



# **Career-Technical Education and Labor Market Outcomes: Evidence From California Community Colleges**

## **A CAPSEE Working Paper**

**Ann Stevens**

**Michal Kurlaender**

**Michel Grosz**

University of California, Davis

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## **Abstract**

This paper estimates the earnings returns to vocational, or career-technical, education programs in the nation's largest community college system. While career-technical education (CTE) programs have often been mentioned as an attractive alternative to four-year colleges for some students, very little systematic evidence exists on the returns to specific vocational certificates and degrees. Using administrative data covering the entire California Community Colleges system and linked administrative earnings records, this study estimates returns to CTE education. We use rich pre-enrollment earnings data and estimation approaches including individual fixed-effects and individual trends, and find average returns to CTE certificate and degrees that range from 12 to 23 percent. The largest returns are for programs in the healthcare sector; among non-health related CTE programs estimated returns range from 5 to 10 percent.

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# 1. Introduction

For the past half-century, the earnings of Americans with less than a four-year college degree have stagnated or fallen. Despite widespread increases in postsecondary participation, the fraction of Americans completing bachelor's degrees has not risen substantially in decades, and is actually declining for ethnic/racial minority groups. Although many efforts have focused on increasing educational attainment, it is clear that encouraging traditional college enrollment in academic pathways is not sufficient. Important demographic and labor market changes have demanded a more skilled workforce with increased postsecondary training. Vocational or career-technical education (CTE) is often mentioned as a potential solution to workforce training needs, but returns to CTE have rarely been systematically and convincingly evaluated.

National efforts to increase college attainment and to address the nation's skills gap have focused heavily on community colleges. The Obama administration identified community colleges as key drivers in the push to increase the stock of college graduates in the United States and to raise the skills of the American workforce, with the president noting: "It's time to reform our community colleges so that they provide Americans of all ages a chance to learn the skills and knowledge necessary to compete for the jobs of the future."<sup>1</sup> The rising demands for skilled workers necessitate states' need to strengthen their community colleges to accommodate much of this expansion, including increased offerings of technical certificate programs (Betts & McFarland, 1995; Bosworth, 2010; Johnson, 2009; Johnson, 2011; Harmon & MacAllum, 2003; Holzer & Nightingale, 2009). Despite this enthusiasm from policymakers at all levels for both vocational education and community colleges more generally, very little is known about the effectiveness of vocational programs within community colleges at raising workers' earnings and employment prospects (Hoffman & Reindl, 2011; Oleksiw, Kremidas, Johnson-Lewis, & Lokes, 2007). This paper takes a major step toward filling that gap, using longitudinal administrative data from the largest community college system in the nation to estimate the returns to specific CTE certificates and degrees.

Community colleges are the primary point of access to higher education for many Americans. Many turn to community colleges on the road to a bachelor's degree, while others arrive at community colleges to learn English as a second language or to obtain a technical certificate. The multiple missions and goals of community colleges have been well documented in the academic literature (Bailey & Morest, 2006; Brint & Karabel, 1989; Dougherty, 1994; Grubb, 1996; Rosenbaum, 2001). In California, two thirds of all college students attend a community college. The role of community colleges as a vehicle in human capital production was the cornerstone of California's 1960 Master Plan for Higher Education, which stipulated that the California Community Colleges are to admit "any student capable of benefiting from

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<sup>1</sup> Available at [http://www.whitehouse.gov/sites/default/files/uploads/community\\_college\\_summit\\_report.pdf](http://www.whitehouse.gov/sites/default/files/uploads/community_college_summit_report.pdf)

instruction.”<sup>2</sup> Over the years, California’s community colleges have grown and have been both applauded for remaining affordable, open-access institutions, and also continually criticized for producing weak outcomes, in particular low degree receipt and low transfer rates to four-year institutions (Sengupta & Jepsen, 2006; Shulock & Moore, 2007). Vocational programs within California’s community colleges, many of which do not have explicit or implicit transfer goals, have often been omitted from these discussions (Shulock, Moore, & Offenstein, 2011; Shulock & Offenstein, 2012).

Growing awareness of the need for postsecondary training beyond traditional academic programs, combined with long-term declines in the real earnings of Americans without college degrees makes it essential to better understand the training potential of postsecondary CTE programs (Rosenbaum & Rosenbaum, 2013). Although the returns to bachelor’s degree attainment in the labor market have been well documented, there is little research on the payoff to sub-baccalaureate degree receipt, particularly in technical/vocational fields.<sup>3</sup> In this paper we investigate the returns to sub-baccalaureate certificates and degrees in vocational or CTE fields among those enrolled at California community colleges. Our approach also addresses the tremendous heterogeneity in types of program offerings within the broad grouping of CTE programs, and we separately analyze fields that include a wide range of courses preparing students for careers as police or prison officials, health care providers, or construction workers, among others.

## 2. Prior Research on the Returns to Postsecondary Schooling

Prior research has found that community college enrollment and degree receipt more generally are rewarded in the labor market. Belfield and Bailey (2011) review a large number of studies on earnings and other returns to community college attendance, degrees, and certificates. Kane and Rouse (1995, 1999) estimate the returns to some college relative to just a high school diploma to be 8 percent, while Leigh and Gill (1997) estimate the returns at 10 percent. Bailey, Kienzl, and Marcotte (2004a, b) find, on average, a 16 percent increase in earnings by advancing from a high school diploma to an associate degree among men, and a 39 percent increase among

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<sup>2</sup> Available at <http://www.ucop.edu/acadinit/mastplan/MasterPlan1960.pdf>. A *Master Plan for Higher Education in California* articulated the distinct functions of each of the state’s three public postsecondary segments. The University of California (UC) is designated as the state’s primary academic research institution and is reserved for the top eighth of the state’s graduating high school class. California State University (CSU) is primarily intended to serve the top third of California’s high school graduating class in undergraduate training and graduate training through master’s degrees, focusing primarily on professional training such as teacher education. Finally, the California Community Colleges system is to provide academic and instruction for students through the first two years of undergraduate education (lower division), as well as provide vocational instruction, remedial/developmental instruction, English as a second language courses, adult non-credit instruction, community service courses, and workforce training services.

<sup>3</sup> In this paper we use the term *vocational* and *career-technical education* (CTE) interchangeably.

women. Utilizing 2000 Census data, Kolesnikova and Shimek (2008) also find that associate degree holders earned more than high school graduates, with important differences by race/ethnicity and gender (18 percent more for White men, 25 percent more for Black men, 27 percent more for Hispanic men, 29 percent more for White women, 30 percent more for Black women, and 29 percent more for Hispanic women). And, in a recent descriptive study of a large sample of community colleges, Klor de Alva and Schneider (2013) compare the differences in wages between community colleges graduates with an associate degree to those who only earned a high school diploma. After factoring in the individual costs of earning the degree, they calculate an annualized median rate of return of 4 percent, with key differences identified by community college campuses.

What has been less well established is whether these returns apply to vocational programs, including both associate degrees in vocational fields and shorter-term vocational certificates. Bailey et al. (2004a), for example, find that occupational associate degrees were associated with higher earnings gains than academic associate degrees. Looking at nationally representative longitudinal surveys of students from the 1980s and 1990s, they find that vocational certificates had particularly large benefits for women, though the earnings benefits of this credential for men was less clear. More recently, Jepsen, Troske, and Coomes (2014) analyze certificates, diplomas, and associate degrees for community college students in Kentucky and find sizeable returns. Returns to vocational programs are reported separately and suggest positive returns to vocational associate degrees and to vocational diplomas for men, but less evidence of returns to shorter term vocational awards for women. Bahr (2014) also examines returns to a large number of programs (including vocational programs) and degrees within the California Community Colleges system. And ongoing work from the Center for Analysis of Postsecondary Education and Employment is also finding positive returns to short-term certificates in North Carolina and Virginia (Xu & Trimble, 2014).

Vocational programs within community colleges have also been evaluated in the context of displaced workers (The Brookings Institution, 2010). Jacobson, LaLonde and Sullivan (2005) use detailed administrative data from the early 1990s in Washington State to evaluate the returns to retraining older (35+) displaced workers. They find that although older displaced workers were less likely to enroll at community colleges relative to younger workers, those that did enroll for a year witnessed similar returns, specifically a 7 percent increase in long-term earnings for men and a 10 percent increase in long-term earnings for women. More descriptive work from the same era looking at California's community colleges finds smaller returns to schooling for older workers when compared to younger workers (Laanan, 1998). Importantly, the demand for retraining displaced workers is particularly high during a recession, but this is also the most cost-effective time since a large part of the cost to training is foregone earnings. Importantly, in this paper we evaluate the returns to college at a time when jobs in California were scarce, and as such, workers faced lower opportunity costs for training.

Focusing more narrowly on particular fields of study, there is a dearth of research on the impact of specific vocational fields of study in community colleges (Holzer & Nightingale, 2009). This remains true despite numerous recommendations that metrics be developed so policymakers can better understand how well such vocational programs are preparing students to meet the skill demands of employers (Hoffman & Reindl, 2011; Jenkins & Boswell, 2002).

CTE programs at community colleges are intended to both enhance school-to-work transitions for students entering or returning to the labor market and to provide opportunities for retraining when individuals and local areas are confronted with changing economic opportunities and conditions. Such programs can take on a variety of forms, from very specific workforce instruction (e.g., construction or nursing) to developmental education to improve basic skills, adult basic education such as computing, and English as a Second Language (Van Noy, Jacobs, Korey, Bailey, & Hughes, 2008). Over the last 10 to 15 years, community colleges have become particularly important in training health and medical workers; for example, almost two thirds of registered nurses receive their nursing degrees from community colleges (Van Noy et al., 2008). Moreover, community colleges have continued to expand their short-term certificate and degree offerings in a variety of CTE oriented fields such as police science, early childhood education, and computing. To date there is little research about the labor market payoff to such short-term certificates. In this paper we address some of this gap by investigating the labor market returns to a wide range of sub-baccalaureate degree and certificates in a range of CTE fields.

### **3. Data**

The California Community Colleges system consists of 112 campuses and is one of the largest public higher education systems in the country, enrolling over 2.6 million students annually (Scott & Perry, 2011). The state's large public postsecondary system of sub-baccalaureate colleges offers great individual and institutional diversity. Colleges represent urban, suburban, and rural regions of California, range in size from 1,000 to over 40,000 students enrolled each semester, and offer a wide range of CTE and traditional academic programs to a diverse set of students (see Figure A.1 in the Appendix for a map of California's community colleges).

We combine two sources of data for the analysis, tracking California community college students through their postsecondary schooling and into the labor market between 1992 and 2011. First, we use detailed administrative records from the California Community Colleges Chancellor's Office (CCCCO), which include college-level and student-level information. Specifically, we employ information on students' demographic backgrounds, course-taking



behavior, and degree receipt by term.<sup>4</sup> We match these data to quarterly student earnings information from the state's unemployment insurance (UI) system.<sup>5</sup> These data are linked to student information by the CCCCCO and extend from 1992 to 2012. Approximately 93 percent of students in our college data are matched to earnings records.<sup>6</sup>

The CCCCCO data contain a vast amount of student-level information. Demographics, such as a student's age, race, and gender, are recorded in each academic term for which a student was enrolled in a course. We define enrollment based on the units attempted in a given term (part-time between six and 12 units, and full-time as more than 12 units). These two definitions are consistent with the number of units needed to qualify for different levels of financial aid. We do not differentiate between students taking fewer than six units and those not enrolled because the workload of a single course is not likely to depress earnings.

We categorize the content of different courses and programs according to the Taxonomy of Programs (TOP), a system unique to California's community colleges. All community colleges in the state are required to use the TOP, which grants us a uniform categorization of the topical content of degrees and courses across time and is common across all of California's community colleges. In particular, the CCCCCO identifies some TOP codes as career-technical (vocational), which allows us to note students who take such courses and earn CTE-identified degrees. In this analysis we focus on awards in TOP codes designated as CTE, or vocational, programs. The narrowest TOP code is a six-digit number denoting a field. The first two digits identify one of 24 broad disciplines, such as education, biological sciences, or health. Another advantage of the TOP code classification is that we are able to align TOP codes to the Classification of Instructional Programs (CIP), which are tied to the Standard Occupational Classifications used by the U.S. Department of Labor to classify occupations. There are CTE and non-CTE fields within each discipline, though the distribution is not uniform across disciplines; for example, engineering and industrial technologies (TOP code 09) has many more CTE fields than the social sciences (TOP code 22).

We evaluate the effects of CTE award attainment by looking at four categories representing a traditional sub-baccalaureate degree (associate degree) and several other short-term certificates. Specifically, we categorize award holders into four categories: Associate of Arts/Sciences degrees (typically 60 credit hours); 30–60 credit certificates; 18–30 credit certificates, and 6–18 credit certificates. Students enrolled full-time typically take 15 units per semester, so these various awards range from two years of full-time coursework to less than a semester.

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<sup>4</sup> Only three colleges use the quarter system, which makes synchronizing the school year to the calendar year straightforward. For the rest, which are on the semester system, we categorize the spring semester (January to June) as the first and second quarters, with summer term and fall semester as the third and fourth quarters, respectively.

<sup>5</sup> We have access to these data as they are provided to the CCCCCO through the California Employment Development Department (part of the California Department of Finance).

<sup>6</sup> Students may not be observed in the earnings records for several reasons including being only self-employed over the period, a true lack of any formal earnings, or having moved out of the state with no recorded earnings in California.

## 4. Sample Construction

To evaluate the returns to vocational awards, we first construct a sample of students who earned a CTE certificate or degree between 2003 and 2007. We begin with relatively broad categories of TOP code disciplines. We limit our initial analysis to just the six largest TOP code disciplines: business and management, information technology, engineering and industrial technologies, health, family and consumer sciences, and public and protective services. Combined, these disciplines cover approximately 50 percent of all CTE degrees granted between 2001 and 2010. We conduct the analyses separately by discipline. Focusing on these large disciplines allows us to look separately at degrees within specific disciplines. Summary statistics of our full sample of CTE award recipients are shown in Table A.1 in the Appendix.

We limit the sample of treated individuals to just those students who earned a CTE degree—though this may not have been their highest degree. We place no restrictions on the first term of enrollment, which means some of these students may have earned their degree in just a year while others may have taken much longer. In fact, on average students take four years to complete their first CTE award (see Table A.1). We observe course-taking behavior and other academic data extending as far back as 1990 for the older students. We match wage data back to 1992, regardless of when students began their coursework. For most students, the wage data extend from before they enrolled for the first time in a community college course until after they graduated. We drop wage and academic data for students in the years before they turned 18 years old. Students may take classes at multiple colleges throughout their academic careers and they can also transfer credits from one community college to another. For the purposes of our sample and because of certain data limitations, we consider each student at each college as an individual case.<sup>7</sup>

We also construct control groups to compare to our treated group of degree and certificate recipients. The control groups consist of students who demonstrated some intention to earn a vocational degree or certificate in the given discipline but never did. As with the degree recipients, we create a separate control group for each TOP code. Students qualify for the control group if they earned at least eight units in that discipline within their first three years of enrollment at the college. This qualification is based on the CCCCCO's own definition of a CTE-degree bound student, and one utilized by the community college system to track degree completion for accountability purposes. Since the treatment groups are based on students who received a degree between 2003 and 2007, and the normative time to degree is approximately two years, we limit the control groups to students who started between 2001 and 2005. A student can qualify for multiple control groups if he took more than eight courses in two different disciplines without ever earning a degree. However, the control group consists only of students

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<sup>7</sup> A student who earned a degree at college X and a degree at college Y will be included in our data twice, once for his career at each college. For a student who took courses at college X and college Y, but only earned a degree at college Y, we only observe the coursework and degree earned at college Y; the coursework at college X drops out of our sample.

who never earned any degree, so if the student took more than eight units in one discipline and actually earned a degree in another, then that student does not qualify for the former control group. We also experiment with alternative definitions of our control group to check for sensitivity of our estimates to this definition.

Two types of students are not represented in either the treatment or control group for any particular discipline. The first is students who did not earn a degree, but also did not take enough courses to qualify for a control group. There are also students in the treatment group who would be excluded from the control group had they not earned a degree. For example, some students may have earned their degree slowly, not completing eight units within the first three years.<sup>8</sup> The second excluded group of students is those who earned non-CTE degrees. We only include CTE degree earners in the treatment group, and only students who never earned any degree in the control groups. It is likely that a number of the students in a control group may have been attempting to complete a non-CTE degree, but because they never earned a degree we cannot know their intentions.

## 5. Statistical Framework for Estimating Returns to CTE Programs

To answer the question of whether CTE programs improve the earnings of award recipients, we take an approach that differs somewhat from typical estimates of the returns to higher education. Instead we use a regression framework similar in spirit to the literature on non-experimental evaluations of worker training programs.<sup>9</sup> The vast majority of students in our sample of those taking vocational courses have a substantial earnings history prior to enrollment. We construct our estimation strategy to make use of these pre-enrollment earnings to better isolate the causal effect of vocational awards on earnings. Specifically, we estimate equations of the form:

$$(1) \ln(Earnings)_{it} = \alpha_i + \gamma_t + \beta Enrolled_{it} + \sum_{k=1}^5 \beta_k (GotDegree\_Type\_k)_{it} + \sum_{j=18}^{65} \delta_j 1(Age = j)_{it} + \varepsilon_{it}$$

These regressions include individual fixed effects ( $\alpha_i$ ), so that the effect of the award receipt is identified from the within-person changes in earnings from before to after the award is received. We also include controls—in the form of dummy variables—for calendar year (T) and age (A); in the fixed effects specification we cannot separately identify linear effects of age, but enter age as a series of dummy variables ( $\delta_j$ ) to capture non-linear age effects on earnings. The coefficient  $\beta$  captures the effect of an indicator for periods in which the individual is enrolled at

<sup>8</sup> Overall, approximately a quarter of degree or certificate holders would not have qualified for a control group if they had not earned a degree (Table 1).

<sup>9</sup> See, for example, Heckman and Smith (1999).

the community college either full- or part-time. This is to avoid conflating the part-time or otherwise reduced earnings while working toward an award with the pre-enrollment earnings as a base against which this specification implicitly compares post-award earnings. The coefficient of interest, vector  $\beta$ , takes a value of one in periods after the student has graduated, depending on the type of degree. We estimate one regression of the form summarized by equation (1) for each of the six largest TOP disciplines.

This equation could be estimated using only degree recipients with earnings observed both before and after the award receipt. In this approach, the dummy for “award\_completed” initially equals zero, and then turns to one upon completion of the award. By the end of the sample period, every individual in this sample has completed the award. It is also helpful, however, to make use of a control group of individuals who never complete an award (or have not completed an award by several years after they first appear in our sample of community college enrollees). In the worker training program literature, control groups are either composed of those randomized out of participation in the training program (in experimentally-based evaluations) or are those who were either rejected or who did not complete program participation.

Our control group is constructed on the basis of both data availability and the desire to best identify those individuals most similar to award recipients in particular CTE programs. We have earnings data only for individuals who have had some contact with the California Community Colleges system, but that involvement can be as minimal as enrollment in a single course. We are also motivated by what is perhaps the most critical issue in estimating returns to education, that of whether individuals who select into higher levels of education are more productive, motivated, or have other unobservable characteristics that would lead to higher wages than those who do not choose more education. With this in mind, we construct our control group from individuals who have shown some indication of participating in each separate CTE program.

Much earlier literature on the effects of worker training programs suggests that it will be critical to look at employment and earnings relative to a control group in the time period just prior to enrollment in a vocational education program (see, for example, Heckman, Lalonde, & Smith, 1999; Heckman & Smith, 1999). The inclusion of a control group here is critical to establish the counterfactual pattern of earnings or employment in the absence of CTE course enrollment.

A common concern with estimates of the effects of education on earnings is that individuals who actually choose to enroll and complete degrees may be more motivated or productive than those who take only a few courses. This can lead to a systematic overstatement of the earnings effects of these programs. Recall, however, that here we are able to include individual fixed-effects, which will control for fixed levels of ability or motivation. In most estimates of the return to higher education, inclusion of fixed-effects is not feasible since students following a traditional path through K-12 and college lack a meaningful pre-enrollment

earnings history. Because many CTE students are already involved in the labor market prior to their enrollment, however, we view this fixed-effects approach as feasible in this context.<sup>10</sup>

Finally, even with fixed effects included, we face several potential sources of bias. First, individuals who choose to enroll (or complete) CTE training may have earnings growth rates that are higher or lower than those who do not. This will lead to correlation between award receipt and expected earnings growth rates and so may also lead to biased estimates. We can directly address this by adding individual-specific earnings growth rates to our specification, indicated by:

$$(2) \ln(Earnings)_{it} = \alpha_i + \gamma_t + \theta_i trend + \beta Enrolled_{it} + \sum_{k=1}^5 \beta_k GotDegree\_Type\_k_{it} + \sum_{j=18}^{65} \delta_j 1(Age = j)_{it} + \varepsilon_{it}$$

Here, we allow for the possibility that our award recipients enrolled specifically because they faced declining earnings prospects and were seeking to improve their earnings possibilities. This will also capture the possibility that more highly motivated individuals are both more likely to have fast growing wages and are more likely to enroll in and complete CTE training.

It is also possible that transitory, unobserved shocks to our treated group could affect both their likelihood of completing a degree and their subsequent earnings, leading to a probable upward bias in our estimated returns. To some extent, this cannot be remedied with the observational data available here, a caveat similar to that made by Jepsen et al. (2014). We argue, however, that the ability to control in a rich way for pre-enrollment earnings and earnings trends and the very large samples available from this unique dataset allow us to provide the most convincing estimates to date of the labor market returns to specific CTE programs.

For a subset of our sample, we also have access to a very rich set of additional control variables that can proxy for underlying abilities that might be correlated with the propensity to complete a CTE award. As a robustness check, we also estimate models that do not include individual fixed-effects, but that control for high school math and English language arts test scores and parental education, as well as demographic characteristics. We expect that this approach, which controls for a fuller set of observable characteristics but cannot control for fixed unobserved characteristics or for trends that are correlated with degree receipt, will lead to higher estimated returns. We show these results below as a robustness check on our main approach.

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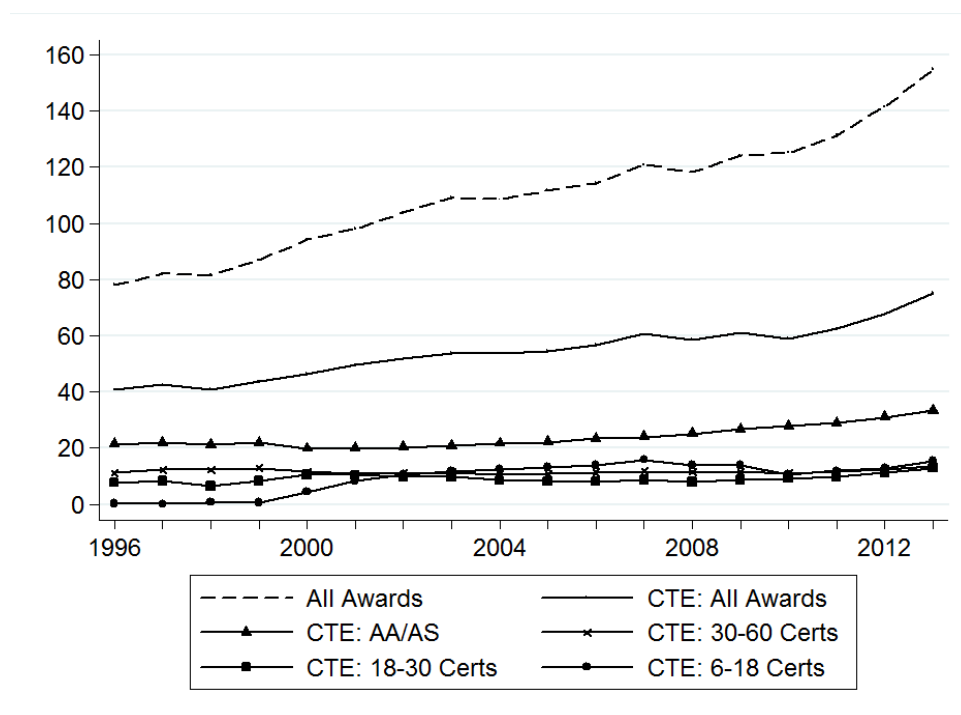
<sup>10</sup> Note that this means we will be identifying off of individuals that do have a pre-enrollment earnings history. If there is heterogeneity in returns to these vocational programs across more- and less-experienced workers, our estimates based on equation (1) will predominantly represent the returns to award recipients with more prior work experience, since those without such experience will not contribute much of the within person variation we need for this identification approach. For this reason, we investigate below (and in future work) heterogeneity across workers of different ages, which may have important implications for interpretation of our overall results.

## 6. Results

### Summary Statistics and Visual Depictions of the Effects of CTE Programs on Earnings

We begin by showing the number of CTE and total awards issued by California Community Colleges by years covered in our sample (Figure 1). The top line shows all awards from the colleges for each year from 2001 to 2011, and the line immediately below shows the subset of CTE degrees. This demonstrates the importance of CTE programs to the overall mission of the community colleges. In a typical year, more than half of all awards issued are for a CTE degree, and more than 60,000 of these vocational awards are given annually in recent years. The figure also shows that these CTE awards are distributed across the various certificate and degree lengths described earlier.

**Figure 1: Number of Awards Granted, 2001–2010 (thousands)**



Next, Table 1 provides summary statistics for our CTE awards (under the treated columns) for the six largest TOP codes, or CTE disciplines. Table 1 also provides these statistics for the associated control groups. Several points from Table 1 will inform our interpretation of the figures and regression results below. First, there is tremendous heterogeneity in student characteristics, distribution of award types, and pre-enrollment labor market attachment across

the six areas. Just 30 percent of those receiving awards in the area of business and management were employed just prior to their initial enrollment, but 50 percent of those in health or public and protective services were employed immediately prior to their initial enrollment. Gender differences across fields are also striking; 93 percent of those receiving awards in engineering and industrial tech were male, but only 14 percent in family and consumer sciences were. Only one third of award recipients in health were male. This points out the potential importance of estimating returns to degrees separately across discipline, since observable (and unobservable) characteristics vary dramatically across disciplines and may have important implications for interpreting overall returns.

The average age at enrollment in our sample ranges from a low of 25 for business and management to 29 for information technology, differentiating this sample from more traditional, non-vocational college programs. Between 75 and 90 percent of students had at least one quarter of nonzero earnings before first enrolling, and between 60 and 80 percent had more than five quarters. For those in our sample who do have some pre-enrollment earnings, we observe 7 to 15 quarters of earnings, depending upon the field prior to enrollment. This suggests that we have a substantial earnings history from which to identify our fixed-effects models.

Finally, Table 1 provides information on how similar our treatment and control groups are to one another. Age and gender distributions are similar across the treatment and control groups within TOP codes. This is important given the large differences in these characteristics across TOP codes and suggests the potential value of having control groups that are specific to each discipline. One potentially important difference between the treatment and control groups is that, across TOP codes, the control group is always more likely to be employed prior to enrollment. This may reflect the greater tendency of employed students to take only a few courses, rather than completing a full degree or certificate program. While our use of fixed-effects should prevent this from being a major source of bias (by effectively conditioning on pre-enrollment earnings), it is important to keep in mind.

**Table 1. Summary Statistics by Discipline**

	<b>Business</b>		<b>Information Tech</b>		<b>Engineering</b>	
	<b>Treat</b>	<b>Control</b>	<b>Treat</b>	<b>Control</b>	<b>Treat</b>	<b>Control</b>
AA/AS	0.67		0.44		0.2	
Cert. 30–60	0.04		0.06		0.29	
Cert. 18–30	0.12		0.12		0.17	
Cert. 6–18	0.11		0.3		0.21	
Other	0.05		0.08		0.13	
Pre-enrollment quarters	6.27	8.4	10.87	9.34	11.3	10.13
Employed pre-enrollment	0.3	0.39	0.4	0.39	0.43	0.47
Age at enrollment	25.75	29.88	29.25	32.13	26.55	30.02
Male	0.43	0.47	0.76	0.73	0.93	0.87
White	0.47	0.51	0.57	0.53	0.5	0.52
Black	0.07	0.07	0.06	0.05	0.06	0.07
Hispanic	0.22	0.19	0.17	0.15	0.32	0.33
Asian	0.23	0.23	0.21	0.27	0.12	0.09
N	12698	60136	2087	19491	9876	44567
	<b>Health</b>		<b>Family/Consumer</b>		<b>Public/Protective</b>	
	<b>Treat</b>	<b>Control</b>	<b>Treat</b>	<b>Control</b>	<b>Treat</b>	<b>Control</b>
AA/AS	0.46		0.3		0.3	
Cert. 30–60	0.16		0.14		0.11	
Cert. 18–30	0.05		0.12		0.11	
Cert. 6–18	0.19		0.4		0.35	
Other	0.14		0.04		0.12	
Pre-enrollment quarters	11.25	12.28	8.11	8.58	11.26	11.42
Employed pre-enrollment	0.51	0.55	0.36	0.4	0.51	0.51
Age at enrollment	26.64	30.3	28.58	31.55	25.68	28.31
Male	0.35	0.34	0.14	0.12	0.75	0.71
White	0.64	0.6	0.4	0.48	0.6	0.59
Black	0.07	0.09	0.11	0.09	0.08	0.07
Hispanic	0.2	0.21	0.35	0.33	0.29	0.29
Asian	0.1	0.1	0.14	0.1	0.04	0.04
N	20194	14401	8995	33196	15583	37822

*Note.* Disciplines correspond to two-digit TOP codes as categorized by the CCCCCO. *Pre-enrollment quarters* refers to the number of quarters prior to first enrollment with nonzero earnings. *Employed pre-enrollment* refers to having at least two quarters of nonzero earnings in the two years prior to first enrollment.

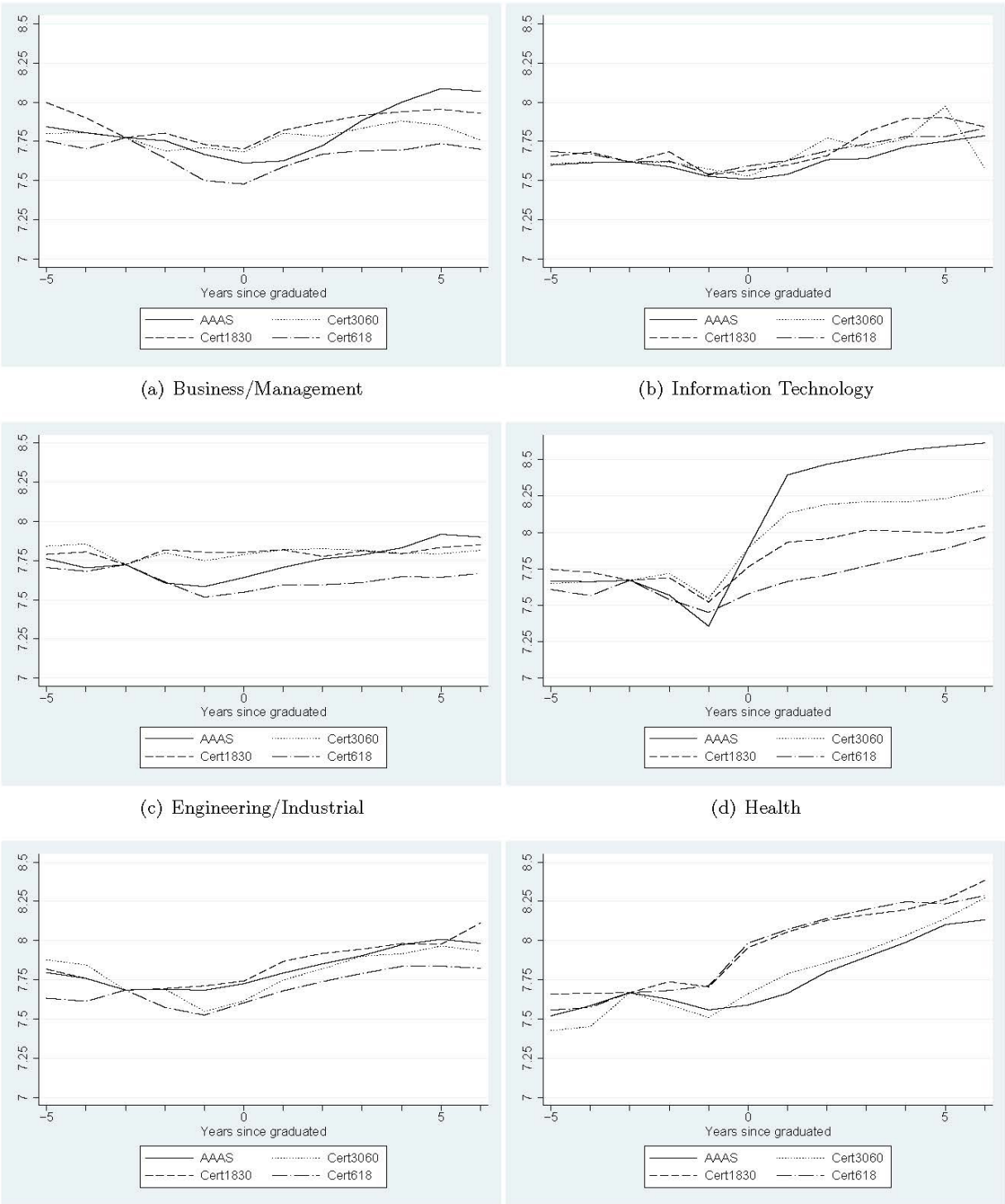


Figure 2 shows the patterns of earnings for our award recipients in the six largest (in terms of CTE awards granted) TOP codes from the period five years prior to their award date to seven years after the award. Each panel represents a different CTE program and TOP code. Differences between panels demonstrates the type of heterogeneity across different fields and award lengths that we anticipated. Panel A shows the earnings of individuals who received certificates or degrees in the area of business and management. In this panel, individuals receiving the shortest term certificates (indicated by the lowest dashed line) offer little evidence of improved earnings (relative to their own earnings). In years after degree receipt, earnings are generally below average earnings before enrollment in the programs. Such a pattern could reflect many things. First, our sample period includes a strong economy at the start and the great recession near the end, so that all worker groups viewed over this period may face some decline in earnings over time. This makes it essential to use a more complete regression specification and control group that can explicitly control for calendar year effects and broad earnings trends that occur regardless of educational investments. Second, for some TOP code groups there is suggestive evidence of declining earnings prior to CTE award receipt. In TOP codes representing health and engineering occupations, for example, earnings decline in the years prior to degree receipt. This dip in earnings prior to degree receipt could also reflect reduced hours while students are enrolled in CTE programs. In our regression results, we control for periods of community college enrollment to avoid this possibility. If the true counterfactual facing these workers was continued deterioration of their earnings, the level of earnings in the years after their award may reflect a true improvement in their employment and earnings prospects. Thus, in later specifications we can also account for not only the pre-award level of earnings, but pre-award trends in earnings as well.

The other lines in Panel A show more evidence of earnings increases following degree receipt. In particular, workers receiving associate of arts or associate of science degrees in the business and management area show a rather steep increase in earnings starting a few years after the award receipt. Given the delay in this earnings increase to several years after associate degree award receipt (labeled as “year 0” in the figures), this pattern may reflect experiences of students who went on beyond the community college to complete baccalaureate degrees at other institutions. Given the availability of bachelor of arts or bachelor of science programs in the areas of business and management, this seems especially likely.

Panel D of Figure 2 shows a dramatically different picture for the earnings of those receiving awards in health-related CTE programs. All of the award types show moderate to large improvements in earnings after award receipt. The extent of the increase grows monotonically with the length of the award program, with the shortest certificate recipients showing some earnings gains of approximately 10 percent, but the longest certificate and associate degree recipients showing very large increases in earnings of .5 log points or more, or returns in excess of 50 percent.

**Figure 2: Earnings Trajectories of Degree Recipients**



*Note.* Earnings are expressed in log quarterly wages. Award recipients are included if they received their highest award between 2003 and 2007. These charts control for race, gender, and calendar quarter effects. They also control for whether a student was enrolled part time (6–12 units per semester) or full-time (more than 12 units).

The other panels of Figure 2 show a variety of patterns both across and within TOP codes. In Panel B, for example, the earnings of information technology award recipients are very flat prior to the awards and then increase (and the profile over time steepens) by a similar proportion regardless of the length of the certificate. This is difficult to explain in a framework in which more coursework generates additional human capital and may suggest the need to further disaggregate into more narrowly defined programs. It may also simply reflect that these graphs cannot control for economy-wide and other labor market features. Finally, patterns for engineering and industrial technologies (Panel C) show little evidence of earnings increases among those who complete awards in that area.

These figures are suggestive of the ability of our longitudinal data to illustrate the labor market results of CTE programs, but also show the many difficulties in interpreting the earnings patterns over time. To provide a better structure for understanding these labor market effects, control for confounding factors, and include comparison groups of similar individuals, we next describe the results from our regression framework.

## Regression Results

We next turn to regression results, initially using the fixed-effects specification summarized in equation (1) and an initial set of control groups as defined above. Recall that our control group for each TOP code consists of students that earned at least eight units in that discipline within their first three years of enrollment at the college, following the CCCCCO's definition of a CTE-degree bound student. Below, we vary this definition slightly.

In the left-hand panel of Table 2, we present our individual fixed-effects regression results by certificate or degree length and discipline. We also show results for the full sample and for the subsample of students over 30, who have even greater pre-enrollment labor market attachment than our full sample, and for whom the fixed-effects identification strategy is more natural. Table 2 shows that, in most cases, there are positive and statistically significant earnings effects of these vocational certificate and degree programs.<sup>11</sup> This is true despite our reliance on a fixed-effects approach that should eliminate any fixed individual characteristics such as “ability” or “motivation” that would conflate estimated returns with positive unobserved characteristics of degree completers. One exception to this pattern of positive returns is information technology, where there is little evidence of positive returns. This set of programs represents a relatively small number of award recipients, particularly in the longer-term certificate programs, with fewer than 500 awards granted for certificates between 18 and 60 units.

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<sup>11</sup> In the log earnings specification, the percentage effect on earnings is given by  $e^{\beta} - 1$ , where  $\beta$  is the reported coefficient.

**Table 2. Estimates by Discipline and Length**

Specification	Individual Fixed Effects		Individual Fixed Effects and Trends	
	All	Older than 30	All	Older than 30
<i>Business/Management</i>				
AA/AS	0.0106 (0.0081)	0.107*** (0.0144)	0.0375*** (0.0090)	0.103*** (0.0155)
30–60 units	0.0984** (0.0346)	0.144** (0.0440)	0.116** (0.0356)	0.113* (0.0462)
18–30 units	0.148*** (0.0190)	0.164*** (0.0217)	0.141*** (0.0221)	0.129*** (0.0251)
6–18 units	0.0508** (0.0193)	0.0626* (0.0246)	0.157*** (0.0232)	0.129*** (0.0281)
<i>Information technology</i>				
AA/AS	0.00496 (0.0242)	–0.00453 (0.0348)	0.0657* (0.0266)	0.0442 (0.0376)
30–60 units	0.0799 (0.0596)	0.0236 (0.0699)	0.0724 (0.0559)	0.078 (0.0674)
18–30 units	0.00657 (0.0421)	0.0015 (0.0480)	0.0288 (0.0495)	0.0368 (0.0551)
6–18 units	0.0176 (0.0255)	0.0258 (0.0287)	0.0930*** (0.0277)	0.119*** (0.0319)
<i>Engineering/Industrial</i>				
AA/AS	0.166*** (0.0138)	0.136*** (0.0229)	0.161*** (0.0154)	0.185*** (0.0256)
30–60 units	0.116*** (0.0103)	0.0862*** (0.0155)	0.0722*** (0.0115)	0.0456** (0.0170)
18–30 units	0.0578*** (0.0135)	0.0734*** (0.0184)	0.0428** (0.0144)	0.0562** (0.0196)
6–18 units	0.0697*** (0.0139)	0.0404* (0.0195)	0.125*** (0.0157)	0.135*** (0.0221)
<i>Health</i>				
AA/AS	0.644*** (0.0078)	0.644*** (0.0105)	0.690*** (0.0081)	0.672*** (0.0109)
30–60 units	0.307*** (0.0116)	0.324*** (0.0158)	0.394*** (0.0129)	0.392*** (0.0180)
18–30 units	0.108*** (0.0226)	0.131*** (0.0313)	0.282*** (0.0244)	0.298*** (0.0340)

6–18 units	0.0104 (0.0134)	0.0079 (0.0201)	0.0964*** (0.0147)	0.113*** (0.0223)
<i>Family/Consumer sciences</i>				
AA/AS	0.105*** (0.0125)	0.137*** (0.0185)	0.0921*** (0.0144)	0.122*** (0.0220)
30–60 units	0.0829*** (0.0215)	0.0392 (0.0287)	0.196*** (0.0246)	0.225*** (0.0314)
18–30 units	0.112*** (0.0199)	0.0651** (0.0252)	0.124*** (0.0229)	0.0851** (0.0272)
6–18 units	0.0679*** (0.0123)	0.0782*** (0.0167)	0.0996*** (0.0138)	0.112*** (0.0183)
<i>Public/Protective services</i>				
AA/AS	0.123*** (0.0102)	0.0787*** (0.0200)	0.126*** (0.0111)	0.150*** (0.0217)
30–60 units	0.170*** (0.0136)	0.164*** (0.0185)	0.151*** (0.0154)	0.0911*** (0.0212)
18–30 units	0.199*** (0.0116)	0.147*** (0.0163)	0.163*** (0.0119)	0.167*** (0.0156)
6–18 units	0.232*** (0.0091)	0.166*** (0.0139)	0.132*** (0.0093)	0.135*** (0.0142)

*Note.* Coefficients on degree received (interacted with award type/length) are from separate regressions for each discipline (two-digit TOP code). Standard errors clustered by individual.

This leads to a second broad finding from Table 2; there is a striking degree of heterogeneity in estimated returns across different TOP codes. A 30–60 unit certificate in business, for example, produces an earnings effect of approximately 10 percent (coefficient .099), compared to an estimated return of 18 percent (coefficient of .166) in public and protective services, and nearly 36 percent in health (coefficient of .307).

A third pattern in Table 2 is heterogeneity, not always in the expected direction, by degree or certificate type. In many cases, there is a tendency for returns to increase as the length of the program increases, but there is not perfect monotonicity. For example, in health, and when focusing on results for the older subsample, estimated returns move from essentially zero for the very short-term certificates, to approximately 14 percent for longer certificates of 18 to 30 units, to 35 percent for still longer certificates. In contrast, in public and protective services, the estimated return to very short-term certificates is a surprisingly high 26 percent, with lower estimated returns for longer certificate programs.

Finally, Table 2 also shows that, in most cases, our results for the full sample and the sample of those age 30 and over at the time of enrollment are similar. One exception to this pattern is the result for associate degrees in business and management. Below, we show and discuss that this pattern seems to be related to students who transfer to other institutions.

In our fixed-effects regression approach, any differences in earnings *levels* prior to enrollment will be absorbed by the fixed effects. If, however, there are differences in earnings growth rates between the treatment and control groups, our results may still be subject to bias. To check for differential rates of earnings growth that could bias our results, we compare the pre-enrollment earnings *changes* between treatment and control individuals. Specifically, we estimate regressions with pre-enrollment earnings changes as the dependent variable and degree receipt as the primary independent variable.<sup>12</sup> The coefficients on degree receipt will show whether a degree recipient had earnings changes prior to their initial enrollment that were systematically different than those who did not eventually complete a program. This exercise, summarized in Table 3, yields statistically significant coefficients on several of the separate regressions, suggesting some concern about differences between treatments and controls. Most of these statistically significant effects are negative, which is consistent with negative selection (on earnings growth) into degree receipt. This could suggest that those who face declining earnings prospects are more likely to complete vocational certificates and degrees.

Given these results, we re-estimate our main effects including a set of individual-specific trends, along with individual-specific fixed effects. The right-hand panel of Table 2 shows results when we add an individual-specific trend, as in equation (2), to the regression specification.<sup>13</sup> Not surprisingly, given the finding that several of our treated groups had earnings trends below those of the controls prior to enrollment, the addition of individual-specific trends increases the returns in several cases. For example, in information technology, results controlling for individual-specific trends show larger positive returns to all award lengths, though only the shortest term certificates show a statistically significant return.

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<sup>12</sup> In particular, these regressions account for 11th grade math and English language arts (ELA) scores. Students take a math test that is consistent with their course level in math, so we include an indicator variable for the test they took. We also account for a student's parental level of education. Since many students do not have complete information on all these variables, we also include dummy variables indicating missing data. In addition, we control for gender, race, and age.

<sup>13</sup> To estimate this equation, we run separate regressions of all variables, for each individual, on an intercept and time trend, and calculate residuals from all of these regressions. These residuals are then the transformed variables, purged of individual-specific trends, and are used to estimate the regressions reported in the right-hand side of Table 2.

**Table 3. Differences in Pre-Enrollment Earnings Changes, Treatments Versus Controls**

	AA/AS	Cert. 30–60	Cert. 18–30	Cert. 6–18
<i>Full sample</i>				
Business/Management	–0.0153* (0.0077)	–0.00742 (0.0255)	0.00305 (0.0106)	–0.0199 (0.0127)
Information tech	0.00706 (0.0189)	0.051 (0.0400)	0.0264 (0.0220)	0.00689 (0.0124)
Engineering/Industrial	–0.0434*** (0.0129)	–0.0194* (0.0090)	–0.0212* (0.0095)	0.00381 (0.0092)
Health	–0.0006 (0.0053)	0.00484 (0.0079)	0.0094 (0.0125)	0.00529 (0.0089)
Family/Consumer sciences	–0.0365* (0.0146)	–0.0112 (0.0140)	–0.0442** (0.0150)	–0.0303 (0.0094)
Public/Protective	–0.0280** (0.0098)	–0.0312** (0.0110)	–0.00848 (0.0080)	0.00193 (0.0069)
<i>Students age 30+ at enrollment</i>				
Business/Management	–0.00758 (0.0094)	–6.9E–05 (0.0308)	0.00849 (0.0115)	–0.0166 (0.0128)
Information technology	0.0087 (0.0224)	0.0463 (0.0436)	0.032 (0.0232)	–0.00725 (0.0113)
Engineering/Industrial	–0.0368** (0.0119)	–0.02 (0.0106)	–0.0186 (0.0107)	–0.00160 (0.0103)
Health	0.00511 (0.0065)	0.0123 (0.0097)	0.0215 (0.0136)	0.00353 (0.0108)
Family/Consumer sciences	–0.0375* (0.0167)	–0.0217 (0.0150)	–0.0351* (0.0161)	–0.0335* (0.0106)
Public/Protective	–0.0277* (0.0131)	–0.0403** (0.0131)	–0.0115 (0.0101)	–0.0128 (0.0081)

*Note.* Entries are regression coefficients by two-digit TOP code and control group type. Each coefficient is from a regression of pre-enrollment earnings changes on treatment, age, and year dummies. Standard errors clustered at the individual level.

This is consistent with the visual evidence in Figure 2, which showed a downward trend prior to enrollment for prospective information technology award recipients. Similarly, estimated returns within engineering and industrial technology, where we found significantly lower pre-enrollment earnings trends among degree recipients, are larger in Panel B in several cases.

The results on the left-hand side of Table 2 are our preferred estimates. In general, results do not differ greatly when we restrict the sample to older workers with longer pre-enrollment

earnings histories. These are largely consistent with the results in the right-hand side of the table, and show positive, statistically significant returns to most of the CTE programs considered here. An exception is in the broad category of information technology programs, where there is limited evidence of substantial returns to certificates and degrees, with the exception of certificates requiring six to 18 units. This may reflect heterogeneity in returns across specific programs within the information technology discipline, a point we return to below.

These results show that, while individual fixed-effects can capture many fixed, omitted characteristics, it may also be important to control for pre-existing earnings trends for prospective degree recipients. This echoes, but extends, the approach taken in Jepsen et al. (2014), who include several fixed, observable worker characteristics interacted with time trends in their main specification.

Summary statistics from Table 1 indicated large gender differences in the specific programs and disciplines in which individuals enrolled and earned degrees. Because we also document substantial heterogeneity in returns across disciplines, we next investigate the returns to CTE program by gender. In Table 4, we repeat our preferred specifications by discipline (controlling for both individual fixed-effects and individual-specific trends) separately for men and women. Some disciplines show notable differences in estimated returns by gender. In business and management, for example, returns for women are higher, often substantially higher, and often by a statistically significant margin. In information technology, certificates of 30 to 60 units show large, significant returns for women and low or no returns for men. Interestingly, relatively few women receive certificates and degrees in the information technology TOP code. Among all associate degrees awarded to women, less than 2 percent are in this TOP code. This also raises the possibility of some gender-specific selection that could complicate interpretation of these returns. Business and management, in contrast, account for a large fraction of all vocational awards to women, comprising 28 percent of vocational associate degrees to women in our sample, and nearly one third of certificates of 18 to 30 units. For the remaining disciplines, returns are similar across genders, and are not typically statistically different between men and women.

This evidence of gender differences in returns, and the different distributions of men and women across TOP codes, suggest caution in drawing conclusions about the payoff of vocational programs as a whole by gender. Even within the broad categories of two-digit TOP codes used here, there may be differences in the specific awards received by men and women.



**Table 4: Estimates by Discipline and Length, by Gender**

	Full Sample		Older Than 30	
	Men	Women	Men	Women
<i>Business/Management</i>				
AA/AS	0.0241 (0.0136)	0.0476*** (0.0119)	0.0996*** (0.0259)	0.106*** (0.0193)
30–60 units	0.00909 (0.0714)	0.160*** (0.0405)	–0.0355 (0.0999)	0.172*** (0.0504)
18–30 units	0.107** (0.0409)	0.156*** (0.0262)	0.104* (0.0469)	0.140*** (0.0296)
6–18 units	0.155*** (0.0375)	0.157*** (0.0294)	0.128** (0.0436)	0.128*** (0.0356)
<i>Information technology</i>				
AA/AS	0.0639* (0.0288)	0.0736 (0.0672)	0.0489 (0.0411)	0.0338 (0.0901)
30–60 units	–0.0196 (0.0664)	0.279** (0.0952)	–0.0295 (0.0825)	0.267* (0.1080)
18–30 units	0.0313 (0.0547)	0.0299 (0.1150)	0.0447 (0.0623)	0.0211 (0.1170)
6–18 units	0.0956** (0.0293)	0.0843 (0.0768)	0.110** (0.0342)	0.16 (0.0824)
<i>Engineering/Industrial</i>				
AA/AS	0.161*** (0.0159)	0.158* (0.0620)	0.187*** (0.0267)	0.166 (0.0896)
30–60 units	0.0727*** (0.0117)	0.0847 (0.0571)	0.0442* (0.0175)	0.0905 (0.0746)
18–30 units	0.0385** (0.0147)	0.151* (0.0751)	0.0476* (0.0201)	0.207* (0.0873)
6–18 units	0.129*** (0.0163)	0.0715 (0.0553)	0.138*** (0.0235)	0.0972 (0.0635)
<i>Health</i>				
AA/AS	0.650*** (0.0151)	0.703*** (0.0096)	0.625*** (0.0199)	0.691*** (0.0129)
30–60 units	0.285*** (0.0205)	0.461*** (0.0164)	0.260*** (0.0274)	0.475*** (0.0235)
18–30 units	0.323*** (0.0592)	0.272*** (0.0267)	0.316*** (0.0754)	0.292*** (0.0379)
6–18 units	0.100*** (0.0216)	0.0942*** (0.0200)	0.0589 (0.0401)	0.143*** (0.0268)

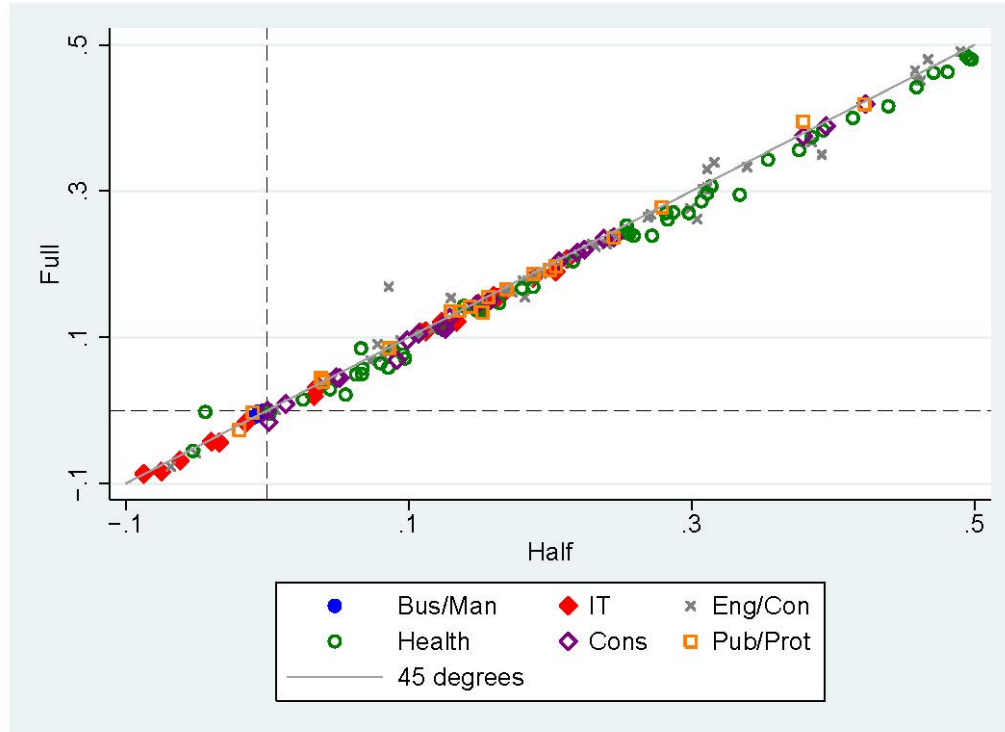
<i>Family/Consumer sciences</i>				
AA/AS	0.152** (0.0499)	0.0858*** (0.0151)	0.124 (0.0894)	0.121*** (0.0225)
30–60 units	0.164*** (0.0437)	0.211*** (0.0296)	0.192** (0.0588)	0.236*** (0.0368)
18–30 units	0.0619 (0.0514)	0.137*** (0.0254)	0.0376 (0.0602)	0.0942** (0.0303)
6–18 units	0.144*** (0.0405)	0.0942*** (0.0147)	0.176*** (0.0510)	0.104*** (0.0196)
<i>Public/Protective services</i>				
AA/AS	0.126*** (0.0133)	0.126*** (0.0205)	0.139*** (0.0267)	0.168*** (0.0373)
30–60 units	0.149*** (0.0176)	0.155*** (0.0324)	0.0664** (0.0248)	0.139*** (0.0401)
18–30 units	0.178*** (0.0130)	0.0976*** (0.0296)	0.177*** (0.0166)	0.135*** (0.0390)
6–18 units	0.144*** (0.0103)	0.0744*** (0.0219)	0.153*** (0.0158)	0.0758* (0.0312)

*Note.* Coefficients on degree received (interacted with award type/length) are from separate regressions for each discipline (two-digit TOP code). Standard errors are clustered by individual.

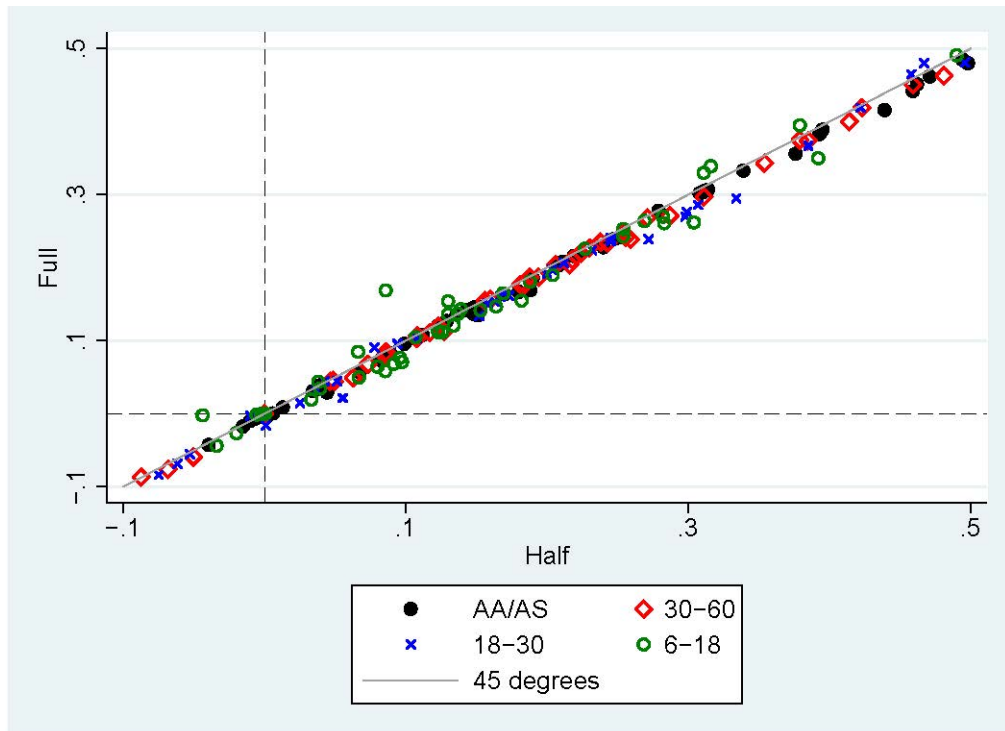
To better understand this variation in returns, we have estimated returns separately by four-digit TOP codes, which correspond much more closely to well-defined fields of study or occupations. For example, in estimating the return to all 18 to 30 unit certificates in the field of family and consumer sciences, we instead allow separate coefficients for returns to programs in child development/early care and education, fashion, and interior design.

These results are summarized in Figures 3 and 4, in which our estimated returns by four-digit TOP code and program length are illustrated on the vertical axis. (The horizontal axis summarizes a robustness check detailed below.) There is, as expected, great variation in estimated returns within TOP codes. To see this, focus on the unfilled circles in Figure 3, which indicate returns to different vocational programs in the broad field of health. The estimated returns in health range from  $-.08$  to  $.50$ . Most of the other TOP codes show a similarly broad range of returns. Another result illustrated in these figures is the overall positive returns to most of the vocational awards considered here. In this more disaggregated examination of returns to specific awards, there are some point estimates at or below zero. The vast majority of estimates, however, are in the positive range, often indicating fairly substantial labor market returns to vocational education.

**Figure 3. Full and Half Control, by Sub-Discipline (4 digits)**



**Figure 4. Full and Half Control, by Degree Type**



The heterogeneity across specific types of CTE programs may explain why comparisons across studies of vocational or CTE programs may be challenging. Differences in the types of degree programs offered or specific patterns of enrollment may alter the overall estimate of returns. Despite this heterogeneity in returns, it is of interest to present a tractable summary of expected returns for the population of CTE students. One way to summarize these estimated returns is to calculate a weighted average return where the weights take account of the relative frequency of degrees in specific disciplines. This also allows for a way to summarize overall returns by gender, while still allowing for the differences in enrollment patterns by gender. In Table 5, we take the estimated returns from the left-hand panel of Table 4 and calculate a weighted average across TOP codes for each degree type.

**Table 5. Estimated Returns by Award Length**

	<b>All</b>	<b>Men</b>	<b>Women</b>
<i>All disciplines</i>			
AA/AS	0.286 (0.0110)	0.198 (0.0170)	0.351 (0.0160)
30–60 units	0.203 (0.0180)	0.128 (0.0230)	0.321 (0.0290)
18–30 units	0.135 (0.0200)	0.114 (0.0260)	0.164 (0.0330)
6–18 units	0.117 (0.0150)	0.131 (0.0190)	0.098 (0.0230)
<i>Excluding health</i>			
AA/AS	0.055 (0.0100)	0.072 (0.0150)	0.042 (0.0150)
30–60 units	0.083 (0.0160)	0.079 (0.0210)	0.09 (0.0260)
18–30 units	0.103 (0.0180)	0.102 (0.0230)	0.106 (0.0310)
6–18 units	0.097 (0.0130)	0.112 (0.0170)	0.076 (0.0210)

*Note.* Estimates come from regressions at the sub-discipline (TOP-4) level. Coefficients are weighted means based on the number of awards in each sub-discipline.

The weights are simply the fraction of all degrees of a specific type (length) earned in the TOP code out of all such degrees earned.<sup>14</sup> This will provide an estimate of the typical return for a random student receiving an associate vocational degree (or a certificate of a given length), with TOP codes that grant relatively large numbers of degrees receiving greater weight. This shows larger overall returns for women than for men. For women, the returns range from .35 for the associate degree to approximately .10 for certificates requiring just six to 18 units. For men, the comparable range is .20 to .13. For comparison, Jepsen et al. (2014) report earnings returns for “vocational” associate degrees of approximately \$1,300 to \$1,500 in quarterly earnings, or increases of 26 to 30 percent given their baseline quarterly earnings of approximately \$5,000. Thus, our results are in a similar range, although they report slightly larger returns for men than for women.

These weighted averages show the importance of the differential selection into TOP codes by men and women. Specifically, in the lower panel of Table 5 we repeat this summary of results excluding health programs. This shows that the overall estimated returns of .35 for women is driven by the large fraction of women receiving associate degrees in health areas. Nearly 44 percent of women earnings associate degrees in our sample do so in a health TOP code; only 20 percent of men earning associate degrees are in health. For men, there is a very heavy concentration of degrees and certificates received in public and protective services (which also have high returns, though not as high as health). Public and protective services account for more than 40 percent of six to 18 unit and 30 to 60 unit certificates for men.

This highlights a potentially important difference between our results and the earlier work by Jepsen et al. (2014); these authors list both “vocational” programs and then, separately, health. Because the health TOP code produces some extremely large estimated returns, we have also calculated the weighted average of vocational returns excluding the health TOP codes. These results are shown in the lower panel of Table 5. Notably, the associate degrees excluding health produce lower returns of 4 to 7 percent. Outside of health, returns are larger among the shorter-term certificates (as opposed to associate degrees), with many returns in the neighborhood of 10 percent. This highlights both the strong role of the health sector in generating these substantial returns to vocational programs, and the sensitivity of the overall returns (especially for women), to this prominent role for the health disciplines.

### **Robustness of Results to Control Group Definition**

We have argued above that an appropriate and well-matched control group is an important part of our identification strategy. In this section, we explore how varying our control group definition affects the estimated returns. Our initial control group includes individuals who have taken at least eight units within the two-digit TOP code examined, but who have not received any degree or certificate. This likely includes a mix of (at least) two types of students:

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<sup>14</sup> This is not the only sensible way to aggregate returns across disciplines. This approach produces an overall return to the “average” degree recipient. Another strategy might be to weight by the number of students attempting degrees in this field; this would produce an average return more appropriate to a typical “potential” awardee.

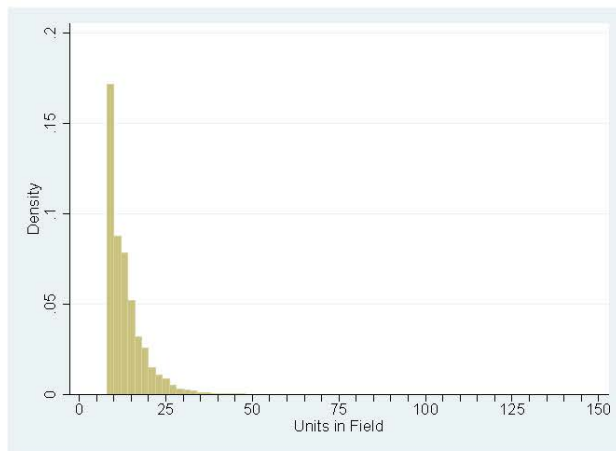
(1) those who have completed only very few units of study and (2) those who are very close to completion of a certificate, but lack a few critical courses. The interpretation of our estimated returns hinges on which of these types of students dominate the control group. If it is the latter, the estimates may be largely capturing a “sheepskin” effect, or the effect of persistence in meeting all requirements, since the control group may also have completed the majority of the coursework.

Figure 5 illustrates the distribution of completed units among the control groups for each of the six broad TOP codes. The common feature across all TOP codes is the concentration of control group students at very low numbers of units completed. This suggests that the control group is mainly composed of students who are not close to degree or certificate completion. To further focus our estimates on the contrast between degree completers and students relatively far from degree completion, we create an alternative set of control groups. Specifically, we add the requirement that control group members have not completed more than half the required number of units in the TOP code for the required degree. This results in relatively modest changes from our initial control group, but it is of interest to see if this affects the estimated returns. These results are summarized by the horizontal dimension of Figures 3 and 4. These figures show the similarity of our results based on the two different control groups—the “Full” control based on our original definition, and the “Half” control where we eliminate individuals who have completed more than half the required units. The fact that the estimates for most TOP codes (Figure 3) and degree types (Figure 4) are close to the 45 degree line emphasizes that there are not large effects, on average, of this variation in the control group definition.

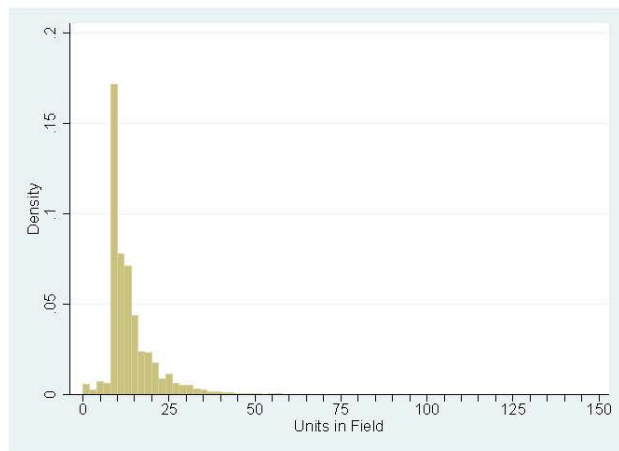
In general, our expectation is that the estimated returns should be higher when we use this alternative control group, since we eliminate controls who may have accumulated levels of human capital that are close to those of the degree recipients. In terms of Figures 3 and 4, this would predict a clustering of estimates below the 45 degree line, which is precisely what we see. In Figure 4, it is notable that the greatest divergence in estimates by control group definition occurs for the shortest certificates, requiring just 6 to 18 units. For these awards, the potential difference in units accumulated by the treatment and control students is low and so forcing a greater contrast (in the “Half” control group) leads to larger estimated effects. This is also consistent with there being some return to accumulating even a few units of vocational credit in some areas.

We have also constructed a single control group across all TOP codes. This is perhaps more comparable to a typical approach in this literature, where treatment and control students may not be in the same field of study. When we use a common control group (not shown) there is less agreement between the two approaches that differ in how many credits the control group student have completed, suggesting that conditioning on participation in coursework within the specific discipline whose return is being measured may be important.

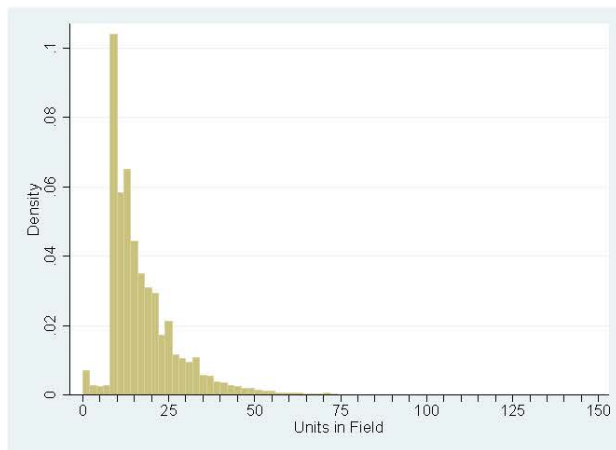
**Figure 5. Units Earned by Control Groups, by Discipline**



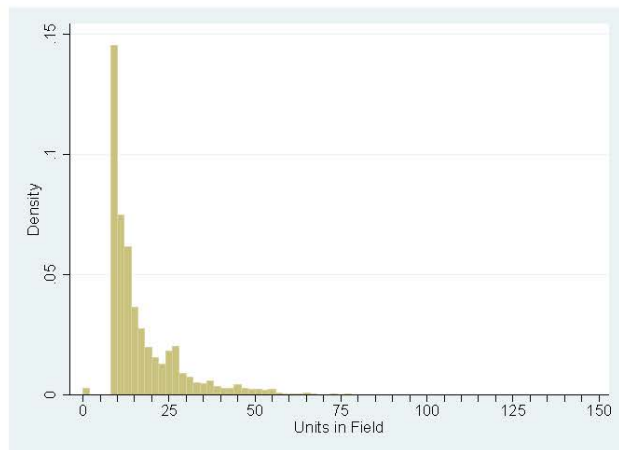
(a) Business/Management



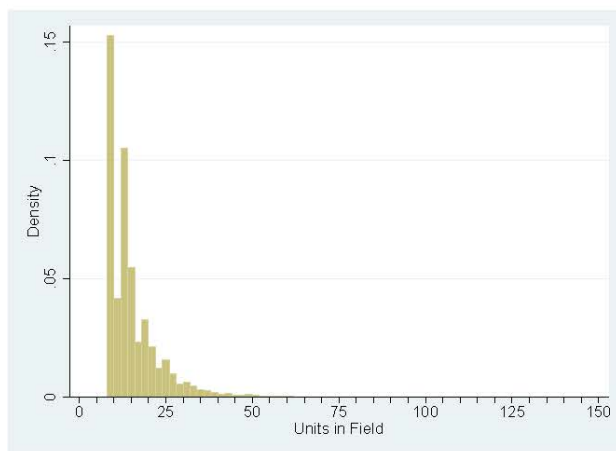
(b) Information Technology



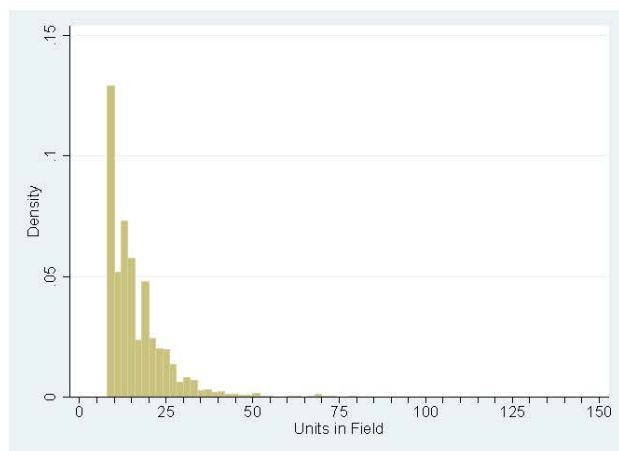
(c) Engineering/Industrial Technology



(d) Health



(e) Family/Consumer Sciences



(f) Public/Protective Services

## **The Potential Role of Transfers to Four-Year Institutions**

In much work on community college students and degrees, it is critical to consider the role of transfers to four-year institutions in generating any observed earnings increases. In more traditional academic settings, for example, earning a two-year degree may simply be a milestone on the way to earning a four-year degree, or even just accumulating additional college credits. Thus, while estimates such as ours would capture a meaningful return to the program, the mechanism by which it generates earnings increases might depend critically on successful transfer and completion of another degree. This point is made by Jepsen et al. (2014) when they note the difficulty of signing the bias if some of their associate degree recipients also complete additional college coursework at a four-year institution.

In our work focusing specifically on vocational degree and certificate programs, the role of the transfer process in helping to generate returns is also uncertain. On one hand, students focused on these vocational awards may be less inclined to transfer and so there may be less concern that the vocational awards are associated with higher earnings partially because they facilitate additional degrees or college attendance. This should mean that eliminating students who transfer would reduce our estimated returns. On the other hand, transfers could work in a very different way if academic and vocational tracks are viewed as substitutes for one another. Suppose that individuals take a few vocational courses (and thus qualify as a member of our control group); if many of these students then decide instead to pursue a transfer path, the earnings of our controls may benefit disproportionately from their decisions to transfer to four-year colleges. In some sense, receiving a vocational degree could signal that a student has not opted for a four-year degree. This is a variation on the “diversion” effect of community colleges (see Belfield & Bailey, 2011 for a review and discussion) in which attendance diverts students from a four-year degree. For vocational programs, there may be an additional issue of diverting students from non-vocational programs that are intended to lead to transfers. If this story is important for our vocational students, we might expect that eliminating students who successfully transfer would disproportionately eliminate high earning control-group members and so increase our estimated returns.

Table 6 repeats the basic analysis in Table 2, but drops students (in both treatment and control groups) who later transferred. This results in dropping from 12 to 40 percent of our samples across different TOP code groups. Despite dropping a large number of cases for some TOP codes, results in Table 6 are very similar to those shown in Table 2, suggesting that transfers do not play a major, systematic role in generating the returns estimated here. One exception to this pattern is for the associate degrees in business and management. Once those transferring are dropped, we see positive returns to the associate degrees in this field across age groups and specifications. Business programs may be a particularly heterogeneous group, since many four-year colleges offer business degrees, but they are also listed as part of the vocational offerings within the California community colleges we study. It seems likely that the business TOP code combines more traditional academic business tracks that are aimed at transferring to four-year colleges and more typically vocational programs which are not.



**Table 6: Estimates by Discipline and Length, Excluding Transfer Students**

Specification	Individual Fixed Effects		Individual Fixed Effects and Trends	
	All	Older than 30	All	Older than 30
<i>Business/Management</i>				
AA/AS	0.134*** (0.0128)	0.155*** (0.0179)	0.136*** (0.0141)	0.137*** (0.0199)
30–60 units	0.129*** (0.0371)	0.153*** (0.0436)	0.120** (0.0408)	0.117* (0.0499)
18–30 units	0.191*** (0.0204)	0.192*** (0.0230)	0.158*** (0.0233)	0.144*** (0.0260)
6–18 units	0.0803*** (0.0212)	0.0644* (0.0259)	0.178*** (0.0256)	0.136*** (0.0305)
<i>Information technology</i>				
AA/AS	0.0903** (0.0293)	0.0397 (0.0408)	0.119*** (0.0343)	0.0474 (0.0487)
30–60 units	0.0913 (0.0599)	0.0294 (0.0694)	0.0641 (0.0608)	0.104 (0.0720)
18–30 units	0.044 (0.0469)	0.0405 (0.0530)	0.0841 (0.0530)	0.107 (0.0587)
6–18 units	0.0714** (0.0274)	0.0566 (0.0304)	0.0957** (0.0307)	0.113** (0.0357)
<i>Engineering/Industrial</i>				
AA/AS	0.214*** (0.0152)	0.160*** (0.0249)	0.183*** (0.0172)	0.193*** (0.0277)
30–60 units	0.129*** (0.0106)	0.0931*** (0.0159)	0.0760*** (0.0118)	0.0543** (0.0176)
18–30 units	0.0766*** (0.0139)	0.0801*** (0.0191)	0.0490*** (0.0148)	0.0562** (0.0200)
6–18 units	0.0760*** (0.0144)	0.0428* (0.0201)	0.130*** (0.0163)	0.139*** (0.0223)
<i>Health</i>				
AA/AS	0.666*** (0.0094)	0.655*** (0.0120)	0.690*** (0.0099)	0.668*** (0.0125)
30–60 units	0.336*** (0.0124)	0.339*** (0.0166)	0.398*** (0.0136)	0.399*** (0.0186)
18–30 units	0.134*** (0.0250)	0.134*** (0.0346)	0.263*** (0.0261)	0.276*** (0.0361)
6–18 units	0.0303* (0.0118)	0.0131 (0.0118)	0.118*** (0.0118)	0.118*** (0.0118)

	(0.0147)	(0.0210)	(0.0166)	(0.0239)
<i>Family/Consumer sciences</i>				
AA/AS	0.145*** (0.0156)	0.150*** (0.0215)	0.115*** (0.0180)	0.125*** (0.0254)
30–60 units	0.0935*** (0.0229)	0.0462 (0.0300)	0.197*** (0.0262)	0.229*** (0.0329)
18–30 units	0.106*** (0.0212)	0.0642* (0.0262)	0.117*** (0.0245)	0.0823** (0.0284)
6–18 units	0.0892*** (0.0133)	0.0919*** (0.0170)	0.109*** (0.0149)	0.113*** (0.0191)
<i>Public/Protective services</i>				
AA/AS	0.186*** (0.0133)	0.120*** (0.0242)	0.155*** (0.0150)	0.172*** (0.0265)
30–60 units	0.178*** (0.0152)	0.171*** (0.0202)	0.154*** (0.0177)	0.103*** (0.0234)
18–30 units	0.193*** (0.0133)	0.151*** (0.0183)	0.169*** (0.0140)	0.176*** (0.0180)
6–18 units	0.213*** (0.0106)	0.169*** (0.0157)	0.142*** (0.0111)	0.146*** (0.0156)

*Note.* Coefficients on degree received (interacted with award type/length) from separate regressions for each discipline (two-digit TOP code). Standard errors clustered by individual.

### Comparisons With OLS Estimates Using Detailed Observable Controls

Our final robustness check examines how our results differ from estimates based on an alternative approach of including detailed controls for students' observable abilities. Specifically, for a subset of our data (certain entry cohorts), we have access to test scores from students' high school years, and to their parents' completed levels of education. Because many prior estimates of educational returns do not follow the longitudinal data methods used here, we compare our results for this subset with those from an approach controlling for these observable factors, but not pre-enrollment earnings. These results are summarized in Table 7. We estimate both ordinary least squares (OLS) models for earnings, including the additional controls for test scores and parental income, and fixed-effects models, for the individual TOP codes shown throughout. We then summarize the resulting coefficients using the same weighted average approach shown in Table 5.

**Table 7. Estimates by Discipline and Length Using Matched High School Records**

	OLS	Fixed Effects	Diff./ <i>p</i> -value	Awards
<i>All disciplines</i>				
AA/AS	0.181	0.103	0.078	4,219
	(0.0410)	(0.0410)	0	
	324,647	324,272		
30–60 units	0.254	0.19	0.064	1,119
	(0.0680)	(0.0920)	0.308	
	281,804	281,500		
18–30 units	0.118	0.196	−0.078	3,032
	(0.0760)	(0.0940)	0.155	
	277,203	276,898		
6–18 units	0.228	0.078	0.15	2,370
	(0.0530)	(0.0540)	0	
	294,683	294,348		
<i>Excluding health</i>				
AA/AS	0.109	0.016	0.093	3,542
	(0.0390)	(0.0380)	0	
	299,963	299,608		
30–60 units	0.186	0.15	0.036	835
	(0.0710)	(0.1010)	0.613	
	263,055	262,762		
18–30 units	0.114	0.164	−0.051	2,748
	(0.0730)	(0.0900)	0.333	
	261,701	261,405		
6–18 units	0.199	0.062	0.137	1,675
	(0.0570)	(0.0570)	0	
	270,902	270,586		

*Note.* Coefficients on degree received (interacted with award type/length) from separate regressions for each discipline (two-digit TOP code). Coefficient, standard error, and the number of observations from the regressions are reported. OLS specifications include controls for 11th grade math and English language arts (ELA) scores, as well as parental education level. *P*-values come from a Hausman test of the two specifications. The final column shows the number of awards in each group. Standard errors clustered by individual.

As expected, most of the estimated returns based on the fixed-effects specification are smaller than the OLS estimates with controls for test scores and parent education. In several cases, these differences are relatively small, and within a standard error of the fixed-effects estimate. Given the much smaller samples sizes available for this exercise, we do not draw

strong conclusions here, but note that this is consistent with a potentially important role for unobserved fixed characteristics and trends.

## **7. Discussion and Conclusion**

The California Community Colleges, enrolling 2.6 million students across 112 campuses, represents the largest public higher education system in the nation. The potential promise of California's community colleges to improve labor market outcomes is highlighted in recent state reform efforts to strengthen CTE offerings, and in recent federal funding initiatives directed at technical/vocational education and community colleges. Research on the CTE mission of community colleges, the diverse needs of their students, and on the relationship between CTE program offerings and the labor market has been scarce.

The approach used here suggests quite substantial, and generally statistically significant, returns to a variety of popular vocational certificates and awards offered in California community colleges. By controlling for both individual fixed effects and individual-specific trends, we address many concerns about using observational data to estimate returns to higher education. Our results suggest average returns ranging from more than 25 percent for associate degrees to approximately 10 percent for shorter-term certificates. Health programs produce very large returns, and this drives both large overall estimated returns to vocational programs in our data, and fairly large apparent gender gaps in vocational returns because of the large concentration of women in this high-return field. Excluding health leads to substantially lower returns to the associate degrees and certificates, although short-term certificates outside the health field continue to show substantial returns.

For the purpose of improving human capital development of less skilled workers, these results raise several important points. First, the substantial heterogeneity in returns to CTE, even within the single system we examine, emphasizes that all CTE education programs are not equal. The returns to awards with the same number of credit hours vary enormously. While some health occupations have double-digit returns for relatively short programs, other certificate programs offer returns that are mere fractions of those high returns. Even within our broad disciplines (two-digit TOP codes) there is substantial variation across specific programs. While this is not different from results across college majors in more traditional four-year college settings, it is particularly important to acknowledge in CTE settings. Second, and very much related, there is substantial heterogeneity in the observable (and likely unobserved) characteristics of students across disciplines and programs. Thus, sensible policies cannot simply funnel workers into "high-return" programs, since underlying differences in the types of students who enroll in them could be quite important. In particular, a deeper understanding of how students choose their courses of study, and how redirecting students to other fields can alter their returns, remain very underexplored areas.

Third, understanding the interactions between individuals, programs, and returns, in order to provide concise information to potential students and college administrators, should be a top priority of workforce development policies. Students should, of course, be aware of the likely returns on investments they are making. Calls to provide better information on labor market returns have begun to be common in the broader realm of education policy, but in the CTE area, given the direct connection to labor market outcomes, this information is especially critical.

Finally, the extremely large returns to health occupations, and the substantially smaller average returns among non-health occupations merit careful consideration. Health occupations are currently receiving a great deal of attention as promising career pathways for those without four-year college degrees. While our results largely confirm the high potential of health occupation training, it remains unclear which types of workers will be able to benefit from such training. Many health-related programs may have substantial requirements for prerequisite courses that not all workers will meet. Much previous and current work on health occupations comes from smaller, randomized training program trials. Our results confirm high returns in a broader, non-experimental setting, but more research is needed to better understand these high returns, and to understand whether and when they will continue.

It is critical to find effective paths to human capital development for individuals who are unlikely to complete standard four-year academic programs. In California and the nation, declining real wages and record high unemployment for those without college degrees, combined with cuts to many state programs serving these populations, make it essential to understand what programs can be most effective. The identification strategy we employ provides for a far more rigorous evaluation of the labor market returns than the simple before and after comparisons of CTE participants' earnings that currently exist. A large literature in economics has considered the most appropriate methods for evaluating worker-training programs, and we draw on the lessons from that literature in our analytic strategy (see Card, Luve, & Weber, 2010 or Lalonde, 1986 for a recent review and meta-analysis of the job training evaluation literature). Short of a randomized assignment of workers into CTE courses or programs, our approach combining longitudinal data with a control group provides the most common approach in the recent literature.<sup>15</sup> Our results suggest that many of these programs, even after accounting for individual pre-enrollment earnings levels and economy-wide earnings growth, have substantial, positive earnings effects.

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<sup>15</sup> Card, Luve, and Weber (2010) report that more than half of the qualifying evaluation studies included in their meta-analysis, published since 1990, used longitudinal data with a comparison group.

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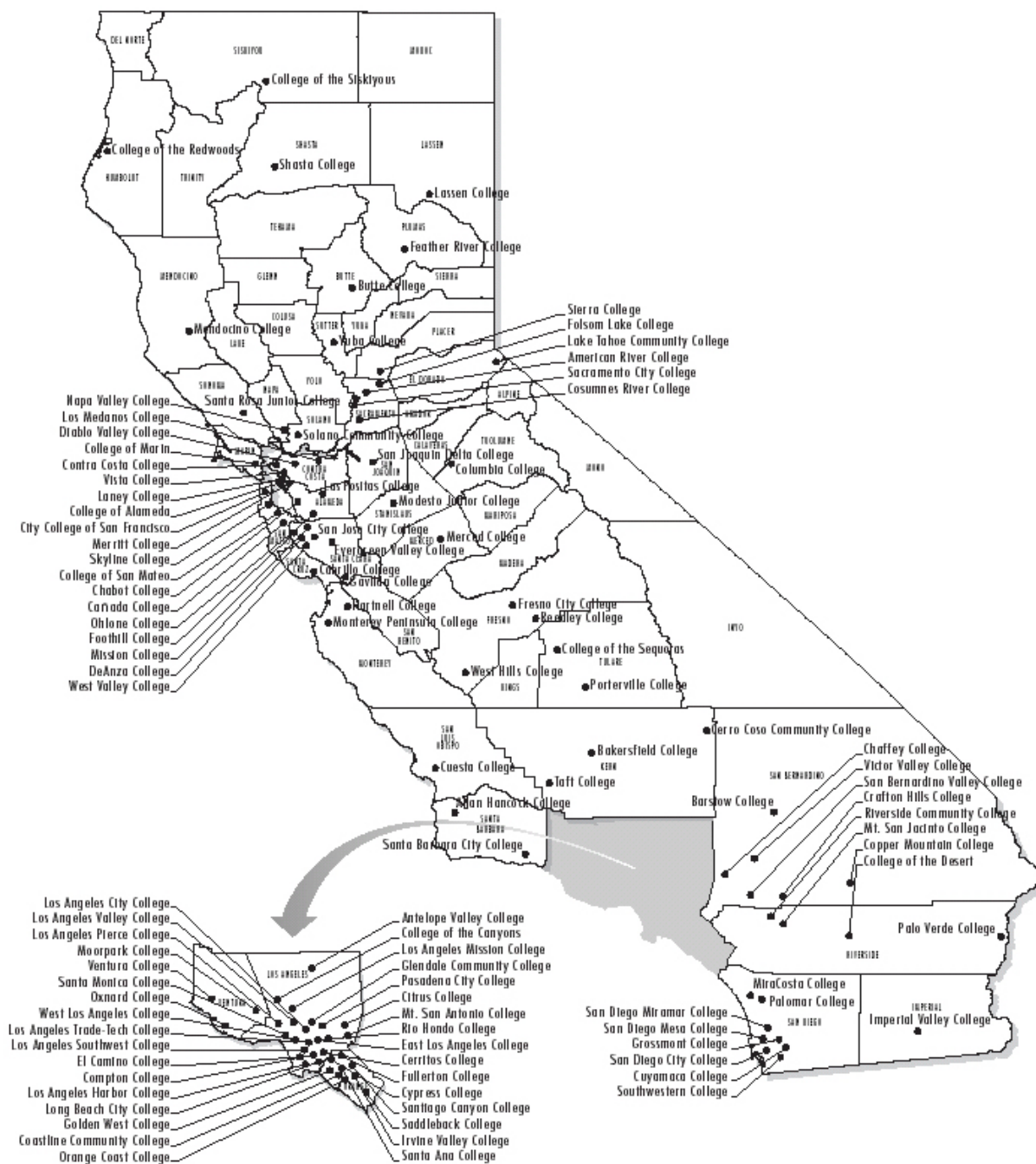
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# Appendix

**Figure A.1**  
**Map of Community Colleges in California**



Source: Community College Chancellor's Office

**Table A.1 Summary Statistics for Award Holders**

	All	Career-Technical Awards				
		All	AA/AS	30–60 Unit	18–30 Unit	6–18 Unit
Number of degrees	1.33	1.52	1.82	1.84	1.94	1.76
Number of CTE degrees	0.69	1.38	1.55	1.7	1.81	1.63
Years to first degree	4.46	4.4	5.02	4.4	4.39	3.73
Years to first CTE degree	4.48	4.48	5.16	4.46	4.43	3.79
Units	81.22	77.04	96.05	84.91	80.38	74.82
Transfer units	64.09	54.7	75.65	54.02	54.39	49.82
Transfer/Credit units	68.55	61.38	77.57	66.94	59	50.5
Credit units to first CTE degree	62.31	62.31	79.38	67.7	59.4	51.07
Age	25.1	27.77	26.3	28.12	29.5	28.18
Female	0.59	0.52	0.59	0.52	0.51	0.51
Male	0.4	0.47	0.4	0.47	0.48	0.48
White	0.4	0.39	0.39	0.39	0.39	0.35
Black	0.07	0.07	0.07	0.08	0.07	0.08
Hispanic	0.27	0.27	0.26	0.27	0.27	0.32
Asian	0.12	0.12	0.13	0.11	0.13	0.1
Other Race	0.01	0.01	0.01	0.01	0.01	0.01
Meets control group criterion	0.43	0.67	0.68	0.78	0.76	0.65
Pre-enrollment earnings (median)	19015.33	20691.59	19336.87	19889.08	22019.67	18631.76
Employed pre-enrollment	0.74	0.71	0.7	0.73	0.69	0.72
N	528847	264805	136197	65828	47238	65700

*Note.* Sample includes degree holders whose largest degree was granted between 2003 and 2007. Recipients of multiple degrees are included in multiple columns. Wages pre-employment are defined as annual wages in the second year prior to a student's first enrolled term. Employment pre-enrollment is defined as nonzero earnings in the second year prior to that first enrolled term.

**Table A.2 Estimates by Discipline and Length Using OLS**

	All		Older than 30	
	Demog	Demog + Academic	Demog	Demog + Academic
<i>Business/Management</i>				
AA/AS	0.0428*** (0.0094)	0.0330** (0.0107)	0.0911*** (0.0167)	0.0860*** (0.0192)
30–60 Units	0.0509 (0.0382)	0.0408 (0.0427)	0.0782 (0.0492)	0.054 (0.0554)
18–30 Units	0.0931*** (0.0215)	0.0825*** (0.0243)	0.143*** (0.0257)	0.123*** (0.0295)
6–18 Units	0.101*** (0.0225)	0.0559* (0.0270)	0.137*** (0.0294)	0.0953** (0.0355)
<i>Information technology</i>				
AA/AS	-0.0132 (0.0267)	-0.0128 (0.0289)	-0.0252 (0.0366)	-0.0259 (0.0387)
30–60 unit	0.0934 (0.0666)	0.122 (0.0739)	0.0129 (0.0765)	0.0621 (0.0881)
18–30 unit	0.0228 (0.0455)	0.0286 (0.0478)	0.031 (0.0536)	0.0289 (0.0548)
6–18 unit	0.0457 (0.0297)	0.0445 (0.0339)	0.0279 (0.0331)	0.0605 (0.0366)
<i>Engineering/Industrial</i>				
AA/AS	0.188*** (0.0158)	0.173*** (0.0177)	0.110*** (0.0258)	0.0851** (0.0290)
30–60 unit	0.0635*** (0.0119)	0.0479*** (0.0135)	0.0578** (0.0177)	0.0378 (0.0196)
18–30 unit	0.0289 (0.0151)	0.0378* (0.0167)	0.0506* (0.0207)	0.0436 (0.0229)
6–18 unit	0.102*** (0.0163)	0.139*** (0.0191)	0.00895 (0.0219)	0.0429 (0.0244)
<i>Health</i>				
AA/AS	0.668*** (0.0084)	0.661*** (0.0096)	0.711*** (0.0111)	0.703*** (0.0128)
30–60 unit	0.328*** (0.0127)	0.340*** (0.0151)	0.346*** (0.0174)	0.381*** (0.0207)
18–30 unit	0.146*** (0.0247)	0.125*** (0.0268)	0.179*** (0.0353)	0.169*** (0.0366)
6–18 unit	0.0967*** (0.0144)	0.102*** (0.0170)	0.0716** (0.0221)	0.0972*** (0.0264)

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<i>Family/Consumer sciences</i>				
AA/AS	0.0900*** (0.0142)	0.0826*** (0.0166)	0.141*** (0.0220)	0.135*** (0.0263)
30–60 unit	0.0946*** (0.0239)	0.0874** (0.0283)	0.0497 (0.0333)	0.0587 (0.0384)
18–30 unit	0.106*** (0.0221)	0.101*** (0.0261)	0.0779** (0.0283)	0.0707* (0.0335)
6–18 unit	0.128*** (0.0132)	0.107*** (0.0158)	0.137*** (0.0180)	0.109*** (0.0214)
<i>Public/Protective services</i>				
AA/AS	0.161*** (0.0117)	0.143*** (0.0132)	0.111*** (0.0228)	0.0733** (0.0258)
30–60 unit	0.236*** (0.0153)	0.163*** (0.0203)	0.216*** (0.0205)	0.171*** (0.0255)
18–30 unit	0.278*** (0.0134)	0.155*** (0.0212)	0.248*** (0.0193)	0.0597 (0.0315)
6–18 unit	0.294*** (0.0102)	0.242*** (0.0158)	0.250*** (0.0158)	0.194*** (0.0261)

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*Note.* Coefficients on degree received (interacted with award type/length) from separate regressions for each discipline (two-digit TOP code). Demographic controls include race, gender, age each term and age at first term. Academic controls include GPA, number of basic skills courses taken, and number of credit units attempted, all measured at the first term. Standard errors clustered by individual.