Does Dual Vocational Education and Training Pay Off?*

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Abstract

This paper analyzes the causal impact of dual vocational education and training (VET) on the labor market insertion of youth. Using matched education and social security records, we estimate the causal impact of a major reform that introduced a new dual track, which combines firm- and school-based training, on the labor market outcomes of the first three dual VET cohorts in the Spanish region of Madrid. The control group is composed of individuals who graduated in the same fields and years in school-based VET. Selection into dual VET is dealt with using a distance-based instrumental variable. Dual VET is found to generate sizable improvements in employment and earnings, but no significant impact on job quality. The results are not driven by pre-reform differences in the quality of the schools that adopted dual VET and the higher retention rate of dual VET graduates only partly explains the dual premium.

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1 Introduction

In 2012, Spain implemented a substantial reform to its vocational education and training (VET). It introduced a dual VET pathway with significantly hightened firm-based training system in its predominantly school-based system. This study assesses the reform's impact on the school-to-work transition of young individuals.

Spain adopted dual VET following a European Commission recommendation. After the global financial crisis, over twenty EU Member States received suggestions to enhance youth employment by reforming or introducing apprenticeship systems. To date, eight of these nations, including Spain, have established dual VET as a formal educational path (Šćepanović and Martín Artiles, 2020). While substantial evidence indicates that dual VET systems generally enhance the school-to-work transition, the causal impact of this type of reforms remains uncertain (see the surveys by Ryan, 1998, 2011; Wolter and Ryan, 2011; and European Commission, 2013).[1] Current evidence on the comparative advantages of dual vs. school-based VET is mostly descriptive. Additionally, it primarily concerns countries with comprehensive dual VET systems that are intertwined with unique institutional frameworks that are challenging to replicate elsewhere. And there is scarce evidence for countries that recently introduced dual VET.

Our study aims to bridge this gap by presenting causal estimates of the effect of dual VET on the labor market insertion of youth in Spain. We leverage linked education and social security records covering the first three cohorts of graduates in the Madrid region. We compare their labor market outcomes vis-à-vis a control group consisting of peers who graduated in the same field and year in the school-based system. To address

[1]Several studies have examined country-specific outcomes in Europe: Bonnal et al. (2002) and Brébion (2017) for France; Parey (2009) and Riphahn and Zibrowius (2016) for Germany; Plug and Groot (1998) for the Netherlands, and Bertschy et al. (2009) for Switzerland.

student self-selection, we employ a highly exogenous instrumental variable (IV) based on differences in travel times to schools providing dual and school-based programs. Furthermore, we ensure that our findings are not driven by pre-reform differentials in the quality of the schools offering these dual VET during the post-reform phase.

Table B1 presents pre-reform data on the orientation, general or vocational, of school leavers in five European countries. It underscores the low share of VET graduates in Spain. Before the reform, the disparity with Germany was nearly 60 percentage points (pp). Furthermore, just one-tenth of VET graduates took programs combining work and study. The underdeveloped VET system and the limited presence of graduates with relevant work exposure help explain the substantial delays in the transition from school to work among Spanish youth (Dolado et al., 2013). Three years after completing formal education, individuals with tertiary degrees exhibited a 20 pp lower employment rate compared to countries with robust dual VET systems, as shown in Table B2. The 2012 reform aimed to narrow this discrepancy.

Dual VET regulation in Spain exhibits substantial regional variation. While the basic legal framework is established nationally, its execution is devolved to regional governments. Our study focuses on Madrid, chosen for its relevance and rapid dual VET expansion. It includes Spain's capital and it accounted for 32% of dual tertiary VET students nationwide in academic year 2015-2016. In this region, a tertiary-level dual VET system was adopted, wherein apprentices spend more than half of their time in firms –exceeding the legal requirement of one-third– and they receive a stipend. In contrast, school-based system students undertake a three-month internship at the end of their second year, without financial compensation. In both systems, firms bear the full cost of firm-based training activities.

Dual VET's advantages are well-known. It enables students to acquire occupation-relevant skills, work habits, and soft skills in a professional milieu, using up-to-date equipment. Moreover, the prolonged appraisal of apprentices allows firms to acquire more information about them, thus fostering their retention. However, these merits must be balanced against the drawbacks of reduced hours of school-based training, which may compromise overall training quality if teachers have better pedagogical

skills than firm tutors. Additionally, it could disrupt the equilibrium between general and specific skills, as firms might overly tailor training to their needs. If so, the returns from dual VET would likely hinge on retention, while in the broader labor market school-based VET graduates might outperform their dual VET counterparts.

We seek to estimate the causal impact of dual VET on a broad array of labor market indicators, while considering the aforementioned factors. Building upon prior research, we allow for potential disparities in the returns from dual VET across fields and over time. Additionally, in an extension, we delve into the underlying mechanisms driving our findings, namely the contributions of training firms and the portability of acquired skills.

Our primary challenge in establishing causality arises from the voluntary nature of participation in dual VET for all parties involved. To address the issue of student self-selection into treatment, we employ a distance-based IV. This instrument measures the difference in travel times to the two closest schools offering dual and school-based VET. This approach capitalizes on the fact that dual VET was initially offered by a limited number of schools. Consequently, individuals who aspired to undertake dual VET typically faced longer trips compared to the school-based option. This exogenously generated difference in travel times emerges as a potent predictor for the selection into dual VET.

Still, the availability of dual VET might reflect disparities in training quality across schools and fields prior to the reform, so we conduct a placebo test to deal with this issue. We identify school-field combinations that were part of the dual track supply during any period in our sample and estimate our model on a pre-reform cohort, assuming that these cells represent the treatment. This pseudo-treatment should exhibit no significant impact on labor market outcomes and it serves to rule out selection on the part of training providers.

Our primary findings indicate the success of the reform. After accounting for selection effects, they reveal that dual VET led to a substantial improvement in the school-to-work transition. Specifically, it yielded a 25% increase in cumulative days of work and a 42% increase in earnings in the first two years post-graduation, and a 23 pp

rise in the first-year retention rate. This notable gain, which we call the *dual premium*, is on par with the raw differences in unconditional means and exceeds the estimates from ordinary least squares (OLS). However, while the latter two measurements also point to significant disparities in job quality, including access to full-time or open-ended jobs, these effects lose statistical significance when accounting for selection based on unobservable traits.

Further analysis reveals that roughly two-thirds of the differences happen in the first twelve months. Additionally, an upward trend in the dual VET premium is evident when comparing across cohorts. We conjecture that it is due to a mix of learning effects and the gradual resurgence of economic growth after the Great Recession. Lastly, two additional findings suggest that the introduction of dual VET has reshaped the distribution of outcomes. The favorable impacts of dual VET are concentrated in fields that exhibited below-average outcomes pre-reform, while at the individual level, completing dual VET raises the probability of outcomes above the median.

These results are obtained using specifications that exclude both the school and the training firm. To delve into the mechanisms underlying the dual premium, we undertake two extensions. First we narrow down the sample to graduates who were not retained and then we introduce training firm fixed effects. In both scenarios, the dual premium subsists, albeit at a reduced magnitude and significance compared to our baseline. While we cannot make any causal claim, these outcomes strongly suggest that the dual premium is not entirely attributable to the higher retention rate. Additionally, the indication that dual graduates fare better in the external labor market is reassuring about the transferability of their acquired skills.

Related literature. Prior attempts to estimate causal differences between dual and school-based VET using observational data have been made, but they have not satisfactorily addressed the selection issue. Among the most closely related are Parey (2009) for France and Brébion (2017) for France and Germany. These studies employ local variation in apprenticeship availability or past take-up as IVs to manage selection into dual VET. Nevertheless, these are potentially endogenous variables, that could be influenced by the expected future recruitment needs of training firms, which compro-

mises their validity as IVs. In contrast, our IV relies on location decisions made years prior to the introduction of dual VET, rendering it significantly more exogenous.

Our identification strategy follows Card (1995), which used the variation in distance to universities to estimate the returns to schooling. Our instrument, based on the difference in distances between the school where the students did their compulsory schooling and the ones offering vocational education seems less prone to identification threats. It is plausible that the student's family chose the address to be close to a preferred primary or secondary school, but selecting a residence close to schools offering dual VET –which were unknown in advance– is much less plausible.

A similar identification is used in Mathewes and Ventura (2022), based on the difference of distances between alternative schooling choices.[2] They study the choice between vocational, academic, or no education at all, and their impact, in a context characterized by "largely classroom based" VET. This contrasts markedly with our study, wherein students opt between classroom-based and dual vocational education.

An emerging literature employs field experiments to explore the impact of firm-based training in VET programs. While most studies focus on brief interventions aimed at disadvantaged youth,[3] two pieces of work delve into a comparison between firm-based and school-based VET. Cahuc and Hervelin (2022) study the employment outcomes of ach who spend between one-half and two-thirds of their time in the firm and receive compensation. They are compared with vocational education graduates, who spend around eight weeks –or no time at all– in firms and they are unpaid. In a correspondence experiment, they submit fabricated CVs of unemployed youth differing solely in their secondary education path to actual job openings. Their estimates show no difference in callback rates by pathway. The authors then use a job search and matching model that predicts more favorable employment outcomes for apprentices, primarily due to their higher retention by training firms. Importantly, this impact

[2]An initial version of our work, Bentolila et al. (2018), was accessible online since 2018. It was moreover presented in 2019 at the Center for Vocational Education Research (CVER), with which these authors are affiliated.

[3]Acevedo et al. (2020) examine the interplay of vocational and soft skill training's effects on employment outcomes for at-risk youth in the Dominican Republic. Katz et al. (2022) investigates the repercussions of sectoral employment initiatives outside formal education, targeting low-wage workers in the US.

does not extend to youth seeking employment in other firms.

Another experimental study is Alfonsi et al. (2020), which contrasts the labor market outcomes of young, low-skilled individuals who undergo six months of workplace-based VET versus school-based VET training in Uganda. It finds that the former achieve higher initial earnings and employment, but they are surpassed by the latter over time. This reversal is attributed to school-based trained individuals exhibiting a higher flow rate out of unemployment compared to workplace-based VET graduates. In light of their findings, the authors underscore the importance of certified training. In our context, training is certified in both tracks. All students in a specific field must fulfill the same compulsory training curriculum and obtain an identical degree.

The rest of this paper is organized as follows. Section 2 explains the key ingredients of the reform and provides some background information. Section 3 describes the data and the sample selection criteria, while Section 4 outlines our empirical strategy. Section 5 presents our results, which is followed by a discussion of the mechanisms that help to explain the dual premium in Section 6. Section 7 concludes.

2 Institutional background

Historically, Spain's VET system was centered around school-based training exclusively. However, the 2012 reform (Royal Decree 1529/2012), establishes the legal framework for a dual VET system that integrates both school-based and firm-based training. In this model, at least one-third of the mandatory training activities must take place in a firm, ideally alternating with training at the school. Conversely, the conventional school-based system confines firm-based activities to a three-month internship, scheduled at the end of the program, once the student has completed all mandatory training components.

The adoption of the dual track is voluntary for all parties involved. Companies are required to appoint a qualified tutor for each apprentice and undertake a portion of their training in accordance with the pre-approved educational program. While both tutors and teachers jointly assess the apprentice's performance, teachers have the final

say in assigning grades. Though their academic calendars differ, students in both the dual and school-based tracks in the same field must fulfill the same mandatory modules and they attain identical degrees upon completion.

The 2012 reform entrusts many features of the dual system to the regional authorities. These include key elements such as the legal standing of apprentices (as interns or employees), their compensation, and the rules for alternation. Madrid introduced dual VET in 2012 following a one-year pilot at two schools. During the initial four years, dual VET was exclusively available at the tertiary level (ISCED level 5). Admission to tertiary VET requires either a high school diploma or a secondary-level vocational degree.[4] Typically, entry occurs at 18 years of age and the standard duration is two years, involving 2,000 instructional hours. In school-based VET, a three-month internship comprises 370 hours. In dual VET, this module is integrated into the overall training regimen, supplemented by approximately 910 hours of firm-based training. Broadly speaking, firms are accountable for over 55% of training activities.

Apprentices in Madrid have the legal status of interns by default. Firms are required to provide them with a monthly stipend of €300, an obligation that is absent in the school-based VET. Dual students are registered with social security, have the same health and safety regulations as employees, and they must take a course on prevention of occupational hazards.

Lastly, right from the outset, there was a distinct admission procedure for dual VET. Students wanting to enroll in dual VET directly apply to a school offering their desired dual track. In case of over-demand, the available slots are allocated based on a ranking mechanism that considers the student's performance in either upper-secondary education or secondary-level VET. The procedure grants additional points for students who earned their prior degree in a related field in recent years and specifically in Madrid. Ties are resolved through a lottery. While we do not have access to application data, oversubscription in dual VET was exceptional during our period. Furthermore, the role of firms in the selection process is limited to conducting

[4]In some instances, applicants without these qualifications can take an entry exam or follow procedures for recognizing equivalent foreign qualifications.

mandatory interviews with applicants. Students who are not granted a slot in dual VET retain the option to enroll in a school-based track of their preference.

Table 1: Participation in dual VET in Madrid, 2012-2016

School year	2012-2013	2013-2014	2014-2015	2015-2016
Firms	27	156	356	356
Schools	6	9	20	20
Fields	13	17	24	26
Students	446	1,023	1,744	1,986
1st year	392	696	1,135	1,004
2nd year	54	327	609	982

Source: Comunidad de Madrid (2017).

Table 1 illustrates the swift expansion of tertiary-level dual VET in Madrid. Over the initial four years, the student count surged from 446 to 1,986. By academic year 2015-2016, dual track students comprised 5.1% of all tertiary VET students in Madrid, surpassing the national average by around 3%. During this period, dual VET became available across 20 schools, spanning 26 fields, in collaboration with 356 firms. Approximately two-thirds of the schools offering dual VET in our sample period were public institutions, contributing to 73.6% of dual VET graduates in our final sample (Table B3).[5] The remaining dual graduates enrolled in chartered programs at private schools, which cannot impose higher tuition fees than public schools (set at €400 in 2012).

3 Data

3.1 Data sources

Our education data set includes nearly all academic records of students enrolled in tertiary VET in Madrid between 2011 and 2016. For graduates spanning 2013 to 2016, this information is matched with longitudinal social security records that span their entire employment histories. Additionally, we append information about their

[5]Tables 1 and B3 yield varying school counts, due to turnover.

preceding degrees, obtained from a comprehensive register containing non-university degrees issued in Madrid from 2004 to 2016. We also compile information on the characteristics of a subset of their training firms from the Central Balance Sheet Data Office (CBSO) of the Banco de España. This source provides balance sheet data and profit and loss accounts for all non-financial firms submitting their annual accounts to Spain's Central Mercantile Register. Furthermore, publicly available data on household income at the district and municipal levels is added.[6] We have also geo-localised all schools offering tertiary VET and lower secondary education in Madrid, to construct our distance-based IV. The IV employs travel times required to reach VET schools by both private and public transport, computed using Google's Distance Matrix Application Programming Interface (API) destination at 9 am on Monday, April 16, 2018. In the rest of this section we describe our education and social security records, as well as our sample selection process. Descriptions of other data sources will be provided in later sections and in Appendix A.

The student records for tertiary VET contain demographics like age, gender, and nationality, as well as the field of study, type of track, part- or full-time dedication, entry qualifications, the VET school's name and location, course-level enrollment and completion timing, grade-point averages, and the official graduation date.[7] Cognitive ability test scores prior to enrollment in tertiary VET are unavailable. Instead, we combine information regarding the individual's age and prior education to create a variable measuring grade repetition in lower secondary education.

Our longitudinal social security records provide exhaustive information on the complete working histories of individuals until June 6, 2018. This coverage enables us to track the first three cohorts of dual VET graduates on a daily basis during their first two years in the labor market.[8] In particular, we use the start and end dates of each employment spell, contract type, hours worked relative to standard hours, occupational

[6]There are 82 areas, comprising 18 districts in the capital and 64 municipalities outside the capital. The average population was around 150.000 inhabitants per district and 98.000 per municipality (2011 census).

[7]The graduation date is missing for a share of students and is imputed, see Appendix A. The impact of this imputation is estimated in a robustness check.

[8]For 17 students graduating between June 7 and June 30, we adjust their employment outcomes proportionally, while those graduating post-June 30, 2016 are excluded from the sample.

category, firm and establishment identifiers, industry, and a monthly observation of an individual's earnings at a specific firm or establishment.[9] Self-employment spells, representing only 5.3%, are disregarded in our benchmark labor market outcomes, but included in a robustness check.[10]

3.2 Sample selection

Our analysis is confined to fields that offer the dual track and have a minimum of 5 graduates in both the dual and school-based tracks. We also restrict the sample to graduates who graduated between 1 January 2013 and 30 June 2016 and were no older than 30 years old at graduation. These criteria for sample selection yield an initial sample consisting of 21,510 graduates, all with education records, as shown in Table B4. For an only slightly smaller subset of 21,453 of these individuals we can link their education and social security records via anonymized IDs. Among these there are 2,171 individuals whose held the same job at least six months before their graduation, which we exclude because in their case attributing their employment situation to the completion of VET would be questionable. Consequently, a final sample of 19,282 individuals emerges, for whom labor market outcomes in the two years post-graduation can be constructed, called the *full sample*.

However, to construct our IV, we also need to know the school where individuals completed their lower secondary education (see below). This information is only available for 9,672 graduates. Of these, 2,406 graduated from school-based VET in 2013 and are used only in our placebo test. The *baseline sample* is then composed of 7,266 individuals graduating in 2014-2016: 975 from dual VET conform the treatment group, while the control group comprises 6,291 graduates in school-based VET.

[9]Earnings are given by the contribution base for social security taxes, which is subject to top-coding. Nonetheless, this cap is hardly ever binding for labor market entrants.

[10]Spell durations and earnings of the self-employed are less reliable than for employees, since they can choose their contribution base and may make social security contributions during inactive periods.

3.3 Summary statistics

3.3.1 Individual characteristics

Tables B5 and B6 provide information on the balancing properties of our baseline and full samples, respectively. The first table confirms the non-random nature of selection into track. The second table reveals notable differences in the composition of the two samples, but this difference is less concerning, as the selection pattern is similar in both samples. Specifically, the share of female graduates is notably lower in dual VET. On average, individuals in dual VET are slightly older and possess more experience –measured in full-time equivalents (FTE)– before starting their studies compared to those in school-based VET. Roughly three-fourths of individuals in the full sample entered tertiary VET having a high school diploma, a figure that exceeds 80% in the baseline sample; with non-significant differences by track. Conversely, in the full sample, the share of graduates with unknown entry credentials is significantly lower, while the share with prior tertiary VET degrees is significantly greater among dual graduates –which is not the case in the baseline sample. Lastly, the size of dual VET cohorts has substantially grown over time, in contrast with the more balanced growth in school-based VET. As a result, a larger share of dual graduates benefited from the increasingly robust economic recovery experienced after 2013. These divergences will be accounted for by the control variables in our estimation.

Table B5 contains additional information about characteristics that are solely observed in the baseline sample. Notably, grade repetition in lower secondary education –employed as a proxy for prior cognitive ability– exhibits minimal variance by track. However, graduates in dual VET come from districts or municipalities with a 3% higher real per capita income.[11]

As indicated, our IV is given by the difference between the travel times to the nearest schools offering dual and school-based tracks in the individual's field of study. For this purpose, we use the location of the lower secondary school as a proxy for the graduate's home address. Calculations are based on the entire distribution of track

[11]There is no *prima facie* evidence of differential selection by track, since official repetition rates are quite similar across tracks.

offerings at the entry year, so that they can change over time even for students from the same lower secondary school who enroll in the same field. Due to the limited dual supply, the average travel time to the nearest school offering a dual track is higher than to the nearest school offering a school-based track. However, those who opted for dual VET faced a smaller additional travel time to school than individuals selecting school-based VET. In particular, this difference stands at 6 minutes via private transport and 22 minutes by means of public transport. Thus, proximity seems to be a significant factor influencing the choice of track. Public transport is the dominant transport mode for tertiary education students in Madrid.[12] However, in our baseline analysis we employ private transport data to construct our IV because it yields more observations, though we conduct a robustness check to ascertain the impact of this choice.

Lastly, Table B7 presents information on the number of dual graduates and the year of inception of the dual track by field. Enrollment in dual VET spans a diverse array of sectors and occupations, with the share of dual graduates ranging from 5.8% in pre-school education to 64% in industrial chemistry.

3.3.2 Labor market outcomes

We employ an broad range of indicators to compare the labor market outcomes of graduates from dual and school-based VET in their first two years in the market. The summary statistics in Table 2 reveal that graduates of dual VET exhibit better outcomes than school-based VET graduates across the board. They enjoy more days of work –either in raw terms or converted to FTE–, achieve higher earnings, and secure better jobs. Additionally, differences in labor market performance are somewhat diminished in our baseline sample vis-à-vis the full sample (see Table B6). Hence, if anything, our sample selection process seems to introduce a conservative bias in our estimates on the impact of dual VET.

Upon closer examination, we find that the disparity in average days of work totals 81.2 days, entailing a notable gain of 21.3% relative to the average for graduates from

[12]According to official data for 2018, among people aged 17 to 31 years old, 60% of students went to school by public transport, 17% by private transport, 21% on foot, and 2% by other means (Consorcio Regional de Transportes de Madrid, 2019).

school-based VET. Moreover, the difference expands to 104.9 days or 34.9% when assessed in terms of FTE. This further gain reflects the higher prevalence of full-time work among dual graduates. Moreover, the difference in the median is almost twice as large as in the average, indicating significantly higher differences in the upper half of the distribution. A key fact that helps explain this feature is the substantially higher retention rate in dual VET. Roughly one in five dual apprentices signs a contract with their training firm in the first twelve months after graduation, compared to around 1% in school-based VET.[13] A notable share of these individuals does not even switch employers in the 24-month window analyzed. Indeed, as illustrated in Figure B1, the share of graduates who work the maximum feasible number of days is quite higher among dual graduates. Conversely, the share of graduates with no days of work is the same across tracks. It is worth noting that, even among dual graduates, employment only reaches 55.5% of the potential 365 days per year, reflecting the low employment intensity among Spanish youth.

Differences in real earnings are similar, though slightly larger, than those in days of work. The difference in average earnings corresponds to 46.9% of the average earnings of graduates in the school-based VE, while the difference in average daily earnings – computed using FTE days of work– is small and insignificant.[14] To contextualize these figures, the average monthly earnings of €673 for dual graduates only represent 88% of the monthly real minimum wage in 2016, whereas their average daily earnings of €43 are 69% higher than the daily minimum wage.[15] As anticipated, considering total income by adding self-employment income to employee earnings does not significantly alter either the levels or the differences between the two tracks.

Apart from yielding better earnings and employment outcomes, dual VET also appears to be associated with higher job quality. On average, graduates in dual VET

[13]The sample size for the retention rate is smaller, due to missing social security numbers for the training firms in 29% of the cases.

[14]The earnings sample is 4.5% smaller than the days of work sample. Some graduates have zero earnings but non-zero days of work or vice versa. We attribute this discrepancy to measurement error in the earnings data, which is less reliable than the contract data, and so we exclude those cases from the sample. We also perform a robustness check on this choice.

[15]These calculations refer to the official minimum monthly wage for 12 months and the minimum daily wage for 360 days.

enjoy longer employment spells and better access to regular jobs –defined as spells lasting at least 3 months. Moreover, almost 40% of the graduates in dual VET obtain at least one open-ended contract in the first two years compared to 32.6% in school-based VET, while the relative shares for having at least one full-time job are three-fourths and 65%. Lastly, they experience a higher number of contracts and employers, but move between a slightly lower number of industries.

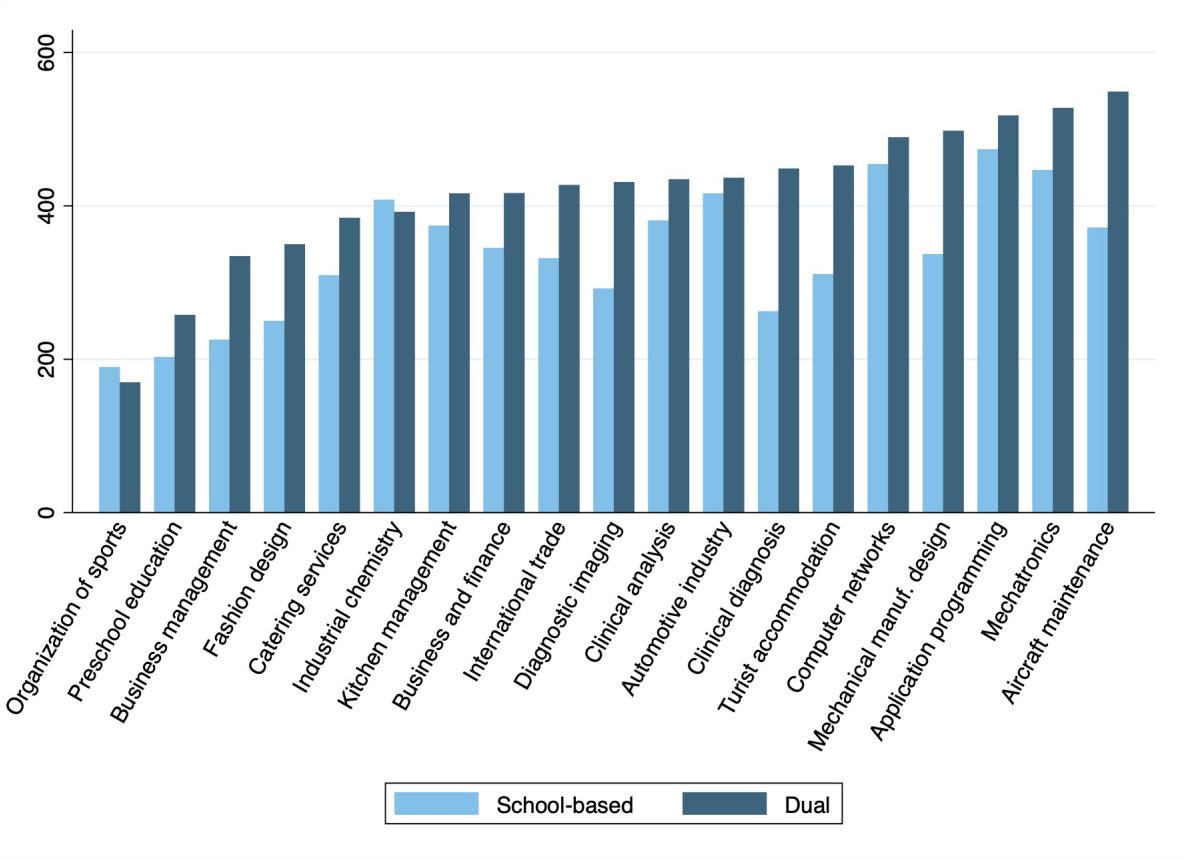
Table 2: Labor market outcomes (baseline sample)

	Dual	School-based	Diff.	p
Days employed	462.98	381.82	81.16	0.00
Days employed FTE				
Average	405.38	300.53	104.85	0.00
P25	147.47	66.00	81.47	0.00
Median	437.00	246.22	190.78	0.00
P75	662.00	517.88	144.12	0.00
Non-employed	7.79	7.71	0.09	0.93
No. contracts	5.46	4.78	0.68	0.03
No. employers	2.04	1.91	0.12	0.02
No. industries	1.30	1.45	-0.15	0.00
Contract length	147.48	123.95	23.53	0.00
Regular job (3 months)	81.74	75.36	6.38	0.00
Any full-time contract	75.18	64.58	10.60	0.00
Any open-ended contract	39.38	32.63	6.75	0.00
Retained first month*	12.86	0.63	12.23	0.00
Retained first year*	19.29	1.22	18.07	0.00
Observations:	975	6291	7,266	
Earnings (€)				
Average	16997.68	11.568.44	5,429.24	0.00
P25	4965.12	2269.25	2696.10	0.00
Median	15461.45	8323.25	7138.21	0.00
P75	27527.34	18625.19	8902.15	0.00
Daily earnings (€)	43.06	44.63	-1.57	0.69
Total income (€)	17226.08	11931.78	5294.30	0.00
No earnings	8.21	8.07	0.14	0.88
Observations	926	6012	6,938	

Note: Graduates from VET in Madrid in 2014-2016. Data are percentages unless otherwise indicated. (*)

Figure 1 shows the variation in average employment across fields. It illustrates that dual VET consistently leads to more days of work in all fields except for two of them. On average, the extent of the gain is negatively correlated with the average days of work in school-based VET. The most substantial differences are found in fields ranging from Clinical Diagnosis, Business Management, Aircraft Maintenance to Mechanical Manufacturing Design, which showcases the diversity of areas in which dual VET demonstrates a positive impact.

Figure 1: Average days of work FTE by track



Note: Graduates from VET in Madrid in 2014-2016. Baseline sample. FTE denotes full-time equivalents.

Lastly, national-level data on the labor market integration of VET graduates, while it adopts a different definition and covers a different period from ours, supports the facts identified here (see Figure B2). For individuals who graduated in 2017, across the twelve regions offering dual VET at the tertiary level, graduates from dual VET

achieved better average labor market outcomes within the first four years of entering the workforce compared to their counterparts in school-based VET. In these data, graduates in Madrid fare relatively better in both tracks compared to the national averages, though over time the differences between tracks appear to narrow down.

4 Empirical strategy

Following our examination of the descriptive evidence, we now outline our empirical approach and identification strategy, which aims to estimate the causal impacts of dual VET on labor market outcomes.

4.1 Baseline specification

As explained in the Introduction, in order to identify the causal impact of dual VET on labor market outcomes, we need a convincing strategy to account for selection on the part of all parties involved. This is vital because dual VET may attract not only the best students, but also the best schools and firms, and their favorable characteristics may help explain the better performance of dual graduates.[16]

To mitigate this concern, we employ an IV design to handle student self-selection and a placebo test to account for potential biases stemming from training provider selection. Our approach capitalizes on a particular feature of the early adoption of dual VET: during the initial phase, only a small subset of VET schools offered dual VET. As a consequence, individuals who opted for the dual track often faced longer travel times compared to those selecting the school-based track. This difference in travel times serves as our IV. We hypothesize that the difference in travel times influences the choice of track. We anticipate that, *ceteris paribus*, as the disparity in travel times in the chosen field increases, individuals are less inclined to enroll in dual VET, and this relationship could potentially be nonlinear.

Moreover, the sensitivity of track choice to differences in distances could depend on

[16]Though notice that during our sample period, none of the participants could observe the labor market outcomes of dual graduates before starting to participate in the dual system.

individual socio-economic background. Cross-sectional variation in sensitivity could arise for several reasons. For instance, students from disadvantaged backgrounds might not be able to afford the transport costs required for studying dual VET at schools located far away. Conversely, students from more affluent families might switch from public to private transport, reducing their commuting time. Additionally, the socio-economic background of students could influence their perceived benefits of enrolling in dual VET, impacting their willingness to accept longer travel times.[17]

Exploiting variation in travel times provides a powerful mechanism for disentangling the causal impact of dual VET on labor market outcomes from potential selection bias that could otherwise distort our findings. A strength of our approach relies on the IV being established before the introduction of dual VET. This order of events lends robustness to our strategy and ensures its validity for drawing causal inference.

Our distance measure was described in the preceding section. For each individual, we calculated the difference in travel time between their lower secondary school and the two nearest VET schools respectively offering the dual and school-based tracks in their field of choice. We would have preferred to use student home addresses, however the location of their lower secondary school is a highly effective proxy for a number of reasons. First, up until 2013, the allocation rules for students made it quite hard for parents to enroll their children in a lower secondary school situated outside their district of residence (see Gortázar et al., 2023, for the case of primary schools). Second, the choice of secondary school is made at least six years before entering tertiary level VET. Consequently, our proxy for parental addresses is based on a choice made well before the introduction of dual VET.[18] From an individual student's standpoint, this implies that differences in travel times are highly exogenous. Furthermore, these distances are likely to be the relevant ones, since young individuals

[17]These mechanisms apply not only to individuals making informed decisions based on perceived trade-offs between tracks, but also for those who are uncertain about the relative benefits or for whom distance is the key concern. Our IV can also accommodate other explanations. For instance, students may be more likely to explore offers from nearby schools compared to those located farther away. Alternatively, secondary schools might have stronger ties with nearby VET schools, leading students to possess more accurate information on the existence or potential benefits of dual VET.

[18]Notice that the third cohort of dual graduates began their lower secondary school education no later than 2008. Even if some of them changed schools shortly before completing the fourth year, this decision still preceded the start of dual VET.

studying tertiary VET typically reside with their parents. Specifically, according to Eurostat, the average age at which young people left their parental household in Spain between 2012 and 2015 was around 29 years old.

Throughout our analysis, we rely on the following IV model:

$$Dual_i = f\left(\alpha' \Delta Distance_i + \beta' X_i + \gamma'_j + \delta'_{jt} + \eta'_t + \mu'_k + \varepsilon_i\right) \quad (1)$$

$$y_i = \alpha \widehat{Dual}_i + \beta X_i + \gamma_j + \delta_{jt} + \eta_t + \mu_k + v_i \quad (2)$$

where $Dual_i$ is a dummy variable that captures the participation in dual VET, taking the value 1 for graduates in dual VET and 0 in school-based VET. In the first stage, we use a Probit specification to regress the treatment dummy on our IV, denoted by $\Delta Distance$, a vector of time-invariant individual characteristics X_i including age at graduation and its square, female, born abroad, work experience and its square, entry route –high school, secondary VE, test, and unknown–, lower secondary graduation one- and two-year delay, previous tertiary VE, and fixed effects by field γ_j, field times year δ_{jt}, cohort η_t –captured by dummy variables for the quarter and the year of graduation– and lower secondary school μ_k (430). In the second stage, we regress the vector of labor market outcomes of interest y_i on the same set of controls, replacing the treatment dummy by its predicted value from the first stage $\widehat{Dual}$.

The parameter of interest is α. Under the assumption that our instrument is valid, it represents the Local Average Treatment Effect (LATE) of completing dual VET rather than school-based VET for the subset of individuals who respond to the difference in travel times –i.e., the *compliers*. The exclusion restriction is that differences in distances influence labor market outcomes solely through their effect on track choice.

Our baseline model offers an estimate of the total return to dual VET, considering the individual's initial characteristics. Potential differences in the effectiveness of dual VET might be influenced by the attributes of schools and firms. However, these factors are both endogenous and inseparable from the decision to choose a particular track, particularly in fields where the dual track is only offered by a single school-firm

combination. For this reason, we omit controls related to VET schools and training firms from our baseline model and postpone the study of their contributions to a later section. Our approach is valid under the condition that the characteristics of training providers are uncorrelated with our distance-based IV.

The inclusion of the remaining controls can be readily justified. Cohort fixed effects are meant to account for potential shifts in the returns of dual VET over time. Since these shifts may not be uniform across fields, we also include a full set of field times cohort fixed effects. In turn, the lower secondary school fixed effects serve a dual purpose. They control for persistent differences in the socio-economic backgrounds of the graduates and simultaneously account for variation in the quality of their prior education. These fixed effects absorb the impact of travel distances to VET schools as well. Nonetheless, for identification purposes, we leverage the changes in three factors that affect our instrument's validity over time: changes in the number of fields offering dual VET, adjustments in the distribution of dual and school-based track offerings in each field, and shifts in the fields selected by individuals who completed their lower secondary education at the same schools but in different years.

4.2 Identification

Throughout the analysis, we perform many tests to ensure that our estimates have a causal interpretation. Once we have dealt with individual track choice, the main threats to identification stem from the endogenous adoption of dual VET by schools and training firms. The schools in our sample may have introduced dual VET because they believed it would benefit, or help to attract, students with particular characteristics. If these students mostly came from nearby secondary schools, this could generate correlation between our IV and unobservable characteristics of the students that matter for their labor market performance. This would violate the exogeneity of our IV. Alternatively, early adopters of dual VET may have been the most innovative schools whose students typically outperform the graduates from other schools, or else some schools may have introduced dual VET to improve the performance of their students in the worse-performing school-based fields. In these cases, our treatment dummy would

capture persistent differences in school characteristics due to self-selection by schools. As a result, our treatment effects would not measure the impact of the teaching mode on labor market outcomes. Similar arguments would apply to the participation decision of the training firms or the selection of the fields with a dual track.

To rule out selection by training providers, we run a placebo test that anticipates the introduction of dual VET by one year. It implies labeling as "dual" all combinations of schools and fields that are part of the offer distribution of dual VET at any point during our sample period. We estimate the effect of dual VET by OLS. In 2011, when the latest of the 2013 cohort of graduates started, the students could not predict which schools would introduce dual and in what fields. Therefore, it would not make much sense to implement an IV model that requires imputing differences in distances to students, using actual distances realized one or more years later. Moreover, all we need for identification is to confirm that graduates from school-field cells that are labelled dual did not have better outcomes before the introduction of dual VET, once we control for observables. To warrant a causal interpretation of our results, the placebo test should yield an estimate that is close to zero.[19]

The second identification threat is a possible violation of the exclusion restriction. It is likely that individuals whose track choice is sensitive to differences in travel times may also be reluctant to commute to work. This is a problem if the individuals who are located far away from schools with dual VET are also far away from firms that might employ them in future. To deal with this problem, we re-estimate our model allowing a different dual impact for the subsample of graduates from the capital city of Madrid vis-à-vis the graduates from the surrounding municipalities, for whom differences in distance are typically much larger than in the capital.

The third source of identification threats is given by spillover effects. Adoption of dual VET could affect the quality of the school-based VET offered by the school. The closer ties between schools and firms that characterise the dual system may improve the school's knowledge of the needs of firms and this may raise the quality of both

[19]We do not have enough variation to create cells at the level of track, school, and training firm. Nonetheless, we will show evidence of the persistent nature of the relationships between schools and training firms, that lends further support to our placebo test.

tracks. Alternatively, the adoption of dual VET may help attract better training firms and some of these may then also offer internships in school-based VET. Such positive spillover effects would strengthen our results, as they would introduce downward bias in our estimates of the impact of dual VET. Conversely, negative spillovers could arise if schools move their best teachers to dual VET, which would lead us to overestimate the gains from dual VET. While our baseline sample includes graduates of all schools offering the fields in our sample, regardless of whether they offer dual VET or not, to assess the relevance of this type of spillovers, we re-estimate our model only with graduates from schools that offer both tracks in a given field. Without spillover effects, the impact of dual VET should be similar on both sets of graduates. Lastly, spillover effects could also stem from hiring decisions, if firms tend to rank dual graduates ahead of school-based graduates. However, only a small minority of the students and firms participated in dual VET over our sample period. Moreover, information about the system was scarce at the time. Thus, it seems unlikely that the introduction of dual VET significantly altered the job finding probability of graduates in school-based VET. In any event, the above-mentioned within-field comparison of the impact of dual VET in all schools vs. those who offer the two tracks should also detect this type of spillovers.

Data limitations prevent us from identifying the reasons why some individuals have zero recorded days of work during the two years after graduation. In particular, we are unable to distinguish those who did not find a job from those who went to college or left the country. This issue is relevant because, according to the official statistics of Madrid, around 30% of the graduates in tertiary VET go on to study at university over the three years after graduating. If, say, school-based track graduates were more inclined to continue their studies than dual track graduates, this would create upward bias in our estimated returns from dual VET. However, the probability of an individual with zero working days being included in our sample is the same across tracks. In any event, we do a robustness check by restricting the sample to the subset of graduates with non-zero days of work. On a related issue, as is customary in view of the usual log-linearity of earnings, we estimate the impact of dual VET on earnings in logs rather

than levels. This prevents us from using null earnings observations, which brings back the potential differential selection into positive earnings across tracks. We run two additional exercises to guard against these issues. We estimate a model for the impact of the track on the probability of having zero earnings and we re-estimate the IV model on earnings levels, including the zeros.

5 Results

In this section we report our main results, starting with the first stage prediction of selection into dual VET. In line with Abadie et al. (2023), the standard errors are clustered geographically, i.e. at the level of lower secondary school.[20]

5.1 First stage

The first three columns of Table 3 report the results of a specification test. Consistent with our previous discussion, we considered three candidate instrumental variables: the difference in travel times, $\Delta Distance$, its interaction with the log per capita income in the district of the individual's lower secondary school, and its square. Both the coefficient of $\Delta Distance$ and the interaction term are significant and have the expected signs, while the quadratic term is insignificant. Consequently, we use the second specification as our benchmark. The last two columns report the results of this benchmark for the smaller samples available for retention and earnings.

Conditional on the socio-economic background of the students, we find a monotonic and highly significant negative relationship between the difference in travel times and the probability of selection into dual VET. The negative coefficient on the interaction term implies that students from relatively poor districts are less inclined to take longer trips to enroll in dual VET than students from more affluent districts. Thus, the subset of compliers includes students from relatively poor neighbourhoods who happen to live relatively close to schools with a dual track in their field of choice.

[20]Estimated using Stata's commands probit and ivreg2.

Table 3: First stage: Predicting graduation in Dual VET

	Baseline sample			Retention	Earnings
ΔDistance	-3.34***	-30.56***	-30.69***	-40.90***	-35.84***
	(0.26)	(8.83)	(8.66)	(10.32)	(9.93)
ΔDistance *		7.9×10^{-4}***	7.9×10^{-4}***	1.1×10^{-3}***	9.4×10^{-4}***
log(Income pc)		(2.6×10^{-4})	(2.5×10^{-4})	(3.0×10^{-3})	(2.9×10^{-4})
$\Delta\text{Distance}^2$			8.36×10^{-8}		
			(1.02×10^{-7})		
Weak identification test	282.28	296.45	295.43	225.20	251.84
Pseudo R^2	0.30	0.30	0.30	0.31	0.31
Observations	7,266	7,266	7,266	5,053	6,029

Note: Graduates from VET in Madrid in 2014-2016. Probit estimates. Control variables: age at graduation level and square, female, born abroad, work experience level and square, entry route dummies, lower secondary graduation one- and two-year delay, previous tertiary VE, and fixed effects by field, field times year, quarter and year of graduation, and lower secondary school. Standard errors clustered by lower secondary school in parentheses. Weak identification test refers to the Kleibergen-Paap rk F statistic. Notation: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

These results confirm the strength and relevance of our IV's. An increase from the first (0 minutes) to the ninth decile (20.9 minutes) of the distribution of $\Delta Distance$ reduces the probability of selection into dual VET by 22.4%. Furthermore, it correctly predicts 88.63% of outcomes (true dual or true school-based). Lastly, the probit specification outperforms an alternative linear probability model, which has less predictive power (Adjusted R^2 of 0.26) and in 11.4% of the cases predicts values of $Dual$ that fall outside the unit interval. On the other hand, a logit model produces very similar results to the probit.

5.2 Main results

We now describe our main findings. In Section 3.3.2, we documented the presence of large and significant differences in the average outcomes of the graduates in dual and school-based VET. These included differences in days worked, earnings, and job quality, which are confirmed by the OLS estimates in panel A of Table 4. IV estimates in panel B show that the gains in the number of days worked, log earnings, and

retention rates survive once we control for selection.[21] On the contrary, there is no evidence of a causal link between dual VET and emploment quality, in that there are no significant improvements in access to full-time or open-ended contracts.

Table 4: Labor market outcomes

	Days of work	Days FTE	Regular job	Open-ended	Full-time	Retention	Earnings	Daily earnings
A. OLS								
Dual	50.06***	58.04***	0.03**	0.03*	0.02	0.17***	0.26***	0.04**
	(9.44)	(9.30)	(0.02)	(0.02)	(0.02)	(0.01)	(0.04)	(0.02)
B. Baseline								
Dual	92.38***	88.38***	0.09	0.03	0.04	0.23***	0.41**	0.16*
	(35.82)	(33.69)	(0.06)	(0.07)	(0.07)	(0.04)	(0.18)	(0.09)
Obs.	7,266	7,266	7,266	7,266	7,266	5,053	6,029	6,029
C. 12 Months								
Dual	64.64***	58.85***	0.25***	0.05	0.07	0.23***	0.46***	0.07
	(18.70)	(17.15)	(0.07)	(0.07)	(0.07)	(0.04)	(0.18)	(0.09)
Obs.	7,266	7,266	7,266	7,266	7,266	5,053	5,092	5,092
D. Placebo								
Dual	4.55	-3.89	0.03	-0.04	-0.01	-0.00	0.03	-0.06
	(18.46)	(14.99)	(0.04)	(0.03)	(0.04)	(0.01)	(0.12)	(0.06)
Obs.	2,406	2,406	2,406	2,406	2,406	1,457	1,912	1,912

Note: Graduates from VET in Madrid in 2014-2016 (panels A-C) and in 2013 (panels D-E). OLS (panels A and D) and IV estimates (panels B and C). Instruments: distance difference and distance difference times log average district per capita income. Control variables: age at graduation level and square, female, born abroad, work experience level and square, entry route dummies, lower secondary graduation one- and two-year delay, previous tertiary VE, and fixed effects by field, field times year, quarter and year of graduation, and lower secondary school. Standard errors clustered by lower secondary school in parentheses. Notation: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

The table shows that the impacts on employment, log earnings, and retention are similar in magnitude to the raw differences reported in Table 2. In particular, they are somewhat larger for days of work and retention, and smaller for days of work FTE and earnings. Furthermore, the IV estimates are much larger than the corresponding OLS estimates, which is at odds with the superior labor market performance of dual graduates being driven by positive selection. On the contrary, it seems that dual VET is a better option for a group of compliers whose track choice is sensitive to differences

[21] To make sure that there is no induced bias from leaving out null earnings, we run an IV model for selection into this outcome, obtaining an estimate on dual VET that is very close to zero and statistically insignificant (see Table A9).

in travel times. One factor that may explain this sensitivity –apart from a possible lack of information on the virtues of dual VET or lack of resources to finance longer trips– is low motivation, so that for these students the combination of studies and remunerated work may offer better results than school-based VET.

Table 4 gives rise to two further observations. First, the comparison between panels B and C shows that approximately two-thirds of the differences in the number of days of work accrue in the first twelve months upon graduation. This pattern is consistent with the idea that the higher retention rates in dual VET lose relevance over time. The gradual convergence in labor market outcomes is further supported by the estimate for regular job becoming statistically insignificant after the first year. Second, the results for our placebo test (panel D), indicate that the superior performance of the graduates in dual VET cannot be attributed to pre-existing differences in the quality of the schools that adopted dual VET.[22] The estimates for all labor market outcomes are all insignificant and close to zero.

5.3 Robustness checks

So far we have shown that the completion of dual rather than school-based VET improved the labor market outcomes of its graduates. The objective of this section is to explore the robustness of our findings.

In the first three checks we alter the specification. Panel A of Table A8 reports the results when we cluster the standard errors by both secondary school (our baseline) and field of study. In the second robustness check (panel B), we drop the interaction term between $\Delta Distance$ and log income per capita from our baseline specification. This restriction imposes the same monotonic relationship between additional travel time and the probability of graduation in dual VET on all individuals, regardless of their socio-economic background. In the third check, we control for socio-economic background by using district-level rather than secondary school fixed effects. The first two changes hardly alter our results, whereas in the third exercise (panel C) the results

[22]To the extent that the partnerships between schools and training firms were formed before the introduction of the dual system, our placebo test also rules out the relevance of pre-existing differences in the quality of training firms. We will return to this issue in Section 6.

are less significant. This suggests that there are relevant within-district differences in the quality of secondary schools that one should account for.

In the following five checks, we alter the sample in various ways. First, in constructing our baseline sample, we reweighted the data from the 2016 cohort –whose employment records are missing the last two weeks– to be able to measure the impact of dual VET over a 24-month horizon for all cohorts. Panel D shows the results when we use the original unweighted data. Panel E reports the estimates when we use data on travel times by public rather than private transport. As already noted, here we lose almost one hundred observations, due to lack of a viable connection to at least one of the nearby VET schools, and the first stage is a tiny bit weaker (the pseudo-R^2 is equal to 0.295 v. 0.301). The results are very similar, except for a reduction in the estimated impact on earnings and its significance.[23] We then re-estimate the baseline specification using only unrevised graduation dates. The results are mixed. Compared to the baseline (Table 4, panel B), the estimates in panel F reveal a stronger impact on the number of days worked and a smaller impact on log earnings and the retention rate. In the latter case, the change in the point estimate is borderline significant, but the retention rate is still much higher in dual VET.

Next, in our baseline we compare graduates in the same field and cohort. We would have liked to further restrict the comparison to individuals from the same school, but this is incompatible with our identification strategy. As an alternative, we have re-estimated our benchmark specification for the subsample of schools offering both tracks in the same field. The higher homogeneity between schools yields much larger impacts (panel G). In the case of FTE days of work the increase amounts to 81% of the baseline estimate. Moreover, this is the only case where dual VET has a significant impact on access to a regular or an open-ended job. However, these results should be interpreted with caution. Sample size is reduced to 14% of the baseline.[24] Moreover, for this reduced sample it is harder to defend the absence of relevant spillover effects. In

[23]Restimating the model on the smaller sample for which public transport distances is available using an IV based on private transport distances also leads to very similar estimates to the baseline ones.

[24]The small sample size also forces us to group lower secondary schools into districts, so as to be able to estimate the first stage.

particular, by reallocating their best teachers and internship slots from school-based to dual VET, the schools in this sample may have contributed to a wider gap in labor market outcomes. Restricting the sample to individuals with non-zero days of work leads to a small reduction in the measured impact on the number of FTE days of work (panel H), which falls slightly further when the estimation sample is restricted to be the same sample as the one used for earnings.

In the last two robustness checks we alter the measurement of earnings. First, we use the level of earnings rather than its log, which allows us to include observations with null earnings. According to the results in panel B of Table A8, dual VET raises earnings by €4,876, which entails a proportional change which is very close to the 42% effect reported in Table 4. This is consistent with the virtually identical share of graduates with no earnings found in Table 2. In our last check, we estimate the effect on total income, which adds self-employment income to employee earnings. The resulting estimate in panel C is very close to the one obtained in the baseline.

Overall, the robustness checks suggest that our baseline provides an upper-bound for the impact of dual VET. Most yield slightly lower and less significant estimates, but the differences are less than 10% of the baseline estimates and none is significant. It is worth noting that the daily earnings premium found in the baseline is robust to most of these variations, which reinforces the conclusion that dual VET improves quantitative outcomes but not the quality of work.

5.4 Heterogeneous treatment effects

Our next objective is to identify possible sources of treatment heterogeneity. There are good reasons to presume that the impact of dual VET need not be uniform or constant over time. For instance, the optimal balance between school-based and firm-based instruction may differ across occupations and need not be the same for all students in the same field. However, in our sample we do not find any evidence of heterogeneous impacts, except for an increase in the returns to dual VET over time.

Specifically, as shown in panel A of Table 5, the estimate for the differential number of FTE days worked increases from 15 days for the first cohort to 125 days for the third

cohort and it is not significant for the first two cohorts. In contrast, the coefficient on the retention rate is significant throughout the sample period, but it declines over time. The observed time pattern for the impact on days of work is consistent with several explanations. The positive impact of dual VET may have increased over time due to progressive learning on the part of the training providers or changes in the menu of dual VET offered. In addition, there may be significant differences in the responsiveness of labor market outcomes of graduates in dual and school-based to changes in the macroeconomic situation. In our dataset we cannot distinguish the separate contributions of each of these channels, but there are no reasons to presume that the 2016 outcomes are outliers.

The strong recovery of the labor market may have also contributed to the fall in the differential retention rate over time, by improving the outside options of recent graduates. Another plausible explanation is the gradual concentration of firm-based training in the second year of the program (see Appendix A). This change makes participation in dual VET more attractive for firms that do not plan to retain their apprentices. By using their apprentices as partial substitutes for qualified employees, these firms can save on labor costs, and our results indicate that this kind of shift from investment in future employees to cost saving need not erode the economic return from graduating in dual VET.

Panels B and C, respectively, show no significant differences in the return to dual VET by gender or between the city of Madrid and the rest of the region (each area comprising roughly half of the sample). This last distinction is interesting in itself, but also a way to rule out a possible violation of our exclusion restriction. As explained before, students who live in the surrounding towns may be located far away from both schools with dual VET and potential future employers. The same reluctance to travel may therefore give rise to enrollment in school-based VET and relatively poor labor market outcomes. In contrast, in the city of Madrid the difference in travel times is small and much less correlated with distance to future employers. We find no support for this issue.

Table 5: Labor market outcomes: Heterogeneity

	Days of work	Days FTE	Regular job	Open-ended	Full-time	Retention	Earnings	Daily earnings
A. Cohort								
Dual×2016	146.03***	125.64***	0.16***	0.12	0.07	0.17***	0.49**	0.08
	(39.27)	(35.76)	(0.06)	(0.08)	(0.07)	(0.04)	(0.19)	(0.08)
Dual×2015	52.16	68.61	0.04	-0.07	0.03	0.28***	0.47*	0.29**
	(52.32)	(50.47)	(0.09)	(0.11)	(0.10)	(0.07)	(0.25)	(0.15)
Dual×2014	-7.78	14.97	-0.10	-0.07	-0.11	0.33***	-0.05	0.18
	(66.02)	(70.27)	(0.10)	(0.13)	(0.12)	(0.08)	(0.35)	(0.14)
B. Gender								
Dual	97.92**	88.44**	0.09	0.06	0.05	0.22***	0.39**	0.15*
	(40.84)	(37.88)	(0.07)	(0.08)	(0.07)	(0.05)	(0.19)	(0.09)
Dual×Female	-13.03	-0.28	0.01	-0.06	-0.03	0.02	0.01	-3 $\times 10^{-3}$
	(40.35)	(37.71)	(0.07)	(0.08)	(0.07)	(0.05)	(0.21)	(0.09)
C. Capital								
Dual	90.34***	90.34***	0.09	0.08	0.07	0.21***	0.45***	0.19**
	(33.21)	(33.22)	(0.06)	(0.08)	(0.07)	(0.04)	(0.18)	(0.09)
Dual×Capital	-13.73	-13.74	0.02	-0.12*	-0.09	0.07	-0.11	-0.07
	(35.82)	(35.82)	(0.06)	(0.07)	(0.07)	(0.05)	(0.19)	(0.09)
D. Field								
Dual×Serv.	98.31***	94.48***	0.07	0.01	0.04	0.19***	0.40**	0.13
	(36.46)	(33.95)	(0.06)	(0.08)	(0.08)	(0.04)	(0.19)	(0.09)
Dual×Manuf.	13.49	4.07	0.03	0.09	-0.06	0.21***	-0.01	0.09
	(51.85)	(51.03)	(0.08)	(0.10)	(0.08)	(0.07)	(0.23)	(0.10)
Dual×STEM	122.57*	123.63*	0.12	0.08	0.03	0.39***	0.63	0.30*
	(74.22)	(72.32)	(0.13)	(0.14)	(0.13)	(0.10)	(0.43)	(0.17)
E. High employment field								
Dual	122.74***	121.40***	0.14**	0.05	0.04	0.26***	0.70***	0.09
	(38.33)	(35.83)	(0.06)	(0.08)	(0.09)	(0.04)	(0.19)	(0.10)
Dual×HEF	-55.90	-64.83	-0.12	-0.03	-0.01	-0.06	-0.65***	0.10
	(45.04)	(43.23)	(0.07)	(0.09)	(0.08)	(0.06)	(0.24)	(0.10)
Obs.	7,266	7,266	7,266	7,266	7,266	5,053	6,029	6,029

Note: Graduates from VET in Madrid in 2014-2016. IV estimates. Instruments: distance difference times dummy variables for cohort, female, capital, industry (Services, Manufacturing, STEM), and high-employment field, plus distance difference times log average district per capita income. Control variables: age at graduation level and square, female, born abroad, work experience level and square, entry route dummies, lower secondary graduation one- and two-year delay, previous tertiary VE, and fixed effects by field, field times year, quarter and year of graduation, and lower secondary school. Standard errors clustered by lower secondary school in parentheses. Notation: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

We also experiment with different groupings of fields, as we do not have sufficient data to estimate heterogeneous impacts at the field level. In panel D we report the results when we distinguish between fields related to services, manufacturing, and STEM (science, technology, engineering, and mathematics). The returns are higher

for services, quite higher but only marginally significant for STEM, and insignificant for manufacturing. In a second exercise we split the fields in two groups which are, respectively, below and above the median of the average FTE days of work for the pre-dual 2013 cohort of graduates in school-based VET. The results indicate that the introduction of dual VET seems to have contributed to a compression of the differentials in outcomes, which is however only significant for earnings.

Lastly, we analyze the distributional implications of dual VET. Following Chernozhukov et al. (2013), we exploit our baseline specification to estimate how dual VET affects the probability of obtaining an outcome above each of the nth deciles of the distribution. The results for FTE days of work and log earnings, reported in Figure B3, show that dual VET significantly improves the probability of a relative favorable outcome above the median.

6 Exploring the mechanisms

The preceding sections have shown the existence of a substantial and robust dual VET premium. In this section we explore the mechanisms that generate this premium, so that we can better understand its origin. Since we lack information on the actual skill level of graduates, our analysis will focus on the role of the training firms.

Our first aim is to investigate the role of the higher probability of retention in dual VET in explaining the dual premium. To that aim, we re-estimate our baseline specification for the subsample of movers, i.e. those who are not hired by their training firm. The first-stage estimates are presented in Table A10 and the results in panel A of Table 6. They indicate that dual graduates also obtain better results than their peers from school-based VET if they move to a different employer, although the differences are smaller and less significant than in the baseline sample. These estimates do not have a causal interpretation, since movers represent a self-selected sample. Nonetheless, these results tentatively suggest that employers other than the training firm also differentially value the skills acquired in dual VET, so that the higher retention rate of dual graduates does not fully account for the dual premium.

Table 6: Mechanisms

	Days of work	Days FTE	Regular job	Open-ended	Full-time	Retention	Earnings	Daily Earnings
A. Movers								
Dual	60.25	66.91*	0.08	0.08	0.08	–	0.47**	0.19*
	(40.29)	(37.49)	(0.06)	(0.09)	(0.08)	–	(0.20)	(0.11)
Obs.	4,335	4,335	4,335	4,335	4,335		3,817	3,817
B. Training firm fixed effects								
Dual	46.32	96.92	0.02	-0.09	0.19**	0.16***	0.72***	0.13
	(66.07)	(62.79)	(0.11)	(0.11)	(0.07)	(0.05)	(0.26)	(0.12)
Obs.	457	457	457	457	457	444	388	388

Note: Graduates from VET in Madrid in 2014-2016. IV estimates. Instruments: distance difference and distance difference times log average district per capita income. Control variables: age at graduation level and square, female, born abroad, work experience level and square, entry route dummies, lower secondary graduation one- and two-year delay, previous tertiary VE, and fixed effects by field, field times year, quarter and year of graduation, lower secondary school, and, in panel B, training firm. Standard errors clustered by lower secondary school in parentheses. Notation: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Turning now to firms, we start by looking at the persistence of school-firm relationships. If the internship firms in dual VET varied significantly vis-à-vis the firms in school-based VET, this could indirectly support a firm-quality basis for the dual premium. To check this issue, we use a couple of measures of persistence. Since using each specific field seems too narrow, we group fields into areas defined by the first two digits of the official field code, getting 24 grouped fields. First take a school that was offering, in a given (grouped) field, school-based VET in academic year 2011-2012 –when no dual VET was offered– and starts offering dual VET later on. Now we ask: does a firm that was hosting interns in that school-field pair in the initial year also participate in dual after that school starts offering dual VET? We have 386 such firm-school-field observations and the share is equal to 13.7%. Since there is attrition even in school-based VET, we should rescale this indicator by the corresponding one for this track. In other words, is a firm that was participating in school-based VET in the initial year, ever observed again in this track after the school starts offering dual in that field? In this case, we have 1,039 observations, with a share of 34%. The ratio between the two shares is equal to 40.4%, which indicates significant inertia, but leaves scope for the better performance of dual graduates being due to a change in the

characteristics of firms as dual VET is introduced.

Next, we collected information about the characteristics of a subsample of training firms from the Central Balance Sheet Data Office of the Banco de España. The CBSO provides balance sheet data and the profit and loss accounts of all non-financial firms that are legally obliged to deposit their annual accounts in Spain's in Spain's Central Mercantile Register. It is highly representative of the census of Spanish firms (Almunia et al., 2018). We match this source with our Social Security data using the firms' tax identification number. We restrict the sample to firms headquartered in the region of Madrid, which are the near totality of the training firms of the graduates in our sample, over the years 2013-2016. In the matching we exclude both firms with low quality and low reliability data, and those which report implausible data on full-time equivalent personnel, as assessed by the CBSO, and also those with likely mismeasured data, such as non-positive value added or employees.

Application of these criteria and a lack of matching with tax identification numbers reported to Social Security both lead to a significant reduction of the sample. We are left with 4,531 observations on 2,638 firms of which, at any point in time, 110 host at least one dual student, 2,503 host at least one school-based student, and 26 host at least one student in each track.

Table A11 presents the characteristics of firms that participate in dual VET or only in school-based VET. It shows that those firms that participate in the dual system are older, larger in terms of output, value-added, employment, and assets, have more temporary employment, and are more investment-oriented and more profitable than the firms that only participate in the school-based system. Table A12 reveals that all these differences, except for age and profitability, remain significant as measured from regressing these variables on a dummy variable for participating in dual VET controling for industry (at the 2-digit level, i.e. 17) and year, while there is now also marginally significant evidence of lower degree of indebtedness.

In Bentolila et al. (2020) we showed, for a similar sample in Madrid, that this type of differential characteristics also distinguish firms that participate in VET, either dual or school-based, from those that do not. This finding corresponds well with the

theoretical and empirical literature on VET, which has extensively studied the reasons why firms may want to devote resources to apprentice training, given that they may not collect the returns from their investment. In particular, Euwals and Winkelmann (2004) find for Germany that training intensity increases with firm size.[25]

We expect these favorable characteristics to result in higher-quality training and thus explain part or all of the dual premium. The small size of the sample of firms participating in dual VET does not allow us to purge the estimated dual premium of their characteristics. However, to take this channel into account, we re-estimate our baseline specification including a full set of training firm fixed effects, which only requires that we observe the firm identifier. However, the inclusion of training firm fixed effects leads to a dramatic reduction in sample size, because some observations are ommited due to collinearity. And it is the subset of firms with at least one apprentice in each track that identifies the coefficient on dual VET. This is a highly selected sample of firms, which should especially exhibit the characteristics shown in Table A11. In spite of the small sample, panel B of Table 6 shows that we still obtain significant differences in earnings, retention, and access to full-time jobs. Moreover, the estimate for FTE days of work is surprisingly close to the corresponding estimate for our baseline sample, though it is estimated with less precision. While non-causal, this evidence suggests the presence of a dual VET premium beyond the better quality of the firms that participate in the dual system.

7 Concluding remarks

In this paper we evaluate the causal effect of a significant reform of the Spanish vocational education and training system that introduced the dual VET track, which entails increased training in firms and reduced traditional school-based instruction. We compare the labor market outcomes of dual graduates with those of individuals who graduated in the same field and year in the traditional school-based system. To this end, we exploit linked education and social security records for the first three

[25]For evidence on a host of factors see also Wolter et al. (2006), Dionisius et al. (2009), Dustmann and Schönberg (2009), Mohrenweiser and Zwick (2009), Muehlemann and Wolter (2014),

cohorts of graduates in the region of Madrid.

The raw data show that dual VET is associated with significantly better labor market outcomes than the traditional school-based system in both quantitative and qualitative dimensions of work. To control for selection by students, we use a highly exogenous instrument based on the differences in travel times to schools offering dual and school-based tracks. Moreover, we make sure that our results are not driven by pre-reform differences in the quality of the schools that offer these tracks in the post-reform period.

After controlling for selection, we find that there is a dual premium: dual VET leads to a 25% increase in total days of work and a 42% rise in total earnings in the first two years following graduation, and a 16 pp increase in the retention rate during the first year. There is however no causal impact on several dimensions of job quality, such as access to full-time or open-ended jobs. We also find that two-thirds of the differences in outcomes are realised in the first twelve months, suggesting convergence of outcomes across tracks over time. Moreover, the reform only started having significant effects with the third cohort, possibly due to a combination of learning effects and the progressive economic recovery in the aftermath of the Great Recession. Lastly, the reform has two kinds of distributional effects: the positive effects of dual VET are concentrated in fields with below-average outcomes in the pre-reform period, whereas completing dual VET improves the probability of outcomes in the upper-half of the distribution across individuals. These findings survive a wide set of robustness checks.

An exploration of the potential mechanisms behind these results reveals that non-retained graduates also benefit from the dual premium, though to a lesser extent than those retained by their firms, which suggests that it is not completely explained by the higher retention rate and supports the transferability of their skills. We also establish that firms that participate in the dual system are older, larger, more investment-oriented, and more profitable than firms that only participate in the school-based system. However, controling for firm fixed effects does not fully remove the dual premium for some of the outcomes, which is an indication that dual graduates acquire some additional skills in their training.

Some caveats are in order. First, our analysis only refers to the initial period of implementation of the new dual VET, which comprised a small share of the students, around 5%. Second, we cannot know whether the dual premium survives beyond the first two years after graduation. Third, cross-regional differences in the regulation and implementation of dual VET may have led to differences in the size of the dual premium. Lastly, Organic Law 3/2022 has recently restructured vocational training in Spain, so that, starting in September 2023, all VET will gradually need to have a dual character and the duration of in-company training has been extended. Our results are favorable to this measure. However, our analysis does not allow us to quantify the general equilibrium effects of the 2012 reform and the extension of dual VET to the whole system is likely to reduce its returns. These issues are left for further research. Even with these caveats in mind, we think that our results are relevant for countries that are contemplating the introduction of a dual VET pathway in their education system.

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Appendices

A Additional information on the data

In this Appendix we provide additional details on the data and its processing.

Distribution of in-company training in the dual system. This share has remained constant throughout our sample period, yet its distribution has varied over time. The inaugural cohort in 2012 dedicated 640 hours to training at the firm in both the first and second years, commencing after a preparatory three-month phase at school. For students starting in 2013, the preparatory period was extended to six months, succeeded by a continuous twelve-month stint at the firm before concluding with a three-month school-based period in the second year. In the third iteration, the authorities introduced a choice between two alternation schemes. The initial option introduced flexibility in the durations of the two school-based training periods, whereas the second scheme entailed spending the entire first year at school and the second year at a firm.

Missing graduation date. The day and month of graduation is missing for 28.8% of graduates in the full sample and 25.2% in the IV sample. As a rule, we impute June 30^{th} –which is the mode for those observed– as their graduation date. This imputation is replaced by the end date of their last internship for graduates whose internships are registered with Social Security. This is most often the case for dual track graduates (since it is compulsory for firms) and rarely for school-based track graduates.

Identifying the training firm. The data allows two ways of matching graduates with their training firms. In education records, the tax identification number (NIF) of the training firm is included for a subset of graduates. This helps us see how firms participating in each VET track differ in Section 6. Alternatively, firms engaged in dual VET –but not school-based VET– are required to register their apprentices with the Social Security administration. This feature enables us to identify the training firm for nearly all graduates in the dual VET track.

Full-time equivalent days. FTE days are computed using coefficients of partiality reported in social security records. In cases where two spells overlap for a worker, we

aggregate the reported fractions by day, up to a full-time daily schedule.

Real earnings. Nominal earnings are annually deflated using the consumer price index for the Madrid region, normalized to 1 in the period going from July 2012 to June 2013.

B Tables and figures

B.1 Comparative statistics

Table B1: Orientation of the highest degree of formal education

Orientation	Spain	Germany	France	U. Kingdom	Netherlands
General education	80.2	21.9	39.0	57.1	23.1
Vocational education	19.8	78.1	61.0	42.9	76.9
Mainly school-based	17.6	1.7	37.8	6.7	
Dual	1.9	75.2	0.0	0.0	
Mainly workplace based	0.2	1.2	21.6	31.7	
No distinction available	0.1	0.0	1.6	4.5	76.9

Source: Eurostat (2009). People aged 15-34 in 2009 with at least secondary education who have left formal education. The reported countries are Spain (SP), Germany (GE), France (FR), United Kingdom (UK) and the Netherlands (NL).

Table B2: Employment rates 3 years after leaving formal education (%)

ISCED groups	All	3-6	3-4	5-6
EU27	70.5	75.2	69.3	81.8
Spain	53.8	62.0	49.0	67.9
Germany	78.9	83.7	80.5	90.0
Austria	82.0	87.4	85.8	92.1
Switzerland	86.1	87.2	83.3	91.8
Netherlands	87.1	91.4	89.0	93.5

Source: Eurostat (2009). ISCED 97 groups: (3) Upper secondary, (4) Post-secondary non-tertiary; (5) First stage of tertiary, and (6) Second stage of tertiary.

B.2 Descriptive statistics: Tertiary VET in Madrid

Table B3: Schools and graduates by school ownership and track

	Dual	School-based	Total
Schools			
Public	17	108	125
Charter	8	85	93
Total	25	193	218
	Dual	School-based	%
Graduates (%)			
Public	76.2	70.3	71.1
Charter	23.8	29.7	28.9
Total	100.0	100.0	100.0

Note: Graduates from VET in Madrid in 2014-2016. The first column reports the number of schools which offer a dual track in some field, while the second column reports the number of schools which exclusively offer school-based VET. Observations: Dual, 975; School-based, 6,291; Total, 7,266.

Table B4: Sample selection

Observed variables	Dual	School-based	Total
1. Education record	1,619	19,891	21,510
2. Employment record	1,588	19,865	21,453
3. No continuing job (Full sample)	1,529	17,753	19,282
4. Secondary school	975	8,697	9,672
Graduated in 2013 (Placebo)	0	2,406	2,406
Graduated in 2014-2016 (Baseline)	975	6,291	7,266

Note: Graduates from tertiary VET in Madrid in 2013-2016. The table shows how sample size changes with the set of variables observed or restricted. The employment record is not observed for part of the sample (line 2). We restrict the sample to students not having the same job 6 months before graduation and immediately after graduating (line 3). The lack of observation of the lower secondary education school further restricts the sample (line 4).

Table B5: Characteristics of vocational education graduates (baseline sample)

	Dual	School-based	Diff.	p
Female	36.6	47.7	-11.1	0.0
Born abroad	2.2	2.6	-0.4	0.4
Age at graduation (years)	22.8	22.4	0.4	0.0
Experience (days)	114.3	87.6	26.8	0.0
Any experience	47.0	38.6	8.3	0.0
Entry route:				
High school	81.0	82.7	-1.7	0.2
Secondary VET	4.5	3.7	0.9	0.2
Test	10.8	11.0	-0.2	0.8
Foreign degree	0.3	0.1	0.2	0.2
Unknown	3.4	2.5	0.9	0.1
Previous tertiary VET	0.1	0.0	0.1	0.0
Graduation in 2014	13.8	24.8	-11.0	0.0
Graduation in 2015	39.5	37.4	2.1	0.2
Graduation in 2016	46.7	37.8	8.9	0.0
Lower secondary education delay:				
No delay	68.7	67.1	1.7	0.3
1 year	22.4	23.5	-1.2	0.4
2 years	8.9	9.4	-0.5	0.6
Average income per capita (€)	14,532.8	14,097.5	435.4	0.0
Distances (minutes):				
Private transport:				
Nearest Dual	17.5	20.8	-3.3	0.0
Nearest School-based	12.0	9.7	2.3	0.0
Difference	5.4	11.0	-5.6	0.0
Public transport:				
Nearest Dual	59.0	72.1	-13.1	0.0
Nearest school-based	34.5	25.9	8.7	0.0
Difference	24.4	46.3	-21.8	0.0
Observations	975	6,291	7,266	

Note: Graduates from VET in Madrid in 2014-2016. Data are percentages unless otherwise indicated. Experience is measued in full-time equivalent days of work. Per capita income refers to 2013; there are 82 areas, comprising 18 districts in the capital and 64 municipalities outside the capital; source: Urban Audit, Instituto Nacional de Estadística (ine.es).

Table B6: Dual vs. School-based tracks, Full sample

	Dual	School-based	Diff.	p
Female	37.5	45.9	-8.3	0.00
Born abroad	4.0	4.0	-0.1	0.91
Age at graduation (years)	23.3	22.8	0.5	0.00
Experience (days)	172.9	140.6	32.3	0.00
Any experience	51.2	45.3	6.0	0.00
Entry route:				
High school	75.7	74.8	0.9	0.43
Secondary VE	4.7	4.7	-0.0	0.95
Test	12.5	10.2	2.4	0.00
Foreign degree	1.2	0.9	0.3	0.27
Unknown	6.0	9.5	-3.5	0.00
Previous tertiary VE	9.0	3.2	5.8	0.00
Graduation in 2014	15.3	27.4	-12.1	0.00
Graduation in 2015	39.1	27.3	11.8	0.00
Graduation in 2016	45.6	26.5	19.2	0.00
Outcomes:				
Days of work	468.7	360.6	108.1	0.00
Days of work FTE	417.0	281.8	135.3	0.00
Observations	1,529	17,753	19,282	
Earnings (€)	17,622.4	11,154.5	6,467.8	0.00
Daily earnings (€)	43.6	46.4	-2.9	0.49
Total income (€)	17,834.7	11,598.5	6,236.2	0.00
Observations	1,454	17,022	18,476	

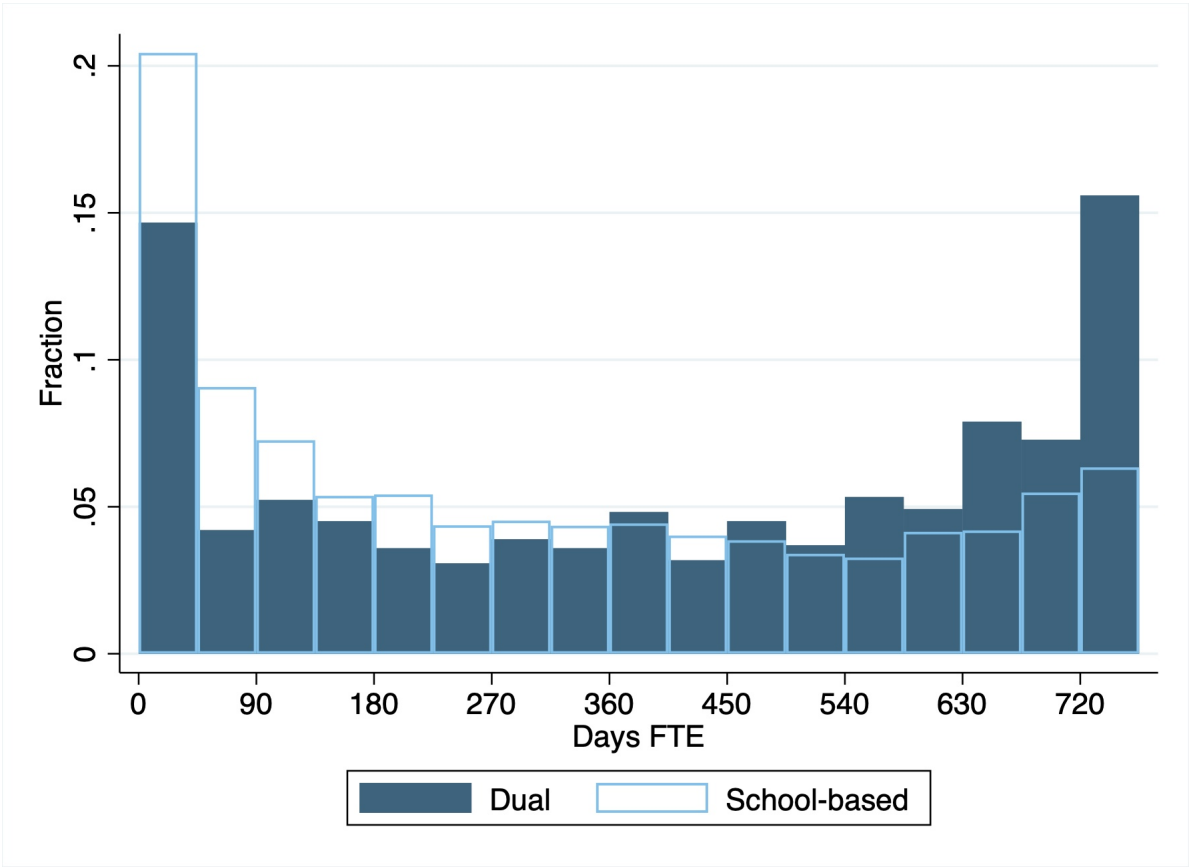
Note: Graduates from VET in Madrid in 2014-2016. Data are percentages unless otherwise indicated. Experience is measued in full-time equivalent days of work.

Table B7: Number of graduates by field and track

Field	Dual	School-based	Total	Initial year
Organization of sports	87	913	1,000	2013
Clinical analysis	28	146	174	2012
Industrial chemistry	9	5	14	2013
Business management	57	443	500	2012
Manufacturing design	10	32	42	2013
Mechatronics	79	92	171	2012
Automotive industry	105	350	455	2012
Fashion design	13	61	74	2012
Aircraft maintenance	21	73	94	2012
Diagnostic imaging	22	167	189	2013
Clinical diagnosis	39	429	468	2012
Computer networks	46	501	547	2012
Application programming	66	373	439	2012
Business and finance	96	1051	1146	2012
International trade	8	96	104	2012
Preschool education	76	1230	1306	2012
Turist accommodation	82	133	215	2012
Kitchen management	92	118	209	2013
Catering services	39	78	117	2012
Total	975	6,291	7,266	

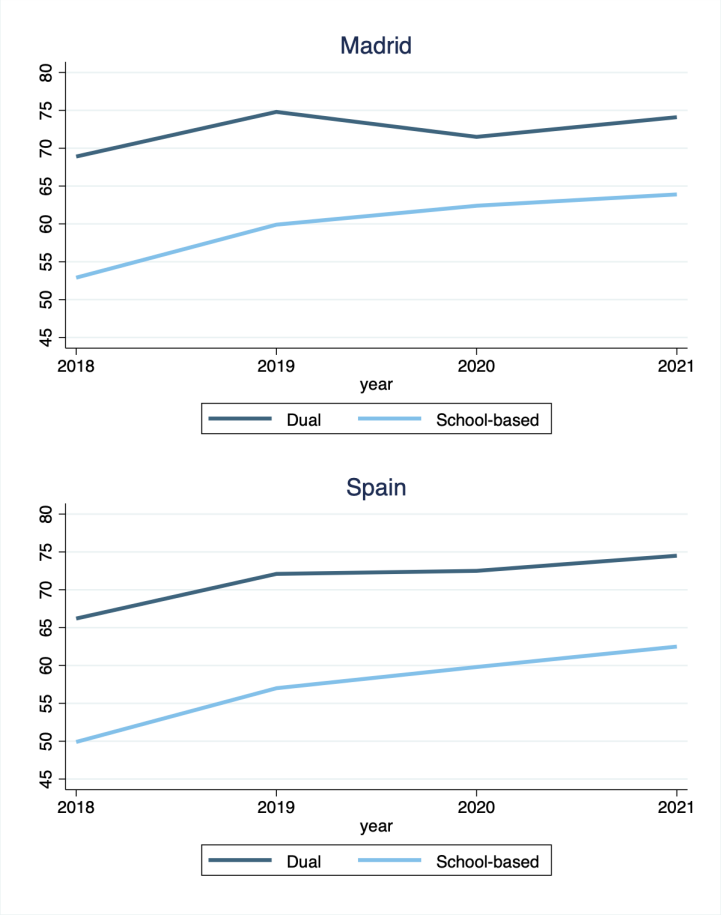
Note: Graduates from VET in Madrid in 2014-2016. The label "initial year" refers to the natural year in which the dual track was introduced.

Figure B1: Distribution of Days of work FTE by track



Note: Graduates from VET in Madrid in 2014-2016.

Figure B2: Official insertion rates in tertiary VET. Madrid vs Spain

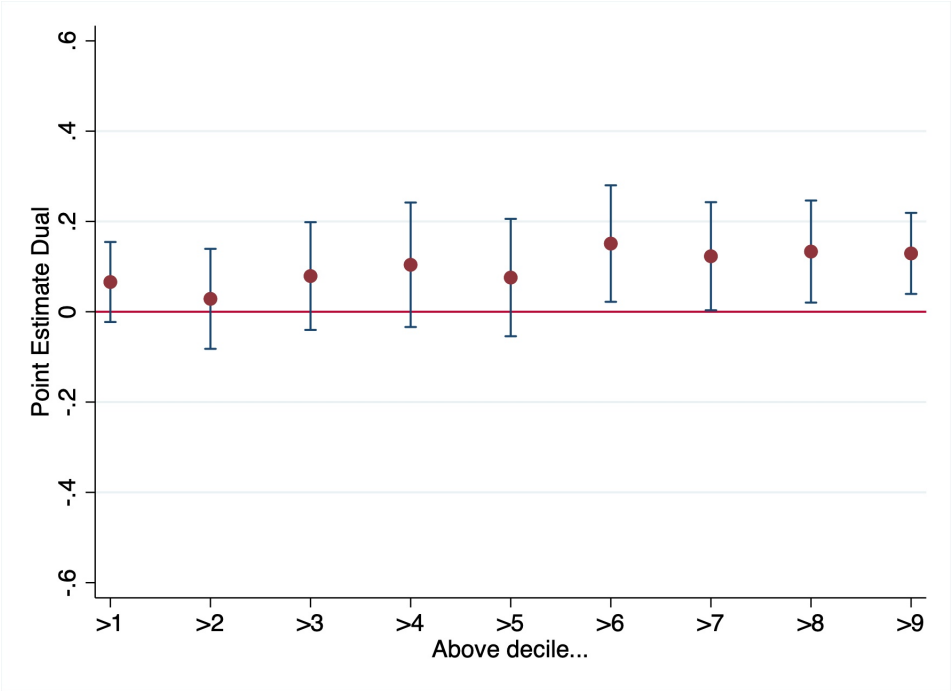


Note: Mean insertion rates for the cohort graduated in 2017 for Madrid and Spain. Insertion rates are defined as the percentage of graduates who work at least one day during the months of March in the four years following graduation. Source: Ministerio de Educación y Formación Profesional (2021).

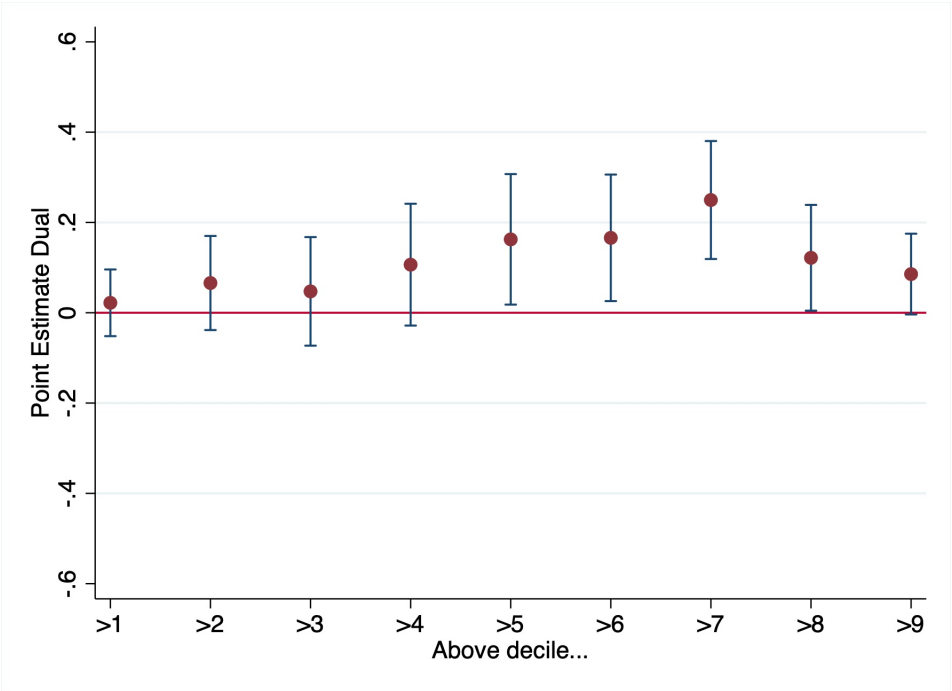
B.3 Additional empirical results

Figure B3: The distributional impact of dual VE

A. Impact of dual VET on Days of work FTE



B. Impact of dual VET on Earnings



Note: Estimates of distributional regressions on the baseline sample.

Table B8: Robustness checks

	Days of work	Days FTE	Regular job	Open-ended	Full-time	Retention	Earnings	Daily Earnings
A. Two-way cluster								
Dual	92.38***	88.38***	0.09	0.03	0.04	0.23***	0.41**	0.16*
	(34.83)	(32.69)	(0.07)	(0.08)	(0.06)	(0.05)	(0.19)	(0.09)
B. Distance difference IV only								
Dual	91.66**	87.61**	0.09	0.02	0.04	0.23***	0.37**	0.17*
	(36.77)	(34.50)	(0.06)	(0.07)	(0.07)	(0.04)	(0.18)	(0.09)
Obs.	7,266	7,266	7,266	7,266	7,266	5,053	6,029	6,029
C. District fixed effects								
Dual	86.11**	81.98**	0.09**	0.00	0.04	0.22***	0.39*	0.08
	(35.36)	(31.95)	(0.05)	(0.07)	(0.07)	(0.05)	(0.21)	(0.12)
Obs.	7,266	7,266	7,266	7,266	7,266	5,164	6,268	6,268
D. Non-reweighted data								
Dual	88.48**	84.69**	–	–	–	–	0.41**	0.15*
	(35.42)	(33.34)					(0.19)	(0.09)
Obs.	7,266	7,266	7,266	7,266	7,266	5,053	6,029	6,029
E. Public transport distance								
Dual	90.26**	82.21**	0.07	0.07	0.02	0.20***	0.33*	0.15
	(38.83)	(37.92)	(0.06)	(0.06)	(0.07)	(0.04)	(0.20)	(0.10)
Obs.	7,168	7,168	7,168	7,168	7,168	4,979	5,936	5,936
F. Non-revised graduation date								
Dual	108.90**	104.07**	0.09	0.10	0.02	0.16***	0.36*	0.13
	(43.25)	(41.13)	(0.07)	(0.09)	(0.09)	(0.04)	(0.21)	(0.11)
Obs.	5,675	5,675	5,675	5,675	5,675	3,882	4,799	4,799
G. Two-track schools								
Dual	131.30***	159.80***	0.11**	0.18***	0.15***	0.12**	0.40	0.10
	(32.81)	(31.10)	(0.05)	(0.05)	(0.05)	(0.05)	(0.51)	(0.28)
Obs.	987	987	987	987	987	746	852	852
H. Positive outcomes								
Dual	89.81***	82.92***	0.07	0.03	0.01	0.23***	0.41**	0.16*
	(32.90)	(31.40)	(0.05)	(0.08)	(0.06)	(0.04)	(0.19)	(0.09)
Obs.	6,563	6,563	6,563	6,563	6,563	4,791	6,029	6,029
I. Earnings sample								
Dual	81.17**	79.50**	0.04	0.05	0.02	0.22***	0.41**	0.16*
	(32.74)	(31.69)	(0.05)	(0.08)	(0.07)	(0.04)	(0.18)	(0.09)
Observations	6,029	6,029	6,029	6,029	6,029	4,386	6,029	6,029

Note: Graduates from VET in Madrid in 2014-2016. IV estimates. Instruments: distance difference and, except in panel B, distance difference times log average district per capita income. Control variables: age at graduation level and square, female, born abroad, work experience level and square, entry route dummies, lower secondary graduation one- and two-year delay, previous tertiary VE, and fixed effects by field, field times year, quarter and year of graduation, and lower secondary school –replaced by district in panels C and G. Standard errors clustered by lower secondary school and –in panel A– by field, in parentheses. Notation: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table B9: Robustness checks: Earnings

	Zero earnings	Earnings	Daily earnings
A. Probability of zero earnings			
Dual	6.35×10^{-3}		
	(0.01)		
Observations	6,938		
B. Earnings in levels			
Dual		4876.82***	10.24
		(1650.70)	(29.09)
Observations		6,698	6,170
C. Total income			
Dual		0.39**	0.14
		(0.17)	(0.10)
Observations		6,029	6,029

Note: Graduates from VET in Madrid in 2014-2016. IV estimates. Instruments: distance difference and distance difference times log average district per capita income. Control variables: age at graduation level and square, female, born abroad, work experience level and square, entry route dummies, lower secondary graduation one- and two-year delay, previous tertiary VE, and fixed effects by field, field times year, quarter and year of graduation, and lower secondary school. Standard errors clustered by lower secondary school in parentheses. Notation: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table B10: Mechanisms: Predicting graduation in Dual VE

	Movers	Fixed effects		
		Days of work	Retention	Earnings
ΔDistance	-30.56***	-237.16***	-229.69***	-258.00***
	(8.83)	(61.67)	(61.67)	(68.98)
ΔDistance *	7.9×10^{-4}***	6.7×10^{-3}***	6.5×10^{-3}***	7.3×10^{-3}***
log(Income pc)	(2.6×10^{-4})	(1.8×10^{-3})	(1.8×10^{-3})	(2.0×10^{-3})
Weak identif. test	296.45	88.76	77.30	95.57
Pseudo R^2	0.30	0.63	0.62	0.62
Observations	7,266	457	444	388

Note: Graduates from VET in Madrid in 2014-2016. Probit estimates. Control variables: age at graduation level and square, female, born abroad, work experience level and square, entry route dummies, lower secondary graduation one- and two-year delay, previous tertiary VE, and fixed effects by field, field times year, quarter and year of graduation, lower secondary school, and, in the last three columns , training firm fixed effects. Standard errors clustered by lower secondary school in parentheses. Weak identification test refers to the Kleibergen-Paap rk F statistic. Notation: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table B11: Characteristics of dual vs. non-dual VET training firms

	Dual	Non-dual	Diff.	p
Age	16.81	14.98	1.83	0.01
Size				
Microenterprise	31.02	52.98	-21.96	0.00
Small	39.35	32.61	6.74	0.04
Medium-sized	9.26	7.53	1.73	0.35
Large	20.37	6.88	13.49	0.00
Output	3257.20	2061.95	1195.25	0.00
Value added	1032.04	638.58	393.46	0.00
Payroll	746.27	488.56	257.71	0.00
Temporary rate	28.71	21.36	7.34	0.00
Investment rate	100.06	51.49	48.57	0.00
Net assets	1686.50	861.32	825.18	0.00
Current assets	1772.27	1088.30	683.97	0.00
Fixed assets	1670.42	783.29	887.13	0.00
Profit rate	17.32	10.42	6.90	0.10
Debt ratio	34.20	37.79	-3.59	0.37
Observations	216	4,315	4,531	

Note: Firms matched with VET students in Madrid in 2013-2016. Sample sizes: Payroll (216 dual, 4,312 school-based), Net assets and Current assets (216 dual, 4,312 school-based), and Temporary employment rate (203 dual, 4,183 school-based). Age is in years, flows and stocks are in thousand 2014 euros, and rates and size groups shares are in percentages. Age and size are measured at the beginning of the period. Flows, stock,s and rates are winsorized at the top and bottom 1%. Size bins: Microenterprises ($<$ 10 workers and $\leq$ 2 million (m.) turnover or $\leq$ 2 m. balance sheet total), Small (10-49 workers and $\leq$ 10 m. turnover or $\leq$ 2 m. b. sheet), Medium-sized (50-249 and $\leq$ 50 m. turnover or $\leq$ 43 m. b. sheet) and Large ($\geq$ 250 workers).

Table B12: Characteristics of dual VET training firms

	Age	Size bin	Output	Value added	Payroll	Temporary empl. rate
Dual firm	0.93	0.41***	944.31***	282.26**	182.20**	5.82**
	(1.12)	(0.12)	(290.42)	(110.79)	(84.96)	(2.03)
Mean	15.07	–	2,118.93	657.34	500.86	21.70
Obs.	4,531	4,531	4.531	4,531	4,528	4,386
	Investment rate	Net assets	Current assets	Fixed assets	Profit rate	Debt ratio
Dual firm	35.66**	626.97***	594.63***	580.93**	6.79	-5.09*
	(13.81)	(146.49)	(175.15)	(205.03)	(5.27)	(2.64)
Mean	53.81	900.68	1,120.93	825.58	10.75	37.62
	4,531	4,528	4,528	4,531	4,531	4,531

Note: Firms matched with VET students in Madrid in 2013-2016. All regressions control for 2-digit industry fixed effects. Size bin estimation with ordered probit model. Standard errors clustered by industry in parentheses. Age is in years, flows and stocks are in thousand 2014 euros, and rates and size groups shares are in percentages. Age and size are measured at the beginning of the period, and flows, stocks and rates are the means during 2014-2016.