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Linking Occupational Concentration to Hourly Wages for Non-College Going Individuals

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Abstract

One of the stated goals of career and technical education (CTE) is to improve the labor market outcomes of participants. One population of students for which concentration CTE may be particularly beneficial is those who determine they will not pursue postsecondary education. By exploring how occupational concentration—defined as earning three or more credits in a specific CTE cluster—relates to labor market outcomes for non-college participants, this study adds to a growing body of research on the benefits of CTE participation. In an effort to gain a more nuanced understanding of these labor market benefits, the current study further disaggregates these potential benefits across different CTE categories. Using a nationally representative dataset to explore the CTE concentration association with eventual earnings, results indicated that occupational concentration in general links to increased wages. However, these benefits are limited to a few specific CTE categories: health sciences, trades, and agriculture and natural resources. Implications for individual students, practitioners, and policymakers are discussed.

Keywords: career and technical education; labor market; earnings occupational concentration

Introduction

There is growing concern in the United States that the next generation of labor market participants is ill-prepared to succeed in the increasingly demanding and fast-paced economy. Employers have expressed concerns that high schools are not adequately preparing youth to enter and succeed in the workforce (U.S. Department of Education, 2010). This concern is further highlighted as more and more careers require both specific technical as well as employability (e.g., critical thinking, problem solving, collaboration) skills for which students do not have the appropriate training or expertise (Brand, Valent, & Browning, 2013).

For the past decade and a half, the proportion of students who enroll in postsecondary education immediately after completing high school has hovered just below 70% (Mcfarland et al., 2019). This implies that more than 30% of high school graduates are choosing to forego postsecondary education for some other opportunity. Higher education participation can help students gain the skills necessary for success in the labor market, and earning a postsecondary credential is associated with a positive return on investment (i.e., higher wages as well as nonmonetary benefits such as job satisfaction) (Oreopolous & Petronijevic, 2013). Therefore, the population of students who do not pursue higher education may need an alternative pathway to career readiness. If students continue to be ill-prepared for these labor market demands, the potential for a skills gap in the United States will continue to grow (Carnevale, Smith, & Strohl, 2010).

Though this career readiness issue persists, policymakers and practitioners are not deaf to the worries being raised by business and industry. In a 2012 report, the US Department of Education (2012) specifically identified the need for education to better provide students with more rigorous and relevant instruction to help them acquire the necessary skills to prosper in their careers. In response, federal policymakers have helped recraft traditional vocational training as career and technical education (CTE)—a more comprehensive suite of classes designed specifically to support and improve career preparation (Education and the Workforce Committe, 2017).

The Benefits of CTE

The 2018 reauthorization of the federal policy governing CTE—the Carl D. Perkins Strengthening Career and Technical Education for the 21st Century Act (Perkins V)—places particular emphasis on the idea the CTE coursework should be both rigorous and relevant (Smith & Boyd, 2018). This emphasis builds on the current purpose of CTE coursework. CTE courses and programs of study are designed to provide students with specific skills directly related to a given career (Brand et al., 2013; Plank, DeLuca, & Estacion, 2008). Simultaneously, these courses are meant to teach students the academic skills necessary to succeed in high-skill, high-demand careers (Bozick & Dalton, 2013).

Perhaps due to this overlap between teaching both technical and academic skills, participation in CTE coursework in high school is quite widespread. Estimates indicate that approximately 90% of high school students complete at least one CTE course during their secondary studies (Bersudskaya & Chen, 2011; Dougherty, 2016). Given the prevalence of CTE coursetaking, a growing body of research has examined how CTE in high school may promote positive outcomes across a variety of environments. Taken as a whole, this literature base indicates that there is a growing perception that CTE provides a suite of benefits for participants.

At the secondary level, CTE participation is linked to higher odds of graduation, higher math self-efficacy, higher math scores, and improved chances of completing advanced math and science coursework (Sublett & Plasman, 2017; Dougherty, 2016; Gottfried, 2015; Gottfried, Bozick, Rose, & Moore, 2016; Kemple & Snipes, 2000). Additionally, CTE coursetaking in high school is linked with increased odds of enrollment in college, while students who participate in STEM-related CTE in high school are more likely to enroll in a STEM-related major in college, which improves the STEM pipeline from high school to career (Gottfried & Bozick, 2016; Plank et al., 2008). Finally, with respect to labor market outcomes, CTE participants are predicted to earn more than their peers who did not participate in CTE (Bishop & Mane, 2004; Dougherty, 2016; Hemelt, Lenard, & Papelow, 2017; J. Kemple & Willner, 2008).

The labor market studies are of particular interest in relation to this current study. There are a few important points to make with respect to the above-mentioned studies. First, Dougherty (2016) found evidence suggesting that certain areas of CTE study may be more beneficial than others. Additionally, Bishop and Mane (2004) found that participation in computer related CTE coursework was particularly beneficial. Another point to make is that both the Kemple and Willner (2008) and Hemelt, Lenard, and Papelow (2017) studies focused on a very specific type of CTE programming delivered in career academies. While the career academy system is a relatively common method of CTE delivery, it is not the only one. There are many students who participate in CTE within traditional, comprehensive high schools. Despite the generally positive findings related to CTE participation, there remains room for a great deal of further exploration. For example, there is little research that explores labor market outcomes specifically for non-college going students, and few studies take into account the clustered nature of CTE coursework.

CTE Concentration and Clusters

As mentioned above, a majority of students do participate in CTE to some extent; however, not all CTE participation is considered equal. There are varying degrees to which students participate in CTE (U.S. Department of Education, 2014). Those who earn three or more credits are referred to as CTE Investors. Within this categorization, there is a further distinction based on whether those credits are earned within a single occupational cluster (concentrators), or whether the credits are spread across more than one cluster (explorers). Students earning fewer than three credits are referred to as CTE Non-investors, which can also be broken into two sub-categorizations. Nonparticipants are those who earn fewer than one CTE credit, and samplers are students who earn more than one but fewer than three CTE credits.

Career and technical education itself is a broad umbrella term that encapsulates a wide range of different courses. In its current form, CTE is divided into sixteen unique occupational clusters: agriculture and natural resources; architecture and construction; communications; business, management, and administration; education and training; finance; government and public administration; health sciences; hospitality and tourism; human services; information technology; law, public safety, corrections, and security; manufacturing; marketing; STEM; and transportation (National Forum on Education Statistics, 2014). These clusters each include unique courses with specific focus on providing skills to succeed in careers related to the cluster theme. These courses can be delivered as standalone electives in traditional high schools, or through articulated programs of study in specialized high schools or career centers (Dougherty, 2016; Hemelt et al., 2017; Kemple & Snipes, 2000). Earning three or more credits in one of these occupational clusters results in a the CTE concentrator designation.

Based on prior research, CTE concentration is linked to a variety of positive outcomes above and beyond simply participating in CTE as a non-concentrator. At the secondary level, concentration is linked with improved graduation rates (Dougherty, 2016). Additionally, there are benefits related to postsecondary enrollment (Dougherty, 2016; Rodriguez, Hughes, & Belfield, 2012). Finally, there is also evidence that concentration is predictive of positive labor market outcomes such as higher wages and likelihood of employment (Rodriguez et al., 2012; Theobald, Goldhaber, Gratz, & Holden, 2017). These employment benefits have been explored across a variety of different subgroups of students, including by disability status (Theobald et al., 2017), gender (Kemple & Snipes, 2000), and race/ethnicity (Kemple & Snipes, 2000). There is also evidence from over two decades ago that vocational education participation (not concentration-specific) for non-college bound youths is related to positive labor market outcomes (Bishop & Mane, 2004; Mane, 1999). However, there is little research exploring labor market outcomes for students who concentrate in this new brand of CTE but do not go on to college—a group that may particularly benefit from this path of study.

Theoretical Framework

The potential connection between CTE and eventual labor market benefit can be understood through an adapted version of Becker's (1962) human capital framework. Under this framework, individuals are able to accumulate various attributes that ultimately produce an economic benefit. Essentially, by improving skills, knowledge, and expertise, people can better set themselves up for access to, and success in, future careers. One means of growing these skills, knowledge and expertise is through education. For students who do not pursue higher education, CTE may provide an opportunity to grow the skills and knowledge that are of benefit in the labor market.

Specifically relating to CTE, there are three theorized mechanisms that may help explain the processes by which CTE impacts later outcomes as viewed through this human capital lens: academic skill reinforcement, new skill building, and relevance and engagement (Gottfried et al., 2016; Plank et al., 2008; Plasman & Gottfried, 2018). The first mechanism, academic skill reinforcement, may not be as important in directly considering labor market success, but one of the first steps along the pipeline into successful employment is high school completion (Rumberger, 2011). As the nature of CTE coursework is to serve as a complement, as opposed to a replacement, to academic coursework, students who participate in CTE may be provided with additional opportunities to practice the skills learned in traditional academic classes (Bozick & Dalton, 2013; Shifrer & Callahan, 2010). This extra learning time then can boost achievement, which is a key predictor of high school completion (Lessard et al., 2008; Stone, Alfeld, & Pearson, 2008).

Building new skills and knowledge, the second mechanism, is a key component of CTE coursework fits closely within the broader human capital theory. In addition to technical skills specific to a certain occupational area, CTE courses also promote the development of key employability skills such as critical thinking, reasoning, logic, and problem solving (Brand et al., 2013; Schargel & Smink, 2001). These courses were intentionally designed to build these skills in an effort to ensure students are both college and career ready upon high school completion (Oakes & Saunders, 2008; Stern & Stearns, 2007).

The final mechanism is relevance and engagement. CTE courses bring together the abstract and theoretical nature of traditional academic work with applied and practical relevance (Brand et al., 2013). Therefore, participation in CTE coursework has the potential to help students gain an appreciation of the importance of high school course content as it links to later career options (Stone & Lewis, 2012). From a practitioner point of view, CTE instructors tend to see the ability of these occupational programs to promote career-readiness skills as a key strength (Partnership for 21st Century Skills, 2010).

Purpose of This Study

The current study fills a gap in the literature as it includes students in traditional high schools and also provides an examination of the benefit to those students who choose not to attend pursue higher education. Furthermore, in this study I provide an in-depth look at the benefits of concentration as they relate to specific CTE categories. In an effort to address this limitation in current CTE literature, this study explores how CTE in high school may prepare students for later success in the labor market. Improving skills – both new technical skills and supplemented academic skills – through CTE coursework may be of particular benefit to the group of students who do not go on to college because their formalized education-based skill-building is essentially over after high school. Additionally, by providing this group of students with a more direct educational connection to later career options (i.e., relevance), they may be more likely engage more deeply in the material as they see the end of high school as the end of their opportunity to gain the skills necessary to succeed in the labor market. To fill this gap in the literature, I ask the following research questions:

1. What are the expected labor market returns associated with occupational concentration in high school?
2. For students who don't attend any postsecondary education, does occupational concentration predict to higher wages?
3. Are there differences in outcomes based on the specific area (e.g., business, health, etc.) of occupational concentration?

With a human capital theoretical framework providing a backdrop for understanding how CTE may relate to improved student outcomes, this study will build on previous literature exploring how CTE participation links to improved labor market outcomes (Dougherty, 2016; Hemelt et al., 2017; Stevens, Kurlaender, & Grosz, 2019). Through analysis of a nationally representative dataset, I first explore how occupational concentration relates to hourly earnings across the full population of surveyed students. Due to the potential confounding factors associated with college participation and employment, I next limit my analysis to a closer look into the earnings benefits for occupational concentrators who choose not to attend college. Finally, there is a growing understanding that different areas of CTE may be beneficial to students in different ways, and, much as it is necessary to make distinctions between the benefits of different types of academic courses, it is necessary to make distinctions between the various CTE clusters (Gottfried & Plasman, 2018; Plasman, Gottfried, & Sublett, 2019). Furthermore, specific occupations in healthcare and certain STEM-related fields that require highly specialized sets of skills are expected to grow particularly rapidly over the next decade (Bureau of Labor Statistics, 2019). Thus, my final analysis digs into how pursuing occupational concentration in specific categories of CTE may be more or less beneficial to students. Understanding whether high school CTE participation can help meet some of these growing labor market needs while providing students with observable benefits may be of particular interest to policymakers in general as well as practitioners and administrators within the schools themselves.

Methodology

Dataset Overview

My analyses relied on nationally representative data from the High School Longitudinal Study of 2009 (HSLS:09), collected by the National Center for Education Statistics (NCES) at the U.S. Department of Education. HSLS:09 was designed to track a cohort of young adults as they progress through secondary school into college and eventually the labor market. It is the most recent nationally representative dataset available that explores students' secondary school experiences. NCES conducted base year surveys with a group of more than 23,000 students in over 900 public and private schools across the country during the fall of 2009 when students were first beginning high school as 9th graders. Students themselves, along with their parents, math and science teachers, school administrators and school counselors all completed survey questionnaires. High school transcripts were collected across the 2013-14 school year and added to the dataset. Most recently, a full follow-up student survey was conducted in 2016, approximately three years after the anticipated high school graduation for the participating students. Combined, the available information provides for a robust and accurate picture of each student.

I relied heavily on data that was aggregated from the high school transcripts. Transcript data included full coursetaking histories, grades received, and credits earned. NCES compiled and aggregated earned credits into a variety of categories, including identified CTE categories. Based on the number of credits earned in a given CTE category, an individual could be identified as an occupational concentrator. Specifically, NCES identified occupational concentrators as those students who earned three or more credits in a single CTE category. Using this indicator, as well as the number of credits earned in each individual CTE category, I was also able to identify in which occupational category a student concentrated.

Considering the necessity to focus on high school coursetaking patterns, individuals were only included in the final analytic sample if they had full transcript and earning data. To account for missing observations on control variables, I employed multiple imputation to impute 20 additional datasets as recommended in previous literature (Graham, Olchowski, & Gilreath, 2007). It is important to note that I did not impute any CTE coursetaking/concentration variables, or any outcome measures relating to wages. After imputation, the final analytic sample included 13,700 individual observations. All sample sizes have been rounded to the nearest hundred as per NCES guidelines. To ensure sample representativeness, I included student-level weights in my analyses.

Outcome: Hourly Wage. To determine whether higher wages were associated with occupational concentration, I relied on data from the 2016 follow-up survey. I used two separate variables – amount earned and earning unit (e.g., hourly, monthly, annually) – to create a single variable identifying hourly wage for the job in which an individual was employed at the time of the second follow-up. In instances in which individuals reported monthly earnings, I divided that value by 168 (average number of hours worked in a month). For annual earnings, I divided the value by 2000 (average number of hours worked in a year). This resulted in a standardized value for which I could compare across individuals.

Occupational Concentration. The key variable of interest indicated whether a student was identified as an occupational concentrator. As mentioned above, NCES created an indicator of occupational concentration that is defined as having earned at least three credits in an identified CTE cluster area. It is important to note this particular definition is not necessarily identical to other definitions of occupational concentration, though it has been used in previous federal documentation (U.S. Department of Education, 2014). Other definitions of CTE concentrators include a student who completes three courses—not necessarily equivalent to three credits—in a program of study (Dougherty, 2016), two credits in a single CTE program area, or some other state-specific definition (Advance CTE, 2014). Concentration in a specified occupational concentration provides evidence that students are more invested in a given topic of study and have made purposeful decisions to pursue that area of study. For the purposes of this study, however, I relied on the NCES coded definition.

In addition to the variable indicating whether an individual was identified as an occupational concentrator, I was also interested in determining in which CTE cluster an individual concentrated. I therefore relied on the NCES-created variables indicating the number of credits each student earned in each specific CTE cluster. Students who earned three or more credits in a cluster were identified as concentrators in that area. I identified seven unique CTE categories: agriculture and natural resources, applied STEM, business, communications, consumer services, health sciences, and trades. The categories of applied STEM, business, consumer services, and trade represent composite categories made up of more than one CTE cluster. An applied STEM concentrator is an individual who concentrated in either computer and information sciences (CIS) or engineering technology. A business concentration includes concentration in one of business, management, and administration; finance; or marketing. The consumer services concentration is composed of concentrators in either hospitality and tourism or human services. Finally, a concentrator in trades is a student who concentrated in manufacturing, architecture and construction, or transportation and logistics. These categories combine clusters that have some similar attributes, and they have been used in previous work looking at different CTE domains (Plasman, Gottfried, & Sublett, 2019; Bozick & Dalton, 2013; Shifrer & Callahan, 2010).

A final point to mention is that there was very little overlap of concentration across different clusters. A majority of cross-cluster overlap was found within my above identified categories. In cases where there was an overlap between categories, I did perform a robustness check to determine whether there was any undue influence on outcomes from these observations. The results were identical in direction and significance, with no meaningful changes in coefficients observed.

Control Variables. I chose a wide array of control variables based on prior research on CTE high school coursetaking, college enrollment, and labor market participation (Adelman, 2006; Allensworth & Easton, 2007; Bowers, Sprott, & Taff, 2013; Dougherty, 2016; Gottfried, Bozick, & Srinivasan, 2014; Hemelt et al., 2017; Long, Conger, & Iatarola, 2012). Table 1 below presents descriptive statistics for the variables included in my analyses. The results are broken

Table 1
Descriptive Statistics

	No Concentration		Concentration	
	Mean	Std. Dev	Mean	Std. Dev
Ever attended college	0.76	(0.43)	0.74	(0.44)
Socio-demographic data				
Female	0.50	(0.50)	0.44	(0.50)
Underrepresented minority	0.39	(0.49)	0.30	(0.46)
Socioeconomic status	0.11	(0.76)	-0.06	(0.68)
Family Arrangement				
Single parent	0.29	(0.45)	0.29	(0.45)
Both biological parents	0.56	(0.50)	0.55	(0.50)
Other arrangement	0.13	(0.34)	0.15	(0.36)
Academic History and Attitudes				
IEP	0.19	(0.39)	0.25	(0.43)
ELL	0.03	(0.16)	0.02	(0.12)
Ever repeated a grade	0.11	(0.31)	0.11	(0.32)
9th Grade GPA	2.70	(0.93)	2.76	(0.75)
Math score	40.53	(12.01)	39.25	(11.49)
Expect to go to college	0.85	(0.36)	0.82	(0.39)
Sense of belonging	0.09	(1.01)	0.02	(0.98)
School engagement	0.06	(0.99)	0.08	(0.96)
Extracurricular participation	0.68	(0.47)	0.65	(0.48)
Curricular Path				
College-bound	0.24	(0.43)	0.27	(0.44)
College-bound, no computer science	0.25	(0.43)	0.25	(0.43)
Core	0.06	(0.25)	0.12	(0.33)
Core, no computer science	0.05	(0.22)	0.12	(0.32)
Minimal	0.06	(0.24)	0.07	(0.25)
Other pattern	0.34	(0.47)	0.18	(0.38)
School Level Variables				
Percent White students	66.35	(28.42)	71.75	(26.52)
Percent Asian students	4.19	(7.67)	2.21	(3.92)
Percent Black students	13.79	(18.45)	14.04	(18.32)
Percent Latinx students	14.27	(20.21)	11.03	(17.87)
Percent ELL students	5.07	(9.11)	3.61	(6.47)
Percent FRL students	32.26	(25.38)	40.23	(22.03)
School Resources	1.85	(0.85)	1.91	(0.84)
School climate	-0.37	(1.08)	-0.53	(0.93)
Comprehensive school	0.93	(0.25)	0.93	(0.26)
N	11,500		2,200	

Note: all variable are binary unless otherwise noted here - SES (-1.75 to 2.28); Math score (15.86 to 69.93); Belonging (-4.35 to 1.59); Engagement (-3.38 to 1.39); School percentage variables (0-100); School Resources (1 to 4); School Climate (-4.22 to 1.97) out by whether a student was identified as an occupational concentrator. Control variables were predominantly sourced from the base year survey. GPA and curricular path were sourced from the transcript files. Each identified variable is binary unless otherwise noted.

As presented in Table 1, I separated control variables into three general categories: socio-demographics, academic history and attitudes, and school variables. Socio-demographic variables included gender, an under-represented minority indicator (as defined in National Science Foundation, 2017), socio-economic status, and family arrangement. Academic history and attitude variables included individualized education plan (IEP) status, English language learner (ELL) status, an indicator for having ever repeated a grade, 9th grade GPA, a standardized math test score, college expectations, sense of belonging at school, school engagement, extracurricular participation, and indicators for which curricular path a student completed.

The curricular path indicators are worth discussing a bit more closely. NCES created a variable to group students together based on the coursetaking patterns they pursued during high school (Ingels et al., 2015). A college-bound curriculum included the following as a minimum: 4 English credits, 3 math credits, 3 science credits, 3 social studies credits, .5 computer science credits, and 2 credits in a foreign language. A core curriculum was defined identically to a college-bound curriculum without the foreign language component. A minimal curriculum was defined as completing at least 4 English credits, 2 math credits, 2 science credits, and 3 social studies credits. I included these variables as students who completed different paths were likely to have different motivations and aspirations related to post-high school decisions about whether to enter the workforce or pursue higher education.

At the school level, I included variables related to race/ethnicity, ELL and free and reduced lunch (FRL) variables, an indicator of whether or not school resources are an issue at the school (a higher score indicates it is a bigger issue), a measure of school climate, and whether the school is a comprehensive high school (e.g., traditional school, charter school, magnet school, etc.). The school resources measure was based on administrators' responses to a question asking whether lack of teacher resources and materials is a problem at the school. The climate measure was a component variable that takes into account a variety of individual indicators relating to a school's climate (see Appendix A). These variables have been linked to high school completion, which is strongly related to eventual labor market outcomes (Rumberger, 2010).

Across these control variables, students who did and did not concentrate in an occupational area looked largely similar except in a few notable areas. Concentrators were less likely to be female or to come from an underrepresented group. They were slightly more likely to have an IEP. Occupational concentrators also exhibited slightly lower levels of sense of belonging at school. There were also some noticeable differences in curricular pathways. Occupational concentrators were more likely to complete a core curriculum, while non-concentrators complete "other" patterns more often. These differences align with what has been identified in the past (Levesque et al., 2008).

Sub-sample Identification. Considering the possibility that there may be some key differences relating to wages earned after high school between students who participate in postsecondary education and those who do not, I wanted to focus my analyses on a specific group of students for whom learning key technical skills may be particularly beneficial: those students who did not choose to attend college. NCES included a variable in the 2016 follow-up that indicated whether a student ever attended a postsecondary institution for any amount of time, and I focused on this definition because of my particular interest in the role of occupational concentration in secondary school on wages.

Regarding my decision to focus on no college whatsoever, as opposed to a definition such as no college credential, it is possible that a student may have attended a college and completed a single course in a specific occupational area without ever having earned any credential. However, that course may have provided them with additional technical skills, which would make for an unequal comparison with students who only participated in secondary coursework. Additionally, there may be some key unobservable differences between students who never participate in college to any extent and those who do, whether that be in ability, motivation, or some other factor. Therefore, I limited the sample to include only those students who never participated in any postsecondary coursework.

Analytic Approach

Research Question 1. To respond to my first research question asking whether occupational concentrators earn, on average, a higher hourly wage than non-concentrators in jobs three years out from high school, I estimated the following ordinary least squares (OLS) regression model:

$$Wage_i = \beta_0 + \beta_1 OCCUcon_i + \beta_2 X_i + \varepsilon_i.$$

In this model, $Wage_i$ represents the hourly wage earned by individual i in the job held three years out from high school completion. The variable $OCCUcon_i$ identifies whether an individual was identified as an occupational concentrator (i.e., earned three or more credits in a single occupational area during high school). Therefore, the coefficient β_1 is that in which I am most interested. This coefficient can be interpreted as the change in hourly wage associated with occupational concentration after controlling for a wide range of covariates. These covariates are represented by X_i, which is an indicator for a vector containing all the control variable as identified above in Table 1. Finally, the term ε_i represents the robust standard error for the estimation.

Research Question 2. My second research question asked whether there was an observable wage increase for occupational concentrators among students who did not attend college after completing high school. The initial estimation model for this research question was identical to that identified above in research question 1, except the sample was limited to those individuals who did not attend college.

Sensitivity Analysis – PSM. Considering students were not randomly assigned into occupational concentration, it is quite possible that there are some key differences between individuals who did and did not choose to concentrate in an occupational area in high school. To account for potential selection bias amongst this subsample of students, I utilized a propensity score matching (PSM) technique in an effort to compare more similar students. Using PSM, I am able to make a more accurate comparison between individuals who were and were not occupational concentrators in high school.

To perform a propensity score analysis, the propensity for each individual to participate in a given behavior must first be estimated. In this case, I estimated the propensity to concentrate in an occupational area. These propensity scores range between 0 and 1, with 0 indicating no chance of participation, and 1 essentially indicating certain participation. Propensity scores are estimated based on the identified covariates, which should be as comprehensive as possible based on the theoretical motivations (Steiner, Cook, Shadish, & Clark, 2010). Individuals in the treatment group are then compared with those in the control group who have similar propensities to participate. The above list of covariates was chosen based on previous research on career and technical education participation (Aliaga, Kotamraju, & Stone, 2014; Plasman, Gottfried, & Klasik, *in press*; Sublett & Gottfried, 2017). While there are multiple techniques that utilize these computed propensity scores, I chose to utilize inverse probability weighting.

Inverse probability weighting more closely replicates random assignment because each observation is inversely compared to their identified propensity. In other words, individuals in the treatment group with higher propensities should receive lower weights because they were more likely to concentrate based on observed covariates. This helps to emphasize the contribution from students who were more random in their choice (i.e., had a low propensity) to concentrate. For students who did not concentrate, it was the opposite. In other words, for students who did not concentrate, the goal was to emphasize the contribution of individuals with high propensities to concentrate.

The following equations represent how individuals are inversely weighted based on whether they were in the treatment (occupational concentration) or control (no occupational concentration) groups and given their propensity to have actually received the treatment:

Treated: $w_x = \frac{1}{P(T=1|X=x)}$

Control: $w_x = \frac{1}{1-[P(T=1|X=x)]}$.

Here, w_x represents the weight given to each observation based on the inverse of the probability to concentrate given a set of covariates in the case of the treatment group. For the control group, the probability is subtracted from one prior to calculating the inverse. These weights are then included in the final equation estimating the relationship between occupational concentration and eventual wages.

Research Question 3. My final research question asked whether there were differential wage outcomes for non-college going students dependent on the area (e.g., agriculture and natural resources, business, health, etc.) in which they concentrated. This model built off that used to respond to research question 2, but I ran separate models for each area of concentration. Additionally, I utilized a fixed effects model to account for potential unobserved biases. More specifically, I employed school fixed effects to hold all school-level variation (whether observed or not) constant within each school. Through this model, I was able to account for any school-level factors, processes, or initiatives that may have influenced a student’s choice or ability to concentrate in a specific occupational category (e.g., whether a school offered coursework related to an identified category). Therefore, all variation is confined within schools, and any schools without variation in the outcome are removed from the model. The equation below represents the school fixed effects model:

$$Wage_{ij} = \beta_0 + \beta_1 OCCUcon_i + \beta_2 X_i + \gamma_j + \varepsilon_{ij}.$$

Here, the term γ_j serves as an indicator for each school j, with one school removed to serve as the reference. It is important to note that under these models, category-specific concentrators were only compared directly to non-concentrators.

Results

Occupational Concentration and Wage

My first research question asked whether occupational concentrators earned a higher average wage than non-concentrators across the entire sample of individuals. Table 2 presents the findings associated with this question. Ultimately, I found that those individuals identified as occupational concentrators were expected to earn significantly higher hourly wages than their non-concentrator counterparts. More specifically, concentrators earned on average approximately \$0.37 ($p < .01$) more per hour than those students who did not concentrate.

Occupational Concentration and Wage for Non-College Goers

There are numerous potential explanations as to why there may be different impacts related to occupational concentration for students who do and do not go to college. One key consideration is that individuals who do attend college may choose not to pursue simultaneous employment during their education. This could bias the overall estimation of hourly wage in relation to occupational concentration. Additionally, as mentioned above, there may be key unobservable differences between college- and non-college goers. Therefore, my second research question attempted to address this potential issue by asking whether there was a benefit to occupational concentration within the non-college going group of students.

Under my baseline model, I found that the wage return related to occupational concentration was actually larger within the population of non-college goers. Table 3 presents the findings associated with this research question. Overall, the relationship remained significant, and occupational concentration continued to be predictive of an increase in hourly wage (\$0.69, $p < .001$). This result highlights the importance of trying to focus on a comparable group of students.

Sensitivity test. Beyond the concern that there may be issues related to differences based on postsecondary enrollment, there may be observable differences between occupational concentrators and non-concentrators. Using an inverse probability weighting technique, I attempted to account for any potential selection biases and more accurately imitate random assignment. Table 3 below also includes the findings from my inverse probability PSM estimations. Results from this PSM estimation indicated that while I may have been

Table 2
Wage Return on Occupational Concentration

	(1) Hourly Wage	
	Coef.	Std. Err.
Concentration	0.37***	(0.10)
Socio-demographic data		
Female	-1.17***	(0.08)
Under-represented minority	-0.23**	(0.08)
Socioeconomic status	0.03	(0.06)
Family Arrangement		
Single parent	0.02	(0.09)
Other parental arrangment	0.13	(0.11)
Academic History and Attitudes		
Individualized education plan	-0.27*	(0.13)
English language learner	-0.28	(0.26)
Ever repeated a grade	0.07	(0.16)
9th grade GPA	-0.07	(0.06)
Math score	0.01	(0.00)
Expect to go to college	-0.10	(0.13)
Sense of belonging	-0.02	(0.04)
School engagement	-0.00	(0.05)
Extracurricular participation	0.04	(0.08)
Curricular Path		
College-bound	-0.40***	(0.11)
College-bound, no CS	-0.42***	(0.12)
Core	-0.28	(0.15)
Core, no CS	0.14	(0.18)
Minimal	0.00	(0.17)
School Level Variables		
Percent White students	0.01	(0.01)
Percent Asian students	0.02*	(0.01)
Percent Black students	-0.00	(0.01)
Percent Latinx students	0.01	(0.01)
School resource issues	0.02	(0.05)
Percent English language learners	0.00	(0.01)
Percent free or reduced price lunch	-0.00	(0.00)
School climate	-0.03	(0.05)
Comprehensive high school	-0.09	(0.17)
N	13,100	

Robust standard errors in parentheses
* $p < 0.05$; ** $p < .01$; *** $p < .001$

overestimating the concentration effect, students who pursued occupational concentration did still see a significant benefit overall. Specifically, occupational concentrators, within the population of non-college going individuals, were expected to earn \$0.47 ($p < .05$) more per hour on average.

Table 3
Wage Return on Occupational Concentration for Non-college Goers

	(1) OLS Regression Hourly Wage		(2) Propensity Matching Hourly Wage	
	Coef.	Std. Err.	Coef.	Std. Err.
Concentration	0.69***	(0.20)	0.47*	(0.23)
N	3,050		3,050	

Robust standard errors in parentheses
* $p < 0.05$; ** $p < .01$; *** $p < .001$

Category-specific Occupational Concentration

My final research question asked whether individuals who concentrated in different occupational categories saw different benefits in relation to wage outcomes. Recall that the key categories in which I was interested included the following: agriculture and natural resources, applied STEM, business, communications, consumer services, health sciences, and trades. Again, it is worth noting that my analyses compared category-specific concentrators to those who earned no concentration. Additionally, I limited the population to non-college goers.

Table 4 presents the results associated with concentration in each different area. Based on these analyses, there were very clearly differential benefits associated with concentration in different occupational areas. There were three areas that presented evidence of a significant benefit. First, Model (1) indicates that concentration in agriculture and natural resources was significantly associated with an expected wage increase of \$1.80 ($p < .01$) per hour. Model (6) shows a significant expected wage increase of \$1.47 ($p < .05$) per hour for students who concentrated in health sciences. Model (7) presents evidence that concentration in a trade-related occupational area was significantly predictive of an expected wage increase of \$1.46 ($p < .001$) per hour.

Among the non-significant findings were the categories of applied STEM, business, communications, and consumer services. Model (2) focuses on concentration in applied STEM, and while the coefficient was positive at \$1.18 per hour, this was not a significant finding. Similarly, Model (3) focuses on business occupational concentration, and the coefficient of \$0.72 per hour was again nonsignificant. Communications is presented in Model (4) and is associated with a nonsignificant negative coefficient of \$0.16 per hour. The final category, presented in Model (5), is consumer services. Concentration in this area was associated a nonsignificant negative coefficient of \$1.16 per hour.

Table 4
Wage Return on Occupational Concentration for Non-college Goers

	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
	Hourly Wage		Hourly Wage		Hourly Wage		Hourly Wage		Hourly Wage		Hourly Wage		Hourly Wage	
Concentration	Coef	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Ag/Nat Res.	1.80**	(0.55)												
Applied STEM			1.18	(0.64)										
Business					0.72	(0.73)								
Communication							-0.16	(1.08)						
Consumer Services									-1.18	(0.63)				
Health Sciences											1.47*	(0.65)		
Trade													1.46***	(0.40)
N	2,590		2,570		2,540		2,520		2,560		2,560		2,680	

Robust standard errors in parentheses
* $p < 0.05$; ** $p < .01$; *** $p < .001$

Discussion

In this study, I explored the relationship between occupational concentration in high school and hourly wages three years after the anticipated high school graduation date. I was particularly interested in looking at this relationship within the population of non-college going individuals to determine whether high school occupational coursework could be seen as a viable avenue to immediate postsecondary success in the labor market. Additionally, I aimed to identify whether different areas of occupational concentration were differentially predictive of later wages. While there has been previous work on the labor market returns of participation in career and technical education in high school (e.g., Kemple & Snipes, 2000; Bishop & Mane, 2004; etc.), this was the first study to explore how different categories of career and technical education concentration might produce different results.

With the resurgence and rebranding of career and technical education in the United States in recent years, understanding how secondary CTE concentration may predict eventual labor market success is of interest to many different stakeholders: CTE participants, CTE school practitioners, and policymakers in general. There is also a growing recognition that not all CTE should be considered equal. Participation in different clusters relates to different outcomes in different ways (Plasman, Gottfried, & Sublett, 2017; (Plasman, Gottfried, & Sublett, 2019; Dougherty, 2016). Therefore, understanding how occupational concentration in specific CTE clusters relates to labor market outcomes could add a great deal of insight into the nuances associated with CTE participation.

This study provided some evidence that CTE does appear to be meeting one of its stated goals—to help prepare students for success later in life (U.S. Department of Education, 2012). Increasingly in recent years, this success has been focused both on college and career. However, it is important not to lose sight of the substantial population that chooses not to attend college and to focus specifically on career readiness for this population. For this group of non-college going students, CTE may serve a different purpose than for those who go on to college, and it may therefore be even more essential to focus on career readiness as the goal of CTE for this population.

Using information from a nationally representative sample of high school students, I found evidence that occupational concentration is beneficial, on average, across all individuals. This finding aligns with previous studies looking at the relationship between CTE participation and improved labor market outcomes (Dougherty, 2016; Hemelt et al., 2017; Kemple & Snipes, 2000; Theobald et al., 2017; Wagner, Newman, & Javitz, 2015). This is a particularly positive result in light of the increasing amount of funding states have been investing in CTE programming in recent years (McLaughlin, Groves, & Lundy-Wagner, 2018). Increased earnings are associated with increased tax revenues, which can help justify this investment in CTE. Ultimately, then, CTE participation appears to be beneficial both to individual students as well as the society at large, at least in the short term. There is evidence that any wage benefit associated with CTE participation may diminish over time (Bishop & Mane, 2004; Wagner et al., 2015), but it is unclear whether these diminishing returns are consistent for both college and non-college bound youth.

For those students who did not matriculate to postsecondary education after high school, the wage-CTE relationship was even stronger. These results held even after performing more rigorous tests to account for potential selection bias into an occupational concentration. Considering the propensity for individuals to live relatively near the geographical area they grew up, and the notion that the relationship between moving farther from home and education is positively correlated (Molloy, Smith, & Wozniak, 2011), this finding may be even greater motivation for schools to focus on providing non-college going students with the opportunity to pursue an occupational concentration.

Finally, there are very clearly some observable differences in outcomes that are dependent on the CTE category of concentration. This finding highlights the importance of considering CTE not just as a broad umbrella, but instead looking at the categories of CTE separately to determine how, and for whom, each cluster may be most effective. The differences across the categories raise some interesting points. First, in the agriculture and natural resources, and trades categories, perhaps postsecondary education is not as necessary as it may be for careers in different areas. Therefore, secondary CTE concentration in these areas may successfully be providing the skills needed. Second, health sciences, recall, was one of the occupational areas expected to see the most growth in the next decade. The finding that occupational concentration in this area is related to higher wages without participating in postsecondary education may bode well in helping to fill the growing labor market demands in this field. With respect to applied STEM and business, it is likely that these areas may be more apt to require postsecondary training to see true benefits. Finally, for communications and consumer services, it may be the case that these areas do not have a particular need for specific technical skills, thereby potentially devaluing any particular benefit from concentrating in these areas.

The finding that CTE concentration is linked to higher wages in the short-term after high school does provide some evidence that concentrators may be benefitting from participation when observed through the three mechanisms lens. First, it is highly likely that these individuals are obtaining job specific skills through CTE participation that will be of benefit in the labor market – as evidenced through a wage increase. Second, it is also likely these students are gaining additional academic skills, which ultimately may help them complete high school and thereby earn higher wages. Finally, engagement and relevance, which are associated with CTE participation (Gottfried & Plasman, 2018), have been linked with high school completion overall (Rumberger, 2011), which is the first step toward success in the labor market.

Implications

There are a number of implications to consider based on the results of this study. First, there are implications from the standpoint of the individual. Students who earn occupational concentrations do, on average, receive a wage bump. For students who do not plan on attending college, pursuing an occupational concentration may be a viable alternative that does provide at least some advantage in the labor market. However, this decision may come with the caveat that the benefit is limited to certain specific categories of occupational concentration and may diminish over time. Specifically, benefits for non-college going occupational concentrators appear to be limited to the agriculture and natural resources, health sciences, and the trades categories. It is interesting to note that, while there is certainly a growing requirement for at least some postsecondary education in most jobs, a number of jobs in these three categories can be obtained without any postsecondary credentials, and many of them do provide relatively good wages. Additionally, the health sciences and trades categories are those in which there is anticipated to be a shortage of trained labor, particularly for jobs that do not require education beyond high school (Bureau of Labor Statistics, 2013; Giffi et al., 2015). On the other hand, careers in the other categories may require more postsecondary training in order to secure the higher paying jobs. Therefore, it may be necessary for individual students to consider these different paths when identifying an occupational concentration—especially if they do not end up going to college.

A second implication relates to schools and centers that provide CTE training. For these schools, it is certainly a positive sign that occupational concentration is predictive of higher hourly wages. However, it is again necessary to consider the nuance related to the individual CTE categories. In order to ensure students are optimally situated to succeed after high school, schools may want to focus on offering CTE coursework in areas projected to experience the most growth or to see the larges gaps in labor supply. Working with local businesses to identify these areas of need regionally may be one way to even further optimize course offerings.

Finally, CTE policy should continue to focus on the concept of college and career readiness. Here, the emphasis is on the word "and." CTE in high school is being asked to walk a very difficult path in an effort to ensure that coursework is helping prepare students for both college and career. While this is certainly the ultimate goal, it may be the case that college readiness is not identical to career readiness. There are undoubtedly many overlaps between the two, but it may be worth considering how these CTE classes are presented to students. Ideally, CTE coursework will become simultaneously more rigorous and more relevant for all students. Policymakers must continue to work with CTE providers to understand how best to ensure these courses continue to be accessible to all students—both college and career bound.

Limitations and Future Research

There are a few limitations that are worth mentioning here, though these limitations may help to guide future research in this area. First, though the analytic sample is based on a nationally representative dataset, students were not randomly assigned into occupational concentrations. For more definitive answers as to the causal effect of occupational concentration on later wages, future studies may look to rely on random assignment or a natural experiment (i.e., acceptance into a CTE program based on a defined cutoff score). In fact, there are more and more opportunities to make these connections as state longitudinal data systems become more accessible and include more information linking students' academic experiences to labor market and other later in life outcomes.

Second, though the dataset overall includes a quite substantial number of students, disaggregation by student subgroup quickly becomes an issue when breaking out concentration into specific CTE category. Again, with the growing accessibility and detail in state longitudinal data systems, it may now be possible to explore some of these outcomes specifically by student subgroup. Based on language found in the Perkins legislation, key groups of interest would include the following: students with disabilities, economically disadvantaged students, English learners, and homeless students. A better understanding of how CTE concentration is linked to key outcomes across these different populations of students could help identify where additional policy may need to be directed to optimize CTE programming.

Finally, while I was able to identify occupational concentrators through the dataset, it is not possible to speak directly to the course content involved in these various occupational programs. Future work could place greater emphasis on exploring the experiences of students in these programs to shed further light on how the proposed mechanisms mentioned in this study play out in practice. Despite potential limitations, the findings from this current study present promising evidence as to the role CTE participation may play for non-college bound students, combined with results of previous research, an even clearer picture regarding the benefits of CTE participation comes into focus.

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AUTHOR'S NOTES

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Appendix A

Items included in School Climate Principal Component Measure

The School Climate measure was created through a principal component analysis of responses to the following question:

> To the best of your knowledge, how often do the following types of problems occur at [your school]?

- Physical conflicts
- Robbery or theft
- Vandalism
- Student use of illegal drugs while at school
- Student use of alcohol while at school
- The sale of drugs on the way to or from school or on school grounds
- Student possession of weapons
- Physical abuse of teachers
- Student racial tensions
- Cyber-bullying
- Other types of student bullying
- Student verbal abuse of teachers
- Student in-class misbehavior
- Student acts of disrespect for teachers
- Student gang activities

> 1 = Daily
> 2 = At least once a week
> 3 = At least once a month
> 4 = On occasion
> 5 = Never happens