

Dual Vocational Education and Crime

Daniel Montolio^{1,2}, Juan Pascual^{1,2} and Jenifer Ruiz-Valenzuela^{1,2,3}

¹*University of Barcelona*

²*Institute of Economics of Barcelona*

³*Centre for Economic Performance, London School of Economics*

Abstract

This paper examines how vocational education reforms can generate sizable crime-reduction externalities at the neighborhood level. We study the staggered rollout of Dual Vocational Training across Catalonia, starting in 2014. This new approach shifted vocational instruction toward firm-based apprenticeships, expanding workplace training from under 500 hours to over 1,000 hours and introducing subsidized paid apprenticeship contracts. Adoption differed across schools over time, generating policy-relevant quasi-experimental variation. We estimate difference-in-differences models with continuous treatment intensity at the census-tract level. The analysis links administrative records for the universe of Catalan vocational students to daily geocoded police reports (2008–2018). The results show that a 1 percentage-point increase in the dual track share reduces reported youth crime by approximately 13%. Effects build gradually and strengthen over the second and third years, consistent with persistent behavioral change rather than purely mechanical incapacitation. Reductions concentrate during daytime hours—when apprentices are typically at firms—consistent with incapacitation. Declines are strongest for economically motivated property crimes (especially theft), consistent with increased opportunity costs through earnings and improved labor-market prospects. These results imply that apprenticeship-style programs can deliver substantial non-pecuniary social returns through reduced criminal externalities and, therefore, may play a role in disrupting intergenerational disadvantage.

Keywords

Vocational training, youth crime, Difference-in-Differences, on-the-job training

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✉ montolio@ub.edu (D. Montolio); juanpascual@ub.edu (J. Pascual); jruizv@ub.edu (J. Ruiz-Valenzuela)

🌐 <https://sites.google.com/site/danielmontolio2/> (D. Montolio); <https://sites.google.com/site/ruizvalenjenifer/> (J. Ruiz-Valenzuela)

1. Introduction

Youth crime remains a pressing concern for policy and society. Criminal activity tends to peak in late adolescence, when many individuals are still enrolled in secondary school (Levitt and Lochner 2001). Moreover, teenagers who drop out of school face substantially higher risks of engaging in delinquency (Lochner 2011). Early criminal justice involvement can also severely hinder a young person's human capital development and future earnings (Waldfogel 1994; Hjalmarsson, Holmlund, and Lindquist 2015). Thus, improving educational opportunities—especially during the critical transition out of compulsory schooling—may help steer at-risk youth away from crime.

In this paper, we investigate whether expanding access to high-quality vocational education programs can reduce crime. Specifically, we study the introduction of an innovative firm-based vocational training initiative (known as Dual Vocational Training, or “DVT”) in Catalonia, and evaluate its impact on local crime rates. Our empirical strategy exploits the staggered rollout of the program across schools and their surrounding neighborhoods. We implement a Difference-in-Differences design that compares crime trends in areas that adopt DVT to those that do not, before and after program implementation. Importantly, take-up was jointly decided by centers and students, so we verify that treated and control locations exhibited parallel pre-treatment crime trends and that prior local crime levels or other observable factors did not drive the timing of program adoption, addressing endogeneity concerns and bolstering the causal interpretation of our estimates.

We find that the introduction of firm-based vocational training leads to a significant decline in crime. The results show that a 1 percentage-point increase in the dual track share reduces reported youth crime by approximately 13%. Effects build gradually and strengthen over the second and third years, consistent with persistent behavioral change rather than purely mechanical incapacitation. Reductions concentrate during daytime hours—when apprentices are typically at firms—consistent with incapacitation. Declines are strongest for economically motivated property crimes (especially theft), consistent with increased opportunity costs through earnings and improved labor-market prospects. A key robustness check finds no offsetting increases in areas hosting training firms, helping rule out spatial displacement. The project implies that apprenticeship-style programs can deliver substantial non-pecuniary social returns through reduced criminal externalities and, therefore, may play a role in disrupting intergenerational disadvantage.

We explore several mechanisms that could explain these crime reductions. The pattern of delayed but sustained declines in offending is consistent with a *dynamic incapacitation* effect (Bell, Costa, and Machin 2022; Huttunen et al. 2023): engaging students in intensive workplace training keeps them productively occupied during peak crime-prone ages and may instill routines and skills that continue to deter criminal behavior over time. In addition, we observe that the decreases in crime are driven largely by economically motivated offenses, suggesting that the program raised youths' future earning prospects and the opportunity cost of illegal activity (an “income effect” channel). Improvements in non-cognitive skills or changes in peer environments due to the program could further reinforce these outcomes. Overall, our findings imply that enhanced vocational education can deter youth from crime through both increased human capital and the structured time that training provides.

This study builds on and extends the literature linking education to crime. A robust body of work shows that keeping adolescents in school longer can reduce criminal involvement, often through incapacitation in the short run and higher returns to legal work in the long run (Lochner and Moretti 2004; Machin, Marie, and Vujić 2011). Other research finds that improving educational quality or school environments also curbs youth crime (Deming 2011). However, much less is known about the crime-prevention role of vocational training. Notably, Huttunen et al. (2023) find that in Finland, admission to any post-compulsory secondary school greatly lowers subsequent criminality, even though they detect no significant difference between attending academic versus vocational tracks. We contribute new evidence by examining a qualitative improvement within vocational education itself: the shift from a purely school-based model to one that integrates substantial firm-based training. Our analysis is the first to causally identify the local crime effects of introducing an apprenticeship-style vocational program. Moreover, by leveraging detailed geocoded crime data, we observe the spatial and temporal

patterns of offending around treated schools, shedding light on how and when educational interventions translate into safer neighborhoods.

The remainder of the paper is structured as follows. Section 2 provides background on the institutional context of vocational training in Spain and the rollout of the DVT program. Section 3 describes the data. Section 4 outlines our empirical methodology. Section 5 presents the main results. Section 6 explores mechanisms and discusses additional robustness checks. Section 7 concludes.

2. Vocational Training in Spain

2.1. Spanish Education System

In Spain, compulsory education lasts until the age of 16. After completing compulsory secondary education, students can choose between continuing their education through academic or vocational tracks. Academic track prepares students primarily for tertiary education, whereas vocational ones train students for specific occupations. Vocational training itself consists of two stages: Intermediate-level vocational training and Higher-level vocational training, each usually lasting two years. Fig. 1 describes the structure of the Spanish education system.

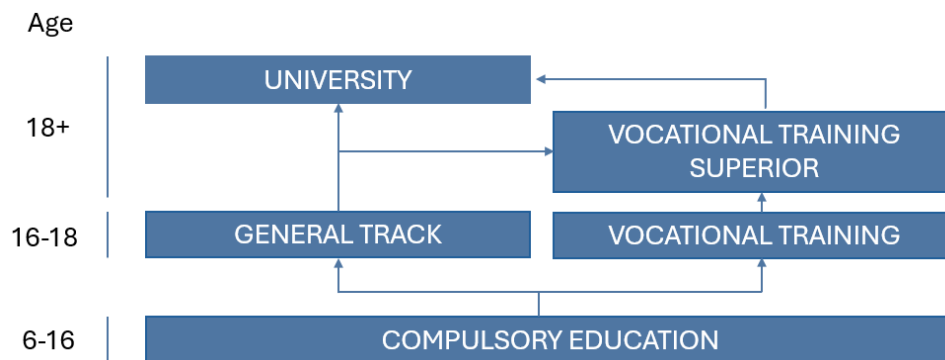


Figure 1: Structure of the Spanish education system.

2.2. Dual Vocational Training

Traditionally, vocational education in Spain was predominantly school-based, with limited exposure to real-world work environments. The dual modality was formally introduced by Royal Decree 1529/2012 of 8 November 2012, which established the contractual framework for training and apprenticeship programs. This reform enabled a tight combination of theoretical instruction at educational centers with practical training in firms, substantially increasing students' engagement with the labor market¹. Because DVT requires a formal training contract, most DVT students receive a salary.² In contrast, regular vocational programs typically involve short, unpaid internships.

A key institutional feature of DVT is the introduction of the *firm tutor*, a designated mentor at the host company who supervises the student during the workplace-based phase, monitors task performance and competency acquisition, and provides a formal evaluation report to the school. Evaluation in DVT is therefore *joint*: teachers at the educational center remain responsible for awarding final grades, but they explicitly incorporate the firm tutor's assessment for the components of the curriculum delivered

¹Subsequent legislation further standardized the dual model, culminating in Organic Law 3/2022 of 31 March 2022, which defined minimum requirements for enterprise-based training. Under this framework, company-based training must represent at least 35% of total program duration in the dual modality and be covered by a paid training contract. The reform consolidated an alternating center–workplace structure, elevating firms to active training agents and strengthening the employability focus of the system.

²Salaries for DVT internships are set by collective bargaining agreements according to the wage of the corresponding professional group. They cannot be lower than 60% of the reference wage during the first year, 75% during the second year, or below the national minimum wage.

at the firm. By contrast, in Regular VT, the student's assessment is almost entirely conducted by school instructors; the brief internship is commonly pass/fail and has limited weight in graded coursework.

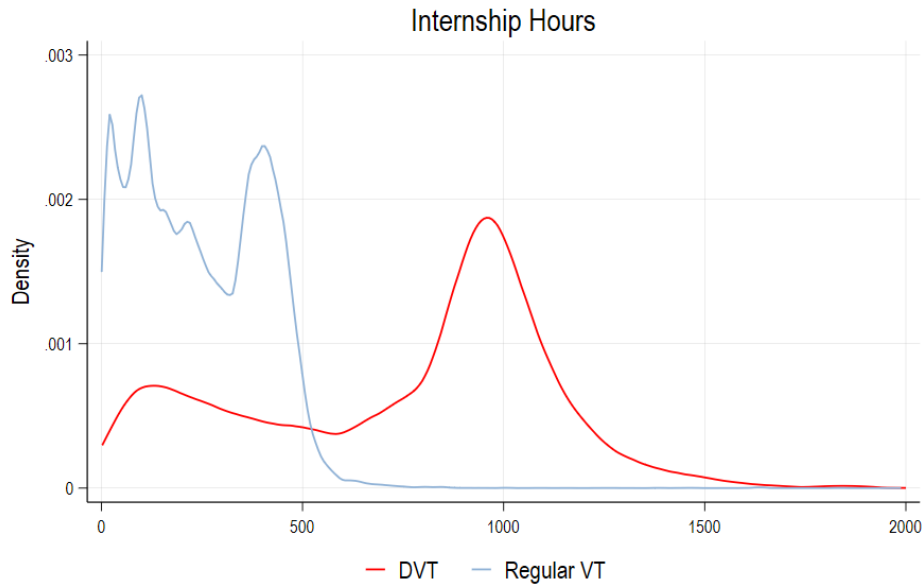


Figure 2: Internship hours in Regular VT and DVT (2013–2018).

Figure 2 documents the distribution of internship hours in both tracks. DVT students complete substantially longer workplace periods (often around 1,000 hours), whereas regular internships are much shorter and concentrated below 500 hours. Crucially, the total program workload and nominal duration are the same in Regular and DVT. What differs is the allocation of time across learning venues: DVT integrates an extended, credit-bearing firm component as a central part of the curriculum, while Regular VT concentrates the bulk of learning at the school and treats the internship as a short complement. Thus, DVT does not lengthen studies; it rebalances school- and firm-based learning within the same overall degree requirements.

DVT positions are heavily subsidized by the state, which covers a substantial share of total training costs. Firms typically contribute only a fraction of the internship salary, making the cost of hiring a DVT student significantly lower than that of hiring the same student under a regular contract. Depending on the training year and collective agreement, firms pay between 25% and 50% of the student's salary, while reduced Social Security contributions further decrease overall employment costs. In short, participation in Dual VT allows firms to substantially reduce total wage and contribution expenses.

Figure 3 shows the roll-out of DVT in Catalonia between 2011/12 and 2023/24 across students, firms, and centers. Between 2014/15 and 2018/19 (the period we analyze), the number of DVT students increased from fewer than 500 to almost 4,000, with parallel growth in firm and center participation.

Regarding admissions, students apply to vocational programs (not to the dual track itself), and there are no catchment areas at this level; admission is merit-based. Once admitted, students must secure a firm placement through school-facilitated offers or by arranging one themselves; at this stage, they choose between DVT and Regular VT. In practice, access to DVT depends on academic performance, the availability of participating firms, and the student's ability to obtain a suitable placement. Schools differ in how strongly they promote and implement the dual modality, generating substantial cross-center heterogeneity.

This institutional setting is central to our analysis. We exploit the staggered adoption of DVT across schools to estimate its causal impact on local crime. While not all vocational students enroll in or complete it, those who do tend to experience higher employment prospects and stronger labor market attachment (Bentolila, Cabrales, and Jansen 2023), channels that plausibly affect local crime dynamics.

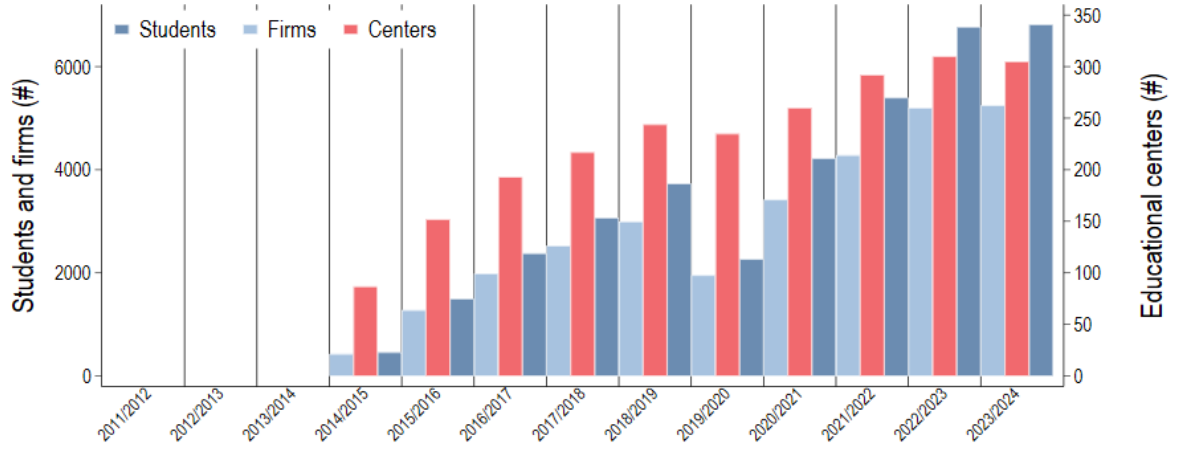


Figure 3: Staggered roll-out of DVT in Catalonia.

3. Data and Estimation Sample

3.1. Data

Our empirical analysis combines rich administrative data from two main sources: the Department of Education of the Catalan Government and the Catalan police force, the Mossos d'Esquadra. The educational dataset covers the period from 2012 onward and includes exhaustive records of all educational training programs offered in Catalonia. Specifically, we observe school-level data on location, type of ownership (public or private), and the availability of both regular and DVT tracks. At the student level, the data includes detailed information on internships such as start and end dates, hours worked, and firm characteristics. Students' demographic profiles are also available, including age, gender, migrant status, postal code of residence, and special education needs.

The crime dataset consists of daily geolocated reports from 2008 to 2018, compiled by the Mossos d'Esquadra. It includes information on more than 300 distinct types of criminal offenses and over 600 types of locations where crimes occurred. Each report includes the date and geographic coordinates of the incident, as well as the characteristics of both the offender and the victim, such as age, gender, and nationality. This high-resolution spatial and temporal data allows us to construct annualized crime rates for small geographic units surrounding each vocational education center.

3.2. Estimation Sample

Our estimation sample is constructed at the level of census sections, which are small geographical units with an average of approximately 1,000 inhabitants. We focus on census sections that contain one vocational education center. For our Difference-in-Differences analysis, we define treatment as a binary indicator that equals one from the first year in which the school in the census section offers at least one DVT spot. Census sections with a school offering Regular-only VT during the sample period serve as controls.

We exclude from the sample schools that started offering DVT spots and subsequently stopped doing so, as well as census sections that host more than one educational center, for the sake of comparability. This way, we are left with 1,440 treated school-years and 1,840 control school-years.

The staggered roll-out allows us to estimate the average treatment effect of DVT on local crime rates by comparing treated and untreated census sections before and after adoption. In the next section, we describe our empirical strategy in detail.

4. Empirical Strategy

4.1. Identification Strategy

To estimate the causal effect of the introduction of Dual Vocational Training on crime, we exploit the staggered adoption of the program across educational centers in Catalonia. The gradual roll-out of DVT across schools and census tracts generates quasi-experimental variation in both timing and location of treatment exposure. We therefore implement a Staggered Difference-in-Differences (DiD) design following Callaway and Sant'Anna (2021), allowing for treatment effects that vary over time since adoption.

Formally, we estimate the following event-study specification:

$$Y_{ct} = \alpha_c + \lambda_t + \sum_{k \neq -1} \beta_k \cdot \mathbf{1}\{t - G_c = k\} + \gamma' X_{ct} + \varepsilon_{ct}, \quad (1)$$

where $Y_{c,t}$ denotes the number of crimes in census tract c at time t ; α_c are census tract fixed effects; λ_t are time fixed effects; and G_c represents the first year in which census tract c is exposed to DVT. The coefficients β_k capture dynamic treatment effects k years relative to the adoption of DVT. $X_{c,t}$ is a vector of time-varying covariates, including population size and the share of foreign residents. Standard errors are clustered at the district level. This framework allows us to trace the dynamic response of crime to the introduction of DVT, while accounting for staggered adoption across units.

The treatment indicator equals one if the educational center located in census tract c offers any DVT position in year t , and zero otherwise. The unit of observation is the census tract, which in our data uniquely maps to a single vocational training center.

Identification relies on the standard parallel trends and no-anticipation assumptions. Specifically, in the absence of DVT introduction, crime trends would have evolved similarly across tracts regardless of adoption timing, and local outcomes should not react to the program before its implementation.

As per Martinez-Bravo (2014), we test the random treatment timing assumption by assessing whether the timing of DVT adoption is plausibly exogenous to pre-existing local trends. Specifically, we examine whether changes in key census tract and school characteristics during the pre-treatment period predict the first year of treatment.

Table 1

Pre-treatment characteristics and timing of DVT adoption

	(β , SE)
Population	-0.008*** (0.002)
% Foreign	0.006 (0.005)
% Female Students	0.002 (0.002)
% Migrant Students	0.001 (0.001)
% Higher Degree VE students	-0.000 (0.001)
Mean Student Age	-0.013 (0.023)
Notes: Each row reports the result of a regression using the first year of treatment as the DV on the named covariate percent change between 2011-12 and 2013-14 (a pre-treatment period), using robust standard errors. The sample only includes census tracts that will be treated at some point during the sample period. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.	

Table 1 presents the results. The dependent variable is an indicator for the first year of treatment, and the explanatory variables capture the percentage change in local demographic and school characteristics between 2011/12 and 2013/14, a pre-treatment period. The sample is restricted to census tracts that eventually adopt DVT during the study period. The results show that, with the exception of total population—which is statistically significant but economically small—none of the coefficients are significant predictors of treatment timing. This suggests that the introduction of DVT across schools was not systematically driven by pre-existing local trends, lending support to the assumption that

program adoption was largely determined by administrative and institutional factors rather than endogenous local dynamics.

5. The effect of DVT on crime

5.1. Main Results

We begin by examining the impact of the implementation of DVT on local crime rates. Figure 4 presents an event study analysis of the estimated effects of DVT on the number of crimes in the treated census sections. The results indicate a clear and statistically significant decline in crime following the introduction of DVT. The effect emerges gradually after the program starts and becomes most pronounced between the second and fourth years post-implementation. Importantly, there is no evidence of pre-treatment trends, supporting the validity of our identification strategy. We find that the introduction of DVT is associated with a reduction in reported crime rates of approximately 10–12%, relative to pre-treatment levels.

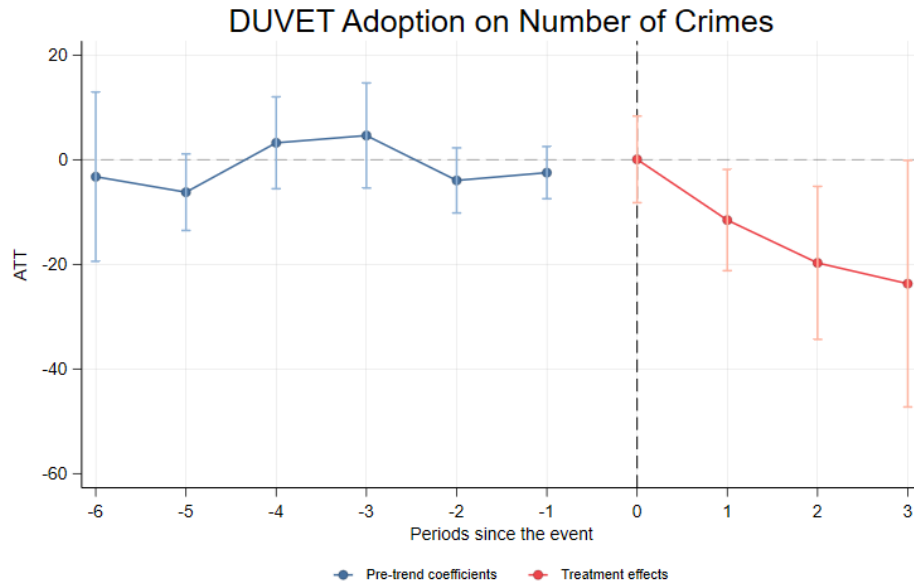


Figure 4: ATT of DVT adoption on the number of crimes.

To ensure that the estimated effects are not driven by changes in the demographic composition of areas or schools following the adoption of DVT, we extend our baseline specification by including additional controls at both the census tract and school levels. At the census tract level, we account for the share of foreign population and land area (in square kilometers). At the school level, we control for the percentage of female, migrant, and higher-degree vocational students, as well as the average age of enrolled students.

The estimated dynamic treatment effects remain virtually unchanged once these covariates are included. The decline in local crime following the introduction of DVT persists in magnitude and timing, indicating that the results are not explained by compositional changes in the student population or local demographic shifts. In other words, the observed crime reduction reflects a genuine treatment effect rather than changes in who attends the schools or lives in surrounding areas.

Regular and DVT spots' shares are very heterogeneous among educational centers (see Fig. 5). To further explore heterogeneity in the intensity of DVT implementation, we estimate specifications using the fraction of DVT students as a continuous measure of treatment exposure. Table 2 reports preliminary estimates from two-way fixed effects regressions, showing that areas with a higher share

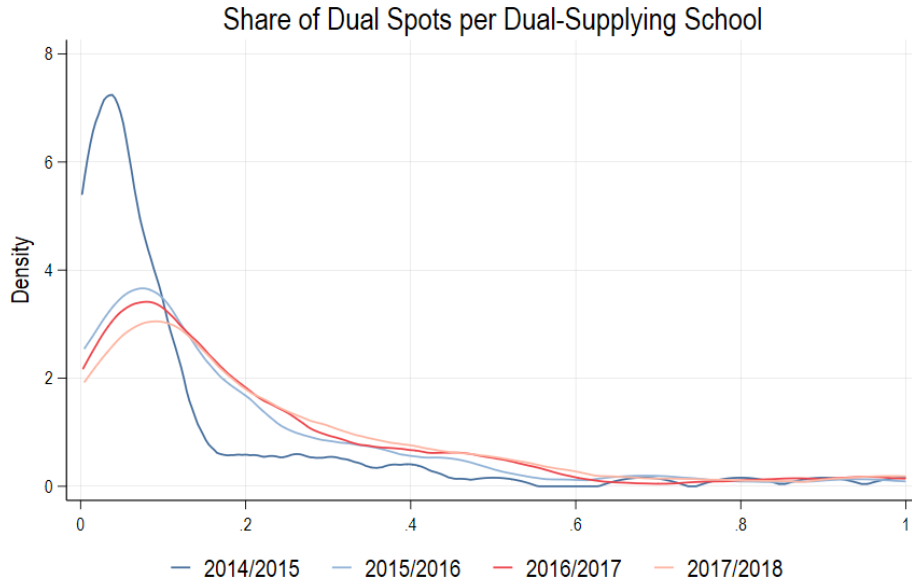


Figure 5: Percentage of DVT spots in treated schools.

of DVT students experience larger reductions in crime. The coefficients are negative and statistically significant, confirming that treatment intensity amplifies the program's local effect.

Table 2

Treatment intensity and crime: two-way fixed effects estimates

	Number of crimes			Log crimes		
	(1)	(2)	(3)	(4)	(5)	(6)
Fraction DVT	-37.718*	-37.792*	-38.073*	-0.073	-0.075	-0.058
(SE)	(19.363)	(19.589)	(19.639)	(0.093)	(0.092)	(0.089)
Controls:						
Population	✓	✓	✓			
Log population				✓	✓	✓
Census tract FE		✓	✓		✓	✓
School-level covariates			✓			✓

Notes: Each column reports the result of a regression of the number of crimes (cols 1–3) or log crimes (cols 4–6) on the fraction of students in DVT (0 to 1), with SEs clustered at the census tract level. Observations: 3,200. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

5.2. Displacement of Crime

In addition to the school-based estimates, we also examine whether the observed crime declines near treated centers could instead reflect a spatial displacement of offenses to the locations where students train. To that end, we perform the analogous event-study analysis on census sections containing firms that host Dual students³, with the estimated effects plotted in Figure 6.

Figure 6 shows the ATT on the number of crimes in each year relative to the firm's first hosting year. All post-treatment coefficients are statistically insignificant: although the point estimates suggest a small uptick in crime after treatment, none of these effects is significantly different from zero. Likewise,

³We have managed to geolocate 76% of the firms using their addresses.

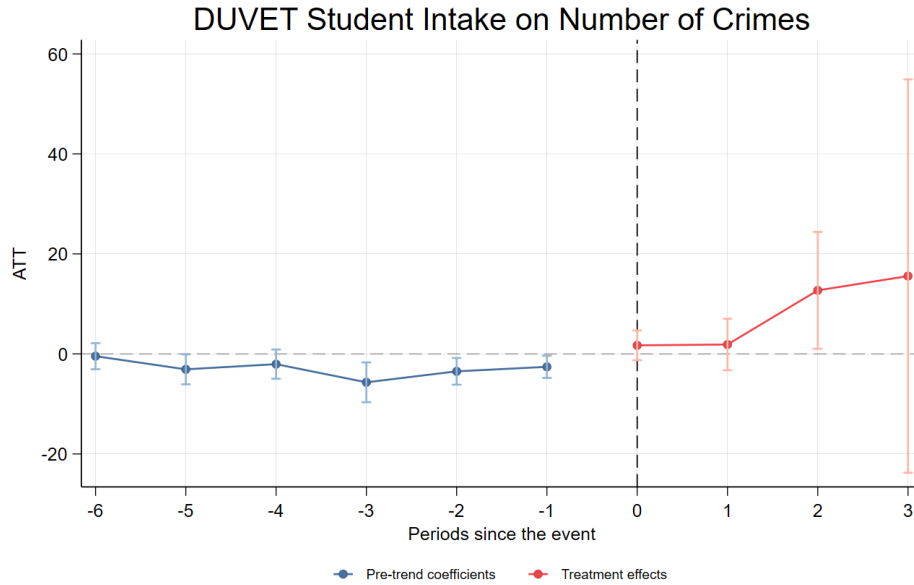


Figure 6: ATT of Dual students hosting on the number of crimes.

we observe no discernible pre-trend. Hence, there is no evidence of increased crime around these firms following the introduction of DVT. The lack of any significant crime rise at the firm locations implies that the reductions observed near treated schools are not due to crime being displaced elsewhere. This finding reinforces the interpretation that the DVT program generates genuine reductions in local crime, rather than merely shifting criminal activity from schools to the firms that host the students.

5.3. Incapacitation Effects

To explore whether the observed decline in crime is partly explained by incapacitation mechanisms, we examine the dynamics of day and night crimes separately. The rationale is that if DVT effectively occupies students' time during working hours—through school attendance, firm-based training, or commuting to internships—its impact should be more pronounced for crimes committed during the day, when students are directly engaged in program activities.

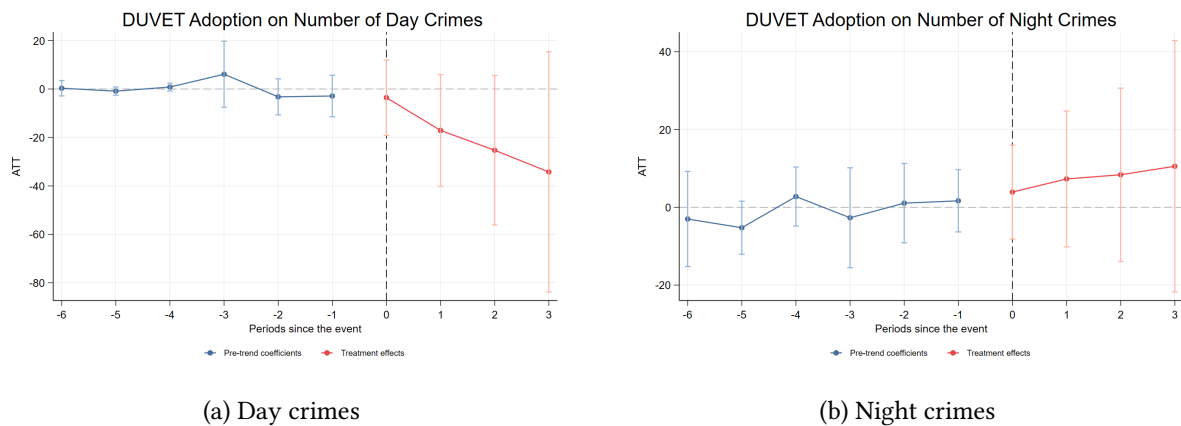


Figure 7: ATT of DVT adoption on the number of day and night crimes.

Figure 7 displays the estimated dynamic effects of DVT adoption on daytime and nighttime crimes. Despite non-significant, the results suggest a post-treatment decline in crimes occurring during the

day, while a non significant increase is observed for crimes committed at night. We interpret this as suggestive evidence that the reduction in overall crime is largely driven by daytime offenses. This pattern supports the interpretation that incapacitation plays a key role in explaining the observed effects. By engaging students in structured activities (training, coursework, and firm-based internships) DVT effectively reduces idle time and opportunities to commit crimes during daytime hours.

5.4. Effects by Crime Type

Figure 8 presents heterogeneity analyses by type of offense. We find that the overall decline in crime is driven primarily by reductions in thefts, which are economically motivated offenses. This pattern of results is consistent with the theoretical channels through which DVT may operate—namely, by improving legitimate employment prospects, increasing the opportunity cost of crime, and incapacitating youth through structured training and work commitments.

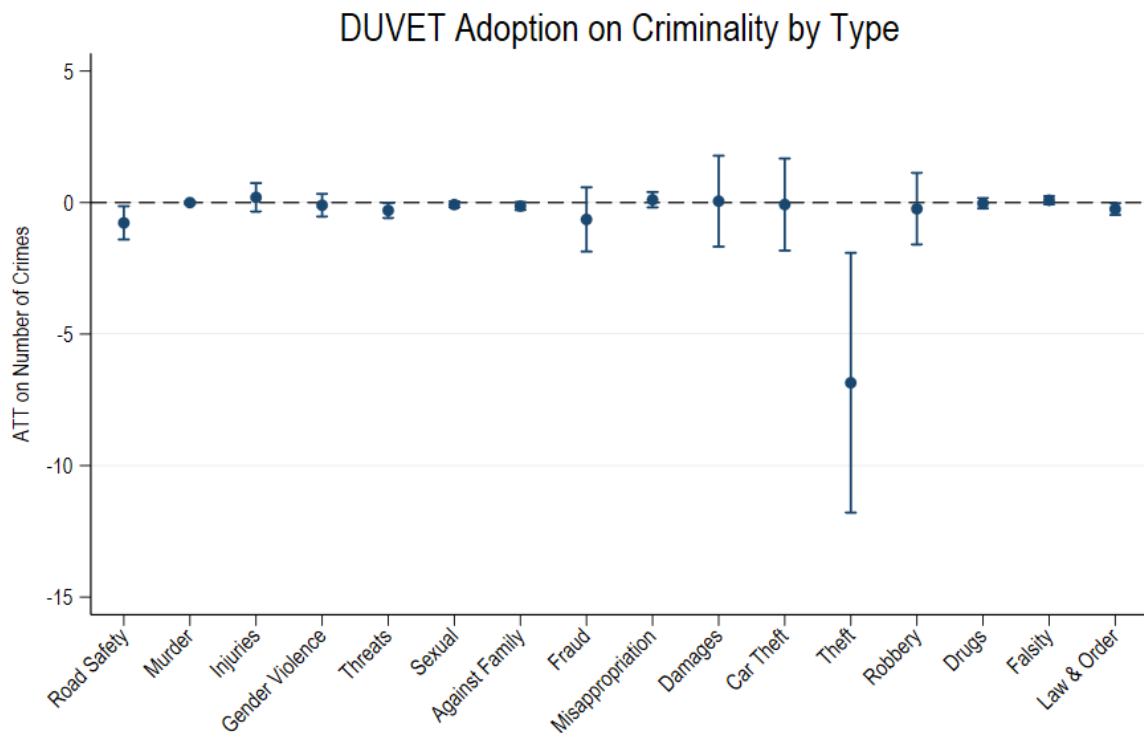


Figure 8: ATT of DVT adoption on crime by crime type.

6. Conclusions

Taken together, the findings demonstrate that DVT has a meaningful and localized effect on reducing crime in the areas where it is implemented. The effects are both statistically significant and policy-relevant, supporting the view that vocational training reforms with strong workplace components can play an important role in crime prevention strategies.

The evidence points to two main mechanisms. First, the results suggest an *incapacitation effect*: the decline in crime is concentrated during daytime hours, when students are engaged in training or internships. By structuring students' daily schedules and limiting idle time, DVT reduces the opportunity to engage in criminal activity. Second, the program may generate an *income effect*: students in the dual track typically receive remuneration through apprenticeship contracts, directly reducing the economic incentives to commit crimes. Together, these channels imply that both time allocation and improved

short-term financial stability contribute to the observed reduction in local crime. This interpretation aligns with recent findings by Bell, Costa, and Machin 2022 and Huttunen et al. 2023.

This is a preliminary version of the paper. In future work, we will assess robustness by exploiting variation in geographical exposure to DVT, redefining the treatment radius to 0 km (same census section), 1 km, 2 km, and 3-5 km “donut” bands. This will allow us to test whether the effects dissipate with distance from implementing schools. We will also extend the analysis to consider continuous treatment within a staggered DiD framework, crime incidence around students’ residence postal codes, heterogeneity across offense types, and differential effects for teenage populations.

Overall, the results highlight that DVT not only facilitates school-to-work transitions but also generates meaningful social externalities through reduced local crime. By improving both employment prospects and short-term income, DVT combines education and economic incentives in a way that effectively contributes to crime prevention.

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