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Connecting High School, College and the Labor Market: Evidence on the Scale-up of Career Pathways in California

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ABSTRACT

I examine a new generation of Career and Technical Education (CTE) models that has shifted from isolated courses to sequences of study that integrate academics and skills in specific career areas. I use data for a competitive grant administered by the California Department of Education (CDE) that incentives K-12 school districts to partner with community colleges and businesses to increase the career readiness levels of high school students. This study provides causal estimates of receiving large grants (i.e., up to 15 million dollars) to create aligned pathways by leveraging a natural experiment that occurs at the margin of grant receipt. Per pupil CTE expenditures increased by 21.7 percent at school districts that received the grant compared to unsuccessful applicants. Furthermore, dropout rates declined by 23 percent in districts receiving grants. The reduction in dropout rates appears to be concentrated for females and 11th grade students. The impacts for females may be related to design choices by grant applicants to focus on creating career pathways in traditionally female dominated sectors (e.g. health care support). The cost of preventing a single student from dropping out from this intervention is approximately 18,000 dollars compared to the present discounted value of a high school diploma of 300,000 dollars.

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Connecting High School, College and the Labor Market: Evidence on the Scale-up of Career Pathways in California

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Abstract

I examine a new generation of Career and Technical Education (CTE) models that has shifted from isolated courses to sequences of study that integrate academics and skills in specific career areas. I use data for a competitive grant administered by the California Department of Education (CDE) that incentives K-12 school districts to partner with community colleges and businesses to increase the career readiness levels of high school students. This study provides causal estimates of receiving large grants (i.e., up to 15 million dollars) to create aligned pathways by leveraging a natural experiment that occurs at the margin of grant receipt. Per pupil CTE expenditures increased by 21.7 percent at school districts that received the grant compared to unsuccessful applicants. Furthermore, dropout rates declined by 23 percent in districts receiving grants. The reduction in dropout rates appears to be concentrated for females and 11th grade students. The impacts for females may be related to design choices by grant applicants to focus on creating career pathways in traditionally female dominated sectors (e.g. health care support). The cost of preventing a single student from dropping out from this intervention is approximately 18,000 dollars compared to the present discounted value of a high school diploma of 300,000 dollars.

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1. Introduction

The economic and social consequences of failing to obtain a high school diploma are stark. The limited job prospects and low wages of drop outs led Cullen and coauthors (2013) to label dropping out of high school an "economic death sentence" (p.134). Outside of the labor market, dropouts are incarcerated at greater rates and experience a host of poorer health and social outcomes (Pettit & Western 2004; Cutler & Lleras-Muney 2006; Rumberger & Rotermund 2012). High school graduation rates have stagnated since the 1970's and gaps persist for blacks, Hispanics and males (Heckman & LaFontaine, 2010; Murnane, 2013). Despite the reality of only 36 percent of young adults obtaining a bachelor's degree, the majority of high schools in the United States focus on a college preparatory curriculum (Snyder & Dillow 2012; McFarland et al. 2017). This stylized fact coupled with others (e.g., increasingly dynamic workforce needs, the rising costs of attending college, and the challenges to college completion) have fueled a renewed interest in new models of Career and Technical Education (CTE) programs for high school students.

This new generation of CTE models has shifted from isolated courses to sequences of study that integrate academic learning and skill-building in specific career areas (Holzer et al. 2013). Three features distinguish these models from previous vocational programs: aligned career pathways; integration of academics and career preparation; and training in practical technical and employability skills (Holzer et al. 2013; Dougherty & Lombardi 2016). Proponents argue that coupling career preparation and training with a college preparatory curriculum is a dramatically underutilized approach that can meaningfully reduce social inequality by providing salient employment skills through multi-course sequences in high school that link to

postsecondary degree and training programs (Cullen et al. 2013; Holzer et al. 2013; Dougherty, 2018).

Recent studies on new CTE models find promising results in terms of improved high school completion, yet these studies focus on a small number of schools that require an application, specialize in CTE and are highly-resourced (see Kemple 2008, Doughtery 2018 and Hemelt at al. 2019). Given their small scale, select-student population and unique set of resources, these studies of CTE impact are useful proof of concepts but may not generalize to the broader population. Furthermore, prior descriptive work on CTE course taking has documented positive student selection into career pathways suggesting that Ordinary Least Squares (OLS) estimates will produce biased estimates (Dougherty 2016, Kreisman & Stange 2017). This study leverages a natural experiment that allows us to recover causal estimates in an at-scale policy environment using data from over 800 school districts in California.

This study examines an innovative statewide competitive grant program, the California Career Partnership Trust (CCPT) that awarded funds to districts partnering with community colleges and local businesses to form articulated career pathways in high-growth sectors. The selection committee used a detailed rubric to rate applicants and a pre-specified threshold based on applicants' plans and their capacity to implement career pathways. Using Regression Discontinuity (RD) designs, I show that at the margin, the applicants who score just above and just below the threshold are indistinguishable based on their baseline characteristics and dropout rates. This study design is uniquely suited to separate out whether underlying capacity, district characteristics or additional dollars for career pathway models drives impact.

This study focuses on two important outcomes. First, I examine the effect of grant receipt on overall CTE spending. Successful applicants increased their per pupil district spending on

CTE by nearly 100 percent of the grant amount. This finding is consistent with extant literature in public policy of local governments using the proceeds of lump sum grants for their intended purpose (i.e., "flypaper effect"). Second, I examine the most salient outcome for an intervention aimed at increasing the career readiness and labor market outcomes for high school students, dropout rates[1]. The substantial 23 percent reduction in dropout was driven by reductions for female students and may have been mediated by district choices to provide pathways in traditionally female dominated sectors (e.g., health care).

This study is organized as follows: in section 2, I discuss the theoretical considerations for career pathways and the prior literature in this area. In section 3, I describe the CCPT grant program, the plans of the applicants and characterize grant implementation. In section 4, I describe the data; and in section 5, I describe the RD estimation strategy. I present my results in section 6 and conclude in section 7.

2. Theoretical Considerations and Prior Literature

The empirical literature on the effect of career preparation and training suggests that participation in CTE are associated with consequential, though not transformative, improvements in student outcomes. Previous research has documented a correlation between participation in vocational coursework and increased wages and labor participation rates (Mane 1999; Bishop & Mane 2004; Meer 2007; Kreisman & Stange 2017). However, research on older models of CTE also note that students positively select into vocational courses (Meer 2007; Kreisman & Stange

[1] I also examine student test score outcomes but privilege the dropout rates in this study because the reduction in dropout implies that the testing population is endogenous. A reduction in the dropout rate suggests that marginal students remain enrolled in high school, potentially lowering the average ability of tested students in treatment schools. However, I find no evidence suggesting there was a change in average test scores at the assignment threshold. Test score results are available upon request from the author.

2017). A defining argument for the career pathway approach is increased student engagement and completion because students are able to make a connection between academics and their future work prospects. Yet the evidence on increases in educational attainment related to vocational course-taking is mixed (Agodini & Deke 2004; Cellini, 2006; Neumark & Rothstein 2006; Kemple 2008; Dougherty, 2018). This may stem from the inability of previous studies to account for student selection into vocational coursework and heterogeneous capacity across implementing schools and districts. The studies that are able to account for confounding factors find increased on-time high school completion (Dougherty 2018; Hemelt et al. 2019) and longer-run evidence of improved labor market outcomes (Kemple 2008). These three studies, however, represent highly-resourced small-scale implementations of model CTE programming and thus may not generalize when implemented at-scale under varying political and economic conditions.

2.1. Theoretical Considerations

The first key result of this paper is to demonstrate that the recipients of the CCPT grant increase their spending on CTE programming. The CCPT grant functioned similarly to a lump-sum grant, increasing the overall resources of recipient districts.[2] Economic theory suggests that the provision of a lump-sum grant to a local government will result in a modest increase in spending on the targeted area. A lump-sum grant effectively increases overall income and residents may choose other spending priorities with their increased budgets. However, a large body of literature has documented larger increases in spending than would be explained by economic theory, known as the "flypaper effect." This well-documented finding that money

[2] The CCPT application required applicants to propose a budget that showed maintenance of effort (i.e., no decrease in CTE spending based on prior year spending). However, these requirements are often without teeth and an applicant could, in theory, decrease their CTE spending or slow intended increased in spending as a result of grant receipt.

tends to stick where it is directed includes instances where local spending increases by unity (Hines & Thaler 1995).

The second key result of the paper examines the impact of districts spending additional CTE dollars on student outcomes. Exposure to career training during high school may affect student outcomes through several channels. First, this training can increase students' technical and soft-skills which can improve their employment prospects and wages. Indeed previous research has documented a correlation between participation in vocational coursework and increased wages and labor participation rates (Mane, 1999; Bishop & Mane 2004; Meer 2007; Kreisman & Stange 2017). Second, linking classroom learning to the real world may increase student engagement as students are able to make a connection between academics and future work prospects. The evidence on increases in educational attainment related to vocational course-taking, however, is mixed (Agodini & Deke 2004; Neumark & Rothstein 2006; Cellini, 2006; Doughtery, 2018).

Persistence in high school is the most proximal outcome. CTE pathways may improve outcomes by addressing information asymmetries for students. If students lack information on the types of careers available to them as well as knowledge about the courses necessary to gain entry to those occupations, structured career pathway sequences will serve to better match students with opportunities in the labor market. Providing students with career pathways can also function as a behavioral nudge. Schools provide a default choice architecture by institutionalizing guidance counseling thus giving students an inferred recommendation for a set of high school courses (and career choices). Career pathways may also reinforce students' social identity and increase their sense of belonging and engagement with schooling.

Career pathways may also simply change the mix of courses students enroll in; time spent in CTE courses results in fewer courses taken in other subject areas. This may result in higher graduation rates along with decreased student learning and/or effort. Nonetheless, these arguments suggest that for students on the margin of graduating, CTE programming has the potential to keep students enrolled in school longer and teach skills valued in the labor market. I now turn to the extant literature on interventions that examine the impact of CTE interventions.

2.2. Relevant Literature

The CCPT call for proposals required partners to develop CTE pathways that are similar to two models examined in the literature, career academies and Linked Learning. Both models combine academic content with career and technical-skill building within a career theme (e.g., health professions). These models also feature partnerships with local business to provide work-based learning opportunities, job shadowing and mentoring to students (Saunders and Chrisman 2011).

The most rigorous evidence comes from a randomized evaluation from the mid 1990's of career academies (Kemple and Snipes, 2000; Kemple, 2008). The researchers found that although the intervention did not improve standardized test scores, participants were at lower risk of dropping out of school and more likely to graduate on-time (particularly at schools with greater levels of support). In the long run, Career Academy students' experienced sustained earning gains (averaging 11 percent or $2088 more per year) compared to their counterparts in traditional high schools. The labor market gains were particularly concentrated among young men (a group that has experience earning declines in recent years). This study, however, focused on 9 oversubscribed high schools in primarily urban contexts. Career academies may be particularly beneficial when students have access to larger labor markets. Furthermore, these

schools, by virtue of being oversubscribed, signal to students and their family that they have unique capacity (i.e., human capital) to provide high-quality services to students.

The other evidence on the effectiveness of career pathways are mixed but use weaker study designs. In one study of a multi-district pilot program of Linked Learning pathways researchers use a propensity score matching design to account for student selection and find no difference in their measures of student engagement: attendance and suspension rates (Fitzgerald et al 2016). The authors find that although participants were more likely to complete a college-preparatory curriculum they were not more likely to enroll in postsecondary education. A study of an earlier-era career pathways program, Tech-Prep, funded by the federal government in the 1990's finds that participation diverted participants from 4-year to 2-year institutions with no impact on high school completion (Cellini 2006).

Two recent studies examine the effect of contemporary career academies on student performance using credibly causal designs. Dougherty (2018) studies the impact of attending three oversubscribed application-based schools in Massachusetts that use a lottery to admit students while Hemelt and colleagues (2019) examine outcomes for attending one career academy high school in North Carolina. Both studies document selection into CTE programs: males, whites and students with lower baseline test scores are more likely to enroll in CTE programs while special education students and English learners are less likely to enroll. In terms of impacts, both studies find increased high school completion using the results of an admissions lottery to simulate a randomized control trial design. These findings have strong internal validity but represent a limited view of the effect of career pathways due to the small-scale and high fidelity nature of the intervention. In this study, I examine the potential of career pathway models to affect change at-scale.

The success of at-scale CTE reforms likely hinges on the fidelity of implementation. As noted by Kemple and Snipes (2000), there was significant heterogeneity in the level of support provided to students at the different Career Academies. Similarly, Linked Learning evaluators noted the wide range of implementation quality across schools (Guha et al. 2013; Fitzgerald et al 2016). Thus, the ability to bring about meaningful improvements in student outcomes may have less to do with the particular traits of a career pathway program and more to do with institutional capacity to implement a high-quality program. In this study, I make two important contributions: I am able to isolate the effect of providing career pathways by comparing school districts with similar capacity to implement these reforms; and I use data from a large heterogeneous state implementing these reforms at-scale.

3. California Career Pathways Trust

3.1. CCPT Grant Overview

The CCPT grant was established to help K-12 school districts, community colleges and employers build partnerships to help students transition into postsecondary education or the workforce in high-growth sectors. This competitive grant program, established by state law in 2014, provided 500 million dollars in funding for career pathway programs. Staff in the Career and College Transition Division of California's Department of Education (CDE) administered the application process across two round of funding in 2014 and 2015. Applicants were rated on a common rubric by multiple experts from CDE, the California Community Colleges Chancellors Office (CCCCO), and the California Workforce Investment Board (CWIB)[3]. Grant

[3] Applicants were rated on seven pre-specified criteria and a rubric available in the application packet (available at https://www.cde.ca.gov/fg/fo/r17/documents/ccpt14app.doc). The scoring rubric consisted of seven criteria including a statement of need, description of the targeted population, the planned approach, partners, outcome measures, capacity and sustainability and budget.

recipients were required to document their use of awarded funds by reporting enrollment in career pathways and tracking grant spending in publicly available district financial summaries.

The short-term nature of the grant (i.e., over three years) provided start-up funding and served as an incentive for districts to develop sequenced curriculum that was aligned to the postsecondary partner institutions. As such, grant funding was distributed over three years with 50 percent of funds dispersed in the first year, 35 percent in the second and the remaining 15 percent in year three. A maintenance of effort provision required recipients to supplement CCPT grant dollars with existing CTE funding streams (i.e., other local, state and federal sources) as detailed in the application's budget narrative.

The CCPT grant design and implementation focused on providing access to and supports for a range of districts. CDE provided guidance to potential applicants through workshops, webinars and by contracting a non-profit agency to provide technical assistance. CDE officials hosted four full-day application workshops in the four major regions of the state as well as two online webinars to provide an overview of the application and answer applicant questions. Additionally, the applicants could apply for three different tiers of grants (i.e., in the amount of 600,000, 6 million or 15 million dollars) to account for the range in school district sizes across urban and rural areas. Individual school districts were also able to form multiple partnerships although agencies could only serve as the fiscal agent (i.e., lead agency) for one grant application. To facilitate partnerships of interested entities the CDE required interested applicants to submit a Letter of Intent (LOI) two months prior to the application due date. A list of entities submitting LOIs was posted publicly on the CDE website and all fiscal agents were required to submit an LOI to be considered for a CCPT grant.

The goal of the CCPT career pathways was to create multi-course sequences in target sectors in high school that aligned with courses of study at postsecondary partner institutions that culminate in credentials that are valued in the labor market. Applicants were required to use data from the Bureau of Labor Statistics (BLS) to identify high-growth industries and high-wage careers in their region to create vertically-aligned pathways with coursework at the high school and postsecondary levels. For each proposed career pathway applicants were required to specify a program of study detailing which courses and subject areas students would complete in secondary school (i.e., in grades 9 through 12) in addition to specific courses at partner institutions in years 13 and 14. The CCPT application rubric and webinar support materials describe successful applicants as those who build partnerships between employers, schools and community colleges to improve student transitions to higher education and employment opportunities.

A hallmark of the CCPT application was its prescriptive nature that prompted applicants to use data to support their design choices. One unique feature of the application requirement was a form that detailed the planned course of study by grade level. This document required applicants to list both the CTE and academic coursework in secondary and postsecondary (i.e., grades 9 through 14) along with specific occupations requiring only a high school education, technical certifications or postsecondary degrees and their average wage levels.[4] For example, in the health care sector and career pathway of health care administrative services an applicant identified a four-course sequence including Medical Core, Medical Careers 1 and 2, and Nursing Assistant (CNA) training to be taken during high school. Occupations identified requiring only a

[4] While there was space in the application to list courses to be taken in years 15 and 16 of postsecondary education for advanced skill jobs these were not required for applicants to receive the highest score on the rubric.

high school diploma included medical record technicians and medical transcriptionists earning approximately 18 dollars per hour. The proposed career pathway continues at the local community college resulting in a Health Information Technology certificate that includes coursework in medical terminology, health care data analysis and medical quality management etc. This certificate qualifies applicants to work as health information managers/specialists resulting in hourly wages of 30 to 36 dollars. Applicants were directed to the BLS url on the application to obtain the necessary wage data.

The CCPT application process guided interested districts in a planning process to identify high-growth sectors in their region and provided support in choosing career pathways to align with this growth. Applicants were expected to build on existing CTE offerings and match grant dollars with existing district funds. This competitive grant process incentivized local school districts to transform their existing CTE programs to models advocates believe can transform student outcomes. In the next section, I discuss the implementation of these new pathways.

3.2. Implementation Evidence

Implementation evidence from CCPT grantees comes from several sources: a legislative report commissioned by the legislature in the original bill securing the programs passage; a 2-year implementation study of grant winners by researchers affiliated with the agency charged with providing technical assistance to grant winners and my own analysis of CCPT grantees applications. Together these sources illuminate the lived experience of CCPT grantees and uncover how the design features of the application process resulted in a particular focus on health support occupations traditionally dominated by females.

The legislative report provides useful information on how the grant winners utilized CCPT funding. The authors reviewed financial and enrollment data provided by grant winners;

surveyed site-leads and utilized state administrative data on student outcomes. The report finds that a majority of funds were used to develop sequenced curriculum (35 percent) and to align those pathways with postsecondary partner institutions (24 percent) (California Department of Education, 2017). An additional 16 percent of grant dollars were spent on hiring specialists to create Work Based Learning (WBL) opportunities that connect CTE pathway curriculum with local business partners. The most common pathway implemented by grant winners was in the sector of Health Sciences and Medicine with a total of 49 pathways. Other popular industries included Information Communication Technology (ICT); engineering manufacturing and design.[5] The report notes that student enrollment in Health Sciences and Medicine pathways was nearly twice as large as the second most popular pathway industry sector in information technology (i.e., 19,690 students versus 10,201). The CDE also surveyed grantee project leads on their career pathway configurations and found 90 percent offered a CTE course sequence, 53 percent offered WBL opportunities and 40 percent of sites had programs of study affiliated with their postsecondary partners (CDE, 2017). This report suggests that grantees utilized the funding as intended and that the focus on the grant funding went to re-designing high school course curriculum.

The lead organization in charge of providing technical assistance during the application process also conducted an implementation study of Cohort 1 applicants over two years. Jobs for the Future (JFF) is a national non-profit that advocates for programs and policies to increase college and career readiness and workforce outcomes of underserved populations. Researchers attended four convening's for CCPT grantees, conducted a document review and interviewed

[5] In Appendix Table 1, the proportion of applicants proposing each pathways are listed. Health Sciences was proposed by 53 percent of applicants whereas ICT were proposed by 41 percent of applicants. I find no discontinuities in the sectors of pathways proposed at the assignment threshold.

representatives from 20 grantee sites. The researchers also conducted multiday site visits at three grantee sites that received 15 million dollar grants. The report finds that grantees spent their funds on professional development to create and align career pathways, purchased equipment to maintain or expand CTE programs and to coordinate across partnership sites (McLaughlin et al. 2017). The report notes that grant recipients focused on training staff to implement these new models of CTE through recognized professional training programs (e.g., Project Lead the Way, Linked Learning models). The findings at the selected sites suggests that the CCPT grant was used as "start-up" funding to train staff, develop plans and launch new pathways.

The report authors also uncovered several noteworthy implementation challenges facing cohort 1 grantees. First, site-coordinators noted that lack of buy-in from district leadership and school boards had been a previous barrier to implementing and extending the reach of career pathways. The coordinators reported that grant dollars and grantee status (i.e., winning a competition) elevated the status of CTE programs for district policymakers. The significant infusion of dollars "legitimized" career pathways as a high school reform approach to address college and career readiness (p. 10, McLaughlin et al. 2017). Second, grantees struggled to find intermediary organizations to facilitate relationships with postsecondary and business partners. Many of the site coordinators in the first cohort were still looking for assistance in establishing work based learning opportunities, scheduling guest speakers and finding internships for students in the second year of the program (McLaughlin et al. 2017). Finally, coordinators reported difficulty finding qualified staff to implement data systems to track students served by pathways and their outcomes. In summary, many cohort 1 grantees report that CCPT funding allowed them to make progress in implementing the career pathway model by lowering political barriers but lack of qualified staff resulted in delayed rollout of crucial aspects of the program.

To supplement the available information on CCPT implementation I conducted a document review of the original CCPT applications. Two important findings result from this review. First, the short time line between the grant competition announcement and due date for letters of interest and first round applications may have resulted in more implementation challenges for the first cohort. Cohort 1 applicants had three weeks to submit their LOI's from the competition announcement and another 6 weeks to devise a plan and submit it to the scoring agency. The announcement of the second round of competition was 13 months before the due date.[6] In addition to the compressed timeline faced by Cohort 1 applicants, the CCPT application underwent some revisions.[7] The update application in 2015 required second round applicants to provide more specific information about the targeted pathway sectors including the roles and responsibilities of each partner schools, districts and businesses participating in a pathway.

Furthermore, Cohort 2 applicants submitted three additional forms related to the design of pathways compared to Cohort 1 that required additional information on pathway plans. The differences in the timeline for planning and implementation in addition to changes to the application materials suggest that Cohort 2 had more planning time and improved technical assistance from CDE staff (i.e., application support and materials etc.).[8] Given these implementation details, I privilege estimates that examine the effects chronologically (i.e., by school year) rather than from time from grant application.[9]

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[6] There was also a 3 month lag between the submission of the LOIs and the application due date for the second cohort. This may have allowed additional districts to find partners who were interested in applying for CCPT.
[7] Personal communication with CDE staff on December 9, 2015.
[8] CDE contracted with an agency to provide technical assistance to both CCPT applicant cohorts and the agency may also have improved their ability to provide technical assistance over time.
[9] In Appendix Table 2, I provide estimates of the treatment effect using a chronological and dynamic treatment effect approaches. The results support the implementation evidence that Cohort 2 experienced more immediate treatment effects while Cohort 1 effects appear after the first two full years of implementation.

In summary, the implementation evidence suggests that CCPT grantees used the funding as intended. The surveys and interviews conducted during the first two years of the grant suggest that most grant dollars were used to support pathway creation at high schools. Furthermore, the implementation evidence for Cohort 1, the first year of the grant was a planning year, consisting of professional development, curriculum development and the purchase of equipment to grow and sustain career pathways in the targeted areas. Another important takeaway comes from the design: applicants were instructed to focus on high-growth sectors and they accordingly focused on careers in the health care industry. Entry level positions in health care support occupations (e.g., medical assistants, certified nursing assistants etc.) are staffed by predominantly female workers. For example, 87 percent of workers in healthcare support occupations identified as woman in 2017.[10]

4. Data and Analytic Sample

4.1. Data Sources

The data come from several publicly available sources. First, staff at the CDE provided the CCPT applications for all applicants as well as the rating score used to determine funding status. The fiscal lead for each application can be a community college, school district, charter school, or county office of education. Most applications contained a list of the names of the secondary and post-secondary institutions and businesses involved in the partnership. I use these lists to locate publicly available data from the CDE and Common Core of Data (CCD) on K-12 public schools and create a data set with district-level characteristics (e.g., race/ethnicity, free/reduced lunch, gender, enrollment etc.) from 2012-13 (i.e., the year prior to grant

[10] Retrieved from Table 11. Employed persons by detailed occupation, sex, race, and Hispanic or Latino ethnicity. Household Data Annual Averages, Department of Bureau of Labor Statistics https://www.bls.gov/cps/cpsaat11.htm

announcement) to 2015-16. CDE also provides district-level financial data on resources and expenditures in an unaudited form using standardized account code structure (SACS). These data files identify spending on CTE broadly in addition to identifying specific CCPT related expenditures. Financial data is available from fiscal year 2013 through 2016. Other outcome data from CDE include subgroup level (i.e., by race/ethnicity and sex) information on dropout, truancy, chronic absence, suspension and expulsion counts. Furthermore, I supplement the available district characteristics with county level data from the Bureau of Labor Statistics on labor market conditions.

4.2. Sample Construction

There were 230 CCPT applicants across both rounds along with 765 district or county office of education partners, however, I exclude applicants for a variety of reasons. Charter schools for the most part do not report financial data separately to the SACS system nor are they represented in state data on dropouts and other outcome data. I therefore exclude the 27 charter fiscal lead applicants and their 10 district partners from the analytic sample.[11] Next, I exclude three county offices of education that did not identify any district partners in their application and thus have no outcome data available.[12] I further exclude 53 county offices of education who have no outcome data available but who have partner districts with available data. Finally, 85 additional partners are omitted who lack baseline data on student demographics in the school year before applying for the CCPT grant. This results in a final analytic sample of 814 district entities representing 200 CPPT applications.

[11] Most of the excluded applications were single charter schools or groups of charter schools operated by the same charter management organization.
[12] County offices of education typically oversee specialized schools that serve special populations (i.e., incarcerated youth, hospital or homebound students etc.) and report data on the students they serve. The dropout rates reported are often over 100 percent and represent small populations in comparison to local education agencies.

We may be concerned that local education agencies and county offices of education who lack financial, demographic or outcome data is endogenous to their CCPT grantee status. It is important to note that missing data only threatens the internal validity of a regression discontinuity design if it discontinuous at the threshold for assigning treatment status. I run auxiliary regressions to test whether any type of missing data is discontinuous at the threshold and find no evidence to support this potential threat.

In Table 1, I present descriptive statistics for this sample of 814 school districts. Just under one half of the sample applied during the first round of CCPT funding and over both rounds over 60 percent received funding. The majority of the grants awarded were at the 6 million dollar and 15 million dollar level with just 5 percent of districts receiving the smaller 600,000 dollar grants. The possible scores ranged from zero to 200 points though in practice they ranged from 28 to 184.5 points with a mean of 138 points. Prior to the announcement of the CCPT grant, districts spent approximately 226 dollars on CTE-related expenses per high school pupil enrolled in their district in 2013. There were broad increases in spending during the sample period due to increased funding from the state's new Local Control Funding Formula (LCFF). In 2015, the first and second year of CCPT funding for cohorts two and one, respectively, CTE spending per high school pupil increases by approximately 90 percent to 436 dollars per pupil.

During the sample period the school level dropout rate at applicant districts declined from a mean of 2.51 percent of students in 2013 to 1.53 percent in 2017.[13] District enrollment of high school students range in size from just 10 students to over 100,000 with the mean size district educating just under 8,000 students in traditional high school grades 9 through 12. The mean

[13] The school-level dropout rate is an event dropout rate consisting of all dropouts (i.e., numerator) in a particular school year divided by all enrolled students (i.e., denominator).

proportion of students eligible for the free or subsidized lunch is 51.7 percent of students but this ranges from nearly zero to almost all students. The average school district enrolls almost 47 percent Hispanic students with whites averaging 34 percent of enrollment. Asians and blacks represent relatively smaller proportions of the public high school population in California at 8.8 and 4.6 percent, respectively. The truancy rate, defined as a student having three or more unexcused absences of 30 or more minutes in one school year, consists of one-third of high school students. Just over 8 percent of students are suspended in a school year at the average school district.

5. Analytic Strategy

5.1. CCPT Application Scores

Each partnership submitted an application that was scored using a common detailed rubric. Each application was read by three different professionals from CDE, the California Community Colleges Chancellor's Office (CCCCO), or the California Workforce Investment Board (CWIB) and then averaged to arrive at the final score. In cases of large discrepancies between reviewer scores (i.e., more than 20 percent of total point difference) applications were assigned to a fourth reviewer, a manager in the Career and College Transition Division or a consultant. The fourth reviewers score was compared to the initial three scores and the outlying score was removed before averaging three scores[14]. The cut score was based on the lowest amount of points applicants in the "outstanding" category on the rubric (e.g., 140 points in round

[14] After personal communications with CDE I was unable to determine how many applications underwent the fourth reviewer rating process. CDE staff maintained it was "minimal." My investigation of the continuity of baseline characteristics and the density of the rating score does not suggest manipulation.

1 and 150 points in round 2). The rating rubric contained seven sections that mirrored the required sections and forms of the CCPT application in each round.

5.2. Identification Strategy

The regression discontinuity approach relies on a relatively weak assumption that the two groups of applicants, those who scored one point above and belief the cut score, are equal in expectation except that one group received a large grant to create career pathways. In other words, in order to provide credibly causal estimates of increased funding for career pathways the only change at the margin of the CCPT grant award status is the probability of grant receipt. The estimation strategy can be described as follows:

$$Y_{id} = \beta\, I(CCPT\ Score_i \geq 0) + f(CCPT\ Score_i) + X_d + \boldsymbol{\tau} + \varepsilon_{id} \qquad (1)$$

Here $I(CCPT\ Score_i \geq 0)$ is an indicator for whether the application score was above the minimum specified threshold for the applicant, *i*, and by extension their district partners, *d*. The variable, X_d represents district-level baseline characteristics, $\boldsymbol{\tau}$ represents a vector of fixed effects for cohort and the grant level amount. Finally, ε_{id} represents the error term, which are clustered at the applicant level. The estimand of interest, β represents the change in dropout status at the CCPT assignment threshold controlling for a function of the application score $f(CCPT\ Score_i)$. The preferred model allows for the slopes to vary on either side of the threshold and models a linear relationship between the application score and dropout outcomes. This preferred model is guided by a visual inspection of the data and Akaike's Information Criteria (AIC) (Cook et al. 2015).

The literature on regression discontinuity designs is evolving as to the recommended estimation strategy, weighting structure and bandwidth selection. I check a variety of

specifications to provide a complete view of the estimated effects in addition to visual inspection of the data to inform our intuition around bandwidth selection and functional form. Following the literature, I estimate local linear regressions using observations in smaller bandwidths successively closer to the CCPT grant assignment threshold (Lee and Lemieux, 2010). I also examine estimates using the bandwidths calculated using the IK method from the procedure introduced by Imbens and Kalyanarman (2012). In this application the IK bandwidth procedure recommends using less than 20 percent of the full sample. Recent literature from Calonico and colleagues (2014, forthcoming) recommend bias-correction procedures that build on the data-driven bandwidth selections of the IK procedure and similarly use triangular kernel weights to emphasize the outcomes of observations close to the assignment threshold. In practice, these procedures produce similar results and I show a range of specifications and bandwidth restrictions to confirm the robustness of the RD results.

The implementation evidence described above suggests that treatment may not have been uniform across the two cohorts. The literature on dynamic treatment effects suggests fitting treatment effects at different points in time (i.e., one year after treatment, two years after treatment etc.) rather than assuming constant effects. In this case, the timing of implementation for both cohorts varied. I estimate both dynamic treatment effects and effects based on calendar year for both cohorts, separately, and in stacked models with fixed effects for application year. I discuss these specification results in section 6 below.

5.3. CCPT Treatment Status

First, I show the first-stage relationship between CCPT grantee status and the assignment variable visually in Figure 1. The first-stage is virtually sharp, the change in probability of treatment status changes from nearly zero to 1 at the assignment threshold. The parametric

estimates in Table 2 confirm these findings ranging from 0.98 to 0.99 using quadratic polynomials and controls for application round year and application amount. One district, Los Angeles Unified School District (LAUSD), received a rating score below the threshold but received a CCPT grant. Personal communication with staff at CDE confirmed LAUSD's grantee status and verified their original application score as being below the assignment threshold. I analyze all outcomes using an intent to treat (ITT) analysis based on the original assignment score rather than treatment status itself though these are highly related. LAUSD is the largest district in the state and I confirm the results by omitting LAUSD entirely and find qualitatively similar results.

The first-stage relationship between the application score and the grant threshold clearly support a discontinuous jump at an arbitrary threshold dictated by CDE staff. Although the rubric was made available to applicants in the appendix of the application materials it is unlikely applicants could manipulate their overall rating score or known the exact cut off point to determine grant eligibility. The scoring process, however, was not blind and the three raters knew the identity of the fiscal agent and partnering district as these were part of the application evaluation. It is possible that raters may have had individual preferences. However, the process of having three raters independently rate applications without seeing the scores of the other raters limits the possibility that a single rater could have manipulated the assignment variable. Furthermore, the process of engaging a fourth reader for outlier scores reduced this possibility.

We can further probe the necessary assumption that applicants are unable to manipulate their grantee status empirically. In Figure 2a, I present a histogram of the assignment variable using very small bin widths to examine potential heaping around the threshold. The histogram does not appear to contain heaps or observations concentrated just above or below the

assignment threshold. We can also look to the Cattaneo et al. density test (2017b, 2018) displayed in Figure 2b to test continuity around the threshold. This density estimator improves upon the McCrary (2008) density test by using a nonparametric approach that does not bin or transform the raw data. Figure 2b clearly demonstrates that there is no statistically significant jump in the density of the CCPT assignment variable at the threshold.

Lastly, I examine the baseline characteristics of applicants in the 2012-13 school year for both rounds of applicants.[15] In Table 3, I present evidence that baseline covariates are continuous at the assignment threshold using a two-stage procedure. In the first stage, I regress the outcome of interest (i.e., dropout rate for the relevant subgroup and year) on a linear function of all the baseline covariates. From this regression one can obtain predicted dropout rates that are an index of baseline characteristics (i.e., predicted dropout rates). This index is thus weighted by the influence of the baseline characteristics on the outcome of interest. We can then estimate an auxiliary regression of the index on the assignment variable to check whether the baseline characteristics are discontinuous at the threshold avoiding multiple comparison issues that arise with testing each baseline characteristic separately.[16]

In summary, both the institutional details and empirical evidence support the validity of the RD design for providing credibly causal estimates of CCPT grantee status. There is no evidence of manipulation of the forcing variable or discontinuities in baseline characteristics at the CCPT grant assignment threshold. Given these results supporting We now turn to the results.

[15] I choose 2012-13 because the CCPT call for applications was publicized as a two-round process during the 2013-14 school year and some districts may have intended to apply in the second round and changed their behavior prior to applying for the grant especially with regards to current levels of CTE spending.
[16] To be thorough, I also present the baseline characteristics in separate regressions in Appendix 3.

6. Results

Increased grant funding should, in theory, increase the availability of career pathway spaces for students. Although districts are required to match CCPT funds with existing funding and report CCPT-related expenditures as a condition of grant receipt the literature suggests that these requirements are often poorly enforced. To investigate whether districts shifted their resources in response to grant receipt we can examine unaudited SACS data. In Table 4, I present parametric estimates the first-stage of per pupil CTE expenditures in columns (1) through (4). The estimates suggest that per pupil CTE expenditures in 2015 increased 45 to 65 dollars at the assignment threshold. The estimates are sensitive to functional form specifications and I use a visual inspection and AIC to determine the preferred model in column 3. As expected, per pupil CCPT grant funds increase at the assignment threshold and these results (in columns 5 through 8) are statistically significant. No districts with CCPT assignment scores below the threshold reported spending CCPT dollars, except LAUSD. However, these results are qualitatively similar excluding LAUSD. In Figure 3, I present visual evidence showing an increase in per pupil CTE spending in 2015 at the assignment threshold. This result suggests a *fly paper effect* for CTE funding, that the districts used most of the intended funds for their stated purpose.

Next, I show graphically in Figure 4 the impact of CCPT grantee status eligibility on dropout rates. Figure 4a shows no difference in 2016 years 1 and 2 of the grant. However, in 2017 (i.e., years 2 and 3) there is a substantial decrease in dropout rates at the assignment threshold. The parametric estimates in Table 5 confirm the results in the figures. The reduction in dropout in 2017 is one-third of a percentage point an implied dropout reduction of 23 percent (i.e., 0.33/1.4). In Table 6, I show estimates with increasingly tighter bandwidths that confirm the graphical and parametric estimates. Although the bandwidths suggest by Calonico, Cattaneo

and Titunik (2014), and Imbens and Kalyanaraman (2012) are not statistically significant this is due to a reduction of power and increase in the standard errors of 150 percent. Importantly, the estimates remain negative implying reductions within the confidence interval of the full sample estimates.

In Table 7, I provide additional estimates for subgroups of student by race/ethnicity and gender. The reductions in dropout rate are driven by reductions for females, whites and 11th and 12th grade students. I estimate these models using Seemingly Unrelated Regressions (SUR) to allow the error structure to correlate across models to directly test whether grade level effects, gender or race/ethnic differences are statistically significant. The magnitude and statistical significance of the estimates using SUR are qualitatively similar to the effects shown in Table 7. Using the SUR framework I find that the estimated effects for 11th graders are statistically significantly different than those for 9th graders but find not differences for other grade levels. Finally, I am unable to reject the null hypothesis that the estimates for whites and Hispanics and males and females are the same.

In the appendix I provide estimates and figures that report dynamic treatment effects. The figures and parametric estimates provide a broadly similar picture of treatment effects concentrated 2 years post-implementation and specifically for female students. Furthermore, by estimating effects separately for cohorts it becomes apparent that dropout reductions are evident for Cohort 2 in year two while Cohort 1 experiences reductions in year three. Stacking the cohorts provides increased statistical precision and confirms the reduction in dropout rates estimating effects by calendar year, when both Cohorts have had time to implement their planned career pathway programming. The dynamic treatment effects are similarly precise when stacked, however, year three outcome data will not be available until spring of 2019.

7. Discussion

In this study, I explore a large-scale competitive grant program that supports school districts in creating articulated career pathways linking high school coursework to community college attendance and job prospects. I leverage unique application data to exploit a natural experiment that occurs at the margin of awarding grants to provide credibly causal estimates of the increased availability of career pathways on high school dropout rates. I provide convincing evidence that CCPT grant recipients increased their CTE spending after receiving the grant relative to non-grant winners. The RD estimates document substantial decreases in the dropout rate for all students that are driven by reductions for female students. These reductions may be driven by applicants' choices to implement career pathways in fields that traditionally attract females (i.e., health care etc.).

The available implementation information provide a unique look into how policy rollout affects student outcomes. The first cohort had limited time to create their planned reforms while the second cohort were able to plan over a longer period and benefit from the learned experience of the earlier adopters. Finally, previous studies have found male students to be more likely to self-select into CTE career academies (Dougherty 2018; Hemelt et al., 2019). The unique design of the CCPT required applicants to identify high-growth sectors based on available government labor market projects and wage-growth data. The health care sector entry level roles are traditionally dominated by female workers and this intervention appears to document increased school engagement amongst females at the implementing school districts. Understanding the importance of these design features will allow practitioners and policymakers to target certain populations.

Additional research is needed to understand the longer-term impacts of career pathway programs however the substantial reduction in dropout rates of over 20 percent is striking. This translates to a reduction in one student dropping out for 300 students served at a cost of nearly 18,000 dollars. These calculations assume, however, that benefits of the grant dollars are only realized for the students served during this time period. In reality, the CCPT grant provided start-up funds to develop curriculum for pathways, train staff and purchase equipment. Thus, the cost per student served is an upper bound estimate. Notwithstanding, the present discount value of a high school diploma is estimated to be 300,000 dollars (Cullen et al. 2013). Career pathways may be a cost effective method of increasing students' educational attainment and providing skills valued by the labor market.

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Table 1. Descriptive Characteristics

Variable	Mean	Std. Dev.	Minimum	Maximim
Application Characteristics				
CCPT Grant Recipient (Year 1 or 2)	0.639	0.481	0	1.0
CCPT Score (centered)	3.2	21.65	-83.3	43.3
I(CCPT Score$_i$ ≥ 0)	0.636	0.481	0	1.0
Round 1 applicant	0.473	0.500	0	1.0
Round 2 applicant	0.527	0.500	0	1.0
600,000 dollar grant	0.055	0.229	0	1.0
6 million dollar grant	0.448	0.498	0	1.0
15 million dollar grant	0.496	0.500	0	1.0
Spending Characteristics				
Per pupil CTE spending, 2013	$226.39	241.73	0	1367.68
Total CTE spending, 2013	$1,987,145	7,226,672	0	56,663,452
Per pupil CTE spending, 2015	$436.36	426.18	0	2624.8
Total CTE spending, 2015	$2,612,019	6,595,140	0	50,523,460
Per pupil CCPT spending, 2015	$51.78	130.01	0	742.54
Total CCPT spending, 2015	$235,389	627,091	0	3,621,278
Outcomes				
Dropout rate, 2016	1.53	1.57	0	14.78
Dropout rate, 2017	1.39	1.49	0	15.07
Baseline Characteristics				
Dropout rate, 2013	2.51	1.92	0	9.68
County unemployment rate	9.87	3.24	5	24.5
Enrollment grades 9-12	7,865	20,268	10	159,724
Free/Reduced-Price Lunch	0.517	0.221	0.003	0.996
Asian	0.088	0.109	0	0.643
Black	0.046	0.061	0	0.363
Hispanic	0.466	0.249	0	0.989
White	0.344	0.231	0	0.881
Truancy rate	33.90	20.78	0.4	85.9
Suspension rate	8.26	5.26	0.0	28.6

NOTES. Abbreviations: CCPT, California Career Pathways Trust. Sample includes 814 school districts with a CCPT assignment variable. Per pupil funding and dropout rates are top coded at 99th percentile. Behavioral, dropout and financial data retrieved from the California Department of Education (CDE) at https://www.cde.ca.gov/ds/dd/. Enrollment and student characteristics retrieved from the Common Core of Data (CCD).

Table 2. First Stage RD Estimates, CCPT Grantee Status

	Dependent Variable: CCPT Grant Recipient (Round 1 or 2)			
	Fuzzy RD			
Independent Variable	(1)	(2)	(3)	(4)
I(CCPT Score$_i \geq 0$)	0.987***	0.986***	0.981***	0.981***
	(0.010)	(0.011)	(0.015)	(0.015)
N	814	814	814	814
R^2	0.989	0.990	0.990	0.990
Linear spline	yes	yes	yes	yes
Quadratic spline	no	no	yes	yes
Controls	no	yes	no	yes

NOTES. *** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$ Applicant group clustered standard errors in parentheses. Each column contains a regression of the estimated effect of treatment status on the assignment variable. The controls contain fixed effects for round of application (i.e., in the 2014 or 2015 round) and grant level (i.e., 600,000, 6 million or 15 million dollars).

Table 3. Auxiliary RD Estimates of Baseline Covariate Balance

Dependent variable:	2016 Dropout index		2017 Dropout index	
Sample	(1)	(2)	(3)	(4)
Overall	0.000	0.050	-0.042	-0.036
	(0.087)	(0.113)	(0.091)	(0.122)
Hispanic	-0.070	-0.099	-0.104	-0.178
	(0.095)	(0.118)	(0.101)	(0.138)
White	-0.017	0.025	-0.043	0.004
	(0.100)	(0.133)	(0.096)	(0.125)
Female	-0.032	0.008	-0.034	-0.047
	(0.089)	(0.116)	(0.099)	(0.134)
Male	-0.017	0.023	-0.067	-0.054
	(0.089)	(0.118)	(0.091)	(0.122)
N	814	814	814	814
Linear spline	Yes	Yes	Yes	Yes
Quadratic spline	No	Yes	No	Yes

NOTES. *** $p < .001$ ** $p < .01$ * $p < .05$. Applicant group clustered standard errors in parentheses. Each cell contains the results of a two-stage regression: in the first stage the 2016 or 2017 outcome for the relevant subgroup is regressed on all 2013 baseline covariates (see Table 1 for a description of covariates) and a predicted drop out composite is generated. The predicted achievement composite is then regressed on I(CCPT $\text{Score}_i \geq 0$).

Table 4. Reduced-form RD Estimates for CTE Spending

Dependent Variable:	2015 CTE Per Pupil Expenditures				2015 CCPT Grant Per Pupil Expenditures			
Independent Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
I(CCPT Score$_i \geq 0$)	44.84	164.4*	65.61*	119.3**	59.40***	54.63***	40.76***	38.77**
	(50.68)	(70.61)	(29.81)	(40.66)	(9.81)	(14.00)	(9.62)	(13.96)
R^2	0.113	0.154	0.493	0.501	0.155	0.157	0.257	0.260
N	814	814	814	814	814	814	814	814
Linear spline	yes	yes	yes	yes	yes	yes	yes	yes
Quadratic spline	no	yes	no	yes	no	yes	no	yes
Controls	no	no	yes	yes	no	no	yes	yes

NOTES. *** $p < .001$ ** $p < .01$ * $p < .05$. Applicant group clustered standard errors in parentheses. Each cell contains the result of a separate regression of the effect of I(CCPT Score$_i > 0$) on Career and Technical Education related per pupul expenditures. Akaike's information criterion (AIC) implied optimal order of polynomial is linear.

Table 5. Reduced-form RD Estimates, Dropout Rate

Dependent Variable:	2016 Dropout Rate		2017 Dropout Rate	
Independent Variable	(1)	(2)	(3)	(4)
I(CCPT Score$_i \geq 0$)	0.0648	0.0456	-0.27	-0.333**
	(0.177)	(0.166)	(0.177)	(0.153)
R^2	0.008	0.6	0.013	0.498
N	814	814	814	814
Baseline controls	no	yes	no	yes

NOTES. *** p < .01 ** p < .05 * p < .1. Applicant group clustered standard errors in parentheses. Each cell contains a regression of the dropout rate on I(CCPT Score$_i \geq 0$), a linear spline of the assignment variable and baseline covariates. All models condition on a linear spline of the assignment variable. Akaike's information criterion (AIC) implied the optimal order of polynomial is linear. See Table 1 for a description of controls.

Table 6. Reduced-form RD Estimates, Dropout Bandwidth Robustness Checks

Dependent Variable:	2016 Dropout Rate		2017 Dropout Rate	
Sample	(1)	(2)	(3)	(4)
	est.	n	est.	n
Full Sample	**0.0456**	814	**-0.333****	814
	(0.166)		**(0.153)**	
$\|CCPT\ Score_i\| \leq 60$	0.0494	809	-0.337**	809
	(0.173)		(0.161)	
$\|CCPT\ Score_i\| \leq 40$	0.0455	768	-0.397**	768
	(0.213)		(0.197)	
$\|CCPT\ Score_i\| \leq 20$	-0.0308	547	-0.657**	547
	(0.298)		(0.258)	
$\|CCPT\ Score_i\| \leq 10$	-0.755*	284	-0.670	284
	(0.436)		(0.418)	
Kernel Weights	-0.252	601	-0.685**	601
	(0.332)		(0.293)	
CCT Estimates	-0.399	207	-0.567	195
	(0.612)		(0.593)	
IK Estimates	-0.865	150	-1.289**	150
	(0.478)		(0.432)	

NOTES. *** p < .01 ** p < .05 * p < .1. Applicant group clustered standard errors in parentheses. Each cell contains a regression of dropout rates for districts within the specified bandwidth on $I(CCPT\ Score_i \geq 0)$, a linear spline of the assignment variable and baseline covariates. Columns 2 and 4 contain the number of districts in the bandwidth. Kernel weight estimates estimate triangular kernel weights for observations within one standard deviation of the forcing variable. CCT are Calonico, Cattaneo and Titunik (2014) suggested bandwidths with kernel weights. IK are Imbens and Kalyanaraman (2012) suggested bandwidths with kernel weights.

Table 7. Reduced-form RD Estimates by Subgroup

Sample	2016 Dropout Rate		2017 Dropout Rate	
Subgroup	(1)	(2)	(3)	(4)
Total	**0.065**	**0.046**	**-0.270**	**-0.333****
	(0.177)	**(0.166)**	**(0.177)**	**(0.153)**
Hispanic	0.0522	0.0579	-0.201	-0.244*
	(0.200)	(0.169)	(0.174)	(0.132)
White	-0.500	-0.498	-0.666**	-0.528***
	(0.382)	(0.305)	(0.265)	(0.164)
Female	-0.007	-0.016	-0.280*	-0.404***
	(0.165)	(0.158)	(0.155)	(0.146)
Male	0.141	0.119	-0.253	-0.256
	(0.204)	(0.198)	(0.206)	(0.170)
Grade Level				
Grade 9	0.0486	0.191	-0.0630	-0.0187
	(0.143)	(0.129)	(0.156)	(0.130)
Grade 10	0.0161	0.0467	-0.213	-0.125
	(0.220)	(0.206)	(0.147)	(0.148)
Grade 11	0.0743	0.00881	-0.272	-0.368**
	(0.176)	(0.188)	(0.179)	(0.182)
Grade 12	0.276	0.260	-0.401	-0.561*
	(0.370)	(0.305)	(0.379)	(0.300)

NOTES. *** $p < .01$ ** $p < .05$ * $p < .1$. Applicant group clustered standard errors in parentheses. Each cell contains the result of a separate regression of $I(\text{CCPT Score}_i \geq 0)$ on dropout rates for different subgroups. All models condition on a linear spline of the assignment variable and the full set of controls from the preferred specification in Table 4. N= 814 school districts for all regressions.

Appendix 1. Reduced-form RD Estimates of Pathway Sector Offerings

Dependent Variable:	(1)	(2)	(3)
			mean
Pathways Listed in Application	0.015	0.002	0.990
	(0.021)	(0.015)	
Sector			
Health Sciences and Medicine	-0.093	-0.307	0.538
	(0.117)	(0.167)	
Technology	0.195	-0.014	0.412
	(0.116)	(0.171)	
Logistics and Transportation	0.006	-0.007	0.161
	(0.093)	(0.126)	
Energy and Environment	0.093	0.052	0.201
	(0.091)	(0.139)	
Engineering, Design and Architechture	0.047	-0.401**	0.221
	(0.101)	(0.140)	
Engineering and Manufacturing	-0.008	-0.081	0.417
	(0.118)	(0.170)	
Arts, Media and Entertainment	-0.057	-0.226	0.186
	(0.100)	(0.142)	
Business and Finance	0.042	-0.265	0.231
	(0.104)	(0.164)	
Hospitatility and Tourism	0.131	0.019	0.156
	(0.088)	(0.130)	
Public Services and Safety	-0.010	-0.104	0.206
	(0.103)	(0.152)	
Building and Construction	0.073	-0.082	0.176
	(0.090)	(0.146)	
Education and Child Development	0.003	-0.027	0.106
	(0.067)	(0.102)	
Agriculture	0.202	0.324*	0.261
	(0.107)	(0.161)	
Linear spline	yes	yes	
Quadratic spline	no	yes	

NOTES. *** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$. Robust standard errors in parentheses. Each cell contains the result of a separate regression of $I(\text{CCPT Score}_i \geq 0)$ on whether the applicant propsed sector pathways in their original application. N=201 applicants for whether pathways were listed in the original CCPT application. n= 199 for all other models indicating the plan to implement the particular pathways sector. All models contain fixed effects for round of application (i.e., in the 2014 or 2015 round) and grant level (i.e., 600,000, 6 million or 15 million dollars). The third column provides the average number of applicants proposing a particular pathways sector.

Appendix 2. Reduced-form RD Estimates Dynamic Treatment Effects

	Cohort 1			Cohort 2			Stacked		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Total	Female	Male	Total	Female	Male	Total	Female	Male
Calendar Year									
2016	0.187	-0.174	-0.213	-0.177	-0.268	-0.0565	0.0456	-0.016	0.119
	(0.167)	(0.167)	(0.229)	(0.301)	(0.273)	(0.366)	-0.166	-0.158	-0.198
2017	-0.249	-0.407**	-0.0806	-0.400	-0.437	-0.349	-0.333**	-0.404**	-0.256
	(0.170)	(0.203)	(0.165)	(0.286)	(0.267)	(0.327)	-0.153	-0.146	-0.17
Dynamic									
1 year after	0.101	-0.138	0.0745	-0.177	-0.268	-0.0565	-0.108	-0.106	-0.0899
	(0.149)	(0.166)	(0.178)	(0.301)	(0.273)	(0.366)	(0.167)	(0.157)	(0.188)
2 years after	0.187	0.174	0.213	-0.400	-0.437	-0.349	-0.169	-0.232	-0.112
	(0.167)	(0.167)	(0.229)	(0.286)	(0.267)	(0.327)	(0.158)	(0.153)	(0.187)
3 years after	-0.249	-0.407**	-0.0806	-	-	-	-	-	-
	(0.170)	(0.203)	(0.165)						

NOTES. *** p < .01 ** p < .05 * p < .1. Applicant group clustered standard errors in parentheses. Each cell contains the result of a separate regression of I(CCPT Score$_i$ ≥ 0) on dropout rates for indicated subgroup and cohort. All models condition on a linear spline of the assignment variable and the full set of controls from the preferred specification in Table 4. n= 385 for cohort 1 and n=429 for cohort 2; N= 814 stacked panel.

Appendix 3. Auxiliary RD Estimates of Baseline Covariate Balance, Individual Covariates

	(1)	(2)	(3)	(4)
Sample:	Full Sample		1 SD ($CCPT_i$)	0.5 SD ($CCPT_i$)
Baseline Covariate				
Unemployment rate	-0.037***	-0.037**	-0.043**	-0.062***
	(0.068)	(0.092)	(0.100)	(0.119)
Per pupil CTE spending	-0.040	0.035	0.009	0.085
	(22.858)	(28.523)	(29.344)	(40.353)
CTE spending (log)	-0.054	0.002	-0.019	0.037
	(0.149)	(0.184)	(0.183)	(0.283)
District enrollment (log)	-0.004	0.007	0.005*	0.010***
	(0.017)	(0.014)	(0.006)	(0.007)
Free/reduced price lunch	0.050	0.035	0.059	0.146
	(0.018)	(0.023)	(0.023)	(0.032)
American Indian	-0.007	-0.019	-0.028	-0.017
	(0.001)	(0.001)	(0.001)	(0.001)
Pacific Islander	0.002	0.010	-0.000	0.006
	(0.000)	(0.000)	(0.000)	(0.000)
Asian	0.003	-0.002	-0.001	0.006
	(0.001)	(0.001)	(0.001)	(0.002)
Hispanic	-0.003	0.011	0.003	0.015
	(0.004)	(0.004)	(0.005)	(0.004)
Black	0.009	0.005	0.010	0.012
	(0.001)	(0.001)	(0.001)	(0.001)
White	0.000	-0.010	-0.008	-0.002
	(0.004)	(0.004)	(0.004)	(0.005)
District dropout rate	0.053	0.019	0.009	0.015
	(0.127)	(0.165)	(0.149)	(0.194)
Truancy rate	0.095	0.144	0.111	0.174
	(2.564)	(3.657)	(3.948)	(5.862)
Suspension rate	0.021	-0.014	0.039	0.090
	(0.462)	(0.638)	(0.620)	(0.719)
N	814	814	603	322
Controls	yes	yes	yes	yes
Linear spline	yes	yes	yes	yes
Quadratic spline	no	yes	no	no

NOTES. *** p < .01 ** p < .05 * p < .1. Applicant group clustered standard errors in parentheses. Each cell contains the result of a separate regression of the estimated effect of the baseline characteristic on the $I(CCPT_i \geq 0)$ and the indicated controls. The control variables included in these models are from 2012, the year prior to the baseline. Unemplomployment rate i measured at the county level, all other variables are measured at the district level.

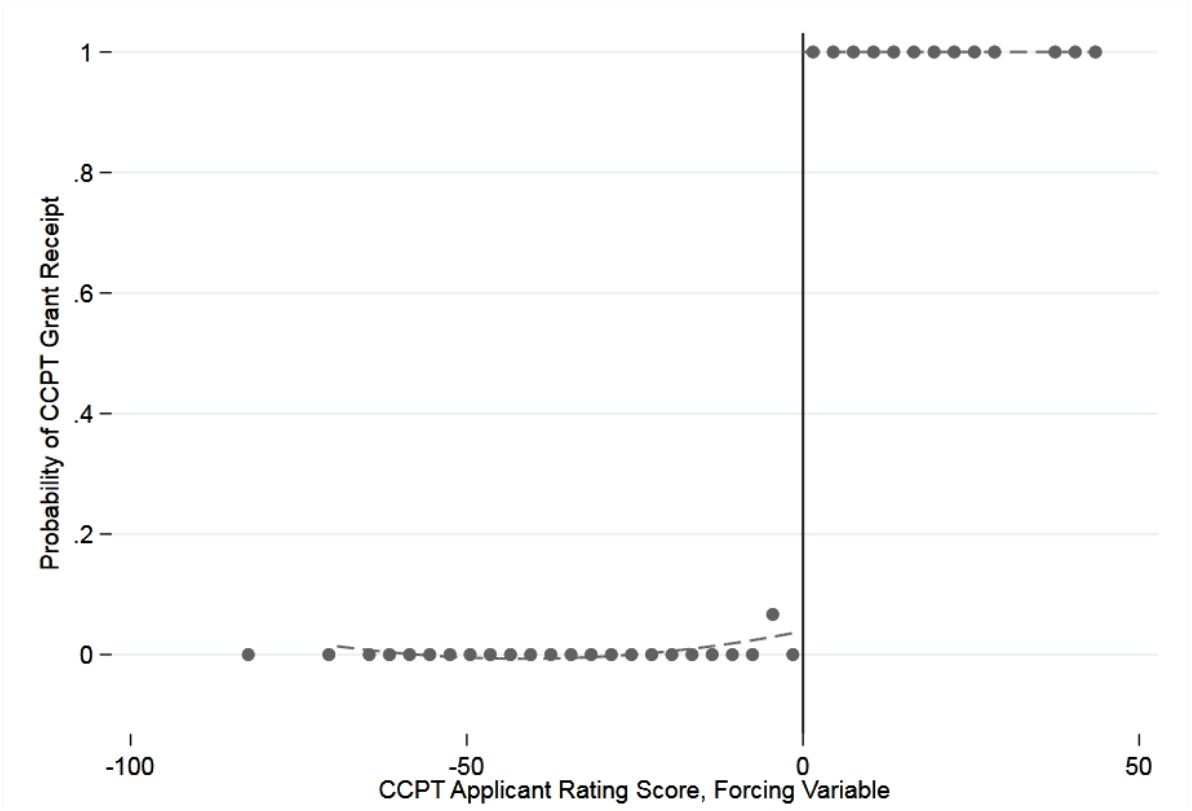
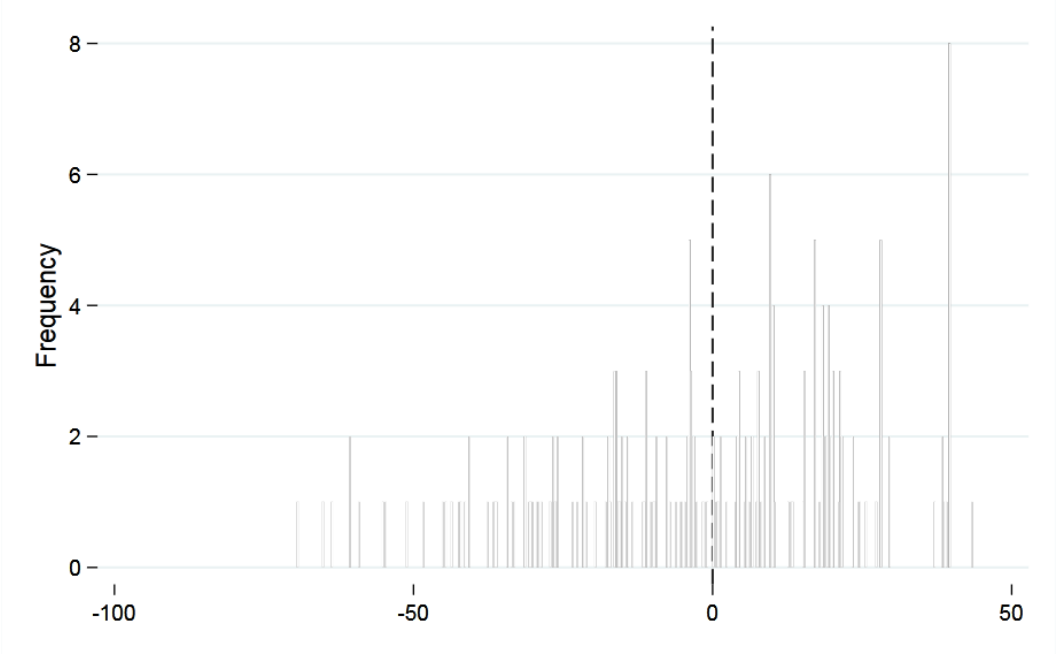
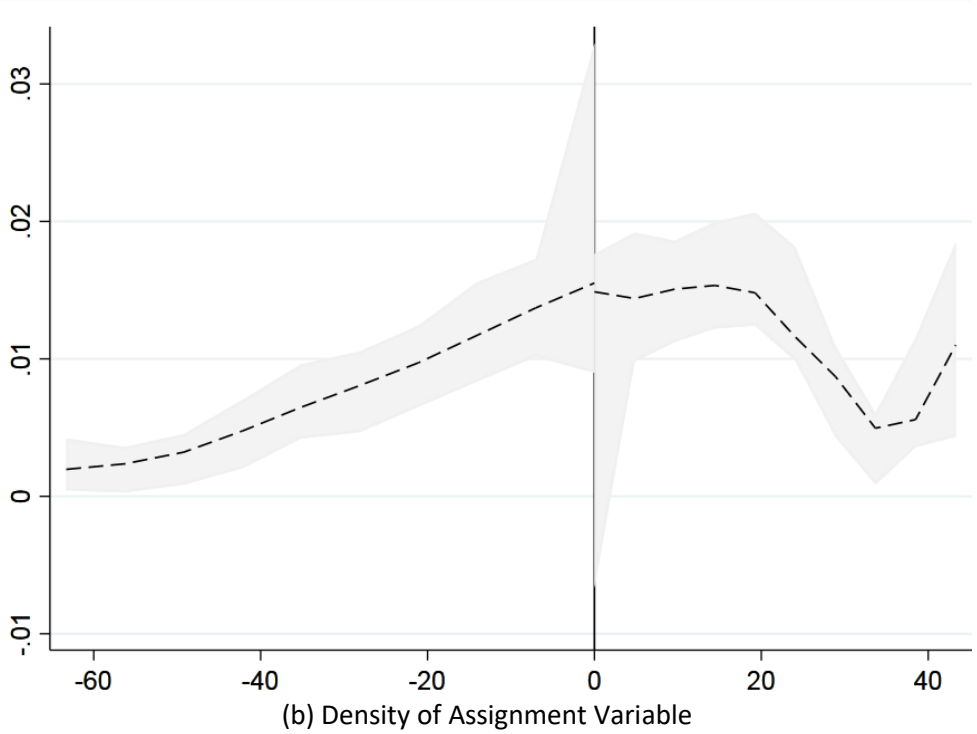


Figure 1. First-stage, CCPT Grantee Status

Notes. Graph of CCPT grantee treatment status by the assignment score (i.e., CCPT application score). Forcing variable centered at zero. Bin width 1.5 points, full sample.



(a) Histogram of CCPT Assignment Variable



(b) Density of Assignment Variable

Figure 2. Integrity of the Assignment Variable

Notes. Assignment variable centered at zero. Full sample, bin width 0.25 points. Cattaneo, Jansson & Ma (2018) density test discontinuity estimate: 0.015 (.792). Standard error in parentheses.

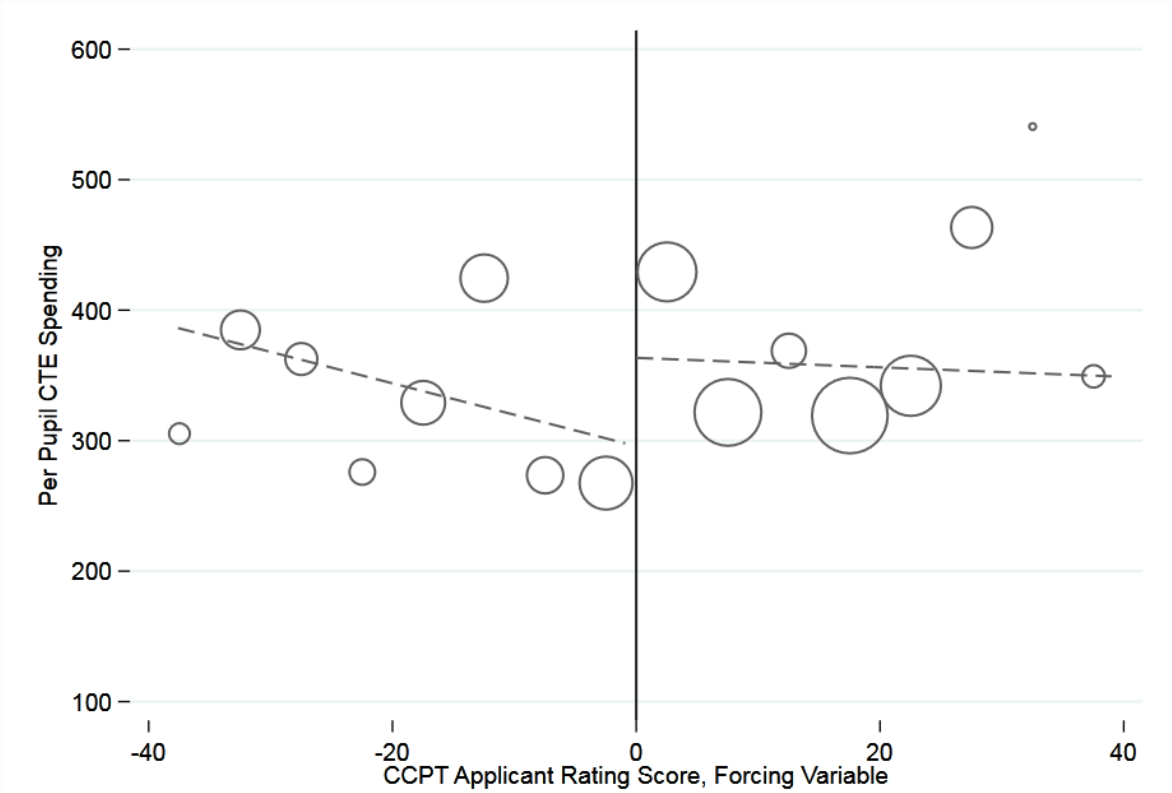
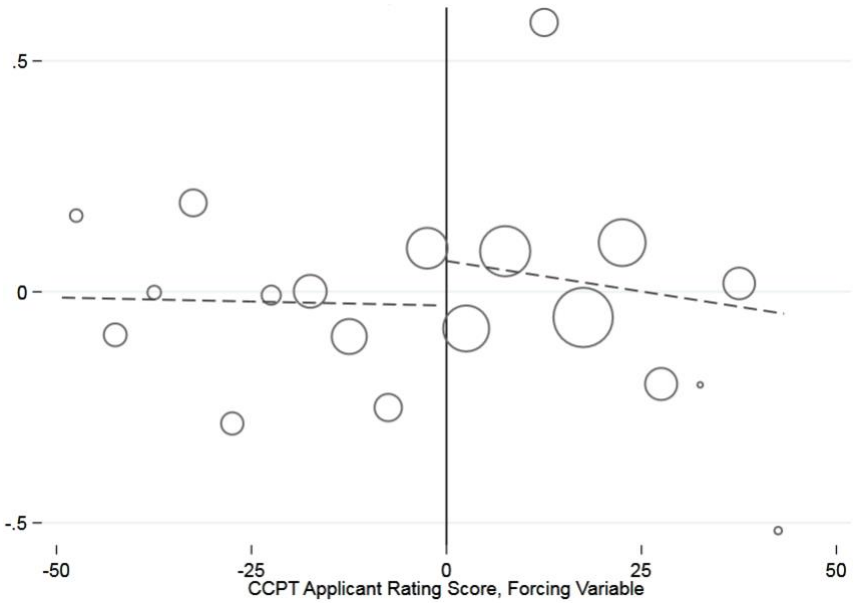
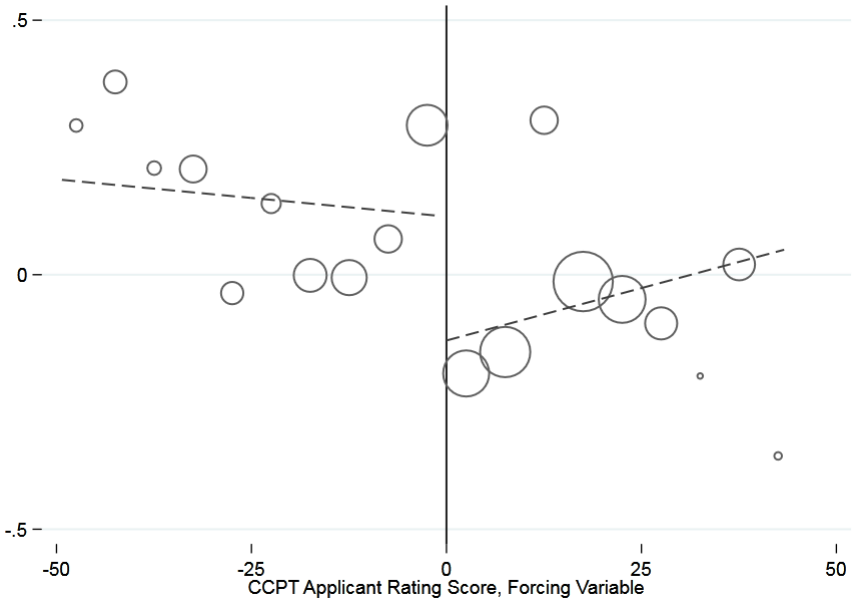


Figure 3. First-stage, 2015 Per Pupil CTE Spending

Notes. Graph of 2015 per pupil Career and Technical Education (CTE) expenditures by the CCPT assignment variable. Bandwidth +/- 40 points, Bin width 2.5 points.



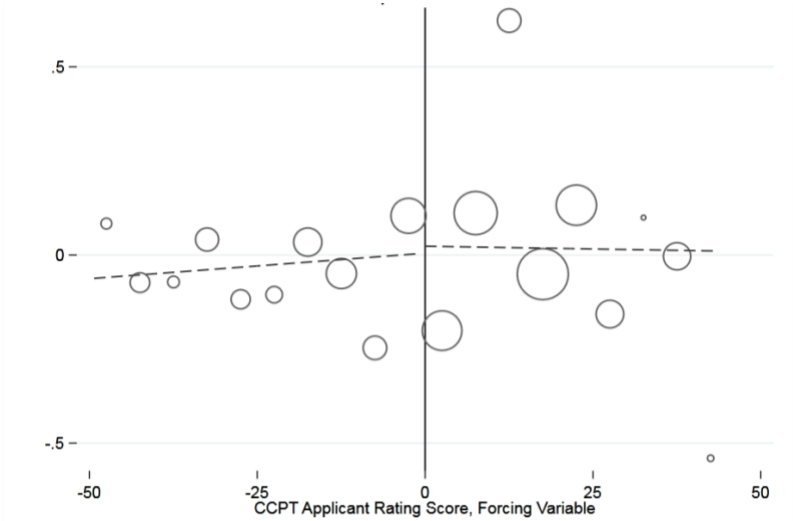
(a) Dropout rate, 2016



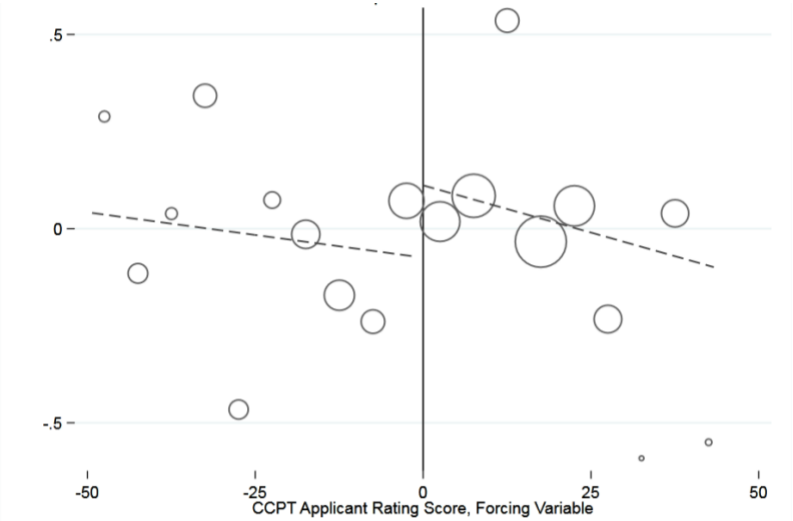
(b) Dropout rate, 2017

Figure 4. Reduced Form Results, Dropout Rates

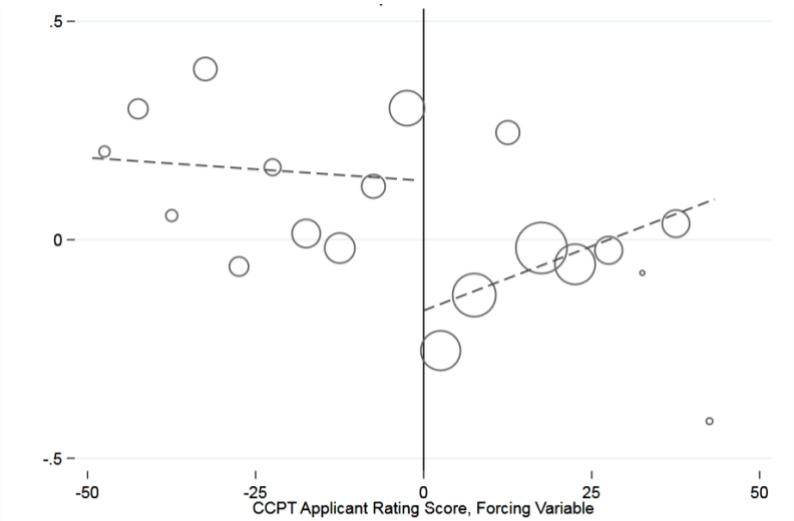
Notes. Graphs of the residualized dropout rates at in 2016 and 2017 by the CCPT assignment variable. Markers weighted by the number of districts in bin. Bin width 2.5 points. Bandwidth +/- 50.



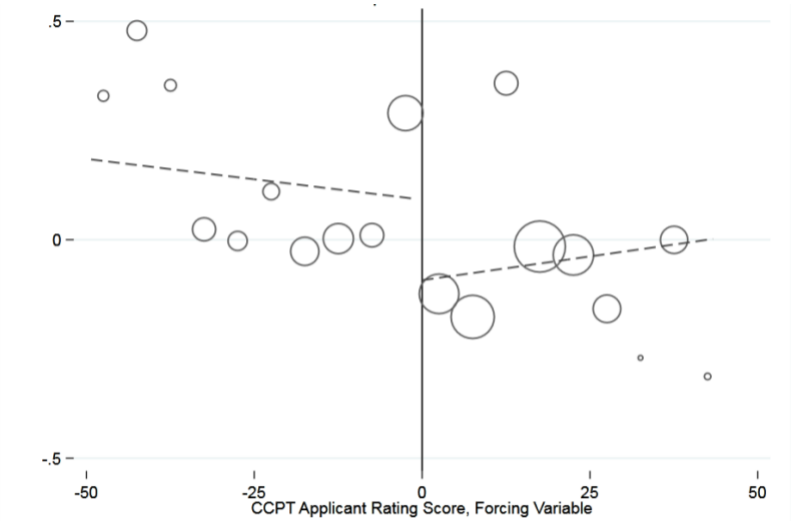
(a) Female dropout rate, 2016



(b) Male dropout rate, 2016



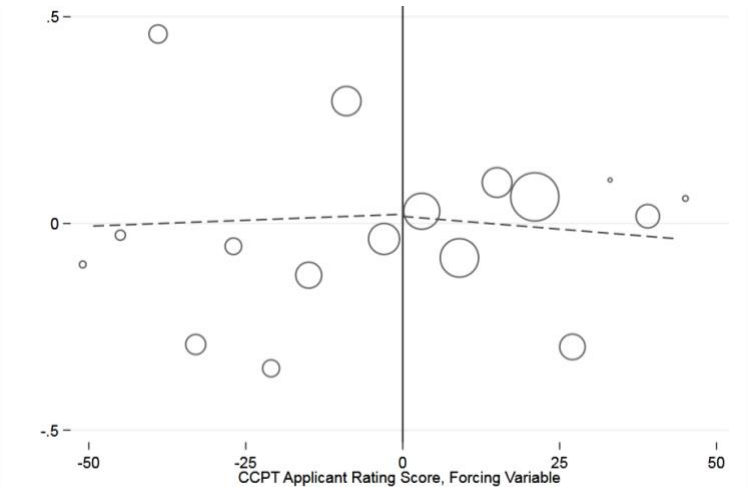
(c) Female dropout rate, 2017



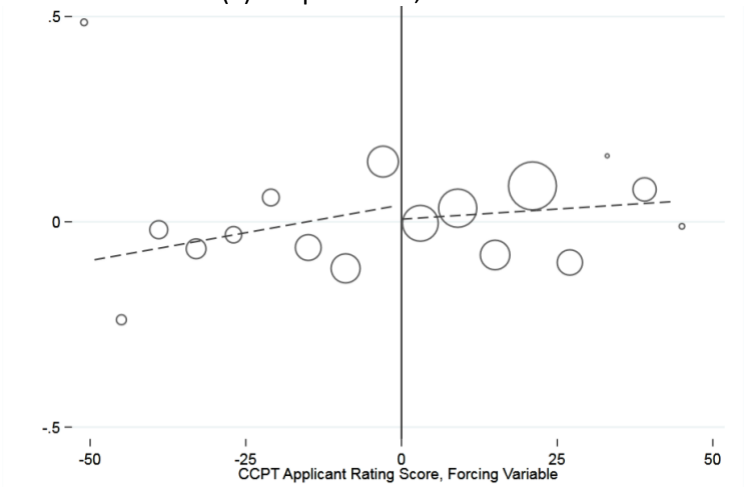
(d) Male dropout rate, 2017

Figure 5. Reduced Form Results, Dropout Rates by Subgroup

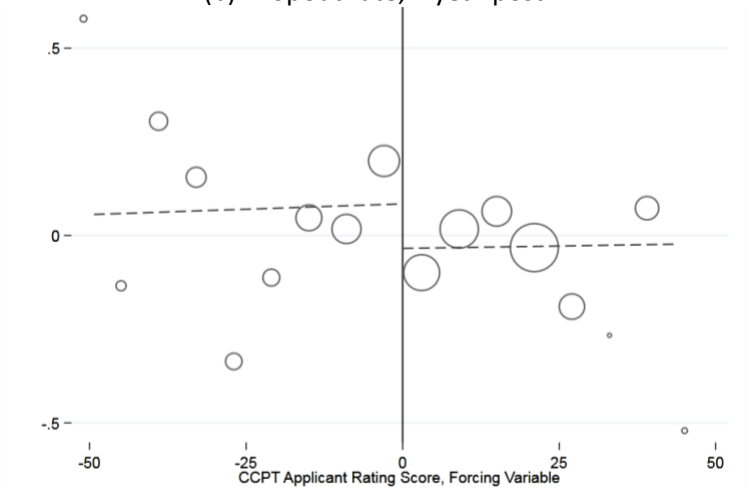
Notes. Graphs of the residualized dropout rates at in 2016 and 2017 by the CCPT assignment variable for indicated subgroups. Markers weighted by the number of districts in bin. Bin width 2.5 points. Bandwidth +/- 50.



(a) Dropout rate, Baseline



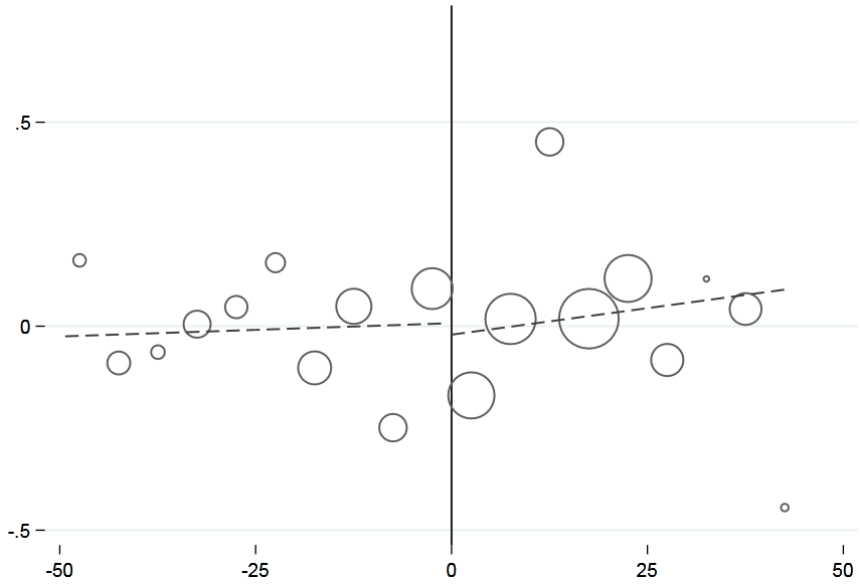
(b) Dropout rate, 1 year post



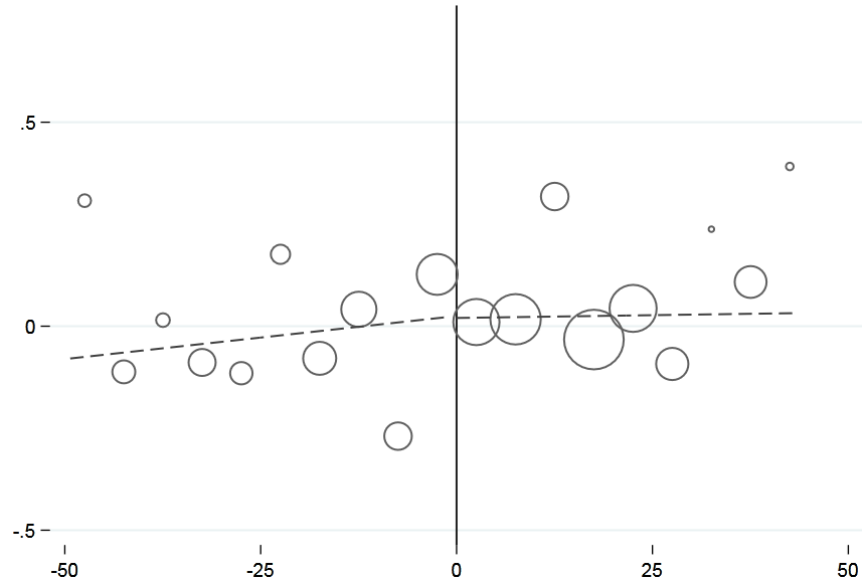
(c) Dropout rate, 2 years post

Appendix 1. Dynamic Treatment Effects, Dropout Rates

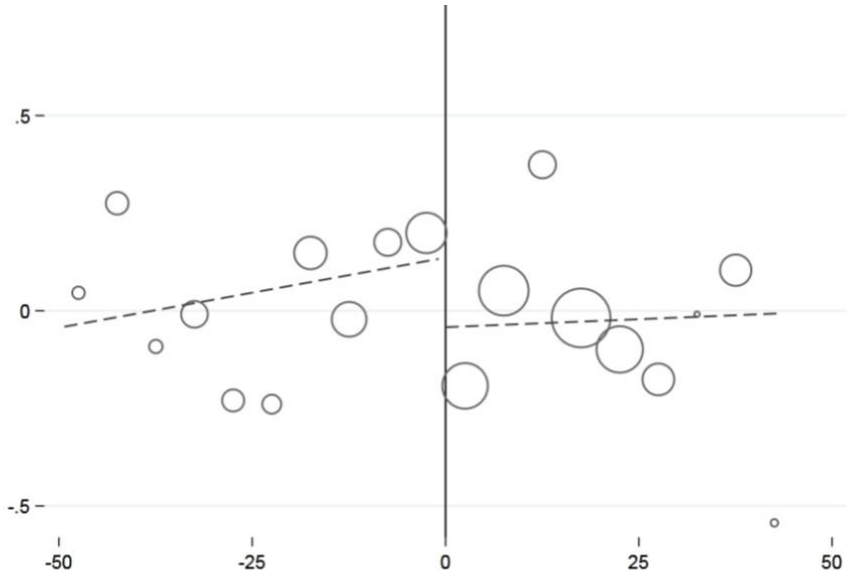
Notes. Graphs of the residualized dropout rates at baseline (e.g. 2013 or 2014), 1-year post (e.g. 2015 or 2016), and 2-year post (i.e., 2016 or 2017) by the CCPT assignment variable. Markers weighted by the number of districts in bin. Bin width 3 points. Bandwidth +/- 50.



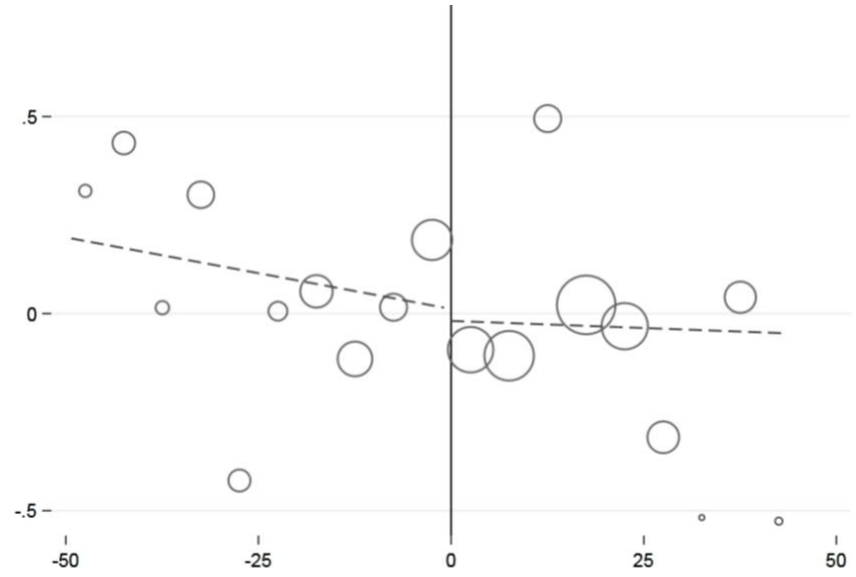
(a) Female dropout rate, 1 year post



(b) Male dropout rate, 1 year post



(c) Female dropout rate, 2 years post



(d) Male dropout rate, 2 years post

Appendix 2. Dynamic Treatment Effects, Dropout Rates by Subgroup

Notes. Graphs of the residualized dropout rates at baseline (e.g. 2013 or 2014), 1-year post (e.g. 2015 or 2016), and 2-year post (i.e., 2016 or 2017) by the CCPT assignment variable. Markers weighted by the number of districts in bin. Bin width 2.5 points. Bandwidth +/- 50.