 'intermunicipal community' and 'district' geographical levels. The resulting estimates are quantitatively similar to those of our preferred ('concelho'-based) analysis, particularly when Portugal's NUTS III subregions are considered. Some estimates lose statistical significance in the district-level analysis, but the coefficients remain uniformly positive (results available upon request). Considering that pupils may study in a municipality other than that in which they live — which would be especially likely if the upper secondary track of their preference had not been available in their municipality of residence — this redefinition of the "geographical level" of analysis provides additional confidence to our general conclusion.

Table B.1: **VET supply and upper secondary track takeup**

	(1) VET takeup	(2) VET takeup	(3) VET takeup	(4) Acad. takeup	(5) Acad. takeup	(6) Acad. takeup
VET supply	0.095	0.108	0.082	-0.047	-0.056	-0.042
	(0.009)***	(0.014)***	(0.009)***	(0.008)***	(0.019)***	(0.008)***
Female	-0.082	-0.082	-0.070	0.088	0.088	0.073
	(0.003)***	(0.003)***	(0.003)***	(0.003)***	(0.003)***	(0.003)***
Age	0.094	0.094	0.062	-0.220	-0.220	-0.126
	(0.003)***	(0.003)***	(0.002)***	(0.003)***	(0.003)***	(0.002)***
Welfare support (Full)	0.121	0.121	0.049	-0.140	-0.140	-0.056
	(0.004)***	(0.004)***	(0.003)***	(0.004)***	(0.004)***	(0.003)***
Welfare support (Partial)	0.109	0.109	0.037	-0.111	-0.111	-0.041
	(0.004)***	(0.004)***	(0.002)***	(0.004)***	(0.004)***	(0.002)***
Compulsory schooling bite	-0.025	-0.025	-0.001	-0.013	-0.013	-0.016
	(0.003)***	(0.003)***	(0.002)	(0.003)***	(0.003)***	(0.002)***
Foreign nationality			-0.114			0.041
			(0.006)***			(0.007)***
PT exam score, 9^{th} grade			-0.005			0.006
			(0.000)***			(0.000)***
Math exam score, 9^{th} grade			-0.004			0.004
			(0.000)***			(0.000)***
Guardian's education			-0.010			0.010
			(0.000)***			(0.000)***
Unemployed guardian			0.004			-0.002
			(0.002)*			(0.002)
Inactive guardian			-0.006			0.029
			(0.004)			(0.004)***
Observations	629676	629676	528111	629676	629676	528111
R^2	0.089	0.072	0.219	0.221	0.204	0.293
F (first stage)		26.2			26.2	
Kleibergen-Paap rk LM statistic		31.41			31.41	
Kleibergen-Paap rk LM p-value		2.093e-08			2.093e-08	

Notes: Standard errors clustered at the *concelho* (municipality) level in parentheses. 'VET [Acad.] takeup' is a binary variable that takes value 1 if the student enrolled in a VET [academic] course right after their final 9^{th} grade enrollment, and 0 otherwise. More information about the covariates can be found in Table B.2. All regressions include municipality and NUTS III-by-year fixed effects. Columns (2) and (5) show the second-stage results from estimations in which 'VET supply' is instrumented by a leave-one-out IV. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table B.2: **VET supply and upper secondary graduation rates (LPM estimates)**

	(1)	(2)	(3)	(4)	(5)	(6)
	Grad. 3 years	Grad. 3 years	Grad. 3 years	Grad. 4 years	Grad. 4 years	Grad. 4 years
VET supply	0.062	0.058	0.057	0.045	0.042	0.036
	(0.008)***	(0.008)***	(0.008)***	(0.008)***	(0.008)***	(0.008)***
Female		0.088	0.076		0.086	0.078
		(0.002)***	(0.002)***		(0.003)***	(0.002)***
Age		-0.138	-0.038		-0.167	-0.077
		(0.002)***	(0.002)***		(0.002)***	(0.002)***
Welfare support (Full)		-0.089	-0.015		-0.094	-0.027
		(0.004)***	(0.003)***		(0.004)***	(0.003)***
Welfare support (Partial)		-0.052	0.002		-0.051	-0.004
		(0.004)***	(0.002)		(0.004)***	(0.003)
Compulsory schooling bite		-0.007	0.007		-0.011	-0.001
		(0.003)**	(0.002)***		(0.003)***	(0.002)
Foreign nationality			-0.058			-0.091
			(0.008)***			(0.008)***
PT exam score, 9^{th} grade			0.005			0.004
			(0.000)***			(0.000)***
Math exam score, 9^{th} grade			0.005			0.005
			(0.000)***			(0.000)***
Guardian's education			0.001			0.002
			(0.000)***			(0.000)***
Unemployed guardian			-0.020			-0.020
			(0.003)***			(0.003)***
Inactive guardian			-0.043			-0.031
			(0.004)***			(0.004)***
Observations	624402	624402	524264	541358	541358	454490
R^2	0.031	0.114	0.190	0.031	0.142	0.180

Notes: Standard errors clustered at the *concelho* (municipality) level in parentheses. 'Grad. 3 [4] years' is a dependent variable that takes value 1 if the student graduated from upper secondary school within 3 [4] years of completing lower secondary education (9^{th} grade), and 0 otherwise. 'Age' is a continuous variable, measured as of June 30^{th} of the civil year in which the student was last enrolled in 9^{th} grade. 'Foreign nationality' is a dummy variable equal to 1 if the student is a citizen of any other country (even if they are also Portuguese nationals), and 0 otherwise. All regressions include municipality and NUTS III-by-year fixed effects. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table B.3: **VET supply and upper secondary graduation rates (Leave-one-out IV)**

	(1)	(2)	(3)	(4)	(5)	(6)
	Grad. 3 years	Grad. 3 years	Grad. 3 years	Grad. 4 years	Grad. 4 years	Grad. 4 years
VET supply	0.055	0.056	0.047	0.050	0.045	0.036
	(0.018)***	(0.017)***	(0.019)**	(0.020)**	(0.018)**	(0.020)*
Female		0.088	0.076		0.086	0.078
		(0.002)***	(0.002)***		(0.003)***	(0.002)***
Age		-0.138	-0.038		-0.167	-0.077
		(0.002)***	(0.002)***		(0.002)***	(0.002)***
Welfare support (Full)		-0.089	-0.015		-0.094	-0.027
		(0.004)***	(0.003)***		(0.004)***	(0.003)***
Welfare support (Partial)		-0.052	0.002		-0.051	-0.004
		(0.004)***	(0.002)		(0.004)***	(0.003)
Compulsory schooling bite		-0.007	0.007		-0.011	-0.001
		(0.003)**	(0.002)***		(0.003)***	(0.002)
Foreign nationality			-0.058			-0.091
			(0.008)***			(0.008)***
PT exam score, 9^{th} grade			0.005			0.004
			(0.000)***			(0.000)***
Math exam score, 9^{th} grade			0.005			0.005
			(0.000)***			(0.000)***
Guardian's education			0.001			0.002
			(0.000)***			(0.000)***
Unemployed guardian			-0.020			-0.020
			(0.003)***			(0.003)***
Inactive guardian			-0.043			-0.031
			(0.004)***			(0.004)***
Observations	624402	624402	524264	541358	541358	454490
Leave-one-out IV ('Concelho')	-62.755	-62.753	-63.914	-66.682	-66.679	-67.716
	(12.239)***	(12.239)***	(12.439)***	(12.484)***	(12.484)***	(12.621)***
F (first stage)	26.29	26.29	26.4	28.53	28.53	28.79
Kleibergen-Paap rk LM statistic	31.44	31.44	32.67	41.35	41.35	42.98
Kleibergen-Paap rk LM p-value	2.061e-08	2.059e-08	1.089e-08	1.271e-10	1.270e-10	5.538e-11

Notes: Standard errors clustered at the *concelho* (municipality) level in parentheses. 'Grad. 3 [4] years' is a dependent variable that takes value 1 if the student graduated from upper secondary school within 3 [4] years of completing lower secondary education (9^{th} grade), and 0 otherwise. More information about the covariates can be found in Table B.2. All regressions include municipality and NUTS III-by-year fixed effects. In the estimations above, 'VET supply' is instrumented by a leave-one-out IV. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table B.4: **VET supply and 5-year upper secondary graduation rates**

	(1)	(2)	(3)	(4)
	Grad. 5 years	Grad. 5 years	Grad. 5 years	Grad. 5 years
VET supply	0.037	0.031	0.047	0.038
	(0.008)***	(0.009)***	(0.025)*	(0.026)
Female	0.081	0.073	0.081	0.073
	(0.003)***	(0.002)***	(0.003)***	(0.002)***
Age	-0.174	-0.090	-0.174	-0.090
	(0.003)***	(0.002)***	(0.003)***	(0.002)***
Welfare support (Full)	-0.092	-0.028	-0.092	-0.028
	(0.004)***	(0.003)***	(0.004)***	(0.003)***
Welfare support (Partial)	-0.051	-0.005	-0.051	-0.005
	(0.004)***	(0.003)*	(0.004)***	(0.003)*
Compulsory schooling bite	-0.012	-0.005	-0.012	-0.005
	(0.003)***	(0.002)**	(0.003)***	(0.002)**
Foreign nationality		-0.095		-0.095
		(0.009)***		(0.009)***
PT exam score, 9^{th} grade		0.004		0.004
		(0.000)***		(0.000)***
Math exam score, 9^{th} grade		0.005		0.005
		(0.000)***		(0.000)***
Guardian's education		0.002		0.002
		(0.000)***		(0.000)***
Unemployed guardian		-0.021		-0.021
		(0.003)***		(0.003)***
Inactive guardian		-0.026		-0.026
		(0.005)***		(0.005)***
Observations	463373	388036	463373	388036
R^2	0.148	0.178		
F (first stage)			43.76	44.61
Kleibergen-Paap rk LM statistic			54.2	55.99
Kleibergen-Paap rk LM p-value			1.809e-13	7.301e-14

Notes: Standard errors clustered at the *concelho* (municipality) level in parentheses. 'Grad. 5 years' is a dependent variable that takes value 1 if the student graduated from upper secondary school within 5 years of completing lower secondary education (9^{th} grade), and 0 otherwise. More information about the covariates can be found in Table B.2. All regressions include municipality and NUTS III-by-year fixed effects. Columns (3) and (4) show the second-stage results from estimations in which 'VET supply' is instrumented by a leave-one-out IV. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table B.5: **VET supply and upper secondary graduation rates (including academic courses' supply)**

	(1)	(2)	(3)	(4)	(5)	(6)
	Grad. 3 years	Grad. 3 years	Grad. 3 years	Grad. 4 years	Grad. 4 years	Grad. 4 years
VET supply	0.055	0.051	0.054	0.038	0.050	0.032
	(0.008)***	(0.018)***	(0.008)***	(0.008)***	(0.022)**	(0.008)***
Academic courses' supply	0.023	0.072	-0.002	0.017	0.017	-0.008
	(0.009)**	(0.032)**	(0.010)	(0.010)*	(0.010)*	(0.011)
Female	0.088	0.088	0.077	0.087	0.087	0.079
	(0.002)***	(0.002)***	(0.002)***	(0.003)***	(0.003)***	(0.002)***
Age	-0.139	-0.139	-0.039	-0.168	-0.168	-0.078
	(0.002)***	(0.002)***	(0.002)***	(0.003)***	(0.003)***	(0.002)***
Welfare support (Full)	-0.090	-0.090	-0.015	-0.094	-0.094	-0.027
	(0.004)***	(0.004)***	(0.003)***	(0.004)***	(0.004)***	(0.003)***
Welfare support (Partial)	-0.052	-0.052	0.002	-0.051	-0.051	-0.004
	(0.004)***	(0.004)***	(0.002)	(0.004)***	(0.004)***	(0.003)
Compulsory schooling bite	-0.007	-0.007	0.007	-0.011	-0.011	-0.001
	(0.003)**	(0.003)**	(0.002)***	(0.003)***	(0.003)***	(0.002)
Foreign nationality			-0.058			-0.091
			(0.008)***			(0.008)***
PT exam score, 9^{th} grade			0.005			0.004
			(0.000)***			(0.000)***
Math exam score, 9^{th} grade			0.005			0.005
			(0.000)***			(0.000)***
Guardian's education			0.001			0.002
			(0.000)***			(0.000)***
Unemployed guardian			-0.020			-0.020
			(0.003)***			(0.003)***
Inactive guardian			-0.044			-0.032
			(0.004)***			(0.004)***
Observations	621745	621745	522026	539028	539028	452516
R^2	0.112	0.086	0.189	0.140	0.115	0.178
F (first stage)		9.969			17.9	
Kleibergen-Paap rk LM statistic		40.64			41.22	
Kleibergen-Paap rk LM p-value		1.826e-10			1.120e-09	

Notes: Standard errors clustered at the *concelho* (municipality) level in parentheses. More information about the dependent variables and covariates can be found in Table B.2. All regressions include municipality and NUTS III-by-year fixed effects. In the estimations above, 'VET supply' is instrumented by a leave-one-out IV defined at the district-level. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table B.6: **VET supply and 3-year upper secondary graduation rates (excluding larger NUTS III)**

	(1)	(2)	(3)	(4)
	Grad. 3 years	Grad. 3 years	Grad. 3 years	Grad. 3 years
VET supply	0.055	0.056	0.027	0.035
	(0.008)***	(0.008)***	(0.016)*	(0.015)**
Female	0.094	0.078	0.094	0.078
	(0.003)***	(0.003)***	(0.003)***	(0.003)***
Age	-0.145	-0.042	-0.145	-0.042
	(0.002)***	(0.003)***	(0.002)***	(0.003)***
Welfare support (Full)	-0.080	-0.013	-0.080	-0.013
	(0.004)***	(0.003)***	(0.004)***	(0.003)***
Welfare support (Partial)	-0.043	0.004	-0.043	0.004
	(0.004)***	(0.003)	(0.004)***	(0.003)
Compulsory schooling bite	-0.011	0.006	-0.011	0.006
	(0.003)***	(0.002)***	(0.003)***	(0.002)***
Foreign nationality		-0.078		-0.078
		(0.011)***		(0.011)***
PT exam score, 9^{th} grade		0.005		0.005
		(0.000)***		(0.000)***
Math exam score, 9^{th} grade		0.005		0.005
		(0.000)***		(0.000)***
Guardian's education		0.001		0.000
		(0.000)		(0.000)
Unemployed guardian		-0.024		-0.024
		(0.003)***		(0.003)***
Inactive guardian		-0.047		-0.046
		(0.006)***		(0.006)***
Observations	330510	281926	330507	281923
R^2	0.114	0.184		
F (first stage)			123.4	120.5
Kleibergen-Paap rk LM statistic			71.05	71.67
Kleibergen-Paap rk LM p-value			3.478e-17	2.538e-17

Notes: Standard errors clustered at the *concelho* (municipality) level in parentheses. Students who lived, during their last 9^{th} grade enrollment, in one of the five most populous 2002 NUTS III regions in mainland Portugal (*Grande Lisboa*, *Grande Porto*, *Península de Setúbal*, *Baixo Mondego*, and *Cávado*) are excluded. 'Grad. 3 years' is a dependent variable that takes value 1 if the student graduated from upper secondary school within 3 years of completing lower secondary education (9^{th} grade), and 0 otherwise. More information about the covariates can be found in Table B.2. All regressions include municipality and NUTS III-by-year fixed effects. Columns (3) and (4) show the second-stage results from estimations in which 'VET supply' is instrumented by a leave-one-out IV. Own calculations based on the MISI data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

C Supplementary tables: Labour market outcomes

Table C.1: **VET course availability and employment (Poisson estimates; Robustness)**

	(1) Emp. w/ VET < 23	(2) Emp. < 23	(3) Total Emp.	(4) Emp. new estab.	(5) Emp. new firms
VET course available	0.039	0.076	0.042	0.179	0.048
	(0.035)	(0.013)***	(0.007)***	(0.104)*	(0.089)
Constant	2.402	5.037	7.291	5.186	3.967
	(0.007)***	(0.002)***	(0.001)***	(0.008)***	(0.005)***
Observations	15940	24234	27096	13196	10720
Pseudo R^2	0.732	0.948	0.985	0.909	0.884

Notes: Standard errors clustered at the *concelho* (municipality) level in parentheses. Municipalities belonging to one of the five most populous 2002 NUTS III regions in mainland Portugal (*Grande Lisboa*, *Grande Porto*, *Península de Setúbal*, *Baixo Mondego*, and *Cávado*) are excluded from the sample. See Tables 8 and 9 for further details with respect to dependent variables and the regressor of interest. All regressions include municipality-by-industry and NUTS III-by-year fixed effects. Own calculations based on the *Quadros de Pessoal* data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table C.2: **VET course availability and average worker compensation (OLS estimates)**

	(1) Avg. comp., < 19	(2) Avg. comp., < 21	(3) Avg. comp., < 23	(4) Avg. comp.	(5) Avg. comp., Female < 21
VET course available	-13.089	12.352	-3.531	4.123	5.286
	(9.085)	(11.898)	(9.211)	(7.460)	(10.913)
Constant	518.323	534.774	575.051	795.947	494.990
	(1.084)***	(1.206)***	(0.832)***	(0.586)***	(1.249)***
Observations	11738	16866	20310	27403	12355
R^2	0.702	0.666	0.734	0.886	0.697

Notes: Standard errors clustered at the *concelho* (municipality) level in parentheses. 'Avg. comp., < 19 [< 21] [< 23]' is the average compensation (in Euros) received by workers in municipality c, in industry s, in year t, who are below 19 [21] [23] years of age. 'VET course available' is a binary indicator equal to 1 if a VET course *associated with industry* s is available in year $t-3$ in municipality c, and zero otherwise. All regressions include municipality-by-industry and NUTS III-by-year fixed effects. Own calculations based on the *Quadros de Pessoal* data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table C.3: **Descriptive Statistics (Worker-level analysis)**

Variable	Mean	Std. Dev.	Min.	Max.	N
A. 2007-2013					
(Upper secondary) VET graduate	0.1	0.3	0	1	848064
(Upper secondary) Academic graduate	0.356	0.479	0	1	848064
Female	0.443	0.497	0	1	848064
Age	21.29	1.477	18	23	848064
Tenure	1.172	1.434	0	7	848064
Base pay	547.065	190.692	300	9959	848064
Total pay	658.625	249.244	300	14572	848064
Overtime pay	10.313	45.347	0	1916.34	848064
Monthly hours of work	164.205	20.14	20	216	848064
Log wage	6.367	0.274	5.578	9.532	848064
Log hourly wage	1.277	0.264	0.588	4.805	848064
Fixed-term contract	0.589	0.492	0	1	848064
CBA uncovered	0.076	0.265	0	1	848064
Firm-provided training hours	13.082	44.644	0	3600	257101
Firm-provided training (0/1)	0.315	0.464	0	1	257101
B. Same workers, 2014-2020					
(Upper secondary) VET graduate	0.115	0.319	0	1	803887
(Upper secondary) Academic graduate	0.38	0.485	0	1	803887
Female	0.434	0.496	0	1	803887
Age	26.958	1.616	24	29	803887
Tenure	3.392	3.132	0	16	803803
Base pay	649.811	235.762	300	10000	803887
Total pay	795.056	319.844	300	15120	803887
Overtime pay	13.524	56.348	0	2596.26	803887
Monthly hours of work	166.617	17.303	20	260	803887
Log wage	6.617	0.312	5.677	9.609	803887
Log hourly wage	1.508	0.295	0.565	4.987	803887
Fixed-term contract	0.433	0.496	0	1	803887
CBA uncovered	0.105	0.307	0	1	803887
Number of years in 2^{nd} period	1.992	1.921	0	7	403275

Notes: N is the total number of worker-year observations. In panel A, we restrict our sample to individuals with 18 to 23 years of age, inclusive, who have graduated from lower secondary schooling (9^{th} grade) but without a post-secondary degree. We drop from the sample all worker-year observations for whom the reported number of monthly work hours is lower than 20, as well as those who report a base pay lower than 300€/month or higher than 10,000€/month. Panel B follows the same workers from 2014 to 2020, inclusive. Information on firm-provided training is only available for 2010 and 2011. With respect to 'Firm-provided training hours': the 99^{th} percentile of the distribution is 198 hours; only 44 observations record more than 2112 hours of training in a year (roughly equivalent to a year of firm-sponsored, full-time training). **Source:** Authors' analysis of the *Quadros de Pessoal* data set.

Table C.4: **Schooling and wages for young workers (OLS estimates)**

	(1)	(2)	(3)	(4)	(5)
	Log wage	Log wage	Log wage	Log wage	Log wage
A. 2007-2013					
(Upper secondary) VET graduate	0.084	0.077	0.081	0.027	0.027
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
(Upper secondary) Academic graduate	0.060	0.052	0.056	0.014	0.014
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Female	-0.103	-0.105	-0.104	-0.041	-0.041
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Tenure			0.011	0.024	0.024
			(0.000)***	(0.000)***	(0.000)***
N	848,064	848,064	848,064	804,783	804,783
R^2	0.068	0.095	0.099	0.561	0.562
B. Same workers, 2014-2020					
(Upper secondary) VET graduate	0.107	0.111	0.112	0.043	0.043
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
(Upper secondary) Academic graduate	0.094	0.095	0.097	0.037	0.037
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Female	-0.141	-0.142	-0.142	-0.070	-0.070
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Tenure			0.010	0.015	0.015
			(0.000)***	(0.000)***	(0.000)***
N	803,887	803,887	803,803	775,871	775,871
R^2	0.117	0.127	0.137	0.589	0.589
Additional controls					
Year FE	Yes	Yes	No	Yes	No
Age FE	No	Yes	No	Yes	No
Firm FE	No	No	No	Yes	Yes
Year x Age FE	No	No	Yes	No	Yes

Notes: Robust standard errors in parentheses. The dependent variable is the natural logarithm of monthly wages. N is the total number of worker-year observations. In panel A, we restrict our sample to individuals with 18 to 23 years of age, inclusive, without a post-secondary degree. Panel B is composed of worker-year observations for the same individuals from 2014 to 2020, inclusive. Own calculations based on the *Quadros de Pessoal* data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table C.5: **Schooling and incidence of fixed-term contracts (OLS estimates)**

	(1)	(2)	(3)	(4)	(5)
	Fixed-term	Fixed-term	Fixed-term	Fixed-term	Fixed-term
A. 2007-2013					
(Upper secondary) VET graduate	0.085	0.092	0.031	-0.013	-0.013
	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***
(Upper secondary) Academic graduate	0.083	0.092	0.028	-0.007	-0.007
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Female	0.007	0.009	0.007	-0.001	-0.001
	(0.001)***	(0.001)***	(0.001)***	(0.001)	(0.001)
Tenure			-0.152	-0.137	-0.137
			(0.000)***	(0.000)***	(0.000)***
N	848,064	848,064	848,064	804,783	804,783
R^2	0.010	0.024	0.197	0.590	0.590
B. Same workers, 2014-2020					
(Upper secondary) VET graduate	-0.014	-0.019	-0.027	-0.027	-0.027
	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***
(Upper secondary) Academic graduate	-0.006	-0.007	-0.023	-0.022	-0.022
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Female	0.004	0.006	0.006	0.010	0.010
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Tenure			-0.087	-0.084	-0.084
			(0.000)***	(0.000)***	(0.000)***
N	803,887	803,887	803,803	775,871	775,871
R^2	0.002	0.009	0.298	0.622	0.622
Additional controls					
Year FE	Yes	Yes	No	Yes	No
Age FE	No	Yes	No	Yes	No
Firm FE	No	No	No	Yes	Yes
Year x Age FE	No	No	Yes	No	Yes

Notes: Robust standard errors in parentheses. The dependent variable takes value one if the worker has a fixed-term contract, and zero otherwise. N is the total number of worker-year observations. In panel A, we restrict our sample to individuals with 18 to 23 years of age, inclusive, without a post-secondary degree. Panel B is composed of worker-year observations for the same individuals from 2014 to 2020, inclusive. Own calculations based on the *Quadros de Pessoal* data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table C.6: **Schooling and collective bargaining agreement coverage (OLS estimates)**

	(1)	(2)	(3)	(4)	(5)
	CBA uncovered	CBA uncovered	CBA uncovered	CBA uncovered	CBA uncovered
A. 2007-2013					
(Upper secondary) VET graduate	0.055	0.054	0.048	0.022	0.022
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
(Upper secondary) Academic graduate	0.023	0.022	0.017	-0.008	-0.008
	(0.001)***	(0.001)***	(0.001)***	(0.000)***	(0.000)***
Female	-0.016	-0.016	-0.017	-0.003	-0.003
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Tenure			-0.014	0.002	0.002
			(0.000)***	(0.000)***	(0.000)***
N	848,064	848,064	848,064	804,783	804,783
R^2	0.006	0.006	0.011	0.773	0.773
B. Same workers, 2014-2020					
(Upper secondary) VET graduate	0.020	0.021	0.020	-0.003	-0.003
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
(Upper secondary) Academic graduate	0.028	0.028	0.026	-0.001	-0.001
	(0.001)***	(0.001)***	(0.001)***	(0.000)***	(0.000)***
Female	-0.009	-0.009	-0.009	-0.001	-0.001
	(0.001)***	(0.001)***	(0.001)***	(0.000)***	(0.000)***
Tenure			-0.009	0.000	0.000
			(0.000)***	(0.000)***	(0.000)***
N	803,887	803,887	803,803	775,871	775,871
R^2	0.003	0.003	0.012	0.847	0.847
Additional controls					
Year FE	Yes	Yes	No	Yes	No
Age FE	No	Yes	No	Yes	No
Firm FE	No	No	No	Yes	Yes
Year x Age FE	No	No	Yes	No	Yes

Notes: Robust standard errors in parentheses. The dependent variable takes value one if the worker is covered by a collective bargaining agreement, and zero otherwise. N is the total number of worker-year observations. In panel A, we restrict our sample to individuals with 18 to 23 years of age, inclusive, without a post-secondary degree. Panel B is composed of worker-year observations for the same individuals from 2014 to 2020, inclusive. Own calculations based on the *Quadros de Pessoal* data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table C.7: **Schooling and firm-provided training (OLS/Poisson estimates)**

Panel A.	(1)	(2)	(3)	(4)	(5)
	Firm training	Firm training	Firm training	Firm training	Firm training
(Upper secondary) VET graduate	0.061	0.060	0.062	0.027	0.027
	(0.003)***	(0.003)***	(0.003)***	(0.004)***	(0.004)***
(Upper secondary) Academic graduate	0.090	0.088	0.092	0.010	0.010
	(0.002)***	(0.002)***	(0.002)***	(0.002)***	(0.002)***
Female	-0.005	-0.006	-0.005	-0.001	-0.001
	(0.002)***	(0.002)***	(0.002)***	(0.002)	(0.002)
Tenure			0.009	0.002	0.002
			(0.001)***	(0.001)**	(0.001)**
N	257,101	257,101	257,101	232,744	232,744
R^2	0.008	0.009	0.010	0.562	0.562

Panel B.	(1)	(2)	(3)	(4)	(5)
	Training hours	Training hours	Training hours	Training hours	Training hours
(Upper secondary) VET graduate	0.423	0.424	0.412	0.120	0.120
	(0.023)***	(0.023)***	(0.023)***	(0.025)***	(0.025)***
(Upper secondary) Academic graduate	0.412	0.413	0.397	0.071	0.071
	(0.015)***	(0.014)***	(0.015)***	(0.014)***	(0.014)***
Female	-0.132	-0.132	-0.133	-0.019	-0.019
	(0.014)***	(0.014)***	(0.014)***	(0.016)	(0.016)
Tenure			-0.050	-0.121	-0.121
			(0.005)***	(0.006)***	(0.006)***
N	257,101	257,101	257,101	140,652	140,652
Pseudo R^2	0.011	0.011	0.012	0.392	0.392
Additional controls					
Year FE	Yes	Yes	No	Yes	No
Age FE	No	Yes	No	Yes	No
Firm FE	No	No	No	Yes	Yes
Year x Age FE	No	No	Yes	No	Yes

Notes: Robust standard errors in parentheses. The dependent variable in Panel A takes value one if the worker was involved in firm-provided training, and zero otherwise; these models are estimated by OLS. The dependent variable in Panel B's Poisson regressions is the number of hours of firm-provided training. N is the total number of worker-year observations. Information on firm-provided training is only available for 2010 and 2011. Own calculations based on the *Quadros de Pessoal* data set. Significance levels: * 0.10, ** 0.05, *** 0.01.

Table C.8: **Schooling and private-sector employment (OLS estimates)**

	(1)	(2)	(3)
	Years in (2^{nd} period) sample	Years in (2^{nd} period) sample	Years in (2^{nd} period) sample
(Upper secondary) VET graduate	0.349	0.244	0.176
	(0.011)***	(0.010)***	(0.008)***
(Upper secondary) Academic graduate	0.207	0.160	0.117
	(0.007)***	(0.007)***	(0.005)***
Female		-0.232	-0.221
		(0.006)***	(0.005)***
N	403,275	266,756	266,756
R^2	0.004	0.008	0.431
Age FE	No	No	Yes

Notes: Robust standard errors in parentheses. The dependent variable is the number of annual observations for worker *i* in the 2014 - 2020 QP panel. Own calculations based on the *Quadros de Pessoal* data set. Significance levels: * 0.10, ** 0.05, *** 0.01.