The Impact of Dual Vocational Education on the Labor Market Insertion of Youth: Evidence from Madrid*

Samuel Bentolila — CEMFI

Antonio Cabrales — University College London

Marcel Jansen — Universidad Autónoma de Madrid and FEDEA

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Abstract

We use a novel dataset to study the impact of participation in dual vocational education (VE) on the labor market outcomes of two cohorts of graduates in the Spanish region of Madrid. Our control group is made of students in full-time VE who graduated in the same years, fields, and schools. After controlling for observable characteristics, we find that graduates from dual VE work more days and earn higher labor income in the first twelve months after graduating than their peers in full-time VE. We also control for selection on unobservables by means of an instrumental variable that exploits differences in commuting times to schools offering either track. Based on this evidence, we do not find any causal differential effect of dual VE.

KEYWORDS: dual vocational education, impact evaluation, Spain

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1 Introduction

Does dual vocational education (dual VE) improve the school-to-work transition of youth? This question has been studied extensively for countries with consolidated systems of dual VE, such as Germany and Switzerland.[1] But, so far, there is hardly any evidence for countries that are making attempts to adopt similar forms of VE. Our objective is to fill this gap with novel evidence for the Spanish region of Madrid.

Historically, Spain's system of VE was exclusively school-based, but this situation has started to change. In November of 2012, the Spanish authorities created the legal basis for a system of dual vocational education and training. The system has two pillars, one that belongs to the system of occupational training and a second one that is within formal education. In this study, we exclusively consider the second pillar. To avoid confusion we will refer to this pillar as dual VE, in line with its name in Spanish.[2]

The main difference with regular full-time VE is the active involvement of firms in the teaching process. The curriculum of the full-time tracks includes a three-month internship at the end of the second year. By contrast, students in dual tracks need to undertake at least one-third of all scheduled training activities at their training firm. The region of Madrid went beyond this legal minimum and opted for a system in which the time in vocational education at the tertiary level is equally split between the school and the firm.

The combination of work and study offers a number of advantages. It allows students to acquire work experience and occupation-relevant skills in a true professional setting with up-to-date equipment. Moreover, the training firm can screen the apprentice during a longer period of time. Dual VE may therefore help to mitigate information asymmetries and this may foster the recruitment (or retention) of appren-

[1] See Section 3 for details.

[2] The formal denomination is "formación profesional dual del sistema educativo" as opposed to "formación profesional dual del sistema de formación profesional para el empleo". The pillar that belongs to the system of occupational training is studied in Jansen and Troncoso-Ponce (2018). It shows similarities with the apprenticeship system in the UK, as the participants are employees of firms who are often not enrolled in formal education. The term apprenticeship could cause confusion, since it is typically used for the two types of system in place in Spain.

tices by their training firm. However, these advantages have to be offset against the effects of a reduction in the hours devoted to classroom instruction. The latter could affect the learning process through various channels. Teachers may be more effective in teaching transverse or abstract skills and often have superior pedagogical knowledge compared to the tutors in firms. Moreover, school instruction is important to safeguard the appropriate mix between general and specific human capital.

The international evidence shows that the overall balance tends to be positive. That is, dual VE leads to better labor market outcomes than full-time VE, although the differences tend to disappear over time. Our objective is to study the same issue with data on the first two cohorts of graduates in dual VE at the tertiary level in Madrid. It is clear that the impact during the first two years need not fully reflect the long-term effect, but an important contribution of our study is that we can measure the value added of dual VE with more precision than most existing studies.

We have access to official student records for the universe of graduates in VE for the years 2014 and 2015 and these data are matched to administrative records from the Social Security administration. The academic records allow us to compare students with similar characteristics who obtained a degree in the same fields and at the same schools but in different tracks, where the comparison is between dual and full-time VE. Moreover, the social security data allow us to follow students in the labor market on a daily basis during a period of one year. We do not have cognitive test scores, but for most individuals in our sample we know their compulsory education date and school. In addition, we observe students' average grade in tertiary VE. One of the few studies with similar-quality data is Allet and Bonnal (2011), but their focus is not the same, as they analyze different pathways after compulsory education.

The evaluation of the impact of education is a notoriously difficult task when students can choose between various programs. In the case at hand, students can express their preferences for the field and the type of track, and in dual VE firms play an active role in the initial selection of candidates. As a result, the pools of students in dual and vocational tracks may have different traits and not all of these differences may be observable in the data. In these circumstances, conventional methods like OLS

or matching generate biased estimates if the unobserved traits have a direct impact on labor market outcomes. A simple example is the case in which the most motivated students opt for dual VE and also search more actively for jobs than the ones who prefer full-time VE. In this case OLS overestimates the benefits of dual VE due to positive selection.

The difficulty consists in finding an exogenous source of variation in the participation in dual versus full-time VE. For countries with a consolidated system of dual VE this problem is typically very hard to solve. The advantage of Spain is that dual VE is still in an experimental stage. In the case of Madrid only around 8% of all VE schools offered at least one dual track during our sample period. Thus, the average student had to travel a larger distance to study any particular field in dual instead of full-time VE. In our empirical analysis we show that the resulting difference in commuting time is a powerful predictor of the individual choice of track and we exploit this feature to obtain an estimate of the causal impact of dual VE that is free from selection effects.

Our main results show that graduates from dual VE obtain substantially better labor market outcomes than their peers in full-time VE. The differences survive when we control for all observable characteristics and we find large variation across fields. However, none of these effects is significant when we use our instrument to control for selection on unobservable characteristics. Thus, in our data we do not find evidence of a causal impact differential of dual VE on labor market outcomes.

The rest of this paper is organized as follows. Section 2 offers useful background information. The next two sections offer a review of the relevant literature and a detailed description of our dataset, while Section 5 outlines our empirical strategy. Section 6 summarizes our regession estimates, Section 7 our instrumental variables results and Section 8 concludes.

2 Institutional background

The legal basis for dual VE was created in 2012.[3] The national regulation defines a set of minimal conditions, while the details of the regulation are left to the regional governments to decide, since they are the competent authority. The students who complete the dual track obtain the same degree as their peers in full-time VE, but a minimum of one-third of their training activities needs to take place in firms rather than in vocational schools.[4] By comparison, the curriculum of full-time tracks only includes a three-month internship (*formación en el centro de trabajo*) at the end of the second and final year. The national regulation does not impose any mandatory payments to apprentices, but most regions, including Madrid, introduced a stipend.

The region of Madrid formally introduced dual VE in academic year 2012-2013, after a one-year pilot project in two vocational schools. In the first few years, the introduction of the dual tracks was limited to the tertiary level (*formación profesional de grado superior*). Access to VE at this level requires either a high school diploma (*bachillerato*) or a vocational degree at the secondary level (*formación profesional de grado medio*), which is part of upper-level secondary education.[5] The regular age at which students enter these programs is 18 and the standard duration of the programs is two years, with a total of 2,000 hours of instruction. In our evaluation exercises we will consider the first two cohorts of students in dual VE at the tertiary level, who graduated in 2014 and 2015 in the region of Madrid.

During our sample period there have been considerable changes in the supply of dual tracks. In academic year 2012-2013, public vocational schools offered dual tracks in 16 different fields, ranging from mechatronics and the design of multi-platform applications to restaurant management. One year later six of these tracks were suppressed and replaced by five new tracks. The labor market prospects of students seem to play

[3] Royal Decree 1529/2012.

[4] The division of the training activities between the school and the firm, as well as all other relevant formal aspects, need to be specified in a written agreement that has to be approved by the regional educational authorities, unless the same program is implemented in various regions. In the latter case, the agreement needs to be approved by the national authorities.

[5] There are entry exams for some groups of persons who do not fulfil these entry conditions and there are procedures for the recognition of foreign degrees.

an important role in the decisions about the supply of dual tracks. Two-thirds of the students are in fields with above-median insertion rates as measured by the days of work during the first year. The voluntary adoption of the new dual tracks by vocational schools and the active participation of firms in the initial selection of apprentices are further factors that may have contributed to selection. In our econometric analysis we need to account for these endogenous choices to avoid bias in our estimates.

The teaching calendar has also undergone relevant changes. In Madrid, the students in dual tracks spend one entire year at their training firms. Initially, this training period was spread over both academic years, but nowadays the students spend the full first year in school and the full second year at their training firm. The students are therefore better prepared when they start their training in firms, but there is no longer any alternation. Moreover, the changes in the teaching calendar also allowed a delay in the timing of the interviews, from September to February of the first year. This feature may help to reduce the impact of initial differences in students' communication skills, because schools have more time to prepare students for the interviews.

Finally, the current regulation does not specify any formal requirements for the personnel of firms that act as tutors or instructors of the apprentices, but large firms typically have experienced instructors. The progress of the apprentices is monitored in monthly tutorials with the participation of school teachers and tutors. However, the responsibility about grading is assigned to teachers.

3 Literature review

There is a vast literature on the impact of dual VE.[6] Although it is difficult to extract general conclusions from this literature due to the great variety in programs, there seems to be a broad consensus that dual VE helps in the transition from school to work when compared to full-time VE.[7] A degree in dual VE is associated with higher

[6]For recent surveys of the literature see Wolters and Ryan (2011) or European Commission (2013). Reviews of the older literature are available in Ryan (2008, 2011).

[7]Parey (2009) and Riphahn and Zibrowius (2015) present evidence for Germany; Bonnal, Mendes, and Sofer (2002) and Brébion (2017) for France; Bertschy, Cattaneo, and Wolter (2009) for Switzerland; and Plug and Groot (1998) for the Netherlands.

employment rates, lower unemployment rates, and more stable jobs, but the differences often vanish after some years. Moreover, most studies fail to obtain significant differences in wages.

The positive impact on the school-to-work transition explains why countries like Spain chose to introduce dual VE. Nonetheless, it is important to stress that the available evidence is far from conclusive about the causal effects of dual VE. In particular, many studies cannot rule out the possibility of selection on unobservable characteristics. Selection occurs if the students who prefer dual VE differ from those who prefer full-time education or if firms with apprenticeship positions select their candidates on the basis of traits that are not observable in the data. In both cases, the estimates from OLS are biased if the same traits also have a direct effect on labor market outcomes. One possible solution is to use a control function to model the choice between dual and full-time VE (e.g. Bonnal, Mendes, and Sofer, 2002), but this method relies on strong distributional assumptions. We therefore prefer to use a instrumental variable design.

Two closely related studies that adopt a similar approach to ours are Parey (2009) and Brébion (2017). Both studies compare the labor market outcomes of graduates from dual and full-time VE and use an instrument based on regional differences in the availability of apprenticeship positions to control for selection. Parey (2009) uses data on apprenticeship vacancies in Germany. Normalising the amount of vacancies by the size of the cohort of non-college bound youth, he obtains an indicator for the availability of apprenticeship positions in 141 local labor markets. Brébion (2017) uses a somewhat different approach. He proxies the local availability of apprenticeships by the lagged ratio between the number of students in dual VE and the total number of students in VE in each region. Furthermore, while Parey (2009) considers apprenticeships in secondary education in Germany, Brébion (2017) compares the impact of apprenticeships at two levels –secondary and tertiary– using data for France and Germany.

Before we discuss their findings, we should point out a weakness in their identification strategy. They rely on the assumption that the local availability of apprenticeship

positions only affects labor market outcomes through its impact on the choice between dual or full-time VE. However, it seems difficult to exclude a direct relationship between apprenticeship availability and the labor market outcomes of apprentices. There is evidence that the supply of apprenticeship positions is sensitive to the business cycle. In other words, firms seem more willing to offer an apprenticeship position when they need more personnel. As a result, the instrument may be correlated with the future employment prospects of apprentices, in violation of the exclusion restriction.

Furthermore, we have access to better data. Access to official student records is key, because it allows us to compare students within the same field and the same schools while controlling for a rich set of personal characteristics that includes proxies for students' cognitive skills and socio-economic background. By contrast, the estimation in the above-mentioned studies only includes year and region fixed effects plus a small set of personal characteristics.

Despite these differences, there are interesting parallels between our results and the findings of Parey (2009) and Brébion (2017). To start with, both studies find evidence of a causal impact of apprenticeship positions in secondary education on the labor market outcomes of non-college bound youth. On the contrary, Brébion (2017) finds no evidence of a causal impact of apprenticeships in higher education, although his OLS estimates reveal significant differences in the risk of unemployment and the access to stable, full-time jobs. The latter results are similar to ours and confirm earlier findings for France (Issehnane, 2011). Overall, these results seem to indicate that dual VE is more effective in secondary education while full-time and dual VE yield similar outcomes in higher education. This conclusion is consistent with the fact that neither we nor Brébion encounter any causal impact on wages.

Nevertheless, there are striking differences in retention rates. Brébion reports mean retention rates of around 60% in Germany and around 40% in France, while we find rates of around 20%. In Germany the high retention rates offer the main explanation for the superior performance of apprenticeships for non-college bound youth.[8] By con-

[8]Brébion (2017) shows that the positive impact disappears when the sample is restricted to individuals who do not remain with their training firm. Similarly, Parey (2009) shows that the positive effect of apprenticeships decreases strongly with age, suggesting that students in full-time education

trast, in France the positive impact of apprenticeships in secondary education survives when the sample is restricted to individuals who move to a different firm. We also obtain similar labor market outcomes for movers and stayers, which suggests that the graduates in dual VE have transferable skills.

Last but not least, we should note that the papers by Brébion and Parey analyze countries with an extensive and well-structured system of dual VE, while we are analyzing a program that is still in its infancy.[9] Hence, it remains to be seen whether the results will change as the participating schools and firms acquire more experience. Finally, our results do not exclude the possibility of a positive impact of dual VE at the secondary level. In the case of Madrid, these programs have started only one year ago, but in other regions they were introduced several years ago.

4 Data and sample selection

Our sample is extracted from the universe of VE graduates in 2014 and 2015 in the region of Madrid. We start from an initial sample of graduates with a full education record, which includes not only information on their performance in VE but in most cases also the date and type of their previous degrees, starting with lower secondary education. In constructing this unique dataset, these data were matched with Social Security records to obtain their employment history, preceding, during, and after graduation in VE. The matching was performed by the regional Government of Madrid and the Social Security administration, who provided us with anonymized data.

As shown in Table 1, not all graduates could be matched across the two sources, which reduces our sample size. For some of these graduates the exact date of graduation was not observed. For most students in dual VE we can recover it from the Social Security record, since it coincides with the end of their training contract. Since we wish to focus on youth, at this stage we also apply the criterion that individuals

tend to catch up with the individuals who completed an apprenticeship.

[9] Riphahn and Zibrowius (2015) also analyze the impact of novel programs in dual VE. However, they study the case of Eastern Germany after the reunification. The firms in Eastern Germany may have benefitted from the ample experience with dual apprenticeships in Western Germany. Even so, they find no evidence of a causal effect of dual VE on the early labor market outcomes of youth.

graduate at an age up to 30 years old (which reduces the sample by 1,219 people in full-time and 118 in dual VE). This leads to our first estimation sample, labeled "Full sample", which contains 11,036 observations, 7.4% of which are in dual VE. Lastly, to construct our instrumental variables (IV) we need to know the school where the individuals graduated from lower secondary education, which is observed for 6,156 individuals, 9.2% of which are in dual VE ("IV sample"). In Table 3 below we compare their characteristics across samples.

Table 1: Number of graduates by track and observed variables

Observed variables	Dual	Full-time	Total
Education record	1,022	15,179	16,201
Employment record	988	13,187	14,175
Graduation date (Full sample)	820	10,216	11,036
Secondary school (IV sample)	567	5,589	6,156

Note: Graduates from VE in Madrid in 2014 and 2015 in fields with dual VE. The table shows how sample size changes with the set of observable variables. In particular, the exact graduation date is not included in all education records (third line) nor the compulsory secondary education school, from which we construct its distances to VE schools (fourth line).

Table 2 displays the number of observations by field and track. It shows that the types of areas where dual VE was introduced are very varied. On the other hand, due to its recent introduction, the number of graduates in dual VE in our sample is relatively small, especially in certain fields. For this reason, in those analyses below in which we focus on fields, we will exclude all fields with less than 10 graduates. The distribution of graduates across fields is not random, in that graduates are skewed towards fields that, as we find below, have better employment outcomes. As shown in Table 3, the majority of schools are public and they comprise the largest share of graduates, but there is a minority of private concerted schools that also offer both tracks. There is however a small difference in the distribution of graduates in dual and full-time tracks by ownership. A first step in estimating the effects of dual education is to check whether dual and full-time track graduates are similar.

Table 2: Number of graduates by field and track

	Dual	Full-time	Total
Forest and environmental management	2	72	74
Organization of physical activity and sports	39	1,773	1,812
Clinical analysis and quality control	34	201	235
Industrial chemistry	9	26	35
Business management and marketing	37	511	548
Production scheduling in mechanical manufacturing	6	160	166
Mechanical manufacturing design	10	66	76
Mechatronics	82	134	216
Automotive industry	102	506	608
Pattern and fashion design	19	79	98
Aircraft maintenance	16	86	102
Pathological anatomy and cytology	2	351	353
Diagnostic imaging	20	367	387
Clinical diagnostic laboratory	42	598	640
Computer system network management	50	805	855
Multi-platform application programming	59	505	564
Business and finance	82	1,517	1,599
International trade	6	238	244
Pre-school education	22	1,678	1,700
Management of turist accommodation	67	192	259
Kitchen management	83	222	305
Management of catering services	31	129	160
Observations	820	10,216	11,036

Note: Graduates from VE in Madrid in 2014 and 2015 in fields with dual VE. Full sample.

Table 4 presents the differences across tracks in the mean observed characteristics, including values of tests of their significance. Focusing on the full sample, the proportion of females is about one-third in dual but close to one-half for full-time tracks. A small proportion of graduates are foreign born, and there is no difference across tracks. At graduation, dual-track graduates are half a year older than full-time graduates and they have about one-month longer work experience at the start of their studies. Their entry route is more often a secondary VE degree and less frequently a high-school diploma. On the other hand, a small fraction of graduates has a previous tertiary VE degree, with dual-track ones having a slightly higher prevalence.

Table 3: Schools and graduates by ownership and track

	Both tracks	Full-time only	Total
Schools			
Public	9	99	108
Private concerted	7	71	78
Total	16	170	186
	Dual	Full-time	%
Graduates (%)			
Public	69.8	77.8	70.4
Private concerted	30.2	22.2	29.6
Total	100.0	100.0	100.0

Note: Graduates from VE in Madrid in 2014 and 2015 in fields with dual VE. 11,036 observations.

Table 4: Vocational education graduate characteristics

	Full sample				IV sample			
	Dual	Full-time	Diff.	p	Dual	Full-time	Diff.	p
Female	35.1	46.5	-11.4	0.00	34.4	50.4	-16.0	0.00
Born abroad	4.0	4.2	-0.1	0.85	2.3	2.6	-0.3	0.63
Age at graduation (y.)	23.5	22.9	0.5	0.00	22.8	22.4	0.4	0.00
Work experience (d.)	257.3	217.1	40.2	0.03	149.9	135.8	14.1	0.35
Entry route:								
High school	71.5	75.9	-4.4	0.00	76.5	82.3	-5.8	0.00
Secondary VE	7.3	4.5	2.8	0.00	7.4	4.3	3.1	0.00
Test	11.6	10.4	1.2	0.30	10.4	10.1	0.3	0.80
Foreign degree	1.1	0.8	0.3	0.43	0.5	0.1	0.5	0.00
Unknown	8.5	8.3	0.2	0.84	5.1	3.3	1.8	0.02
Previous tertiary VE	7.0	2.7	4.3	0.00	8.1	3.1	5.0	0.00
Graduation in 2015	72.4	49.8	22.6	0.00	75.0	60.3	14.6	0.00
Lower secondary ed.:								
No delay					69.3	67.1	2.3	0.28
1 year delay					22.0	23.3	-1.3	0.50
2 years delay					8.6	9.6	-1.0	0.45
Public school					48.0	54.0	-6.0	0.01
Avg. income p.c. (€)					13,330.0	13,327.1	2.9	0.99
Distances (minutes):								
Nearest dual school					41.5	50.8	-9.3	0.00
Nearest full-t. school					29.0	23.5	5.5	0.00
Difference					12.6	28.4	-15.9	0.00
Observations	820	10,216	11,036		567	5,589	6,156	

Note: Graduates from VE in Madrid in 2014 and 2015 in fields with dual VE. Data are percentages unless otherwise indicated, "y." denotes years and "d." denotes days. Per capita income refers to 2013, source: National Statistics (Urban Audit) and Madrid city council.

Graduates in the smaller sample, for which we have lower secondary education information (IV sample), exhibit similar characteristics and differences across tracks. The exception is work experience, which is now much smaller and does not show a significant difference across tracks. About two-thirds of individuals in both tracks graduated on time from lower secondary education. Dual-track graduates are significantly less likely to have studied in public schools. We use as a socio-economic indicator of the graduate's parents the average per capita income in 2013 of the district where the school in which the student finished lower secondary education is located. As is apparent from Table 4, they are the same on average for dual and full-time track graduates.

We also construct measures of the distances (in minutes) from the graduate's lower secondary school to the nearest schools offering, at the time of registration, the dual and the full-time track in the field where the student graduated. The lower secondary school serves as a proxy for the student's address, which is not observed. The difference between these two distances is our instrumental variable, that is meant to reduce the degree of endogeneity of track choice (see Section 5). Since dual tracks were new, there were much fewer schools offering them and therefore it took graduates longer to reach a dual-track school in their field (50 minutes) than a full-time school (23 minutes), i.e. the average distance is almost half an hour. As attested by Table 4, graduates who studied in the dual track were closer to dual-track schools and farther away from full-time track schools than full-time graduates. The difference across tracks is highly significant.

Table 5: Labor market outcomes

	Full sample				IV sample			
	Dual	Full-time	Diff.	p	Dual	Full-time	Diff.	p
Days employed	204.6	155.2	48.9	0.00	199.3	156.2	43.1	0.00
Days employed FTE								
Mean	181.1	119.2	61.9	0.00	173.9	120.6	53.3	0.00
Median	182.8	76.0	106.8		171.2	78.0	93.2	
Contract length (d.)	130.0	95.1	34.8	0.00	125.5	97.3	28.2	0.00
Regular job (3 m.)	70.7	58.7	12.1	0.00	70.2	59.2	11.0	0.00
Part-time contract	37.4	48.6	-11.2	0.00	39.9	49.3	-9.4	0.00
Open-ended contr.	31.7	22.7	9.00	0.00	29.3	21.6	7.7	0.00
Retention								
Immediate (1 m.)	11.1	7.0	4.1	0.00	11.3	7.4	3.9	0.00
Short-term (1 y.)	21.9	16.0	5.9	0.00	21.5	16.7	4.8	0.01
Labor income (€)*								
Mean	8,040.2	5,085.9	2,954.3	0.00	7,838.8	5,047.9	2,790.9	0.00
Median	6,321.3	3,014.4	3,306.9		6,094,6	2,965.1	3,247.4	
Hourly wage (€)**	7.0	6.6	0.4	0.00	7.2	6.5	0.7	0.01
Observations	820	10,216	11,036		567	5,589	6,156	

Note: Graduates from VE in Madrid in 2014 and 2015 in fields with dual VE. "d" denotes days, "m" denotes months, and "y" denotes years. (*) Full sample: Dual, 798 obs.; Full-time, 10,127 obs. IV sample: Dual, 555 obs.; Full-time, 5,549 obs. (**) Full sample: Dual: 653 obs.; Full-time: 7,577 obs. IV sample: Dual: 447 obs.; Full-time: 4,205 obs.

The outcomes that we analyze are displayed in Table 5. They are all referred to the first 12 months after graduating from VE. Starting with the full sample, dual-track graduates work on average for almost 7 months, whereas full-time graduates work 1.5 months less. This difference is increased to two months when we convert days of work into full-time equivalents (FTE). The distribution of days seems to be right-skewed for full-time track graduates, since the median is significantly below the mean, but not for dual-track graduates. Measures of the quality of jobs are on average favorable to dual-track graduates vis-à-vis full-time track graduates: the average length of labor contracts is four months vs. three months, and they are more likely to have a regular job (defined as one lasting at least three months), less likely to work part-time, and more likely to hold an open-ended contract. Retention by the training firm for dual VE graduates is slightly larger than for full-time graduates during both the first month and the first year after graduation; however the rates are very low, around one-half of

the typical level in France and one-third of the level in Germany. Dual VE graduates' total labor income during the first year and the hourly wage are both higher. All these differences are smaller in the IV sample and are strongly significant in both samples.

5 Empirical strategy

Our empirical strategy follows three steps. In the first step, we estimate the following standard OLS specification:

$$y_i = \alpha_t + \theta_j + \gamma_k + \beta X_i' + \delta Dual_i + \varepsilon_i \tag{1}$$

where y_i denotes the labor market outcome of individual i, α_t denotes fixed effects for the year and quarter of graduation, θ_j field-of-study fixed effects, γ_k school fixed effects, and X_i' a vector of personal characteristics: age at graduation and its square in years, born abroad dummy, work experience and its square in days, entry route (high school, secondary VE, test, and unknown), and having a previous tertiary VE degree. *Dual* is our treatment dummy. It takes the value of 1 if the individual followed the dual track and 0 if the person graduated in full-time VE. Standard errors are clustered by field and school.

This specification allows us to compare the labor market outcomes of similar individuals who studied in the same school and who obtained the same vocational degree in different tracks. Our coefficient of interest is δ. If the assignment to the two tracks were completely random, δ would measure the causal impact or the average treatment effect of dual VE. The same interpretation holds under the weaker assumption of conditional independence, which requires the choice of school track to be random conditional on the observable variables included among the regressors. However, there are good reasons to expect that this condition may be violated. The students who choose dual tracks may have different unobservable traits such as motivation or non-cognitive skills than the ones who opt for full-time VE, and these same traits may have an effect on labor market outcomes. If this is the case, then our OLS estimates

are biased.[10]

In our second approach we estimate the same specification using matching techniques. These techniques allow us to make pairwise comparisons between the most similar individuals in the two tracks. This procedure does not address the problem of selection on unobservable characteristics, but it leads to better results than OLS if there is imperfect overlap between the characteristics of the individuals in dual and full-time tracks. To be more precise, we use a nearest neighbor estimator that matches similar individuals within the same field of study, establishing similarity between subjects based on a weighted function of the remaining covariates for each observation (see Abadie and Imbens, 2006, 2011).

Finally, in our third approach we use an instrumental variable design to address the problem of selection on unobservables. A valid instrument is a variable that has a significant impact on the choice between dual and full-time VE, but no direct impact on labor market outcomes. In our analysis, we exploit exogenous differences in commuting time.

During our sample period only 16 out of 186 vocational schools in the region of Madrid offered dual tracks. Thus, on average, individuals had to travel a larger distance if they wanted to study in a particular field in the dual rather than the full-time track. We conjecture that an increase in commuting time may discourage the choice for dual VE even if the individual preferred dual over full-time education.

We do not have access to the home addresses of the individuals in our sample, but we do have the addresses and coordinates of all the secondary schools (*centros de ESO*) and vocational schools in the region of Madrid. Using the address of an individual's compulsory secondary school as a proxy for his or her home address, it is straightforward to calculate the commuting time to the nearest vocational school where this individual could have studied his or her chosen field in either the full-time or the dual track. To be more precise, we calculate the time it took to arrive by car to either of these schools at 9 am on Monday 16 April 2018. We then calculate the

[10]Our estimate of the treatment effect would still be unbiased if the unobservable characteristics were perfectly correlated with the controls for observable characteristics, but once again this need not be the case.

difference between these commuting times to obtain our instrument.

We implement our instrument using two-stage least squares (2SLS), as follows:

$$Dual_i = f\left(\alpha_t' + \theta_j' + \beta' X_i^{'} + \delta' \Delta Distance_i\right)$$

$$y_i = \alpha_t + \theta_j + \beta X_i^{'} + \delta \widehat{Dual}_i + v_i$$

where the variables are as in eq. (1) and $\Delta Distance$ denotes the differential distance to dual and full-time schools. Thus, in the first stage we estimate a probit model for the dummy *Dual* on a set of controls plus our instrument. Next, we replace the dummy *Dual* in (1) by its predicted value.[11] The controls in X are as in eq. (1) plus dummy variables for one- and two-year delays in lower secondary education, the log of the average per capita income in 2013 in the district or municipality of the individual's lower secondary education school, and a dummy variable for public school in lower secondary education.

Once again the coefficient of interest is δ, but in this specification it measures a local average treatment effect (LATE) on a subset of individuals called *compliers*. This subset includes all agents whose decision to enroll in either the dual or the full-time track depends on the value of the instrument. In other words, compliers are individuals who are likely to opt for a nearby school.

It is important to notice that our instrument is completely exogenous, as the choice of secondary school was made years before the introduction of dual VE. In fact, the regulation in place at the time made it difficult for parents to register their offspring in schools outside their district (for those who live in the city of Madrid) or municipality. Next, our identification strategy relies on the assumption that the difference in commuting time only affects labor market outcomes through their impact on the choice between dual and full-time VE. This assumption is innocuous for individuals who live within a small radius of the city of Madrid, but there could be cases of individuals in small municipalities who only consider local vocational schools and who discard

[11] The only difference with the OLS specification is the exclusion of the school fixed effect. Some dual tracks are only offered in one school. Hence, the choices of school and track may not be independent decisions.

employment opportunities in the city of Madrid. To deal with this potential violation of the exclusion restriction, we repeat our estimation for a sample of individuals who completed mandatory education in the city of Madrid.

Lastly, our instrument is computed using the option of car transport. This option may however not be available to all individuals and other alternatives like public transport typically produce larger differences in commuting time. The latter suggests that the sensitivity of the choice between dual or full-time education to the difference in commuting time may depend on individual socio-economic background. To address this issue, we analyze a second specification of our IV in which the distance indicator is interacted with the log of the average per capita income in the district or municipality of the individual's compulsory secondary education school.

6 Baseline results

This section summarizes our results for OLS and matching. Throughout the analysis we will present coefficient estimates for eight labor market outcomes referring to the first twelve months after graduation: (1) Total days of work, (2) Total full-time equivalent days of work, (3) Contract duration, (4) Having at least one regular job (3 months), (5) Having at least one open-ended contract, (6) Having worked part-time, (7) Total earnings, and (8) Hourly wage.

We first illustrate the choice of our baseline OLS specification with one of these variables, Total full-time equivalent days of work, and then show our estimates for all outcomes using OLS and matching techniques.

6.1 Baseline specification

Table 6 illustrates our choice of the baseline OLS specification. The table shows how the estimated coefficient on dual VE changes as we add more controls. When we only include year and quarter dummies we obtain a raw difference of 57 FTE days of work (col. 1). Adding a school fixed effect reduces the difference to 52 days (col. 2), while adding a field fixed effect causes a further reduction to 35.5 days (col. 3). The rest of

the controls cause only modest changes in the estimate. Controlling for demographic characteristics (col. 4) and individual's entry route[12] (col. 5) reduces the coefficient by 3.7 days, while including a second-order polynomial for previous work experience raises the estimate by less than one day to 32.8 FTE days of work (col. 6). This is our baseline OLS specification. All estimates of the dual VE effect are significant at the 1% level.

Table 6: Dual VE and Days of work FTE: Adding covariates

	Year and quarter	School fixed effects	Field fixed effects	Demo-graphics	Entry route	Expe-rience	Second-ary ed.	Avg. VE grade
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dual	57.06***	52.00***	35.46***	32.14***	31.73***	32.76***	28.74***	34.74***
	(4.55)	(7.25)	(7.69)	(7.47)	(7.37)	(7.21)	(8.52)	(7.99)
Previous tertiary					7.65	13.11**	13.43	9.53
VE					(5.31)	(5.68)	(7.44)	(6.91)
Work experience						0.06***	0.09***	0.08***
						(0.01)	(0.01)	(0.01)
Work experience^2						-6.33***	-2.10***	-1.90**
(10^{-6})						(0.95)	(0.50)	(0.81)
Lower secondary							-3.75	-0.79
ed. delay 1 yrs.							(3.26)	(4.25)
Lower secondary							-8.02	0.38
ed. delay 2 yrs.							(6.46)	(5.96)
Log(Income pc)							-15.40**	-12.46*
							(6.43)	(6.42)
Av. VE grade								4.35
								(2.85)
Adj. R^2	0.03	0.10	0.15	0.18	0.18	0.19	0.18	0.19
Obs.	11,036	11,036	11,036	11,036	11,036	11,036	8,196	5,883

Note: Graduates from VE in Madrid in 2014 and 2015 in fields with dual VE. OLS estimates using Stata module reghdfe (Correia, 2017). Control variables: age at graduation level and square, born abroad, entry route (high school, secondary VE, test, and unknown), field and school fixed effects, quarter and year of graduation. Standard errors clustered by field and school in parenthesis (Cameron *et al.*, 2011). Notation: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

For completeness, we also illustrate how the results change if we include controls

[12]The entry route includes a control for the individuals with a prior degree in dual VE at the tertiary level, which is only significant at the 10% level.

for the level of cognitive skills and proxies for the socio-economic background of the individuals. In a first step we add two controls for the years of delay in compulsory education (col. 7). This specification also includes the log of average per capita income of the school district or municipality where the individuals completed their compulsory education. The results indicate that students from poorer neighbourhoods obtain worse labor market outcomes, while the dummies that capture delays in compulsory education are non-significant. The combined effect is a 4-day reduction in FTE working days.[13] On the contrary, controlling for the average grade in tertiary VE would raise the coefficient estimate by 6 days to a level that is comparable to the specification that only includes school and field fixed effects.

As explained, we do not include the delay in compulsory education in our baseline specification as this would reduce the sample size by 25%. By contrast, the average grade in VE is excluded due to its endogeneity.

6.2 OLS estimates

After this brief discussion of our benchmark specification, we now proceed to present the OLS estimates for our full range of labor market outcomes. Table 7 follows the order indicated in the introduction of this section. All of the estimates indicate better outcomes for students from dual VE, though only six out of the eight coefficients are significant.

Column (2) reports our baseline result for the difference in FTE days, which is around one month. The comparison with the estimate in Column (1) shows that graduates from dual VE enjoy longer working days than their peers in full-time VE. Moreover, the correction for the length of the working day improves the precision of our estimates. Dual VE is also associated with significantly longer contracts (col. 3), higher chances of a regular job (col. 4) and an open-ended contract (col. 5), and

[13]Replacing the log of local per capita income by a secondary school fixed effects (724) leads to virtually the same result: 33.4 days of work FTE, significant at the 1% level. These fixed effects absorb all time-invariant differences in socio-economic circumstances at the local level. The similarity of the results with both indicators implies that differences in per capita income capture most relevant differences in socio-economic background.

Table 7: Dual VE and labor market outcomes

	Days employed	Days employed FTE	Contract length	Regular Job	Open-ended contr.	Part-time job	Labor income	Hourly wage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dual	27.36***	32.76***	22.86***	0.05*	0.04**	-0.05	1,619.17***	0.29
	(8.07)	(7.21)	(6.64)	(0.03)	(0.02)	(0.03)	(377.83)	(0.24)
Adj. R^2	0.12	0.19	0.10	0.08	0.05	0.10	0.18	0.02
Obs.	11,036	11,036	11,036	11,036	11,036	11,036	10,925	8,229

Note: Graduates from VE in Madrid in 2014 and 2015 in fields with dual VE. OLS estimates using Stata module reghdfe (Correia, 2017). Control variables: age at graduation level and square, born abroad, work experience level and square, entry route (high school, secondary VE, test, and unknown), previous tertiary VE, field and school fixed effects, quarter and year of graduation. Standard errors clustered by field and school in parenthesis (Cameron *et al.*, 2011). Notation: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

higher annual earnings (col. 7). In absolute terms, the difference in contract length is equal to 22.9 days, while the difference in annual earnings amounts to 1,619 euros. Nonetheless, for our purposes it is more interesting to consider relative differences. A comparison with Table 5 shows that graduates from dual tracks work on average 27% more FTE days while the relative difference in earnings amounts to 32%. This last difference is the combined effect of more days of work, longer hours, and longer contract duration.

In line with most of the literature we do not obtain a significant difference in hourly wages either. In a competitive labor market, this result would indicate that full-time and dual VE lead to similar levels of productivity. However, the Spanish labor market is heavily regulated and the wages of most entrants are set in collective agreements, not necessarily reflecting entrants' productivity.

We don't present results for retention rates, because the differences turn out to be very low and non-significant. It is however interesting to check whether the Dual VE effect is present for graduates who were not retained by their training firm, namely those not hired by this firm during the first year after graduation. The estimated coefficient is equal to 28.4 days FTE, significant at the 1% level, which is not statistically different from the baseline estimate of 32.8 days. The same is true for Labor income,

where the estimate is equal to €2,260, again significant at the 1% level. In this case, if anything, non-retained graduates seem to perform better than retained ones, which indicates that their skills are transferable.

6.3 Differences by gender, field and type of vocational school

So far we have analyzed the mean differences in labor market outcomes between the two groups of graduates. In this section we probe below the surface to analyze the differences by gender, field, and school ownership , where we will make a distinction between public and private schools.[14] The results for the differences by fields are reported in Table 8, while those for gender and school type are shown in Table 9. All specifications include the same controls as our baseline plus an interaction between our treatment dummy *Dual* and the variable of interest.

Differences by field of study

In a first step we analyze the differences across fields in the outcomes for graduates in dual and full-time tracks. We only report results for fields with a minimum of 10 students in the dual track. For each of these fields, Table 8 reports the average FTE days of work in full-time and dual tracks plus the absolute value and the relative size of the difference between the two tracks.

Inspection of the Table shows surprisingly large differences across fields. In five fields the students in dual tracks obtain significantly better results than their peers in full-time tracks. In absolute terms, the largest (significant) differences are observed in Mechanical manufacturing design (130 FTE days) and Aircraft maintenance (120 FTE days). In these sectors, the students in dual tracks accumulate on average, respectively, 296 and 278 FTE days of work during the first twelve months.

At the other extreme, there are four sectors in which the difference in FTE days of work between is negative and significant, with values ranging from 7 days in Diagnostic

[14]Initially, dual vocational tracks were also offered in so-called concerted schools. These are private schools that receive a fixed compensation per student from the State in return for using the same rules for admission as public schools. The covenant with private schools no longer exists, but the students who choose private schools receive a financial compensation from the State that covers part of the difference in tuition fees.

imaging to 52 days in Organization of physical activity and sports. It is worthwhile noticing that some of the negative results are in fields with below-average outcomes in full-time tracks. The clearest example is the program on Pre-school education, with an average of 69 FTE days of work in full-time VE and a modest 43 FTE days in dual tracks.

Finally, there are some fields with excellent labor market outcomes in both tracks but in which the difference between dual and full-time tracks is non-significant. This is the case for Mechatronics or Multi-platform application programming.

Table 8: Dual VE and Days of work FTE by field

	Full-time	Dual	Dual effect	Dual effect (%)	Sign.
Org. of physical activity and sports	92.8	44.8	-48.0	-51.7	***
Clinical analysis and quality control	134.8	110.0	-24.8	-18.4	**
Business mgmt. and marketing	95.5	128.6	33.1	34.6	
Mechanical manufacturing design	165.9	295.9	130.0	78.4	***
Mechatronics	189.9	206.6	16.7	8.8	
Automotive industry	147.1	196.6	49.5	33.7	**
Fashion design	60.6	127.8	67.2	110.9	***
Aircraft maintenance	157.9	278.0	120.1	76.1	***
Diagnostic imaging	131.1	122.1	-9.1	-6.9	***
Clinical diagnostics	108.4	155.6	47.2	43.5	
Computer network management	168.3	190.4	22.1	13.2	
Multi-platform app. programming	195.8	231.0	35.2	18.0	
Business and finance	138.3	146.9	8.6	6.2	
Pre-school education	69.0	43.1	-25.9	-37.6	***
Mgmt. of turist accommodation	98.4	180.2	81.8	83.1	***
Kitchen management	149.9	163.7	13.8	9.2	
Management of catering services	109.6	135.3	25.7	23.5	

Note: Graduates from VE in Madrid in 2014 and 2015 in fields with dual VE. OLS estimates of field fixed effects and coefficients on dual VE and dual interactions with field using Stata module reghdfe (Correia, 2017). Control variables: age at graduation level and square, born abroad, work experience level and square, entry route (high school, secondary VE, test, and unknown), previous tertiary VE, field and school fixed effects, quarter and year of graduation. Standard errors clustered by field and school in parenthesis (Cameron *et al.*, 2011). Notation: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Differences by gender

In Section 4 we showed that women are under-represented in dual VE. But inspection of Table 9 shows no significant gender differences in the benefits from dual VE. None of

the interactions is significant at the 5% level except for the finding that male graduates in dual tracks have a higher probability of having an open-ended contract than full-time graduates, whereas there is essentially no difference across tracks for women. Somewhat surprisingly, though, we find that women generally obtain better labor market outcomes than men, irrespective of whether they choose dual or full-time VE. The women in our sample work more days, have longer contracts, have a better access to regular employment, and earn more than men. On the downside, they obtain more part-time jobs than men, while there is no evidence of a gender gap in hourly wages.

Table 9: Dual VE and labor market outcomes: Gender and school ownership

	Days employed	Days employed FTE	Contract length	Regular Job	Open-ended contr.	Part-time job	Labor income	Hourly wage
Dual	30.44***	34.05***	24.32**	0.06**	0.07***	-0.03	1,565.49***	0.57*
	(8.59)	(9.40)	(9.83)	(0.03)	(0.02)	(0.04)	(465.15)	(0.33)
Female	19.83***	13.79**	10.68***	0.07***	0.01	0.07***	348.80*	-0.17
	(4.98)	(5.41)	(3.73)	(0.02)	(0.01)	(0.01)	(186.31)	(0.22)
Dual *	-8.12	-3.42	-3.85	-0.02	-0.08***	-0.05	140.31	-0.70*
Female	(8.81)	(9.65)	(9.04)	(0.03)	(0.02)	(0.03)	(565.65)	(0.36)
R^2	0.12	0.19	0.10	0.08	0.05	0.10	0.18	0.02
Obs.	11,036	11,036	11,036	11,036	11,036	11,036	10,925	8,229
Dual	28.26***	35.19***	21.85**	0.04	0.03**	-0.08*	1991.22***	0.36
	(6.56)	(6.93)	(8.74)	(0.03)	(0.01)	(0.04)	(302.63)	(0.28)
Dual *	2.59	-4.00	6.05	0.05	0.02	0.14**	-1358.15	-0.3
Private	(27.25)	(25.35)	(22.93)	(0.08)	(0.07)	(0.05)	(893.75)	(0.37)
R^2	0.11	0.19	0.10	0.08	0.05	0.10	0.18	0.02
Obs.	10,730	10,730	10,730	10,730	10,730	10,730	10,621	8,003

Note: Graduates from VE in Madrid in 2014 and 2015 in fields with dual VE. OLS estimates using Stata module reghdfe (Correia, 2017). Control variables: age at graduation level and square, born abroad, work experience level and square, entry route (high school, secondary VE, test, and unknown), previous tertiary VE, field and school fixed effects, quarter and year of graduation. Standard errors clustered by field and school in parenthesis (Cameron *et al.*, 2011). Notation: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Differences between public and private schools

The comparison between public and private schools only yields one significant difference. Namely, we find that dual VE reduces the incidence of part-time work for graduates from public schools (by 8.27 pp, significant at the 5% level) while the oppo-

site is true for graduates from private schools. In particular, adding the coefficients of *Dual* and of its interaction with a dummy for private schools delivers a net-increase in the incidence of part-time work of 5.9 pp. In other words, despite the fact that there is evidence of a more positive perception of dual VE among the teaching staff at private schools (Pineda Herrero *et al.*, 2017), this does not show up in larger differences in labor market outcomes between students in dual and full-time tracks.[15]

6.4 Matching estimates

The OLS results measure the average difference in labor market outcomes between the graduates from dual and full-time VE once we control for observable characteristics. Matching techniques allow us to make pairwise comparisons between the most similar individuals in both groups. Our nearest-neighbour estimator matches students within the same field and minimizes the differences in all other observable dimensions. The results are reported in Table 10.

Table 10: Dual VE and labor market outcomes: Matching

	Days employed	Days employed FTE	Contract length	Regular Job	Open-ended contr.	Part-time job	Labor income	Hourly wage
Dual	28.09***	35.95***	21.75**	0.09	0.00	-0.02	1,406.69***	-0.77**
	(10.67)	(8.81)	(8.54)	(0.07)	(0.02)	(0.04)	(405.15)	(0.34)
Obs.	10,522	10,522	10,522	10,522	10,522	10,522	10,415	7,870

Note: Graduates from VE in Madrid in 2014 and 2015 in fields with dual VE. Nearest neighbour matching estimates with exact matching by field and bias adjustment for continuous variables (Abadie and Imbens, 2006, 2011) using Stata module reghdfe (Correia, 2017). Control variables: age at graduation level and square, born abroad, work experience level and square, entry route (high school, secondary VE, test, and unknown), previous tertiary VE, field and school fixed effects, quarter and year of graduation. Robust standard errors in parenthesis. Notation: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

A comparison between Tables 7 and 10 reveals small differences in the point estimates, but none is statistically significant except for the probability of having an

[15]Our specification with school fixed effects does not allow us to test for differences in level effects between public and private schools.

open-ended contract, which now disappears. The similarity between OLS and matching results is reassuring. It shows that there is a sufficient degree of overlap between the samples of students in dual and full-time tracks despite the differences reported in Table 4.

7 Instrumental variables

Until now we have treated the choice between dual and full-time VE as exogenous. However, as explained in the Introduction, in reality the students made a choice, and in the case of dual tracks, the training firms participated in the initial selection of candidates. In order to obtain an unbiased estimate of the causal impact of dual VE we therefore need an exogenous source of variation in the propensity to enroll in either the dual or the full-time track.

We experimented with three different sets of instruments. All are based on the difference in commuting time between an individual's secondary school and the two nearest vocational schools that offered the chosen field in the dual and full-time tracks ($\Delta Distance$). Since the supply of dual tracks has changed over time, we control explicitly for the year in which individuals started their studies of VE at the tertiary level. In our first specification we use the difference in commuting time in the entry year to predict the participation in dual VE. In the second specification, we use the interaction between these differences in commuting times and the log of average per capita income at the district or municipality level. This second specification allows us to test whether the impact of differences in commuting times depends on the income level of the parents, where the latter is proxied by average local per capita income. These differences could arise because of different opportunity cost of either money or time, or because some individuals are constrained to travel by public transport while others can afford to travel by car. Finally, our preferred specification includes the previous two instruments plus the square of our distance indicator, which allows us to control for potential non-linearities in the impact of the difference in commuting time on the propensity to participate in dual VE.

First-stage results

In the first stage, we estimate a probit model for the probability that an individual chooses the dual track. The regressors include all the controls of our baseline specification, except for the school fixed effects, plus our IV. We cannot include the school fixed effects because in several fields the choice of dual is isomorphic to a choice of school. To increase the precision of the estimates we therefore include the three variables indicated in Section 5, which are related to lower secondary education.

Table 11: First stage: Predicting graduation in Dual VE

	(1)	(2)	(3)
ΔDistance	-0.86***	-9.74***	-7.54***
	(0.12)	(2.69)	(2.23)
ΔDistance^2			0.49***
			(0.09)
ΔDistance * log(Income p.c.)		0.94***	0.65***
		(0.28)	(0.23)
Weak identification test	117.43	110.07	125.11
Pseudo R^2	0.23	0.23	0.24
Obs.	6,156	6,156	6,156

Note: Graduates from VE in Madrid in 2014 and 2015 in fields with dual VE. Probit estimates. Control variables: age at graduation level and square, born abroad, work experience level and square, entry route (high school, secondary VE, test, and unknown), previous tertiary VE, lower secondary graduation one- and two-year delay and public school, log average district per capita income, field fixed effects, quarter and year of graduation. Standard errors clustered by field in parenthesis. Weak identification refers to the Kleibergen-Paap rk F statistic. Notation: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

The first-stage results are reported in Table 11. In all three cases our instrument is highly significant, with p-values well below 1%. As conjectured, an increase in commuting time reduces the probability that the individual opts for dual VE. The marginal effect is smaller for individuals from richer households, as indicated by the positive coefficient of the interaction term in Column 2, and it is decreasing in the square of the difference in commuting time. A complier is therefore likely to be an individual from a relatively poor neigbourhood who happens to live relatively close to a school with the dual track in the field of his choice.

Apart from the high level of significance of our instruments, it is also important to highlight their relevance. An increase in the difference in commuting time from

the value at the 25th percentile (8.4 minutes) to its value at the 75th percentile (42.9 minutes) reduces the probability of participation by 43 pp.[16] Finally, in all three cases our IV passes the weak instrument tests without any problem. The conventional critical value for the F-test is equal to 10, while we obtain values in the range between 113 (for labor income) and 125 (for all outcomes except income and hourly wage).

In sum, commuting time is a very powerful predictor of participation in dual VE. This feature is crucial for the reliability of the results in the second stage, but it also seems to indicate that few students were aware of the potential benefits of dual VE when it was first introduced.

Second-stage results

The second-stage results are reported in Table 10 and correspond to our preferred specification.[17] Since the sample size is smaller than before, we have re-estimated our baseline OLS specification on the same sample for the same set of controls – hence we have replaced the school fixed effects by a dummy to distinguish public and private schools. The coefficient of the predicted value of *Dual* is our estimate of the causal impact of dual VE, while the difference between this LATE estimate and the corresponding OLS estimate is a measure of the magnitude of the selection effects.

Inspection of the Table shows that none of our LATE estimates is significantly different from zero for any of the labor market outcomes. In other words, none of the differences reported in the previous sections has a causal interpretation. This results is the combined effect of a decrease in the value of the estimated coefficients and an increase in the value of the standard errors. The estimates are less precise than before because we are forced to exclude the school fixed effects.

The Table shows that the corresponding OLS specification only yields significant differences (at the 5% confidence level) along four dimensions. In the case of FTE days of work, the control for selection on unobservables reduces the coefficient estimate by roughly 50%, from 28.6 to 14.1. On the contrary, in the case of average contract

[16]The calculations are based on our preferred specification of the IV (col. 3).

[17]The second-stage results for the other two specifications are available upon request. We do not report them in the table because there are no statistically significant differences with the results of the chosen specification.

length the difference is negligible, while our control for selection eliminates the entire difference in earnings. Whereas the OLS coefficient of *Dual* in the case of earnings is equal to €1,621, LATE yields a statistically non-significant difference of €5 in favour of graduates in full-time VE. The larger standard errors explain why our LATE estimate of the effect on contract length is not statistically different from zero. On the contrary, in the case of FTE days of work and annual income the causal impact would not be significant even using the standard errors of the corresponding OLS estimates.

Table 12: Dual VE and labor market outcomes: Instrumental variables

	Days employed		Days employed FTE		Contract length		Regular job	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Dual	25.23**	-2.94	28.56***	14.13	20.38***	20.05	0.06	-0.10
	(9.75)	(25.69)	(8.94)	(25.03)	(6.75)	(24.97)	(0.03)	(0.11)
Adj. R^2	0.12	0.12	0.19	0.18	0.10	0.10	0.09	0.08
Obs.	6,156	6,156	6,156	6,156	6,156	6,156	6,156	6,156
	Open-ended contract		Part-time job		Labor income		Hourly wage	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Dual	0.05**	0.07	-0.03	-0.10	1,621.49***	-4.91	0.55*	1.68
	(0.02)	(0.10)	(0.04)	(0.07)	(486.81)	(963.08)	(0.27)	(1.58)
Adj. R^2	0.05	0.06	0.11	0.11	0.18	0.17	0.02	0.01
Obs.	6,156	6,156	6,156	6,156	6,104	6,104	4,652	4,652

Note: Graduates from VE in Madrid in 2014 and 2015 in fields with dual VE. IV estimates using Stata module reghdfe (Correia, 2017). Instruments: distance difference, distance difference times log average district per capita income, and distance difference squared, Control variables: age at graduation level and square, born abroad, work experience level and square, entry route (high school, secondary VE, test, and unknown), previous tertiary VE, lower secondary graduation one- and two-year delay and public school, log average district per capita income, field fixed effects, quarter and year of graduation. Standard errors clustered by field in parenthesis (Cameron *et al.*, 2011). Weak identification test (Kleibergen-Paap rk Wald F statistic): 125.11; for Labor income: 113.09; for Hourly wage: 137.52. Notation: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

In other words, we find clear evidence of positive selection –the students in dual tracks not only have more favorable observable traits, they also differ favorably in terms of unobservable traits from their peers in full-time tracks– and once we take these effects into account we do not find coefficient estimates that are significantly

different from zero.

Finally, we have performed a number of robustness checks to see whether the results change if we limit our attention to more homogeneous subsamples. First, we have estimated separately for men and women. In one set of exercises, we restricted our sample to individuals who finished their compulsory education in the city of Madrid. This restriction puts a natural upper-limit on commuting times and avoids a possible violation of the exclusion restriction as individuals in remote municipalities may ignore both schooling and employment opportunities in the city. Next, re-estimated the model separately for the fields with above- and below-median labor market outcomes, measured by FTE days of work by full-time VE graduates. This dummy allows us to test whether dual VE has a causal impact in the subset of fields with above-median outcomes. However, neither of these tests alter our basic results. The next logical step would be to look for causal impacts at the field level, but this requires data on at least one additional cohort of graduates, so as to enlarge the sample, and is left for future research.

8 Concluding remarks

In this study we have presented the first rigorous evidence on the impact of dual vocational education on labor market outcomes in Spain. Contrary to most studies in this literature, we are able to compare students in dual and full-time VE within narrowly defined cells. Moreover, the scarce supply of dual tracks during our sample period allowed us to construct a powerful instrument to control for selection on unobservables. The instrument is based on differences in the commuting time of students to schools with dual and full-time tracks.

Our study documents large differences in labor market outcomes between graduates in dual and full-time VE. However, we also show that these differences do not have a causal interpretation, at least in the case of the compliers. Since our data refer to the first two cohorts of graduates, the results may improve over time as schools and firms acquire more experience with the system. The existence of large differences in the

labor market outcomes by field offers a further margin of improvement and so does the fact that many students seem to base their enrollment decisions on proximity. Efforts to adapt the supply of dual tracks in line with the observed differences in insertion rates and improvements in student orientation in secondary school might thus yield improvements in overall outcomes.

Nonetheless, beyond these straightforward margins of improvement, it is important to draw attention to the institutional setting in Spain. The current regulation was designed to offer regions the option to experiment with the introduction of dual tracks. It imposed only a small set of minimum conditions and many elements of the system, such as the requirements for tutors, were left unregulated. Moreover, decades of experience with dual training have resulted in the design of an intricate institutional setup in countries like Germany, with a prominent role of the social partners and sectoral organizations, that are hard to replicate.

Finally, further research and experimentation should shed light on a number of important open questions. One important issue is the frequency and the timing of the alternation between the school and the firm. Does alternation lead to better learning outcomes and, if so, what regulation would be appropriate? Second, currently students are entitled to stipends in most regions, but there are proposals to give apprentices employee status. Salary payments may improve the motivation of the students but they should be in line with apprentice productivity. Collective agreements therefore seem to be the natural place to regulate the salaries of apprentices. Last but not least, virtually all programs in VE last two years. In highly specialized fields this may leave little time for school instruction if the students spend the entire second year at a training firm. The legal option of three-year programs exists. Well-designed pilot projects could inform us about the appropriateness of such extended programs.

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