The Effect of Career and Technical Education on Industry Choice and Earnings

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Overview

- Over the last several decades, many high paying manufacturing industries have seen significant reductions in labor demand (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, Glaeser, and Summers 2018).

- Traditional training programs and active labor market policies, even expensive programs, have been generally unsuccessful in improving the employment outcomes of young adults (Greenberg et al. 2003; Card et al. 2018; Kluve et al. 2019).

- Recent evidence suggests that Career Technical Education (CTE) may provide a means for improving the labor market success of young, non-college bound males by providing hands-on training, practical skills, and promoting early entry and integration into high paying jobs and industries.

Overview

- The purpose of this study is to provide the first causal evidence on how participation in CTE programs impacts industry of employment choices and unique evidence on how CTE participation affects the within industry earnings premiums of young adults.

- Our analysis is based on the universe of students that applied to the Connecticut Technical Education and Career System (CTECS), a statewide system of public CTE focused high schools, between 2006 and 2011.

- We use admission score thresholds to estimate a regression discontinuity (RD) model of the reduced form effects of being above the threshold.

Connecticut Technical High School System

- Quasi-independent, all high school district of choice
- Delivered at scale: 16 high schools, enroll 11,000 students ~8% of all HS enrollment
  - ~1/3 of enrollment from five largest cities
- Open to students across the state, without residency restrictions
- Most elective course offerings are CTE
- We examine 57,000 8th graders applying to join the entering freshman cohorts from 2006-07 through 2013-14, but excludes students applying as 9th graders and students with an IEP (special education).
- 8 applications years, across 16 schools per year

Earlier Findings

- Our prior work focused on a program evaluation of the effects of attending one of 16 standalone schools that are part of CTECS on student short- and long-term outcomes.

- All 16 schools are oversubscribed and use a score-based admission system allowing us to implement a regression discontinuity identification strategy to isolate the causal effect of attending a CTE high school.

- Use admission data from 2006-2012 with matched administrative data on demographics and outcomes (graduation, test scores, attendance), clearinghouse data on college attendance, and labor market data on employment and earnings.

  - Brunner, E. J., Dougherty, S. M., & Ross, S. L. (2023). The effects of career and technical education: Evidence from the Connecticut Technical High School System. *The Review of Economics and Statistics*, 105(4), 867-882.

Earlier Findings

- Male students are 10 percentage points more likely to graduate from high school relative to a mean graduation rate of 80 percent.
- Male students have 35% higher quarterly earnings post high school and earnings effects persist into the future with former male CTHSS students aged 23-25 earning 33% more on average per quarter in the labor market.
- Two thirds of gains within industry, potentially students gaining general skills.
  - Male students have higher math and reading test scores in 10^{th} grade and higher attendance in 9^{th} grade relative to counterfactual students.
- Effects are homogeneous over admission thresholds, student demographics, and attributes of sending town or counterfactual school.
- Except for CTE offerings of counterfactual high school, but course offerings only explain 1/3rd of effects (possible effects from stand alone nature).
- Find no effects of attending a CTHSS school on female students.

Motivation

- Lack of findings for female students
  - Observed in Career Academies study as well (Kemple and Willner 2008)
  - Women are underrepresented in CTE and women tend to sort into very different programs than men (Lui and Burns 2020; Jacob and Ricks 2020)
  - No data on programs pursued, but industry is a good indicator of career pursuits.
- Part of the goal of the CTECS system is to meet the workforce needs of key industries in the state – our work aims to inform policymakers about this goal.
- In our current work, we use our regression discontinuity framework to examine the effects of attending a CTECS high school by gender on:
  - Industry choice in post-high school years
  - Differences in earnings gains from attending CTECS across industry categories

Empirical Framework

- We employ a RD identification strategy.

$$y_{ist} = \alpha_0 + \beta T_i + \omega_1 S_{ist} + \omega_2 (T_i \cdot S_{ist}) + \delta_{st} + \varepsilon_i$$

y_{ist} is an indicator for the industry choice or continuous measure of earnings for student *i,* who applied to CTECS school *s* in year *t.*

T_i is an indicator for receiving an offer of admission (i.e. being above the admission threshold) to a CTECS school.

S_{ist} is the admission score (running variable)

δ_{st} is a vector of CTECS school by admission year fixed effects

- Reduced form models of being above threshold with 15-point bandwidth.
- Model industry choice as series of linear probability models examining likelihood of employment in industry in given quarter, relative to default industry of Retail Trade.
- Industry earnings based on interaction of industry with being above admissions threshold.

Quarterly Earnings By Industry

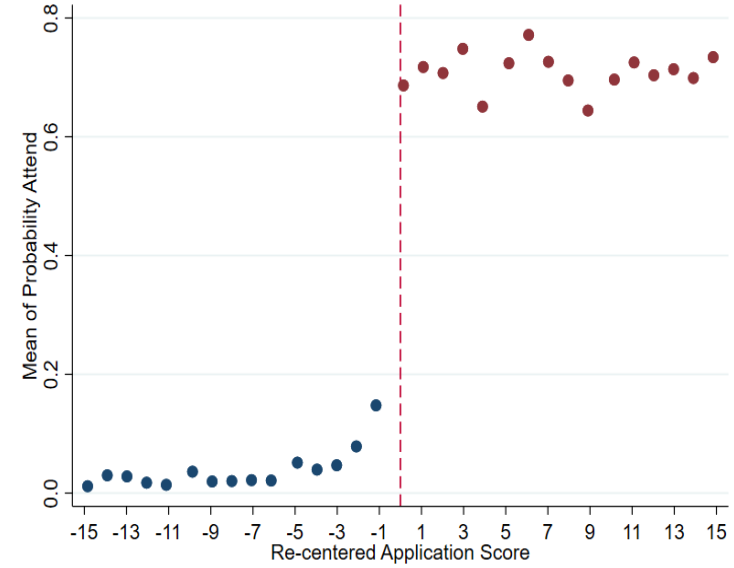
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				Male BW 15		Female BW 15	
	Full Sample	Male	Female	Below Threshold	Above Threshold	Below Threshold	Above Threshold
Manufacturing	9031.62	9384.67	7283.38	8368.65	9378.67	6435.91	7424.38
	(4785.87)	(4796.42)	(4328.39)	(4095.68)	(4571.11)	(3704.04)	(4283.60)
Retail	4421.65	4963.54	3779.18	4668.15	5142.98	3511.03	3851.63
	(3065.90)	(3365.51)	(2520.81)	(3065.69)	(3530.18)	(2312.33)	(2434.91)
Transportation	5597.47	5881.23	4741.59	5186.56	6158.81	4523.33	4854.59
	(4247.72)	(4481.60)	(3303.95)	(3784.21)	(4731.36)	(3265.88)	(2989.39)
Professional	7273.52	8178.28	6212.06	6731.34	8509.04	5843.28	6157.88
	(4760.92)	(5356.91)	(3675.26)	(4371.84)	(5662.77)	(3648.46)	(3372.16)
Services	4127.85	4323.30	3974.98	4031.64	4588.07	3718.79	4064.49
	(2803.44)	(3049.76)	(2584.32)	(2884.91)	(3219.01)	(2346.68)	(2513.32)
Construction	9633.95	9683.14	8112.95	8103.10	10075.81	6194.56	7850.29
	(5428.76)	(5449.77)	(4477.48)	(5116.13)	(5574.44)	(3922.27)	(4046.72)
Wholesale Trade	7664.36	7965.11	6035.58	7668.16	8183.40	5628.14	5687.05
	(4445.43)	(4518.84)	(3614.86)	(4248.74)	(4440.17)	(4649.29)	(3332.85)
Operation Support	6568.82	6894.47	4899.64	5915.68	7242.45	4289.70	4825.40
	(4515.51)	(4686.92)	(2996.60)	(3520.80)	(4634.44)	(2489.32)	(2803.08)
Office Support	3999.84	4205.94	3694.20	3752.52	4331.58	3207.54	4031.23
	(3177.90)	(3346.98)	(2882.41)	(2892.59)	(3289.43)	(2563.10)	(3011.36)
Health, Education & Public Administration	5759.73	6509.44	5444.11	6162.64	6711.51	5215.60	5405.03
	(3993.00)	(4872.06)	(3511.09)	(4486.12)	(4806.90)	(2961.61)	(3155.18)

Summary Statistics

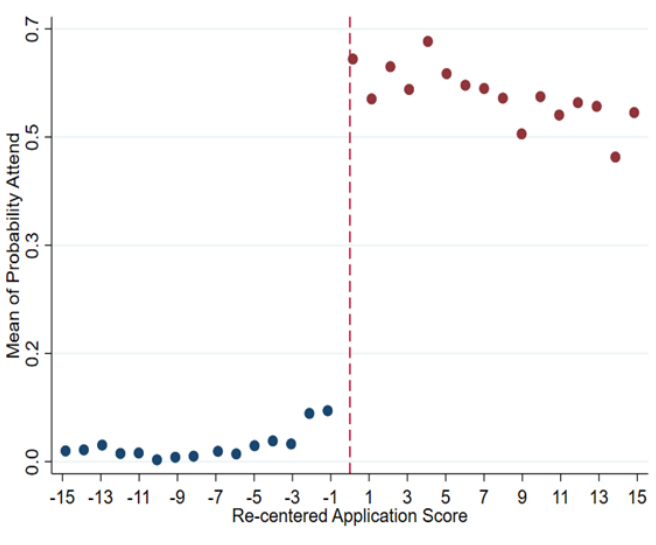
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				Male BW 15		Female BW 15	
	Full Sample	Male	Female	Below Threshold	Above Threshold	Below Threshold	Above Threshold
Quarterly Earnings	5632.33	6449.80	4593.40	5560.62	6794.43	4268.60	4632.85
	(4187.57)	(4674.50)	(3181.67)	(3943.68)	(4786.40)	(2843.80)	(2988.86)
Manufacturing	0.08	0.12	0.03	0.09	0.13	0.02	0.03
Retail	0.27	0.26	0.28	0.28	0.26	0.29	0.28
Transportation	0.03	0.04	0.02	0.04	0.03	0.02	0.02
Professional	0.05	0.05	0.05	0.04	0.05	0.05	0.05
Services	0.21	0.17	0.27	0.18	0.16	0.25	0.27
Construction	0.06	0.11	0.00	0.07	0.13	0.00	0.00
Wholesale Trade	0.02	0.04	0.01	0.04	0.03	0.00	0.01
Operation Support	0.05	0.08	0.02	0.09	0.08	0.02	0.02
Office Support	0.05	0.05	0.04	0.06	0.04	0.06	0.04
Health, Education & Public Administration	0.17	0.09	0.27	0.09	0.09	0.28	0.27
Female	0.44	--	--	--	--	--	--
Asian	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Black	0.21	0.17	0.26	0.21	0.16	0.29	0.27
Hispanic	0.32	0.27	0.38	0.31	0.26	0.43	0.39
Free Lunch	0.61	0.52	0.71	0.63	0.51	0.79	0.71
English Learner	0.06	0.05	0.07	0.07	0.04	0.11	0.07
^{7th} Grade CMT-Reading	226.01	227.58	224.05	208.31	227.49	202.87	222.56
	(33.88)	(34.04)	(33.59)	(26.52)	(25.80)	(24.90)	(25.28)
^{7th} Grade CMT-Math	241.65	245.44	236.90	226.06	244.67	215.45	235.02
	(34.40)	(34.19)	(34.06)	(24.42)	(25.53)	(24.21)	(25.15)
^{7th} Grade CMT-Writing	230.33	226.15	235.56	214.02	226.00	222.48	234.45
	(27.33)	(26.91)	(26.96)	(21.41)	(22.28)	(22.75)	(22.67)
Total Application Score	58.66	58.77	58.52	46.07	59.66	46.00	59.25
	(17.47)	(17.12)	(17.90)	(8.12)	(8.35)	(8.53)	(8.68)

First-Stage: Probability of Attending a CTECS School

Male Students



Female Students



	Probability of Being Admitted Full Sample (1)	Probability of Attending Full Sample (2)	Probability of Attending Male Students (3)	Probability of Attending Female Students (4)
Outcome				
Offer	0.894***	0.604***	0.622***	0.585***
	(0.0108)	(0.0170)	(0.0174)	(0.0248)
Controls	Yes	Yes	Yes	Yes
F	6794.67	1259.52	1273.63	558.37
Observations	174,013	174,013	98,723	75,289

Intent-to-Treat and Treatment on the Treated Effects

Outcome	Probability of Being Admitted Full Sample (1)	Probability of Attending Full Sample (2)	Probability of Attending Male Students (3)	Probability of Attending Female Students (4)
Offer	0.894***	0.604***	0.622***	0.585***
	(0.0108)	(0.0170)	(0.0174)	(0.0248)
Controls	Yes	Yes	Yes	Yes
F	6794.67	1259.52	1273.63	558.37
Observations	174,013	174,013	98,723	75,289

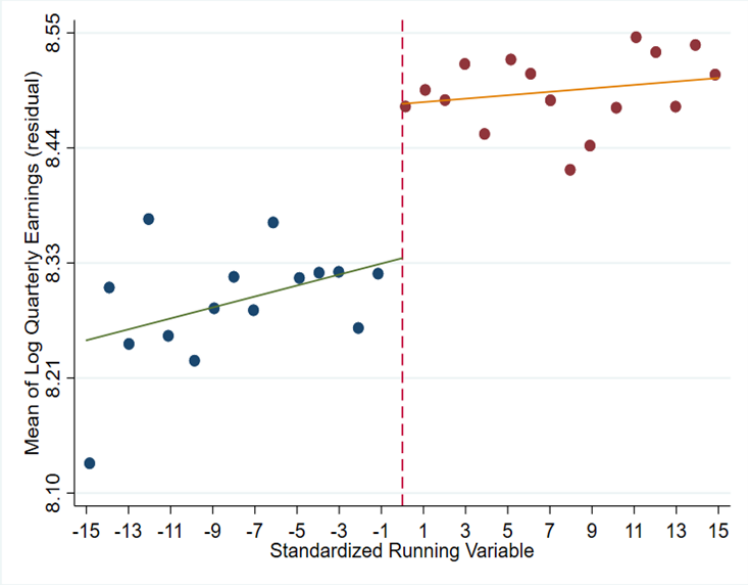
- We estimate reduced form models for simplicity given the large number of interactions in many of our specifications. Thus, we present ITT estimates.
- TOT estimates are obtained via 2SLS using the Wald Estimator:
- $\hat{\beta}_1^{IV} = \frac{E[y_i|z_i = 1] - E[y_i|z_i = 0]}{E[T_i|z_i = 1] - E[T_i|z_i = 0]} = \frac{Reduced\ Form\ Estimate}{First\ Stage\ Estiamte}$
- For males, first stage estimate is 0.622 implying the TOT estimate can be obtained by multiplying our reduced form estimates by ~ 1.6 (i.e. the TOT estimates are ~ 60% larger then reduced form estimates)

Balancing Tests (BW 15 points)

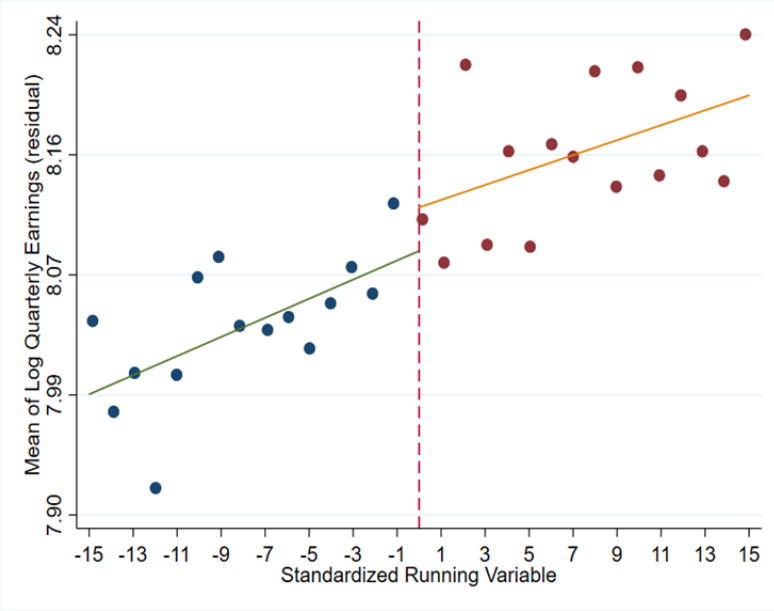
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
			Individual-level Covariates					School Covariates	
Outcome	Black	Hispanic	Free Lunch	English Learner	7th Grade Test Scores	6th Grade Attendence	Spending Per Pupil	Pupil Teacher Ratio	6th Grade Average Math Score
					Male Students				
Offer	0.020	-0.004	-0.004	-0.004	0.801	-0.004	61.170	-0.042	-0.107
	(0.013)	(0.005)	(0.019)	(0.010)	(1.039)	(0.003)	(53.160)	(0.106)	(0.247)
Observations	98,723	98,723	98,723	98,723	49,353	49,353	92,690	98,028	97,052
Mean CG	0.210	0.312	0.629	0.068	103.969	0.947	16249.100	14.001	240.880
St. Dev. CG	(0.408)	(0.463)	(0.483)	(0.251)	(108.737)	(0.043)	(2699.105)	(2.482)	(18.856)
					Female Students				
Offer	0.003	0.009	0.005	-0.005	1.694	-0.004	72.230	-0.051	-0.065
	(0.020)	(0.015)	(0.019)	(0.018)	(1.136)	(0.002)	(60.730)	(0.066)	(0.213)
Observations	75,289	75,289	75,289	75,289	38,473	37,480	69,145	74,809	74,596
Mean CG	0.294	0.425	0.793	0.109	107.164	0.947	15846.570	14.151	236.394
St. Dev. CG	(0.456)	(0.494)	(0.405)	(0.312)	(107.632)	(0.044)	(2681.700)	(2.714)	(17.423)

ITT Average Quarterly Earnings

Male Students



Female Students



Pairwise Linear Probability Estimates: Industry Choice

	(1)	(2)	(3)	(4)	(5)
Outcome	Manufacturing	Transportation	Professional	Services	Construction
			Male Students		
Offer	0.0969***	0.00962	0.0523***	0.0241	0.0827***
	(0.0207)	(0.0106)	(0.0161)	(0.0219)	(0.0274)
Observations	73,869	59,648	60,167	83,536	71,427
Share Relative to Trade	0.323	0.161	0.169	0.401	0.300
Earnings Industry FE	0.775	-0.064	0.354	-0.266	0.733
			Female Students		
Offer	0.00392	0.00843	-0.0298**	0.0180	0.0121*
	(0.0143)	(0.0115)	(0.0140)	(0.0207)	(0.00674)
Observations	48,565	48,289	52,880	87,176	45,005
Share Relative to Retail	0.089	0.084	0.163	0.493	0.017
Earnings Industry FE	0.844	0.067	0.543	0.032	0.666

	(6)	(7)	(8)	(9)	(10)	(11)
Outcome	Wholesale Trade	Operation Support	Office Support	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

Earnings by Industry for CTECS Applicants

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Male Students				Female Students			
	Overall Treatment Effect	Conditional on Industry FEs	Treatment Effect by Industry		Overall Treatment Effect	Conditional on Industry FEs	Treatment Effect by Industry	
Offer	0.160***	0.124***	0.0728**		0.0341*	0.0402*	0.0502	
	(0.032)	(0.031)	(0.034)		(0.020)	(0.021)	(0.032)	
Manufacturing		0.622***	0.578***	0.0663*		0.565***	0.543***	0.116*
		(0.022)	(0.033)	(0.036)		(0.057)	(0.063)	(0.060)
Transportation		-0.0387	-0.108**	0.112		0.0849	0.0765	-0.00111
		(0.038)	(0.044)	(0.078)		(0.088)	(0.087)	(0.108)
Professional		0.337***	0.236***	0.147***		0.410***	0.395***	0.0206
		(0.033)	(0.045)	(0.051)		(0.042)	(0.040)	(0.046)
Services		-0.166***	-0.185***	0.0290		0.0564	0.0477	-0.0183
		(0.027)	(0.035)	(0.036)		(0.040)	(0.041)	(0.052)
Construction		0.598***	0.443***	0.210***		0.361*	0.355*	0.289
		(0.026)	(0.046)	(0.044)		(0.213)	(0.205)	(0.228)
Wholesale Trade		0.481***	0.522***	-0.0661		0.349**	0.341**	-0.0505
		(0.037)	(0.060)	(0.062)		(0.154)	(0.156)	(0.146)
Operation Support		0.217***	0.156***	0.0961**		0.122***	0.113**	0.0454
		(0.030)	(0.044)	(0.048)		(0.045)	(0.046)	(0.056)
Office Support		-0.336***	-0.411***	0.124***		-0.333***	-0.331***	0.170***
		(0.030)	(0.038)	(0.039)		(0.049)	(0.049)	(0.055)
Health, Education & Public Administration		0.180***	0.182***	-0.000441		0.357***	0.364***	-0.0604
		(0.033)	(0.044)	(0.046)		(0.034)	(0.038)	(0.043)
Observations	98,723	98,418	98,418		75,289	75,210	75,210	

Mechanism Findings

- For male applicants, treatment leads to increases of 9.7% and 8.3% in the likelihood of employment in manufacturing and construction, respectively, relative to retail during high school years (i.e. work - based learning).
  - TOT estimate for manufacturing is 15.5% and for construction is 13.3%.

- Increased levels of experience while in high school and industry specific experience from work-based learning explains roughly one third of the treatment effect on the earnings premium in construction and manufacturing for male students.

- Treatment raises the 8th grade standardized test scores of male students entering, transportation, professional, and office support industries.

- Earnings returns to test scores explains 30% and 67% of the treatment earnings premium for professional and for office support, respectively.

Conclusions

- Unlike men, CTECS does not lead women to systematically select into higher wage industries
- While women are paid less, they earn similar returns in high wage industries overall and similar wage premia within high wage industries for attending CTECS
- Higher earnings premiums from treatment in manufacturing and construction attributable to in-school work experience for males
- For construction, treatment premium also attributable to labor market experience as a young adult for both males and females
- Treatment premium in professional and office support arise from higher returns to cognitive skills in those industries.

Conclusions

- 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).

- In this study, we examine the effect of one such program that has been widely implemented across the United States, Career Technical Education.

- Our results suggest the delivery of CTE in dedicated Career and Technical High Schools, as done in Connecticut, may provide a valuable strategy for improving the labor market outcomes of non-college bound, young men.

- Our study also helps to shed light on a puzzle in CTE research in that many studies find positive effects for male students, but minimal effects for female students (Brunner et al. 2023; Bertrand et al. 2019; Page 2012).

Conclusions

- In terms of female students, recall that the CTECS system focuses heavily on post-high school career readiness as opposed to college preparation, and CTECS students who do pursue post-secondary education typically attend two-year colleges.

- However, among female dominated programs in CTECS, 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.

- Our finding that attendance at a CTECS school does little to shift female applicants towards working in higher paying industries on average, suggest 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.

- To access high paying jobs in industries such as health and education a hybrid CTE model that also emphasizes college preparatory skills may be more appropriate.

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