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Eric Brunner
Shaun Dougherty
Stephen Ross

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ABSTRACT

We examine the effect of attending stand-alone technical high schools on industry of employment and within industry earnings premiums among students that applied to the Connecticut Technical Education and Career System (CTECS). Regression discontinuity estimates suggest that admission shifts male students towards working in higher paying industries, broadly defined, that align with CTECS programs of study but has a much more modest impact on female students. Surprisingly, industry earnings premiums are similar and sometimes larger for female students in traditionally male dominated industries like manufacturing and construction. Both male and female students are also more likely to work in specific industries that have a close occupational match to CTECS programs, and this match helps explain a substantial portion of the CTECS earnings premium for males in manufacturing and construction. Finally, male students admitted to a CTECS school who do not initially place in higher paying industries are more likely to transition into higher paying industries over time, and as a result, eventually experience these earnings premiums.

Eric Brunner
Department of Public Policy
University of Connecticut
10 Prospect Street, 4th Floor
Hartford, CT 06103
eric.brunner1@gmail.com

Shaun Dougherty
Harvard University
shaun.dougherty@bc.edu

Stephen Ross
Department of Economics
University of Connecticut
341 Mansfield Road, Unit 1063
Storrs, CT 06269-1063
and NBER
stephen.l.ross@uconn.edu

A data appendix is available at http://www.nber.org/data-appendix/w30408

I. Introduction

Over the last several decades, many high paying manufacturing industries have seen significant reductions in labor demand (Autor, 2019; Autor, Levy and Murnane 2003; Acemoglu and Autor 2011). In turn, these declining labor market opportunities have led to declining labor force participation among non-college going, prime-age males (Abraham and Kearney 2018; Aguiar, Bils, Charles, and Hurst 2021; Autor 2019; Austin et al. 2018). Recent evidence suggests that Career and Technical Education (CTE) programs in high schools and technical colleges may provide a means for improving the labor market success of young males (Brunner et al., 2023; Bonilla, 2020; Bertrand et al., 2019; Bockermann et al. 2018, 2019; Stevens et al. 2019; Jacob, 2017; Cullen et al., 2013; Page, 2012; Kemple and Willner, 2008).

To date, little evidence is available on the mechanisms that contribute to these labor market gains. Advocates often point to industry placement and the provision of industry specific skills as potential explanations, but almost no studies examine the impact of CTE on industry placement. Carruthers and Sanford (2018) provide one exception to this lack of evidence documenting placement in high paying industries as a critical mechanism. They find that adult students (sample average age of 30) that earn certificates from postsecondary technology centers are more likely to be working in higher paying industries relative to their pre-training industry. They also show that a significant portion of the earnings gains arise for workers who changed industries after gaining certification.[1]

[1] Brunner et al. (2023) examine educational outcomes as a potential mechanism behind labor market gains, and others similarly document improvements in education outcomes (Helmelt et al., 2019; Bonilla, 2020; Dougherty, 2018), but to our knowledge only Carruthers and Sanford (2018) and our paper examine industry placement.

In this paper, we examine the effect of CTE education at specialized high schools on the industry and earnings outcomes of young adults.[2] In contrast to Carruthers and Sanford (2018) who focus on the effect of post-secondary CTE targeted primarily at workers already active in the labor market, we focus on the effect of high school CTE on initial entry into the labor market and the early labor market experiences of young adults. Several states have stand-alone CTE high schools and many others have CTE centers that provide more centralized training to students in public high schools. Our study provides the first investigation of the impact of intensive CTE training in high school on industry of employment and on industry disaggregated earnings. Specifically, we examine the effects of admission to the Connecticut Technical Education and Career System (CTECS), a statewide system of public CTE focused high schools. Our identification strategy exploits the fact that all CTECS high schools are oversubscribed, allowing us to use a regression discontinuity identification strategy to examine the effects of CTE on industry choice and industry earnings premiums.[3]

Our industry choice models examine the likelihood that a student is observed working in a specific industry after high school relative to retail trade, which is the most common industry of employment in our sample and an industry that is relatively unrelated to the CTE programs at CTECS.[4] We then test for a discontinuity in the relative likelihood of employment in each sector at the admissions threshold. We depart from Carruthers and Sanford (2018) who compare the likelihood of working in a specific industry relative to all other industries because such a comparison conditions on employment in industries that also are expected to be influenced by

[2] Jacob and Ricks (2023) examine CTE program choice in high school rather than initial industry placement and Stevens et al. (2019) examine earnings gains by program choice, but we do not observe the program in which each CTECS student participated.

[3] Carruthers and Sanford (2018) use a student fixed effect approach comparing students before and after obtaining certification. This source of identification is not feasible in our application to high school CTE because adult labor market outcomes cannot be observed prior to treatment.

[4] Retail trade represents about one quarter of employment in our sample, 24% of males and 26% of females.

CTE.[5] One can view industry of employment as a choice from among many discrete options, and these pairwise comparisons relative to retail trade are equivalent to a multinomial choice model with retail trade as the omitted category. Given that male and female students tend to pursue very different programs of study[6] and some studies have found that labor market gains accrue primarily to men (Brunner et al., 2023; Bertrand et al., 2019, Page, 2012),[7] we conduct separate analyses for female and male students.

We first replicate earlier work from Brunner et al. (2023) including newly available years of data and show that for male students being above the admissions threshold (i.e. intent to treat) increases quarterly earnings by 15.1% and labor force participation as captured by the number of quarters with earnings rising by 1.2 quarters, but unlike Brunner et al. (2023) given additional years of earnings data we now find a modest 5.2% increase in quarterly earnings for female students.

Turning to the results on industry of employment, we find that for male students being above the admissions threshold significantly increases the likelihood of working in manufacturing, professional (e.g. accounting and legal services), construction, office support, education, and health care. Furthermore, the first three industries have large, unexplained earnings premiums of 78%, 35% and 73% relative to retail trade, implying that placement in these industries could lead to substantial earnings gains. For female students, being above the

[5] For example, the effects on manufacturing employment conditional on all other employment would likely be reduced relative to pairwise comparisons because CTE also increases employment in construction and transportation.

[6] For example, using aggregate data on program enrollment in one year, CTECS programs like automotive manufacturing and technology, carpentry, collision repair, heavy equipment repair, electrical, HVAC, masonry, plumbing, and welding enroll 73 percent of male students, but only 33 percent of female students. In contrast, 52% of female students enrolled in culinary arts, guest services, early childcare and education, hairdressing and cosmetology, health technologies, hotel hospitality, and tourism programs, but less than 7 percent of male students enrolled in such programs. See Appendix Table A1.

[7] A notable exception is Silliman and Virtanen (2019) who find positive effects for female students in Finland.

CTECS admission threshold reduces the likelihood of working in professional services, which provides a substantial earnings premium, and increases the likelihood of working in office support, which provides an earnings penalty. Notably, for female students, we do not find statistically significant effects of treatment for placement in education or health care, even though females are heavily represented in related CTECS programs.[8]

After replicating the earnings models in Brunner et al. (2023) with additional years of data, we estimate models that allow the effect of CTECS on earnings to vary by the industry of employment. We present both estimates of absolute earnings premia arising from being above the admissions threshold, as well as estimates relative to the CTE premium in retail trade because retail trade is the industry where the industry specific skills provided in CTE programs are least likely to apply and earnings gains are most likely to arise due to acquisition of general skills. Notably, we find minimal gender differences in the earnings premium associated with being admitted to a CTE school in the retail trade sector, with estimated gains of 5.5% and 7.5% for male and female students respectively. Further, we find CTECS earnings premia for male students relative to retail trade in the following industries: manufacturing (6.1%), transportation (12.8%), professional (16.6%), construction (18.8%), operations support (10.0%), and office support (12.6%). Notably, we do not observe any statistically significant earnings premiums above the retail trade premium for treated female students.[9]

While we do not have student level data on program enrollment,[10] we investigate potential mechanisms behind the labor market effects of CTECS by creating a match between

[8] The lack of treatment effects for women in the areas of education and health are notable given earnings premiums of 22% and 55% in those industries, respectively.
[9] Unlike the industry estimates, our earnings estimates are not causal because students select their industry, but at least on observables, bias from selection appears minimal as our treatment effect estimates are quite stable to adding controls for student test scores and demographics.
[10] See Bockerman et al. (2018, 2019) for a study that exploits information on vocational field of study in higher education.

CTECS programs and industry employment based detailed industries codes by manually matching programs to related occupations and using the American Community Survey to measure occupational composition in each industry. Relative to retail trade, both male and female students who are above the admissions threshold are more likely to work in specific industries that have a close occupational match to CTECS programs across a wide array of industry categories or sectors, particularly in manufacturing, construction, and services. The program to industry match is also improved by CTECS admissions for female students working in education and health industries. Working in a specific industry with a high match is associated with higher wages for male students and controlling for this match explains much of the overall return to being above the admission threshold for male students in manufacturing, construction and operations support. This suggests the wage premiums we observe for male students arise in part from industry specific skills obtained while studying in a CTE intensive high school.

On the other hand, the declines in the CTECS earnings premium after adding the match quality control for transportation, professional, and office support are substantially smaller, suggesting that factors other than industry specific skills may play a role in these specific earnings premiums. We run additional models allowing industry earnings to vary by student test scores. We document a substantial earnings premium from higher test scores in professional and office support consistent with earnings gains in these sectors being driven in part by the impact of CTECS on general skills, as captured by treatment effects on test scores and high school graduation as documented in Brunner et al. (2023).

We also find evidence that is suggestive of a role for work-based learning in explaining the industry employment patterns and earnings premiums we observe. While we cannot distinguish between employment obtained through CTECS and independent employment while

in high school, being above the admissions threshold is associated with male students being more likely to work in manufacturing, professional, construction, and operations support during high school.[11] We also document positive effects of high school work experiences on both the likelihood that male students work in a specific industry that has a high occupational match to CTECS programs and on overall earnings premiums. These results suggest that CTECS work-based learning programs may play an important role in providing a pathway to these high-paying jobs that reward male students for the skills obtained in these schools.

Finally, we examine whether earnings gains associated with industry placement arise entirely from the initial job placement post-high school, versus the effect of skills provided by attending CTECS, which might facilitate transition to higher paying industries over time. We classify the industry categories of manufacturing, construction, professional, wholesale trade, operations support, and health as high paying, and show that students whose initial jobs are in low paying industries are more likely to transition to a high paying industry if they are above the CTECS admissions threshold. This is especially true for students who initially work in retail, service, office support, or public/social service industries after high school. [12]

From a policy perspective, our results suggest CTE specialized high schools in Connecticut place non-college bound male students into high paying industries and provide the skills necessary to transition to high paying industries even when a student's placement out of high school is into a lower paying job. This is particularly important given that early jobs held by young workers can have disproportionate effects on long-run earnings as shown for initial

[11] We also find increases in female high school employment in Manufacturing and Construction, but effects for female students are substantially smaller than for male students.

[12] However, while the earnings gains over time are larger for workers who transition to high paying industries, admission to CTECS is not independently associated with earnings gains over time. Therefore, these earnings gains are driven primarily by the effect of CTECS on the likelihood of industry transition. Finally, we find that overall these earnings gains are persistent over time including in industries where admission to a CTECS high school implies large within industry earnings gains.

industry (Ross and Ukil 2021), firm size (Arellano-Bover 2019; Muller and Neubaeumer 2018), and whether a firm is higher paying (Abowd, McKinney, and Zhao 2018).

II. Connecticut Technical Education and Career System (CTECS)

CTECS is a statewide public school district comprised of 16 high schools. The system focuses on providing skills to support transition into the labor market following high school graduation. While CTECS students must meet the standard high school graduation requirements, they also complete CTE coursework in lieu of other electives. At CTECS, 9th grade students explore 3 to 6 programs of interest and at the end of the first semester rank programs they wish to pursue. In the spring of 9th grade, they are assigned a program based on preferences and availability and spend the next three and a half years completing their CTE coursework with a stable cohort of peers and instructors. Within their selected program, students take a minimum of three aligned courses. Often, these sequences are combined with career awareness activities and opportunities for work-based learning in settings outside of school.[13]

Roughly 11,000 students attend the 16 CTECS high schools comprising more than seven percent of all high school students in the state. Approximately, 30 percent of total enrollment comes from the state's five largest city school districts and as a result CTECS tends to serve a disproportionate share of students from lower-income families. Eighth graders across the state can elect to apply in the winter before they enroll in 9th grade to attend one of the CTECS high schools. Students can apply to multiple schools, but must rank-order their choices. All 16 of the technical high schools are oversubscribed and receive more applicants than they can accommodate.

[13] In contrast, traditional comprehensive high schools typically offer only 2 to 4 CTE programs, and students may only take one or two courses, often not even in the same program.

Each student receives an application score following a common standardized formula. For the 9th grade years of 2006-07 through 2008-09, the score is based on standardized 7th grade test scores in math and language arts (reading and writing) plus GPA and attendance in middle school. For the 9th grade years of 2009-10 through 2013-14, two additional categories were added based on points for extracurricular activities and a written statement.[14] Even though the underlying attendance and standardized test scores are close to continuous, the scoring system discretizes each of these components into an ordinal set of points that are then added together to form the total score.[15]

School administrators have described establishing an admissions threshold in each school every year and then sending out initial acceptance letters primarily to students whose scores lie above the threshold. However, some students may be admitted with lower scores in order to increase diversity, and later waves of letters can be sent out to lower scoring students if all seats in the school are not filled. Other students with higher scores may not be admitted because they applied late, withdrew their application prior to a second wave of admissions, or were excluded based on information in their disciplinary file. Therefore, the admissions process results in a "fuzzy" discontinuity where the noise arises from deviations of school administrators from the scoring system, errors in the recording of acceptance letters, and imperfect take-up by applicants. Finally, applicants with identified disabilities, i.e. applicants with an Individualized Educational Plan, are subject to another layer of review and evaluation prior to admission, and so are excluded from our analysis.

[14] The number of points associated with each component in each application year is shown in Appendix Table A2. Points for extracurricular activities and the written statement are based on information provided by the applicant.
[15] As discussed in detail by Brunner et al. (2023), the discrete nature of application components yields a distribution of raw scores that is lumpy and irregular. However, all evidence (Brunner et al. 2023) suggests the scoring system is the reason for the irregular distribution, as opposed to manipulation at the threshold. As we demonstrate later in the paper, balancing tests provide no evidence of changes in the composition of students across the admissions threshold.

III. Methods

We model the relationship between student outcomes and admission scores using a regression discontinuity design with a uniform kernel. As discussed by Brunner et al. (2023), we do not observe the threshold established for sending out admissions letters and hence follow Porter and Yu (2015) and identify the score thresholds empirically as the threshold that yields the largest discontinuity in the probability of receiving an offer of admission. We then create a centered score, $\tilde{X}_{isyt} = X_{isyt} - \widehat{X^*_{sy}}$, where X_{isyt} is the application score of student *i* who applied to CTECS school *s*, from 8th grade school district *t* (typically town of residence), in application year *y*, and X^*_{sy} is the school-by-year admission cutoff score.

Finally, we create a panel so that each applicant has multiple observations, i.e. one observation for each quarter and year *q* a student is observed in the labor market and pool the data across schools and years in order to estimate reduced form linear probability models of industry:

$$I^j_{isytq} = \beta_{1j} d\left(\tilde{X}_{isyt} \geq 0\right) + \theta_{j21}\tilde{X}_{isyt} + \theta_{j22}\tilde{X}_{isyt} d\left(\tilde{X}_{isyt} \geq 0\right) + \delta_{1sy} + \gamma_{1t} + \varphi_{1q} + \varepsilon^j_{1isytq} \quad (1)$$

where I^j_{isytq} takes the value of one if student *i* is observed working in industry *j* in year and quarter q and zero if they are working in the baseline industry *0* (individual by quarter observations where the individual works in another industry are omitted from the sample), $d\left(\tilde{X}_{isyt} \geq 0\right)$ is a binary indicator that equals one if student *i*'s application score is above the admissions threshold, δ_{1sy} is a vector of CTECS school-by-application year fixed effects, γ_{1t} is a vector of applicant 8th grade district fixed effects, effectively identifying the likely counterfactual high school or schools, φ_{1q} is a vector of year and quarter of year fixed effects, and ε^j_{isytq} is a random disturbance term. Standard errors are clustered following our fixed effects structure: application school by application year and sending 8th grade school district.

Next, we estimate models of earnings by quarter y_{isytq} allowing earnings and the treatment effects on earnings to vary by industry:

$$y_{isytq} = \omega_0 d\left(\tilde{X}_{isyt} \geq 0\right) + \left[\sum_{j\neq 0} \omega_j d\left(\tilde{X}_{isyt} \geq 0\right) * \rho_j\right] + \theta_{j3}\ \tilde{X}_{isyt}$$
$$+\theta_{j3}\ \tilde{X}_{isyt} d\left(\tilde{X}_{isyt} \geq 0\right) + \rho_j + \delta_{2sy} + \gamma_{2t} + \varphi_{2q} + \varepsilon_{2isytq} \quad (2)$$

where ω_0 captures the level effect of treatment on earnings for the baseline industry, ρ_j is a vector of industry fixed effects, and ω_j captures the differential effect of treatment on earnings for industry j by interacting d with the industry fixed effects.

To illustrate the predictive power of the threshold, we estimate a first stage equation for attendance A_{isyt} in the sample of applicants:

$$A_{isyt} = \tilde{\alpha}\ d\left(\tilde{X}_{isyt} \geq 0\right) + \theta_{41}\tilde{X}_{isyt} + \theta_{42}\tilde{X}_{isyt} d\left(\tilde{X}_{isyt} \geq 0\right) + \delta_{3sy} + \gamma_{3t} + \varepsilon_{3isy} \quad (3)$$

where $\tilde{\alpha}$ represents the composite or sample average effect of being above the threshold on being treated, i.e. attending a CTECS school.

IV. Data, Sample and Identification

Our sample consists of approximately 22,800 8th graders who applied to a technical high school during the academic years of 2006-07 to 2013-14. The sample contains one observation for every application so students with multiple applications independently contribute to estimates based on being above the threshold of each school. Sixteen percent of the sample applied to two schools and only three percent applied to three schools (the maximum allowed), but a much smaller fraction are within the bandwidth of the admissions threshold for more than one school.[16] The CTECS admissions data contains each applicant's name, date of birth, home town, middle school, the total admissions score, the individual components of the score, and in later years the

[16] Correlation between observations from the same student is addressed by clustering by sending 8th grade school district. Results are robust to dropping students who applied to more than one school.

State Assigned Student Identification Number (SASID). We match the CTECS admissions records to the Connecticut State Department of Education's (CSDE) longitudinal data system using the following criteria sequentially: 1) SASID; 2) exact match on first and last name plus birth year; 3) first initial and exact match on last name plus birth year and month; and 4) exact match on last name plus exact birth date. The reason for the sequential process is reporting errors for birth dates, spelling errors and nicknames in the CTECS application that was filled out by hand. Our resulting match rate was 95 percent. The CTECS data does not contain the student's selected CTE program.

From the CSDE longitudinal data system, we obtained information on each student's race, gender, free-or reduced-price lunch status, English learner, special education status (i.e. presence of an IEP) and 8th grade standardized test scores. Through Connecticut's P20Win process, students in our sample are matched to Connecticut State Department of Labor (CSDOL) data on quarterly earnings and the industry of the primary employer for each quarter. This CSDOL match is facilitated by Department of Motor Vehicle records that contain gender, birth date, and first and last name, which is matched to the CSDOL data using social security numbers. CSDOL personnel then match the resulting data to the CSDE data using an exact match on birth date and gender and a fuzzy match algorithm on name. The fuzzy match algorithm requires an estimated confidence of 70%, which yields a match rate of 72.3% between the student applicant records and the CSDOL data.[17] Student are in the labor market sample if CSDOL observes unemployment insurance covered earnings in any quarter for which the

[17] A fuzzy match criteria of 60% only yields an additional 500 matches, many of which looked erroneous upon visual inspection by CSDOL personnel. Neither the match quality nor the matches below the 70% threshold were provided to us by CSDOL.

students is age 16 or older.[18] While the DOL data contains the detailed industry NAICS code for an individual's primary employment in each quarter, the data does not contain any additional information on the actual firm at which the individual is employed.

Our sample includes quarters of earnings after allowing for five years to complete high school and two quarters to enter the labor market. For both male and female students, the match rates rise for the first few quarters in our sample, but then stabilize at just above 60% in each subsequent quarter and year (see Appendix Tables A3 and A4). We restrict our labor market data to end in the 1st quarter of 2020 prior to disruptions created by the pandemic. Therefore, we restrict the sample to cohorts applying to CTECS in 2006 to 2013 so that for 2013 applicants our sample period contains labor market data based on the criteria above. Foote and Stange (2022) identify three approaches for testing whether attrition from the sample is a concern when working with state labor market data: 1) association between treatment and having non-missing earnings; 2) balanced sample composition over treatment for the sample with non-missing earnings; and 3) assessing whether migration is related to treatment. Below, we verify that membership in the labor market sample is not influenced by CTECS attendance and that the labor market sample passes standard balancing tests. Further, Brunner et al. (2023) document higher rates of missing earnings for students residing in towns on the state border, and then demonstrate that estimated effects of attending CTECS are robust to dropping towns on the state border. However, we must interpret our quarters with earnings analyses as the likelihood of having quarterly earnings within the state of Connecticut. Further, given this limitation, we

[18] Several factors drive the failure to match applicants in the CSDOL data including never having a driver's license in Connecticut, name changes due to marriage or other factors, moving out of state prior to or upon completion of high school or failure to participate in the labor market after high school perhaps due to college attendance.

cannot consider missing quarters to be quarters of zero earnings and so when studying quarterly earnings, we restrict our analysis sample to quarters with non-zero earnings.

We next divide employment into 12 major industry categories: manufacturing, retail trade, transportation, professional, services, construction, wholesale trade, operations support, office support, public/social services, education, and health.[19] These categorizations depart from 18 two-digit NAICS sectors defined by the U.S. Census Bureau in several places. For parsimony, we combine NAIC codes 51-55 (information, finance and insurance, real estate, profession/scientific/technical, and management) into an overall category of professional, and arts/entertainment/recreation (code 71) and accommodation/food services (code 72) are combined into services capturing CTE programs related to hospitality. We also selected these categories based on the types of programs offered by CTECS and based on known patterns of gender sorting across industries. NAIC code 56 (administrative and support) combines many traditional female dominated jobs such as office administrative services and male dominated jobs like facilities support, waste management and investigation/security. For example, Business Support Services 5614 is 66% female, while Services to Buildings and Dwellings 5616 is only 20% female. We therefore split these into two categories which we call office and operations support, and further combine operations support and utilities for parsimony. Health care is separated from social assistance services within code 62 due to health care's significant role for women in CTE and child day care services 6244 is combined with educational services due to a focus in CTECS on early childhood, as opposed to K-12, education. The rest of social assistance services (code 624) are combined with public administrative services (code 92) given the significant government role in providing family, relief and vocational services. The catch all

[19] We delete the tiny fraction of applicant-quarter observations (0.24 percent) associated with employment in NAICS code 11 Agriculture, Forestry, Fishing and Hunting or 21 Mining, Quarrying, and Oil and Gas Extraction.

category of other services 81 is divided up with 811 repair and maintenance assigned to operation support, personal and laundry services 812 assigned to services, and religious/grantmaking/civic 813 assigned to public/social services.[20] We also present results using the 18 census defined sectors, see footnotes 28 and 30 below.

For our estimation sample, we select a bandwidth of 15 points around the admissions threshold for each school and year.[21] Table 1 shows the industry and demographic composition of students in our sample. For comparison purposes, columns 1 and 2 first present summary statistics for a representative sample of Connecticut residents between the ages of 19 and 26 and without four-year college degrees drawn from the American Community Survey (ACS). Columns 3 and 4 present summary statistics for our sample overall, while columns 5-8 present the same information within the bandwidth separately for subsamples above and below the threshold. Retail trade is the largest industry of post-high school employment regardless of gender with approximately 25% of both the male and female sample working in this industry. Male students are more heavily represented in manufacturing, transportation, construction, wholesale trade and operations support, and female students are more heavily represented in services, public/social services, education, and health. Being above the threshold leads to substantial increases in male student representation within manufacturing and construction of 4 and 5 percentage points, respectively, but minimal changes in the industry composition of female

[20] See Appendix Table A5 for a detailed crosswalk between NAICS codes and our industry categories, as well as the gender composition of the specific industry categories based on a representative subsample of the American Community Survey.

[21] Brunner et al. (2023) used a smaller bandwidth of 10, but also show that changes in the bandwidth had minimal effects on their estimates. We use a larger bandwidth because our analyses within industry imply that effects are identified based on smaller subsamples. Our balancing tests with the larger bandwidth are quite similar to the balancing tests of Brunner et al. (2023).

students. The CTECS applicant and ACS samples have similar industry representation by gender.[22] [23]

Table 2 presents average quarterly earnings for the sample by industry. On average, male students earn more in every industry, but the industries with the largest male-female differences (around $3,000 per quarter) are manufacturing, wholesale trade, construction, operations support, and public/social services. We also observe differences in earnings when comparing the sample of male students above and below the admissions threshold, with the largest differences (from $1,000 to $2,000 per quarter) in manufacturing, transportation, professional, construction and operations support. Among female students, earnings differences of this magnitude only arise for manufacturing and construction.[24]

To validate our discontinuity-based identification strategy, we present balancing tests across the cut-off boundaries in Table 3.[25] These tests examine whether there are any discontinuities in student attributes over the admissions threshold, where the existence of such a discontinuity would raise concerns about manipulation around the threshold. For both the male and female students pooled across years and schools, we regress student and sending school

[22] The exceptions are 1) Office Support where the largest subcategory 5611 office administrative services is not identified in the ACS because in the ACS those workers are distributed across the industries associated with each specific office type; and 2) Public/Social Service where total share of employment assigned to social service industries in the ACS is much smaller than in our sample and Social Service employment is predominantly female

[23] Brunner et al. (2023) also compare the CTECS applicant sample to the student population statewide. The applicant sample is substantially less female (42%) than students statewide. On average, minority students and students qualifying for free and reduced-price lunch are overrepresented among the population of applicants with percent African American being 50 percent higher and percentages of Hispanic and Free-lunch eligible almost double the shares statewide. This pattern of overrepresentation is even stronger for female applicants.

[24] Appendix Table A6 presents descriptive statistics for whether a student is in or out of the labor market and by whether the student is above or below the admissions threshold. While there are some differences across subsamples, the above/below threshold differences are quite similar when comparing the subsamples that are in and out of the labor market sample.

[25] As noted by Brunner et al. (2023), traditional tests for manipulation cannot be applied due to the scoring system that leads to a non-standard distribution of the running variable. Therefore, to address concerns about bias from manipulation, we also estimate models using a donut hole approach dropping observations at the cut-off for the school and year (Barreca et al., 2011). However, as shown by Brunner et al. (2023), results are nearly identical regardless of whether the donut hole observations are dropped.

district attributes on a dummy variable for whether the student's score is above the cut-off, the linear running variable for the student's score and the interaction of that running variable with the dummy for being above the cut-off.[26] The student attributes include: 1) whether the student is in the labor market sample; 2) race and ethnicity; 3) whether the student is free lunch eligible; 4) whether the student is an English language learner; 5) 8th grade composite test scores; and 6) sixth grade attendance. The sending district attributes include: 1) spending per pupil; 2) pupil teacher ratio; and 3) 6th grade average math scores. Only two of twenty estimates are significant at the 10% level, consistent with a rejection rate arising from type 1 error. Appendix Table A7 presents the balancing test for alternative bandwidths and results are similar.

We next estimate the first stage equation given by equation (3), pooling data from all schools and years. Figure 1A and Table 4 column 1 present the pooled estimates for whether a student receives an acceptance letter using our 15-point bandwidth. Figures 1B-1D and the additional columns of Table 4 present first-stage estimates for attending a CTECS high school for the full sample and then separately for male and female students. All figures show a clear discontinuity. The estimated first stage effect of being above the cut-off on receiving an acceptance letter is 0.88, implying an 88 percentage-point increase in the likelihood of receiving a letter. The first stage for being observed in the technical high school is somewhat smaller, but still sizable, at 0.66 for male students and 0.61 for female students.[27]

[26] As with our main RD models, these balancing tests include school by application year fixed effects and applicant 8th grade school district fixed effects.

[27] In principle, the power of the first stage could be overstated because the same sample was used to identify the thresholds and estimate the pooled first stage model. Brunner et al. (2023) demonstrate using hold-out samples that the strong power of this first stage is relatively unaffected by this problem.

V. Main Results

Table 5 presents the results of pairwise linear probability models examining the likelihood of being employed in each industry in any given quarter of employment, relative to our default industry of retail trade (omitting applicant by quarter observations in other industries), see equation (1). We select retail trade as the comparison (omitted) industry because it represents the most common job held by both male and female CTECS applicants and to avoid conditioning on other industries where employment was also affected by CTECS. For example, automotive service technician and food preparation workers are the two largest occupations within retail trade that are clearly associated with CTECS programs, but each of these occupations represent less than 1% of total employment in retail trade. As noted above, these pairwise comparisons are equivalent to estimating a multinomial choice model.

The top panel of Table 5 presents results for the first five industries and bottom panel of Table 5 presents results for the last six industries. The first column of Table 5 shows the overall effect of admissions on number of quarters with earnings. The estimates on offer (being above the threshold) for males are in the top rows in each panel and the bottom rows present estimates for females. The results reported in Table 5 are intent to treat estimates for being above the threshold. Given the magnitude of the first stage estimates, treatment on the treated effects are over 50 percent larger than the estimates presented in the table. These estimates are based on models that include the individual student-level balancing test controls. Appendix Tables A8 and A9 show that estimates are very similar when the model excludes those controls or uses alternative bandwidths.

The second row underneath the parameter estimates shows the fraction of workers employed in an industry relative to employment in retail trade to assist in evaluating effect size,

while the actual share of employment in each industry is shown in Table 1. For example, the top panel of Table 5 Column 1 for males has an entry of 0.32 for manufacturing implying that just under 1/3rd of all jobs designated as either manufacturing or retail trade are in manufacturing, or about twice as many males are employed in retail trade than in manufacturing. The third row presents the industry fixed effect estimate from log of quarterly earnings models that will be presented in further detail below. For example, looking at column 1, we observe approximately a 78% earnings premium in manufacturing relative to retail trade for male students and an even larger premium for female students.

We find that male students are 9.7, 5.2, 8.3, 4.3, 2.4, and 4.1 percentage points more likely to be employed in manufacturing, professional, construction, office support, education, and health, respectively, if they are above the admission threshold relative to retail trade. All these estimates are statistically significant and quite large in magnitude given the relative likelihood of employment in these specific industries of 32, 17, 30, 18, 9 and 15 percent, respectively. Notably, the first three of these industries have a large earnings premium over retail trade of 78%, 35% and 73%, respectively. Therefore, on average, treated male students are more likely to work in industries that yield higher earnings.[28] The industry selection effects for manufacturing and construction are not surprising given that skilled trade related programs such as automotive manufacturing and technology, electrical, heating-ventilation-air conditioning, mechanical design, and welding enrolled 79 percent of all male students in CTECS in 2019. However, the concentration of effects in professional, office support, health and education are

[28] The only exception is office support, which has average earnings that are 43% below earnings in retail.

less expected, but in most cases consistent with male students obtaining employment in sectors where CTECS offers related programs.[29]

While the local linear RD only identifies a local average treatment effect, the admissions thresholds vary considerably, i.e. the region covered by the thresholds lies in the middle of the distribution of scores and contains over half of applicants. Therefore, our models capture the average effect over a wide range of student academic performance. Further, the effects on industry choice are relatively broad based over the prior academic performance of students and the range of admission thresholds. For example, we estimate models where the offer indicator is interacted with whether the admissions threshold for a given school and cohort was in the top or bottom tercile of the distribution of admission thresholds, and both interactions for all industries are statistically insignificant, implying little heterogeneity in treatment effects across admission thresholds (see Appendix Table A11).[30]

For female students, we find that being above the admissions threshold reduces the likelihood of working in the professional services industry by 3.0 percentage points relative to a base share of 16 percent, and increases the likelihood of working in construction by 1.2 percentage points relative to a 2% share, and in office support industries by 2.3 percentage points relative to a 16% share. The decline in employment in professional industries implies less

[29] Appendix Table A10 presents results using the 18 census defined industry sectors. While key sectors like Manufacturing, Construtions and the reference sector of retail are unchanged, this table presents several new estimates for male students. The positive effects for professional are concentrated in Finance/Insurance, Real Estate and Scientific/Technical industries. The positive effects for operations and office support are replicated for the combined census defined sector of Administrative/Support/Waste Management, and the positive effects in Education and Health are similar in magnitude even though early child care (previously in Education) and social services have been moved to Health. The only noticeable change is that treated male students are modestly more likely to work in public administration, less than 3 percentage points, now that social services has been removed from that industry.

[30] Further, we have also estimated separate models for each industry by school by cohort, recognizing that each school by cohort represents a separate regression discontinuity (Bertanha, 2020). While the individual estimates are very noisy, our point estimates from the stacked RD fall well within the scatter plots of those individual estimates and are similar to their mean.

representation of successful female applicants in an industry that carries a female wage premium of 54% relative to retail trade. Similarly, the increase in employment in office support implies greater representation in a sector with a 29% earnings discount relative to retail trade. While construction offers a substantial earnings premium, the absolute increase in employment is too small to have a substantial effect on earnings. Further, estimates of the impact of selection into the health, education or the service industries, which includes both Arts, Entertainment, and Recreation and Accommodation and Food Services industries, are insignificant even though CTECS programs that focus on culinary arts, guest services, early childcare and education, hairdressing and cosmetology, health technologies, hotel hospitality, and tourism enroll approximately 52% of all female CTECS students. Both education and health offer substantial earnings premiums relative to retail trade of 21% and 55%, respectively. Therefore, we find much less evidence that CTECS is placing female students in jobs related to their program choices at higher rates than comparable students who did not attend CTECS.[31] [32]

Our findings for males are comparable to Carruthers and Sanford (2018) who found positive effects of certificate or diploma receipt on employment in construction, transportation, business services, professional services, and health care for adults who received left the labor market to receive post-secondary technical education. The lack of effects in their paper for manufacturing and smaller effects for business and professional services likely arises because their models include construction and health care as part of the employment basis, industries that

[31] For female students, Table A10 shows that the negative effects on placement in professional industries arises primarily for the Finance/Insurance and Scientific/Technical sectors. However, the positive effects for females in office support is lost when combined into the larger, more male dominated sector of Administrative/Support/Waste Management.

[32] We also estimate models of this type separately by student race, free lunch status and whether the student comes from a central city school district. We only find evidence of substantial heterogeneity by location in a central city school district with effects concentrated among students who did not originate from a central city school district. Appendix Tables A12 (male) and A13 (female) present these estimates.

were also affected by CTE participation. Consistent with that notion, Appendix Table A14 reruns the analyses in Table 5 except includes the entire sample using employment in all other industries as a basis of comparison, and while the qualitative results are robust, the quantitative effects are substantially smaller.

To capture the overall earnings effects of treatment on industry choice, we estimate specifications similar to those reported in Table 5 except we use the entire student-quarter sample across all industries and replace the industry of employment dependent variable with the associated industry fixed effect estimate from the last row for each gender in Table 5. As shown in Appendix Table A15, male students who are admitted to CTECS experience on average a 4.7% increase in the industry earnings premium to which they are exposed. For female students, the estimate is small, negative, and statistically insignificant.

Table 6 presents estimates of the impact of being above the admissions threshold on quarterly earnings overall and by industry of employment. As noted above, due to the fact that our data misses the earnings of individuals who are working in other states, we cannot treat quarters without earnings as representing zero earnings, and so we only include quarters where workers have non-zero earnings in the sample. Columns 1 and 3 in panel 1 show the direct effect of being above the admissions threshold on the log of quarterly earnings for male and female students, and Appendix Figure 1 presents these results in graphical format. Being above the admissions threshold raises quarterly earnings by 15.1% for male students, consistent with the 33% treatment on the treated estimate of CTECS on quarterly earnings in Brunner et al. (2023), and Appendix Figure 1 Panel A shows a clear discontinuity. The estimate for female students is much smaller at 5.2%, but statistically significant and larger than the statistically insignificant estimate in Brunner et al. (2023) whose labor market data ended two years earlier. Columns 2

and 4 in the first panel show the direct effect after including industry fixed effects. After conditioning on industry fixed effects, the treatment effect estimate for male students falls to 10.5% which is again similar to Brunner et al. (2023), implying industry selection effects potentially explain one third of the gain in quarterly earnings. On the other hand, the inclusion of industry fixed effects leads to a modest increase in the treatment effect estimate from 5.2% to 5.9% for female students, consistent with negative effects of industry selection on earnings for females. Further, referring back to the bottom row of Table 5, the industry fixed effect estimates are very similar across gender, except for professional and health where the industry earnings premiums are larger for female students.

Finally, the bottom panel of Table 6 presents novel estimates based on the specification given by equation (2) where the effect of CTECS on earnings varies across industry. Note that because individuals in our sample self-select into industries, these estimates may not have a causal interpretation. However, as with the model of industry choice, the estimates are robust to the inclusion or exclusion of controls or the use of alternative bandwidths (Appendix Table A16). Columns 1 and 3 present the level effect by interacting every industry fixed effect with the offer variable for being above the threshold and show substantial positive earnings gains for male students in most major industry categories, with the exceptions of Professional, Education and Health. For female students, while many estimates are noisy, estimates are near or above the 5-6 percent average earnings premium in all industries except Professional, Education and Health.

If we consider retail trade to be an industry where the gains from CTECS in terms of industry specific skills are modest, then the estimate on retail trade can in principle be interpreted as evidence of the effect of general skills on earnings. Columns 2 and 4 then present the same estimates on industry earnings premium except that those estimates are relative to the earnings

premium for retail trade, as a possible indication of the provision of industry specific skills by CTECS high schools, above and beyond skills obtained through CTE education available in traditional highs schools. For retail trade, the male and female treatment effects are relatively similar at 5.5% and 7.5%, respectively, consistent with male and female students obtaining similar benefits in terms of general skills. However, for male students, we find statistically significant additional effects of treatment on earnings in manufacturing (6%), transportation (13%), professional (17%), construction (19%), operations support (10%) and office support (13%), while for female students, we do not find any significant industry wage premium relative to retail trade associated with being above the admissions threshold. Therefore, while the industry earnings fixed effects are similar for male and female students, female students do not appear to gain substantial industry specific earnings returns from admission to CTECS, although sizable, noisy estimates arise for the very small fraction of female students who work in construction.[33] The earnings effects for male students are quite broad-based over admissions score thresholds with only the interaction of the top tercile indicator with construction being statistically significant, implying construction effects for only the middle and bottom terciles, see Appendix Table A18.[34]

[33] Appendix Table A17 presents results using the 18 census defined industry sectors. For male students, the positive effects relative to retail trade for professional arise for all sectors, but are largest in Finance/Insurance, Scientific/Technical and Management, although the estimates on management are noisy. The positive effects on earnings for operations and office support are replicated for the combined census defined sector of Administrative/Support/Waste Management. The only noticeable change is that statistically insignificant negative effects on treated male student earnings in Public/Social are substantially larger and now significant at the 10% level once social services have been removed from that industry. For female students, the insignificant 7 percent loss in earnings in professional is associated with statistically significant earnings losses in the Information and the Finance/Insurance sectors. Almost no women in our sample are employed in the utilities sector, and those estimates are unreasonably large.

[34] Appendix Tables A19 (male) and A20 (female) present earnings models separately for each subsample considered in Appendix Table A12. Appendix Table A21 presents effects by industry on quarters worked, but industry differences in the effects on quarters worked are minimal.

VI. Detailed Evidence on Mechanisms

We begin by examining potential links between the programs offered by CTECS and industry of employment and earnings. We start with the full list of CTECS programs (P) in Appendix Table A1, and for each six-digit occupation code (O) we identify up to five programs that are relevant to each occupation based on visual inspection of program and occupation titles, and aggregate those codes up to four digit census occupation codes.[35] Based on the national sample of the 2021 American Community Survey, CTECS programs are relevant to occupations associated with approximately 60 percent of employment in the U.S. We use the ACS to provide a cross-walk between occupations and three- to six-digit industry NAICS codes (I) depending upon the precision of the ACS industry reporting,[36] and calculate the fraction of industry employment in each occupational category (F_{IO}). Then, for each CTECS program, we calculate the fraction of industry employment in occupations for each matched program as: $\sum_{\forall O} N_{PO} F_{IO}$, where N_{PO} is a discrete variable for the number of CTECS programs associated with an occupation. Finally, we sum over all programs to calculate a match index for each detailed industry NAICS code, which can be greater than one because some occupations are associated with multiple CTECS programs:

$$Match_I = \sum_{\forall P}(\sum_{\forall O} N_{PO} F_{IO}).$$

For example, across all construction industries, over 6% of industry employees are electricians and almost 10% of employees are carpenters, both occupations associated with equivalent CTECS programs. Similarly, 6% are first line supervisors of construction, which is associated with three of the building trade programs at CTECS. On the other hand, the

[35] See Appendix Table A22 showing the first, and when relevant, second match for each occupation.
[36] The ACS does not use NAICS codes, and so we use the Integrated Public Use Microdata Sample mapping from census industry code to NAICS for the lowest level NAICS code that can be uniquely matched to a census industry code.

occupation of drivers and sales workers is not associated with any CTECS program, and while this occupation is one of the most represented occupations within construction among those not associated with a program, the occupation accounts for only 2% of industry employment. If we were to calculate this index for construction, rather than detailed industries within the construction sector, we would add together the percentages weighted by the number of the programs adding 0.10 for carpenters, 0.06 for electricians, 0.18 for construction supervisors and 0.0 for drivers and sales workers, continuing to add the weighted percentages over all represented occupations. Alternatively, for retail industries, many key occupations are not associated with CTECS programs, like sales persons at 16%, cashiers at 13%, and stockers and order fillers at 8.5% of employees. On the other hand, automotive service technician or food preparation workers are two of the occupations that are most represented within retail trade among occupations associated with CTECS programs, and as note previously each occupation represents only about 1% of retail trade employment.

Appendix Table A23 presents summary statistics for the estimated index for the ACS sample overall and by gender and for the CTECS sample separately for male and female students. The average sample match index is 0.78 with a standard error of 0.29 for male students, and smaller at 0.71 with standard deviation of 0.33 for female students. Match quality is especially high, near or above one, for Manufacturing, Construction and Wholesale trade industries, and lowest for retail trade and transportation. Match rates by gender in the ACS are substantially higher for men than women except for education, health and also construction, where very few women are employed. In the application sample, overall match rates tend to be modestly higher for male than female applicants. Finally, match rate patterns are relatively similar between the ACS and our CTECS applicant sample.

Table 7 Panel 1 presents models that regress the match indices for an individual's detailed industry of employment on an indicator for being above the admissions threshold, the running variable, the interaction of the indicator for being above the admissions threshold and the running variable, and the application school by cohort and middle school district fixed effects. For male students, being above the threshold increases the match quality by 0.045, about 5 to 6 percent of the mean or about a 15% of a standard deviation in the match variable, with no effect of being above the threshold for female students. Therefore, on average, for male students being above the admissions threshold leads to a substantial increase in the likelihood of working in specific industries that are related to CTECS programs.

However, these simple estimates mask considerable heterogeneity. In panel 2, we present models of the match index that include interaction terms between the broad industry categories and being above the threshold including retail trade so that these estimates test whether being above the admissions threshold either increases or decreases the likelihood of being in an industry that has a high occupational match with CTECS programs. The estimate on the match index is negative for retail trade (-0.37), implying that being above the admissions threshold reduces the match quality associated with retail trade. These negative effects may reflect an impact of the general skill increase associated with CTECS on the breadth of labor market opportunities within retail trade. On the other hand, the estimates on the interaction with manufacturing and construction are positive and sizable for both male and female students with estimates between 0.55 and 0.60 for manufacturing, almost a two standard deviation increase in the match index from CTECS admission, and between 0.33-0.37 for construction. In all broad industries categories except for transportation, professional and office support, the estimates are positive implying that within most industry sectors, students that gain admission to a CTECS

school are more likely to work in specific industries with labor demands that are related to CTECS programs. Further, estimates for female students are relatively similar to estimates for male students, but the mean estimate in panel 1 is near zero because far fewer female students are found in manufacturing and construction where the effects of offer/admission to CTECS on the match index are the largest.

We next examine the relationship between earnings and the industry match to CTECS programs. We re-run the wage models from Table 6 adding controls for the overall match and the interaction of the match with being above the admissions threshold. Columns 1 and 3 of Table 8 present the original estimates from Table 6 panel 1. Columns 2 and 4 present the same estimates for models that also include the match controls. Specifically, panel 1 presents estimates for the baseline treatment model, panel 2 presents estimates from a model that conditions on industry fixed effects, and panel 3 presents the model where industry fixed effects are interacted with the offer variable.

Beginning with panel 1 for male students, a one standard deviation increase in match quality within a broad industry category increases the earnings return from being above the threshold (column 4) by over 50%. The estimate on the interaction of match with offer falls from 17.7 to 8.9 when industry sector FE's are included suggesting that about half of this effect arises because admission affects industry of employment. Moreover, the earnings premium associated with being above the admissions threshold when evaluated at the industry match mean for retail trade is only 3.4% suggesting that most of the CTECS earning premium is explained by the program match with industry. For female students, the return to working in a specific industry that is related to CTECS programs is similar in magnitude to estimates that do not control for

match, but noisily estimated, suggesting that match quality cannot conclusively explain the modest female earnings premium associated with CTECS.

Turning to Panel 3, the entire CTECS male earnings premium in manufacturing is explained by the earnings premium arising from the industry program match. Similarly, 44% and 61% of the male premium associated with working in construction or operations support, respectively, is explained by the match control. Notably, the inclusion of the match control demonstrates negative wage returns for admitted female CTECS students in health and education unless they are working in a program related specific industry. This is consistent with our earlier discussion regarding relatively low wages in education and health among workers without advanced training.

Overall, these results suggest that CTECS students earn substantial wage premiums in part arising from job specific skills obtained while studying in a CTE intensive high school. However, attending CTECS high schools may also aid in entry to specific industries through work experience in high school. In Table 9, we re-estimate the model of treatment effects on industry choice from Table 5 for a sample of quarters where the applicant is over the age of 16 and the quarters fall within the four-year post-application period in which the individual is expected to be in high school. For male students, we find strong treatment effects of 5.9, 3.2, 4.3 and 4.3 percentage points on the likelihood of working in manufacturing, professional, construction or operations support while in high school, respectively, relative to retail trade. For female students, we only find effects for manufacturing and construction, and those effects are smaller at 2.1 and 0.9 percentage points, respectively. For male students, we also find that high school work experience in a student's current broad industry category is associated with working in a specific industry that has higher demand for occupations that match CTECS programs

(Appendix Table A24) and is associated with higher earnings (Appendix Table A25). The inclusion of these high school industry experience variables explains about 24% and 16% of the manufacturing and construction earnings premium effects, respectively. Therefore, work-based learning experiences may play a significant role in the earnings gains from attending CTECS, particularly for male students.

Note that several industry specific treatment effects in Table 8 Panel 3 fall more modestly as controls for match quality are included: declines for transportation of 19%, professional of 16%, and office support of 29%, suggesting that a substantial part of the return in these general industry categories may arise from sources other than program specific skills gained in CTECS high schools. We therefore re-estimate earnings models where the industry fixed effects are interacted with both offer and a student's 8^{th} grade standardized composite test scores. These results are shown in Table 10 columns 1 and 2, respectively for male students, and columns 3 and 4 for female students. For both professional and office support industries, we find a substantial male earnings premia of 6.9% and 9.1%, respectively, for a one standard deviation increase in test scores. The analogous relative earnings treatment effects of being above the threshold for these two industries fall by 16% and 39%. This is consistent with part of the CTECS earnings premia in these industries arising from the general skill gains in CTECS, as indicated by positive test score and high school graduation effects of CTECS admission (Brunner et al. 2023).

Finally, we conduct analyses to distinguish between placement advantages associated with work experience in high school or CTECS connections with local employers, from broader labor market advantages that arise from skills obtained in CTECS high schools. We do this by examining changes in industry placement over time. Specifically, we classify the industry

categories of manufacturing, construction, professional, wholesale trade, operations support, and health as high paying, and draw a sample of students whose initial industry of employment fell into one of the other industry categories, i.e. low paying industry. We then estimate models for whether being above the admissions threshold leads to a higher likelihood of transitioning to a higher paying industry based on an indicator variable that takes the value of one if the student is working in a high paying industry in the last quarter of observed earnings.

These results are shown in Table 11. Whether we control for initial industry placement fixed effects or not (panels 2 and 1), we find that male students are substantially more likely to move to a high paying industry. Specifically, male students who receive an offer of admission are 8 percentage points more likely to transition to a higher paying industry. In panel 3, we present results where the effect of offer differs by initial low paying industry, and we find that the effects are concentrated among students who initially placed into retail trade, service, office support, and public/social service industries. We observe no effects for female students on average, and when based on first observed industry of employment we only find effects for female students initially in office support, the lowest paying industry category.

We next examine whether these transitions are associated with earnings gains. Specifically, using our sample of students with initial placement in low paying industries, we select the maximum of the first two quarters of earnings and the maximum of the last two quarters of earnings to minimize bias from partial quarters of employment, while restricting ourselves to students where we observe at least 5 quarters of earnings. We then regress the change in earnings between the early and final quarters on the following variables: offer, whether moved to a high paying industry, the interaction of offer and high paying industry, plus the running variable, school by cohort and middle school district fixed effects, a fixed effect for

number of quarters between expected high school graduation and the quarter on which initial earnings are based, and a fixed effect for number of quarters between expected high school graduation and the quarter on which final earnings are based.

These results are presented in Table 12. We find large effects for male and female students of moving to a higher paying industry, 0.36 percent increase in earnings for males and 0.24 for females. Note, however, that since the interaction of "move to higher paying industry" with offer is small (at least for males) and insignificant, all the earnings gains from CTECS arise due to an increased likelihood of transitioning to a higher paying industry. Also, the male coefficient on offer is quite small suggesting that students who initially place in lower paying industries have minimal earnings gains unless they successfully transition to higher paying industries later in life. Turning to Panel 2, where we control for both initial and final industry fixed effects, we see that half or more of these earnings effects are associated with the earning premium arising from that specific industry. These results are similar to the findings of Carruthers and Sanford (2018) who show that adult students have higher earnings gains after attending a post-secondary CTE program if they changed industries.[37]

Finally, we conduct similar analyses for earnings for the entire sample including interactions of offer with whether the earnings are associated with quarters more than three years after the beginning of the quarterly earnings sample for each cohort. We find no evidence of erosion in the earnings premium over time overall or in any of the industries with large earnings gains from attending a CTECS high school, see Appendix Table A28.

[37] Again, while the estimates in Tables 11 and 12 are not purely quasi-experimental because they condition on important labor market outcomes, all estimates are very similar in magnitude whether we include or omit the balancing test controls (see Appendix Tables A26 and A27), suggesting that these endogenous controls do not undermine the central inference of interest.

VII. Summary and Conclusion

Policymakers, practitioners, and government officials have long been interested in identifying effective job training and other active labor market programs for non-college bound young adults. In the U.S and other developed countries, training programs, even expensive programs, have been generally unsuccessful in improving youth employment outcomes (Greenberg et al. 2003; Card et al. 2018; Kluve et al. 2019). At the same time, some local youth employment programs with sector targeted training, like San Antonio Quest (Elliot and Roder 2017) and Year-Up Boston (Heinrich 2012-13), have had large impacts on youth earnings. Notably, in both programs, earnings effects were driven heavily by increases in hourly wages associated with placement into targeted sectors. Career and Technical Education is a common strategy, domestically and internationally, for providing sector-specific or targeted skills to youth while they are still engaged in formal education.

In this study, we attempt to unpack the impacts of CTE on sector of employment and industry specific earnings gains. We examine the effect of attending one of the 16 stand-alone technical high schools in the state of Connecticut on students' post high school choice of industry and earnings by industry using a regression discontinuity design. Using data on the universe of 8th grade student applicants to the Connecticut Technical Education and Career System (CTECS) between 2006 and 2013, we find that being admitted to a CTECS high school shifts male students towards working in higher paying industries, increases the ability of male students to transition from low to high paying industries over time, and raises earnings in several CTE related industries. Further, these earnings gains are persistent both overall and within key industries.

In our more detailed mechanism analyses, we find that these gains are especially large when students work in specific industries that have a strong demand for work in occupations related to CTECS programs, consistent with returns to specific skills. Emphasizing the importance of work-based learning, we also find evidence that in manufacturing and construction work experience while in high school matters. On the other hand, for professional and office support industries, we find that a substantial portion of the treatment effects on earnings arise because earnings in these industries are higher for students with higher 8th grade tests scores, consistent with demand for workers with higher levels of general skills.

Our study also helps to shed light on the common but puzzling finding of many studies that participation in CTE has positive impacts on male students, but minimal effects for female students (Brunner et al. 2023; Bertrand et al. 2019; Page 2012). Specifically, our results suggest that, in contrast to male students, admission to and attendance at a CTECS high school has a much more modest impact on the industry of employment of female applicants. Further, in several cases, the industry effects observed for female students shifts these applicants towards lower paying industries. Surprisingly, the overall industry earnings premiums are similar and sometimes larger for female applicants in traditionally male dominated industries like manufacturing and construction that are often the target of career and technical education programs. These high paying industries have the potential to yield significant earnings gains for young women, but to be broadly successful CTE programs must find a way to provide female students with more relevant work experience and target those students into industries that offer substantial earnings premiums.

On the other hand, among the female dominated programs, the two related industries that offer substantial earnings premiums are health and education, both industries that require four-

year college degrees for access to the key high paying jobs such as registered nurse and state certified K-12 teacher. The CTECS system focuses heavily on post-high school career readiness as opposed to college preparation, which may help explain the lack of any effects on the likelihood of employment in the education or health sectors. CTECS students who do pursue post-secondary education typically attend two-year colleges where certificates in early childhood education or health related fields are offered, but may lead to less lucrative employment.[38] In contrast, Bonilla (2020) finds the largest effects of increased CTE spending on educational attainment for girls and Stevens et al. (2019) find the largest returns in health care for California, a state where CTE tends to have a strong focus on college readiness. Similarly, while Silliman and Virtanen (2022) find positive earnings effects for women in Finland, they also observe that vocational track students pursuing secondary education typically attend the Universities of Applied Sciences (UAS), which are four-year Bachelor's degree granting institutions offering for example business, education, engineering and nursing degrees.

When combined with the findings of Bonilla (2020) and Silliman and Virtanen (2022), our finding that attendance at a CTECS school does little to shift female applicants towards working in higher paying industries on average, suggests that the strong focus on health and education within many CTE programs (including in CTECS) may be a poor fit for many of the students enrolled in such programs. Notably, after controlling for returns from working in specific industries with strong demand for program skills, the returns to female students of working in health and education industries is actually negative for industries that have occupational demands that weakly match CTECS programs. The strong focus on workforce readiness and transition to employment in CTECS may be poorly aligned with higher paying

[38] Notably, Brunner et al. (2023) find no effect of CTECS attendance on college admission.

traditional female dominated jobs in health care and education. To access high paying jobs in those industries, a hybrid CTE model that also emphasizes college preparatory skills may be more appropriate.

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Table 1: Summary Statistics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
					Male BW 15		Female BW 15	
	ACS Males	ACS Females	Male	Female	Below Threshold	Above Threshold	Below Threshold	Above Threshold
Quarterly Earnings	6092.34	4794.02	6,851	4,402	5,904	7,181	4,072	4,440
	(5277.31)	(3635.92)	(5,825)	(3,750)	(5,028)	(5,941)	(3,402)	(3,641)
Retail	0.22	0.24	0.241	0.261	0.258	0.236	0.266	0.262
Manufacturing	0.11	0.04	0.118	0.0285	0.0921	0.130	0.0240	0.0268
Transportation	0.04	0.02	0.0462	0.0223	0.0570	0.0418	0.0266	0.0228
Professional	0.06	0.07	0.0523	0.0550	0.0426	0.0535	0.0472	0.0540
Services	0.18	0.27	0.165	0.261	0.178	0.157	0.246	0.262
Construction	0.10	0.01	0.108	0.00535	0.0733	0.122	0.00231	0.00584
Wholesale Trade	0.03	0.01	0.0376	0.00881	0.0413	0.0362	0.00636	0.00964
Operation Support	0.09	0.02	0.0781	0.0209	0.0943	0.0780	0.0246	0.0200
Office Support	0.01	0.01	0.0518	0.0459	0.0641	0.0473	0.0566	0.0450
Public/ Social Service	0.09	0.04	0.0296	0.0629	0.0296	0.0271	0.0710	0.0604
Education	0.04	0.10	0.0252	0.0540	0.0203	0.0255	0.0489	0.0530
Health	0.04	0.18	0.0438	0.172	0.0469	0.0435	0.178	0.176
Observations (by Quarters)			352,832	297,293	71,943	133,184	61,068	106,771
Female	0.44		0.46					
Asian	0.03	0.02	0.0137	0.0125	0.0101	0.0127	0.00979	0.0109
Black	0.11	0.14	0.176	0.271	0.223	0.163	0.314	0.278
Hispanic	0.20	0.24	0.290	0.404	0.334	0.283	0.442	0.413
Free Lunch			0.552	0.739	0.651	0.535	0.812	0.737
English Learner			0.0502	0.0721	0.0731	0.0429	0.107	0.0699
8^{th} Grade CMT-Reading			235.2	231.9	220.2	235.2	216.3	230.7
			(31.75)	(30.55)	(26.99)	(25.85)	(24.66)	(24.59)
8^{th} Grade CMT-Math			241.9	232.1	224.8	241.5	213.2	230.8
			(33.43)	(32.90)	(26.94)	(26.25)	(25.06)	(25.34)
8^{th} Grade CMT-Writing			230.3	236.4	217.8	229.7	224.0	235.2
			(30.44)	(29.93)	(25.78)	(25.69)	(25.08)	(25.50)
Total Application Score			60.56	61.24	48.45	61.76	48.90	61.93
			(18.00)	(18.96)	(9.798)	(9.718)	(10.38)	(10.35)
Observations			18,954	14,785	4,368	7,872	3,454	6,005

Notes : Table presents summary statistics from the American Community Survey (ACS) and CTECS applicant samples on quarterly earnings, industry classifications and student demographics by gender and, for our CTECS applicant sample, achievement. Columns 1 and 2 present means and standard deviations for the ACS sample, columns 3 and 4 present means and standard deviations for our CTECS applicant sample. Columns 5-8 present summary statistics for students within a 15 point bandwidth of the RD cutoff score. Columns 4 and 6 present summary statistics below the cutoff while columns 5 and 7 present summary statistics above the cutoff. The ACS samples are based on 2013-2018 for workers residing in the State of Connecticut, age 19-26, worked at least 27 weeks last year, and on average at least 20 hours per week. In the ACS sample, Office support does not contain industry 5611 office administrative services and operation support does not contain 5612 facilities support services because those industries are not identified in the ACS, but instead the workers are distributed across the industries associated with the specific office or facility.

Table 2: Quarterly Earnings By Industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				Male BW 15		Female BW 15	
	Full Sample	Male	Female	Below Threshold	Above Threshold	Below Threshold	Above Threshold
Retail	4325.41	5064.94	3516.32	4822.64	5206.70	3257.66	3601.28
	(3674.48)	(4102.94)	(2933.13)	(3876.02)	(4217.10)	(2693.77)	(2935.70)
Manufacturing	10250.26	10706.51	8004.15	9569.33	10697.79	6960.93	7850.80
	(6069.12)	(6107.47)	(5335.68)	(5393.21)	(5948.89)	(4319.61)	(5076.43)
Transportation	5463.09	5947.17	4275.99	5260.24	6299.38	4006.14	4508.82
	(5029.79)	(5448.63)	(3543.33)	(4787.15)	(5775.16)	(3519.55)	(3664.26)
Professional	7795.52	8829.61	6630.92	7360.33	9012.48	6327.76	6380.58
	(5970.84)	(6724.56)	(4723.98)	(5749.69)	(6876.79)	(4480.24)	(4420.61)
Services	3775.73	4029.32	3586.21	3780.09	4259.25	3331.18	3668.19
	(3074.90)	(3361.46)	(2827.14)	(3172.51)	(3594.13)	(2635.80)	(2827.36)
Construction	10788.98	10913.22	7807.50	9288.12	11287.79	5437.52	7569.15
	(6752.96)	(6771.64)	(5504.36)	(6445.98)	(7008.06)	(4032.56)	(5192.00)
Wholesale Trade	8433.13	8887.23	6135.36	8302.99	8977.85	5998.50	5618.57
	(5923.74)	(6056.51)	(4552.79)	(5470.25)	(5507.22)	(5240.54)	(3711.36)
Operation Support	6765.71	7258.35	4585.33	6233.50	7640.68	4230.81	4634.72
	(5720.19)	(5968.82)	(3745.95)	(4737.80)	(6062.19)	(3351.48)	(3526.20)
Office Support	3623.98	3876.87	3285.73	3492.17	4061.12	3031.96	3444.46
	(3458.84)	(3629.80)	(3184.91)	(3318.64)	(3541.40)	(2895.36)	(3268.04)
Public/ Social Service	4882.59	6827.75	3799.29	6293.37	7012.63	3526.64	3957.66
	(5326.00)	(7004.81)	(3682.18)	(6182.57)	(7170.46)	(3505.39)	(3748.73)
Education	5255.35	6821.23	4391.13	7388.02	6907.94	4227.14	4332.56
	(4850.57)	(6336.31)	(3500.94)	(6848.77)	(6083.98)	(2871.07)	(3424.85)
Health	6103.49	6486.25	5987.79	6350.05	6350.32	5716.08	5960.61
	(4365.22)	(4721.11)	(4245.05)	(4397.97)	(4286.44)	(3790.06)	(4059.66)

Notes : Table presents mean quarterly earnings by industry. Column 1 presents means and standard deviations of quarterly earnings for the full sample, while columns 2 and 3 present separate summary statistics for the sample of male and female students respectively. Columns 4-7 present quarterly earnings by industry for male and female students within a 15 point bandwidth of the RD cutoff score. Columns 4 and 6 present summary statistics below the cutoff while columns 5 and 7 present summary statistics above the cutoff.

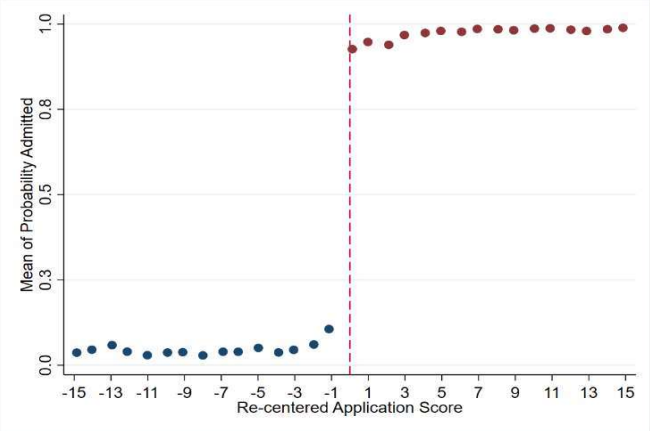
Table 3: Balancing Tests

	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)
			Individual-level Covariates						School Covariates	
Outcome	Labor Market	Black	Hispanic	Free Lunch	English Learner	8th Grade Test Scores	6th Grade Attendence	Spending Per Pupil	Pupil Teacher Ratio	6th Grade Avg Math Score
						Male Students				
Offer	0.00435	0.00260	-0.00343	-0.0101	-0.00608	0.358	-0.00221	29.84	0.0209	-0.195
	(0.0106)	(0.0117)	(0.0141)	(0.0168)	(0.0108)	(1.033)	(0.00298)	(43.92)	(0.0917)	(0.214)
Observations	16,446	11,324	11,324	11,324	11,324	10,425	6,771	10,796	11,270	10,352
Mean CG	0.819	0.223	0.334	0.651	0.0731	220.87	0.95	16263.57	13.83	242.07
St. Dev. CG	(0.38)	(0.42)	(0.47)	(0.48)	(0.26)	(21.99)	(0.05)	(2700.01)	(2.44)	(18.88)
						Female Students				
Offer	-0.00932	-0.00703	0.00701	0.00653	0.0118	0.507	-0.00294*	81.93*	-0.0474	0.0665
	(0.0135)	(0.0183)	(0.0150)	(0.0177)	(0.0147)	(1.000)	(0.00163)	(48.01)	(0.125)	(0.212)
Observations	13,571	8,717	8,717	8,717	8,717	7,800	5,649	8,169	8,679	7,853
Mean CG	0.781	0.314	0.442	0.812	0.107	217.78	0.95	15897.01	13.99	237.37
St. Dev. CG	(0.41)	(0.46)	(0.50)	(0.39)	(0.31)	(20.85)	(0.05)	(2650.22)	(2.63)	(17.32)

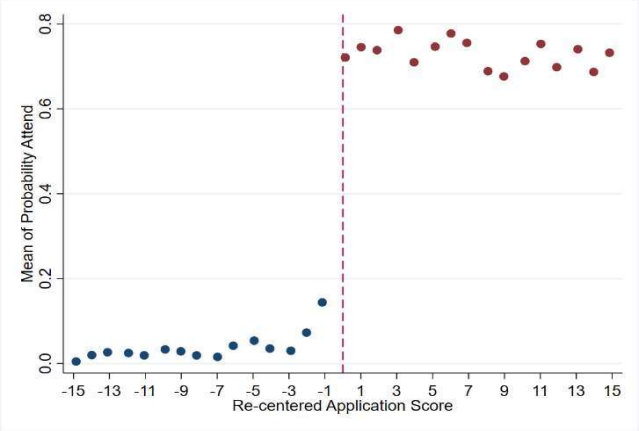
Notes: Table presents balancing tests for the samples of male and female students. Estimates are from a RD specification using local linear regression and a 15 point bandwidth. Top panel presents balancing tests for male students while the bottom panel presents balancing tests for female students. Columns 1-5 present balancing tests for individual covariates. Columns 6 and 7 present balancing test for 8th grade raw test scores and 6th grade attendance, respectively. Columns 8-10 present balancing tests for school-level spending per-pupil, pupil-teacher ratio and 6th grade average math scores for sending middle schools. Spending per-pupil is for sending middle schools in 2017, and pupil teacher ratio and average 6th grade test scores are for 2006 - 2011. Mean CG is the mean of the dependent variable for the control group and is defined as the mean to the left of the cutoff within the 15 point bandwidth. St. Dev. CG is the standard deviation of Mean CG. All specifications other than spending per-pupil include CTHSS school-by-year fixed effects and 8th grade school district fixed effects. Spending per pupil specification omits town fixed effects. Robust standard errors, clustered at the school-by-year and district levels in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Figure 1: Probability of Being Admitted to or Attending a CTECS School

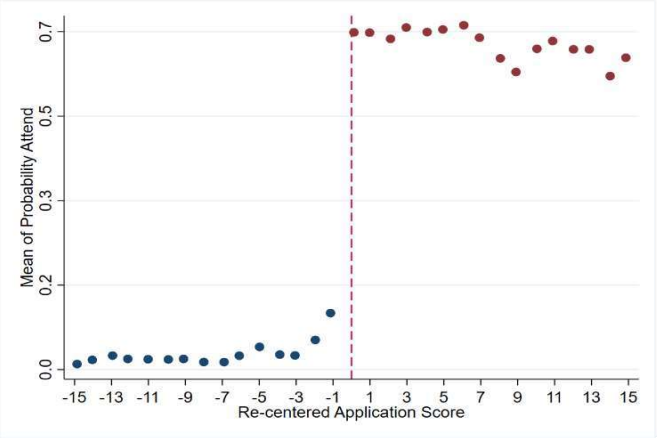
Panel A: Admitted to a CTECS School Full Sample



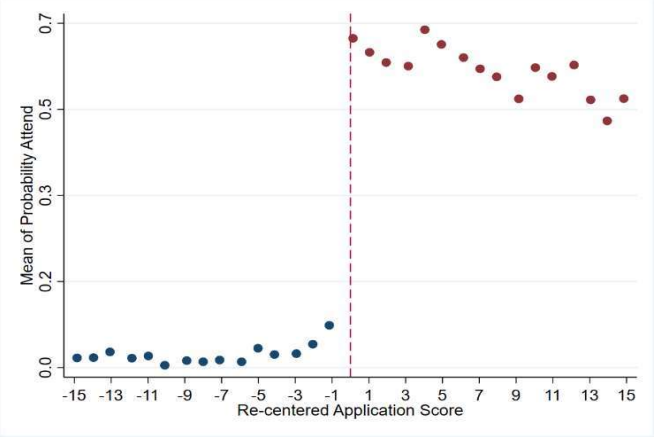
Panel C: Attending a CTECS School Male Students



Panel B: Probability of Attending Full Sample



Panel D: Probability of Attending Female Sample



Notes : The scores forming the horizontal axis have been re-centered by subtracting the threshold for each school and year from the scores associated with the applicants from those schools and years. These figures document the share of students admitted to or enrolled for each discrete application score where the size of the circle indicates the relative number of applications at each score. The figures are based on all applications from 8th graders from 2006-2013 (omitting IEP students and students not observed in 9th grade). Panel A shows the results for admission, panel B shows the results for attendance, and panels C and D show the results separately for the male and female subsamples.

Table 4: First Stage Estimates (Bandwidth 15)

Outcome	(1) Probability of Being Admitted Full Sample	(2) Probability of Attending Full Sample	(3) Probability of Attending Male Students	(4) Probability of Attending Female Students
Offer	0.882***	0.637***	0.660***	0.612***
	(0.0158)	(0.0217)	(0.0218)	(0.0281)
Controls	Yes	Yes	Yes	Yes
F	1949.90	503.8	221.69	131.89
Observations	20,041	20,041	11,324	8,717

Notes: Table presents first-stage estimates of the probability of being admitted to a CTECS school and the probability of attending a CTECS school for the sample of all applications from 8th graders from 2006-2013. Column 1 presents first-stage estimates of the probability of being admitted to a CTECS school where the dependent variable is an indicator for receiving an offer of admittance and the sample includes both male and female students. Column 2 presents main first-stage estimates for probability of attending a CTECS school after receiving an offer where the dependent variable is an indicator for attendance at a CTECS school in 9th grade. Columns 3-4 present the same information as column 2 but limit the sample to male and female students respectively. All specifications include controls for whether a student is: Asian, Black, Hispanic, Free lunch eligible or an English Learner as well as the standardized sum of 8th grade math and reading score. All specifications include CTECS school-by-year fixed effects and 8th grade school district fixed effects. Robust standard errors, clustered at the school-by-year and 8th grade district in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Pairwise Linear Probability Estimates: Industry Choice

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome	Quarters w/ Earnings	Manufacturing	Transportation	Professional	Services	Construction
			Male Students			
Offer	1.207***	0.0969***	0.00962	0.0523***	0.0241	0.0827***
	(0.266)	(0.0207)	(0.0106)	(0.0161)	(0.0219)	(0.0274)
Observations	448	73,869	59,648	60,167	83,536	71,427
Share Relative to Trade	NA	0.323	0.161	0.169	0.401	0.300
Earnings Industry FE	NA	0.775	-0.064	0.354	-0.266	0.733
			Female Students			
Offer	-0.506	0.00392	0.00843	-0.0298**	0.0180	0.0121*
	(0.311)	(0.0143)	(0.0115)	(0.0140)	(0.0207)	(0.00674)
Observations	284	48,565	48,289	52,880	87,176	45,005
Share Relative to Retail	NA	0.089	0.084	0.163	0.493	0.017
Earnings Industry FE	NA	0.844	0.067	0.543	0.032	0.666
	(7)	(8)	(9)	(10)	(11)	(12)
Outcome	Wholesale Trade	Operation Support	Office Support	Public /Social Service	Education	Health
			Male Students			
Offer	0.00723	0.0319	0.0428***	0.0196	0.0239**	0.0412**
	(0.0135)	(0.0215)	(0.0124)	(0.0123)	(0.0102)	(0.0201)
Observations	57,785	67,130	60,897	55,739	54,856	59,150
Share Relative to Trade	0.134	0.255	0.179	0.103	0.088	0.154
Earnings Industry FE	0.569	0.216	-0.430	-0.124	0.114	0.281
			Female Students			
Offer	0.0114	-0.00326	0.0230**	-0.00388	-0.0107	0.000730
	(0.00875)	(0.00996)	(0.0111)	(0.0162)	(0.0171)	(0.0153)
Observations	45,658	47,879	52,498	55,018	52,876	73,855
Share Relative to Trade	0.031	0.076	0.157	0.196	0.163	0.401
Earnings Industry FE	0.432	0.200	-0.287	-0.086	0.218	0.546

Notes : Table presents pair-wise linear probability estimates for the probability that a student is observed in the industry listed in the corresponding columns relative to being observed in retail. Top and bottom panels present estimates for different industries. The top rows in each panel present estimates for a sample of male students. Bottom rows present estimates for a sample of female students. All estimates are based on a reduced form RD specification using local linear regression and a 15-point bandwidth. All specifications include the full set of controls listed in Table 3 . All specifications include CTHSS school-by-year fixed effects and resident 8th grade school district fixed effects. Robust standard errors, clustered at the school-by-year and district levels in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Earnings by Industry

	(1)	(2)	(3)	(4)
	Male Students		Female Students	
	Replication	Industry FE's	Replication	Industry FE's
Offer	0.151***	0.105***	0.0519**	0.0589***
	(0.0297)	(0.0254)	(0.0217)	(0.0225)
R-Square				
	Industry Interaction with Offer			
	Interactions	Conditional on Retail	Interactions	Conditional on Retail
Offer	NA	0.0554**	NA	0.0758**
		(0.0250)		(0.0312)
Retail	0.0554**	NA	0.0758**	NA
	(0.0251)		(0.0312)	
Manufacturing	0.116***	0.0607**	0.0706	-0.00515
	(0.0300)	(0.0281)	(0.0563)	(0.0502)
Transportation	0.184***	0.128**	0.0656	-0.0102
	(0.0542)	(0.0553)	(0.0854)	(0.0747)
Professional	0.221***	0.166***	0.00147	-0.0743
	(0.0450)	(0.0458)	(0.0515)	(0.0486)
Services	0.0859**	0.0305	0.0770***	0.00123
	(0.0373)	(0.0367)	(0.0272)	(0.0299)
Construction	0.243***	0.188***	0.307	0.231
	(0.0362)	(0.0368)	(0.227)	(0.208)
Wholesale Trade	0.0692	0.0138	0.0501	-0.0257
	(0.0470)	(0.0566)	(0.142)	(0.146)
Operation Support	0.155***	0.100**	0.0792	0.0034
	(0.0575)	(0.0500)	(0.0921)	(0.0754)
Office Support	0.181***	0.126***	0.116**	0.04
	(0.0533)	(0.0471)	(0.0555)	(0.0441)
Service	-0.0614	-0.117	0.109***	0.0329
	(0.0864)	(0.0942)	(0.0401)	(0.0547)
Education	-0.0819	-0.137	-0.0414	-0.117
	(0.102)	(0.0982)	(0.0689)	(0.0715)
Health	0.0187	-0.0367	0.02	-0.0557
	(0.0525)	(0.0603)	(0.0281)	(0.0359)
R-Square	0.184		0.098	
Observations	204,467		167,611	

Notes: Table presents reduced-form estimates where the dependent variable is the log of quarterly earnings. All estimates are based on a RD specification using local linear regression and a 15-point bandwidth. Columns 1 and 2 present estimates for the sample of male students. Columns 3 and 4 present estimates for the sample of female students. Panel A presents models in columns 1 and 3 that exclude industry fixed effects and in columns 2 and 4 present estimates that add industry fixed effects. The estimates on the fixed effectes are shown in Table 5. The bottom panel presents estimates based on a specification that includes both industry fixed effects and those fixed effects interacted with the offer indicator. Columns 1 and 3 present the effect of offer seperately for each industry, while Columns 2 and 4 present the same estimates relative to the estimated effect of offer on the omitted category of retail trade. All specifications include CTECS school-by-year fixed effects, resident 8th grade school district fixed effects, quarter and year fixed effects and the full set of controls listed in Table 3. Robust standard errors, clustered at the school-by-year and district levels in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 7: Industry Program Match as Dependent Variable

	(1)	(2)
Sample	Male	Female
Offer	0.0453***	0.00356
	(0.0109)	(0.00642)
Observations	204,654	167,452
R-squared	0.053	0.031
Effects of Offer By Industry Category		
Retail*Offer	-0.376***	-0.408***
	(0.0144)	(0.0119)
Manufacturing*Offer	0.595***	0.552***
	(0.0174)	(0.0175)
Transportation*Offer	-0.227***	-0.108***
	(0.0307)	(0.0335)
Professional*Offer	-0.148***	-0.255***
	(0.0166)	(0.0199)
Services*Offer	0.256***	0.282***
	(0.0170)	(0.0150)
Construction*Offer	0.327***	0.376***
	(0.0163)	(0.0153)
Wholesale Trade*Offer	0.0412***	0.0959***
	(0.0151)	(0.0193)
Operation Support*Offer	0.0493*	0.0870***
	(0.0288)	(0.0198)
Office Support*Offer	-0.134***	-0.125***
	(0.0168)	(0.0154)
Public/Social Service*Offer	0.0351*	0.0988***
	(0.0205)	(0.0126)
Education*Offer	0.159***	0.220***
	(0.0171)	(0.0147)
Health*Offer	0.113***	0.128***
	(0.0155)	(0.0103)
Observations	204,056	167,266
R-squared	0.492	0.511

Notes: Table presents models of occupation to CTECS program match for a worker's specific industry choice. The first panel presents an estimate of the effect of offer on match. The second panel presents estimates on the interaction of offer with indicators for all major industry categories including retail trade and the variable offer itself is excluded so all estimates are relative to a zero effect of offer on industry match. Column 1 presents estimates for males and column 2 for females. All estimates are based on a reduced form RD specification using local linear regression and a 15-point bandwidth. All specifications include the full set of individual student controls listed in Table 3 . All specifications include CTECS school-by-year fixed effects and resident 8^{th} grade school district fixed effects. The models in the second panel also include major industry category fixed effects. Robust standard errors, clustered at the school-by-year and district levels in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 8: Earnings by Industry Conditional on Detailed Industry Program Match

	(1)	(2)	(3)	(4)
	Male Students		Female Students	
	Baseline	Match	Baseline	Match
Offer	0.151***	-0.0271	0.0519**	0.0514
	(0.0297)	(0.0320)	(0.0217)	(0.0372)
Program Match		0.526***		0.166***
		(0.0215)		(0.0363)
Program Match*Offer		0.177***		-0.00232
		(0.0244)		(0.0421)
R-Square	0.099	0.136	0.054	0.056
Observations	205,125	204,654	167,839	167,452
Conditional on Industry Category Fixed Effects				
Offer	0.105***	0.0254	0.0589***	0.0475
	(0.0254)	(0.0327)	(0.0225)	(0.0378)
Program Match		0.523***		-0.0165
		(0.0507)		(0.0507)
Program Match*Offer		0.0887***		0.0146
		(0.0258)		(0.0403)
R-Square	0.183	0.193	0.098	0.098
Observations	204,467	204,056	167,611	167,266

Notes: Table presents reduced-form, RD local linear regression estimates for log of quarterly earnings regressed on offer, program match with detailed industry, and the interaction of offer and program match where the dependent variable is the log of quarterly earnings. In panel 1, Columns 1 and 3 in panel 1 present the estimates from Table 6 panel A columns 1 and 3, and Columns 2 and 4 present the estimates after including controls for program match and the offer/program match interaction. Panel 2 presents for the same model except adds major industry category fixed effects so that columns 1 and 3 of the table present the estimates from panel A columns 2 and 4 of Table 6. In panel 3 on the next page, the industry by offer interactions are included and their interactions presented so that columns 1 and 3 now present the estimates from Table 6 panel B columns 2 and 4. Robust standard errors, clustered at the school-by-year and district levels in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 8 (Continued): Earnings by Industry Conditional on Detailed Industry Program Match

	(1)	(2)	(3)	(4)
	Male Students		Female Students	
	Baseline	Match	Baseline	Match
Offer	0.0545**	-0.00730	0.0750**	0.0396
	(0.0249)	(0.0347)	(0.0306)	(0.0439)
Program Match		0.498***		-0.104
		(0.0616)		(0.0709)
Program Match*Offer		0.126**		0.149
		(0.0581)		(0.103)
Manufacturing*Offer	0.0627**	-0.0646	-0.00455	-0.113
	(0.0280)	(0.0621)	(0.0503)	(0.0903)
Transportation*Offer	0.130**	0.105*	-0.0101	-0.0396
	(0.0556)	(0.0604)	(0.0744)	(0.0728)
Professional*Offer	0.167***	0.140***	-0.0744	-0.0863**
	(0.0459)	(0.0499)	(0.0485)	(0.0363)
Services*Offer	0.0321	-0.0332	0.00165	-0.109
	(0.0369)	(0.0506)	(0.0294)	(0.0794)
Construction*Offer	0.189***	0.101*	0.235	0.202
	(0.0367)	(0.0559)	(0.210)	(0.184)
Wholesale Trade*Offer	0.0150	-0.0472	-0.0249	-0.0584
	(0.0556)	(0.0613)	(0.145)	(0.148)
Operation Support*Offer	0.102**	0.0393	0.00365	-0.0500
	(0.0501)	(0.0594)	(0.0752)	(0.0808)
Office Support*Offer	0.128***	0.0902	0.0400	0.00773
	(0.0469)	(0.0546)	(0.0438)	(0.0704)
Public/Social Service*Offer	-0.116	-0.171*	0.0335	-0.0557
	(0.0947)	(0.101)	(0.0547)	(0.0817)
Education*Offer	-0.136	-0.179	-0.117	-0.227**
	(0.0968)	(0.120)	(0.0711)	(0.106)
Health*Offer	-0.0349	-0.0822	-0.0550	-0.152**
	(0.0601)	(0.0683)	(0.0359)	(0.0597)
R-Square	0.184	0.194	0.098	0.098
Observations	204,467	204,056	167,611	167,266

Table 9: Pairwise Linear Probability Estimates: Industry Choice in High School

	(1)	(2)	(3)	(4)	(5)	
Outcome	Manufacturing	Transportation	Professional	Services	Construction	
			Male Students			
Offer	0.0586***	-0.00433	0.0319*	0.00491	0.0433***	
	(0.0198)	(0.0126)	(0.0169)	(0.0127)	(0.0151)	
Observations	19,747	16,613	19,260	62,223	18,299	
Share Relative to Retail	0.138	0.024	0.091	0.583	0.105	
			Female Students			
Offer	0.0214**	-0.000783	-0.00107	0.00245	0.00904**	
	(0.00971)	(0.00481)	(0.0161)	(0.0131)	(0.00357)	
Observations	18,161	15,028	17,672	60,639	16,714	
Share Relative to Retail	0.061	0.006	0.091	0.626	0.016	
	(6)	(7)	(8)	(9)	(10)	(11)
Outcome	Wholesale Trade	Operation Support	Office Support	Service	Education	Health
			Male Students			
Offer	-0.0126	0.0432**	-0.00139	-0.00373	-0.0187	0.0267
	(0.0150)	(0.0201)	(0.0128)	(0.0161)	(0.0149)	(0.0203)
Observations	17,120	19,290	17,318	22,231	20,686	20,611
Share Relative to Retail	0.045	0.144	0.038	0.162	0.114	0.105
			Female Students			
Offer	0.00545	0.00419	-0.00335	0.000700	-0.0331**	-0.000667
	(0.00646)	(0.00883)	(0.0127)	(0.0147)	(0.0151)	(0.0220)
Observations	15,536	17,706	15,733	20,647	19,102	19,025
Share Relative to Retail	0.017	0.030	0.035	0.169	0.139	0.149

Notes : Table presents pair-wise linear probability estimates for the probability that a student is observed in the industry listed in the corresponding columns at the age of 16 or older through four years after beginning high school, relative to being observed in retail. Top and bottom panels present estimates for different industries. The top rows in each panel present estimates for the sample of male students. Bottom rows present estimates for the sample of female students. All estimates are based on a reduced form RD specification using local linear regression and a 15-point bandwidth. All specifications are identical to those in Table 3 with only the sample changed to focus on quarters of work during the relevant time frame for attending high school. Robust standard errors, clustered at the school-by-year and district levels in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 10: Earnings by Industry with Offer and 8th Grade Test Scores Interacted

	(1)	(2)	(3)	(4)
	Male		Female	
	*Offer	*Test Score	*Offer	*Test Score
Offer	0.0509**		0.0733**	
	(0.0250)		(0.0294)	
Manufacturing	0.0616**	0.00724	-0.00150	0.00120
	(0.0307)	(0.0206)	(0.0534)	(0.0429)
Transportation	0.110**	0.0406	-0.00629	0.00703
	(0.0553)	-0.0442	(0.0770)	(0.0532)
Professional	0.141***	0.0685*	-0.0827*	0.0318
	(0.0448)	(0.0365)	(0.0470)	(0.0429)
Services	0.0492	-0.0397*	0.0167	-0.0171
	(0.0360)	(0.0225)	(0.0313)	(0.0257)
Construction	0.186***	-1.15e-06	0.114	0.237**
	(0.0356)	(0.0307)	(0.171)	(0.119)
Wholesale Trade	-0.000588	0.0398	-0.0377	0.0612
	(0.0574)	(0.0355)	(0.160)	(0.0749)
Operation Support	0.0910*	0.0150	-0.0144	0.0601
	(0.0545)	(0.0286)	(0.0737)	(0.0729)
Office Support	0.0776	0.0907***	0.0184	0.0510
	(0.0476)	(0.0306)	(0.0789)	(0.0490)
Public / Social Service	-0.139	0.0354	0.0277	-0.00691
	(0.0938)	(0.0789)	(0.0544)	(0.0428)
Education	-0.101	-0.0621	-0.0976	-0.0439
	(0.104)	(0.0915)	(0.0731)	(0.0453)
Health	0.00349	-0.0726	-0.0705*	0.0153
	(0.0615)	(0.0498)	(0.0359)	(0.0330)
R-Squared	0.185		0.098	
Observations	204,466		167,598	

Notes : Table presents reduced-form estimates where the dependent variable is the log of quarterly earnings adding additional controls for the interaction of 8th grade test score with the indicator variables for the major industry categories. All estimates are based on a RD specification using local linear regression and a 15-point bandwidth including the same controls and fixed effects and using the same sample as Table 6 panel B. Columns 1 and 2 present estimates for male students while columns 3 and 4 present estimates for female students. The omitted or reference industry is retail. Columns 1 and 3 present estimates for the industry categories interacted with offer and columns 2 and 4 present estimates for test score interacted wtih offer seperately for male and female students. Robust standard errors, clustered at the school-by-year and district levels in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 11: Move to High Paying Industry as Dependent Variable

	(1)	(2)
Sample	Male	Female
Baseline Model		
Offer	0.0840***	0.00360
	(0.0178)	(0.0193)
Observations	10,656	10,568
R-squared	0.075	0.076
Includes Initial Industry Fixed Effects		
Offer	0.0830***	0.00330
	(0.0174)	(0.0192)
Observations	10,656	10,568
R-squared	0.081	0.078
Effects of Offer By Initial Industry Category		
Retail*Offer	0.0957***	0.00215
	(0.0190)	(0.0222)
Transportation*Offer	0.0514	-0.00950
	(0.0335)	(0.0812)
Services*Offer	0.0636**	-0.0110
	(0.0249)	(0.0234)
Office Support*Offer	0.116**	0.0872**
	(0.0473)	(0.0436)
Public/Social Service*Offer	0.108	0.0154
	(0.0657)	(0.0311)
Education*Offer	0.0154	0.0518
	(0.0556)	(0.0447)
Observations	10,656	10,568
R-squared	0.081	0.078

Notes: Table presents models of a change in the worker's industry category choice from low paying to high paying industry from the first to the last quarter of earnings observed. The first two panels present estimates of the likelihood of offer on moving to a high paying industry with the second panel adding initial industry fixed effects. The third panel presents estimates on the interaction of offer with indicators for lower paying major industry categories the variable offer itself is excluded so all estimates are relative to a zero effect of offer on move to high paying industry. Column 1 presents estimates for males and column 2 for females. The sample only includes individuals observed in lower paying industries for the first quarter of labor market earnings. All estimates are based on a reduced form RD specification using local linear regression and a 15-point bandwidth. All specifications include the full set of individual student controls listed in Table 3 . All specifications include CTECS school-by-year fixed effects and resident 8th grade school district fixed effects. The models in the second and third panels also include major industry category fixed effects. Robust standard errors, clustered at the school-by-year and district levels in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 12: Earnings Changes with Move to High Paying Industry

	(1)	(2)
Sample	Male	Female
Baseline Model		
Offer	0.0276	0.0427
	(0.0489)	(0.0689)
Move to High Paying Industry	0.356***	0.241***
	(0.0526)	(0.0704)
Offer*Move to High Paying Industry	0.0121	0.0509
	(0.0571)	(0.0694)
Observations	10,650	10,563
R-squared	0.169	0.134
Includes Initial and Final Industry Fixed Effects		
Offer	0.0482	0.0377
	(0.0512)	(0.0629)
Move to High Paying Industry	0.146**	0.106
	(0.0685)	(0.0946)
Offer*Move to High Paying Industry	-0.0352	0.0365
	(0.0554)	(0.0681)
Observations	10,629	10,547
R-squared	0.272	0.276

Notes: Table presents models of a change in the worker's quarters log earnings between earliest and latest quarters of work as a function of whether moved from low paying to high paying industry category between the first and last quarter of earnings observed. Earliest and lastest quarter earnings are based on the maximum of earnings in that quarter or the immediately following or preceding quarter for the first and last quarters, respectively. All specifications include the full set of individual student controls listed in Table 3, as well specifications include CTECS school-by-year fixed effects, resident 8th grade school district fixed effects, year and quarter of earliest earnings fixed effects, year and quarter of latest earnings fixed effects, number of quarters since expected high school graduation until quarter of earliest earnings fixed effects and number of quarters since expected high school graduation until quarter of latest earnings fixed effects. The models in the second panel also includes initial major industry category fixed effects and final major industry category fixed effects. Robust standard errors, clustered at the school-by-year and district levels in parentheses. *** p<0.01, ** p<0.05, * p<0.1