ABSTRACT

DEAL, SARAH, A. The Promise of Free College: Three Essays on Dual Enrollment in North Carolina. (Under the direction of Dr. Audrey Jaeger and Dr. A. Brooks Bowden).

To address the importance of postsecondary attainment in North Carolina, this study is comprised of three essays that focus on the state's dual enrollment program, Career and College Promise (CCP). These studies examine the descriptive outcomes and causal effects of CCP on postsecondary attainment by employing several analytical techniques. The first essay uses a descriptive analysis to examine participation rates disaggregated by student demographics and the two CCP pathways – Career and Technical Education (CTE) and College Transfer Pathway (CTP). This essay uses OLS to describe the relationship between CCP and postsecondary attainment. The second essay uses a regression discontinuity design to examine the effects of participation in CTP on postsecondary outcomes including earning credits that are eligible for transfer to a University of North Carolina system school. This essay leverages the 3.0 weighted high school GPA requirement for students to participate in CTP as an exogenous threshold which creates a treatment and comparison group. The third essay uses the distance from students' high schools to North Carolina community colleges in an instrumental variables approach to estimate the effect of both CCP pathways on postsecondary attainment. Previous research suggests that dual enrollment programs have a positive effect on postsecondary attainment, but results are contextualized based on each state's policy context. By examining the effect of North Carolina's dual enrollment program using multiple methods, these three essays combined provide strong support for the positive effects of CCP on postsecondary attainment. The findings from these studies inform research, policy, and practice concerning the effects of CCP and the extent to which the program is reaching all students.

The Promise of Free College: Three Essays on Dual Enrollment in North Carolina

by
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A dissertation submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

Educational Leadership, Policy, and Human Development

Raleigh, North Carolina
2020

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BIOGRAPHY

Sarah A. Deal is a native of Batavia, New York. Sarah attended a small, rural K-12 school in Elba, New York and benefitted from the strong support of a tightknit community. Attending the State University of New York at Buffalo (University at Buffalo) was an eye opening experience for Sarah where she learned that other incoming first-year students had opportunities to earn college credit in high school and had familiarity with the college environment. Sarah was fortunate to connect with Student Affairs professionals at the University who helped her transition to college and hired her for student leadership positions. This experience taught her that earning college credit early was helpful in transitioning to college as was the compassionate, caring outreach of college professionals.

Sarah completed her bachelor's degree in Communication at the University at Buffalo and went on to attend The Ohio State University earning her master's in Higher Education and Student Affairs. At Ohio State, Sarah had the opportunity to work in Housing and Residential Life with internships in First Year Experience and the Student Union. These experiences taught her about the multitude of ways that colleges and universities work to support diverse students into and through their postsecondary degree. At Ohio State, Sarah learned about the missions of land grant and open access institutions which align with her values of access to higher education for all students.

After graduating with her master's degree, Sarah served as a Community Director at the University of North Carolina at Chapel Hill where she experienced what an elite institution can do to increase postsecondary attainment through scholarships, students supports, and a commitment to high quality education in and out of the classroom. Sarah transitioned into the Coordinator for First Year Experience where she sought to provide these students supports

broadly to new students and create structured learning environments in the residence halls. In addition, Sarah worked to create inclusive environments through developing and assessing a multicultural advisor program aimed at increasing multicultural competency in paraprofessionals.

Her desire to serve students through open access institutions eventually lead her to Central Carolina Community College where she served in roles that provided proactive outreach and intervention to students who were at-risk of stopping out of college. Central Carolina was awarded a research grant and Sarah moved into the role of Project Activity Director for a ten-college, randomized controlled trial, studying the impacts of this proactive outreach model on student success, retention, and completion. Her involvement in this research intensive project led her to pursue her Ph.D. in Educational Policy, Research, and Human Development at North Carolina State University. Her research interests center around what works in higher education for rural students and community colleges with a focus on North Carolina.

Upon graduation, Sarah will continue her employment as Lead Consultant with DVP-PRAXIS LTD. where she works on evaluation and research projects with community colleges and tribal colleges and universities around topics such as holistic student supports, student basic needs, and guided pathways.

ACKNOWLEDGMENTS

Completing this degree would not have been possible without the support and encouragement of many individuals. First and foremost, I would like to thank my husband Wade Deal. One of our secret wedding vows was to never leave the other person hanging (in a high five) and I look forward to high fiving you over this accomplishment. You have provided endless support and encouragement throughout this pursuit and have been a listening ear, a shoulder to lean on, and importantly a willing editor. I look forward to spending more quality time together and supporting you as you pursue your dreams and we create our future together.

To the phenomenal and inspiring women of my committee Dr. Audrey Jaeger, Dr. A. Brooks Bowden, Dr. Anna Egalite, and Dr. Lisa Chapman. Each of you have profoundly influence me personally and professionally, in ways that you are likely unaware. I sincerely hope this dissertation is a chapter in a long relationship together. Dr. Jaeger, you have been an advocate for me since before I was accepted to this program. You saw something in me that I did not recognize in myself and pushed me to work hard, all while supporting me. Your values embody the work you do and the life you lead, serving as a role model for how I want to live my professional and personal lives. Your contribution to me as an individual and to community college professionals in the state of North Carolina cannot be overstated. Thank you for being you and may your work continue to grow and impact those of us lucky enough to know you.

Dr. Bowden, you have always pushed me to excellence and hold me to high standards. Your knowledge and expertise in research are matched only by your passion for ensuring that your work has a positive impact. Thank you for the countless hours of methodology coaching, from Quant. II through today, and for the hundreds of emails back and forth as you supported me

in pursing this three essay dissertation, however lofty the goal. The University of Pennsylvania is fortunate to have you, and may you continue to mentor and grow strong graduate students.

To Dr. Egalite, your Quant. I class was the very first time in my life when understanding and conducting quantitative research felt achievable. You have an incredible talent for teaching complicated methodology in a way that is both rigorous and consumable. All of this is highlighted by your fantastic sense of humor. To Dr. Chapman, while we have been "avoiding" each other since my first position with the community colleges, I prefer to think about it as following in your great footsteps. You are a tireless advocate for students and for community colleges. The way you analyze complicated problems, pulling in pieces of information from many sources is a lesson I hope to continue learning from you.

Thank you to my colleagues at the North Carolina Community College System Office for providing me the inspiration and data to conduct this research. Bill Schneider, Dr. Ashley Sieman, Katie Bao, and Bob Hemond, you have each provided me guidance, feedback, and insight. I miss sharing cube space with you all and hope we can continue to partner. To Susan Barbitta, you are superwoman to me. The way you engage multiple perspectives to change systems that will help students is inspiring on top of your constant thoughtfulness for me as an individual. To my colleagues at Central Carolina Community College, in particular Dr. Brian Merritt who has shown me how much of an impact we can have every day in the lives of students. To the countless other colleagues and professionals with whom I have the honor to work, thank you for the work you do.

To my NC State cohort members who have been amazing at supporting each other through all of the life and school events we experience. It is an honor to graduate from the same program as you and more so to call you friends. To my Ohio State HESA cohort, thank you for

many years of personal and professional friendship especially for frequent jokes about famous theorists who shall not be named. This is a conversation occurring as I write this acknowledgement.

To my family, John, Marybeth and Timothy Hoffarth, Mary Walker, Jerry and Sharon Deal, and Krista Phillips. Thank you for understanding my periods of frequent communication and times of long silence. Your love and support have lifted me up and helped me achieve this goal. Thank you to Mary Schmid-Carter who has answered endless CCP questions, is like a sister to me, and often a roommate, and who has had my back since we were assigned to be "BFFs" as Orientation Leaders, I could not have accomplished this without you. Last but not least, to my tribe of fierce friends who have provided fun interludes throughout this program including Josh Alexander, Rachael Anderson, Sarah Brudz, Sydney Darden, Ciji Heiser, Melissa Pannell Hickam, Christie Hickey, Erin Kwiatkowski, Colleen Mihalic, Kristy Newitt, Nate Peterson, Rebecca Riner, Ashley Scofield.

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INTRODUCTION

The value of a college degree has increased exponentially over the past several decades and is seen by many as a prerequisite to jobs that earn livable wages (Baum, Ma, & Payea, 2013; Jackson, 2014). Additionally, the buying power of a high school education is no longer enough to guarantee a person's long-term financial security (Bailey & Karp 2003; Baum et al., 2013; Jackson, 2014). Despite this increased buying power, enrollment in institutions of higher education are declining (Baum et al., 2013). These factors combined with increased demand for a skilled labor market leave policymakers and educators searching for solutions (Jackson, 2014). One promising solution that has emerged over the past few decades is dual enrollment. Dual enrollment (DE) programs have been gaining traction throughout the United States over the past two decades as a tool for supporting the transition between high school and college and therefore a promising practice in increasing the number of students earning a college degree (Tobolowsky, 2016).

DE in North Carolina, called Career and College Promise (CCP), is one of the mechanisms by which practitioners and policymakers seek to address the high school-college divide (Bailey & Karp, 2003). Implemented in 2012, North Carolina implemented CCP which is a comprehensive DE program because it offers both college transfer (CTP) and career and technical pathways (CTE). College transfer pathways include general education courses such as English, math, arts and humanities whereas career and technical pathways are meant to lead to an industry recognized certificate or credential. CCP provides free college tuition for eligible high school juniors and seniors (and some freshmen and sophomores). DE is an opportunity for high school students to earn college credit that applies toward both their high school diploma as well as an associate's degree (Tobolowsky, 2016). Earning college credit earlier in a student's

academic career is important as the value of a college degree has increased over time (Jackson, 2014). When this credit is earned during high school, students are able to "try on" college and become socialized to the norms and expectations of the college experience (Karp, 2012). The ability for students to have essentially a dress rehearsal for college is particularly impactful for underrepresented students who don't often gain this cultural capital from parents or family members (Bailey & Karp, 2003; Karp & Hughes, 2008). Trends across the United States show that despite reform efforts, historically underserved students are still disproportionately accessing college (Karp, 2012, Tobolowsky & Allen, 2016). It is imperative to examine structures, programs, and curricula to bridge this high school to college divide.

CCP is funded by the North Carolina State legislature (North Carolina State Law, 2011). CCP includes the opportunity for students to take classes that transfer to the 58 North Carolina Community Colleges and the 16 University of North Carolina System schools. Most commonly, DE classes under CCP are offered in partnership between the high schools and local community colleges. During the academic year 2010-2011, 71% of students in a DE program were enrolled at a local community college compared to 21% of students enrolled through public 4-year colleges and the remaining students at private colleges (Marken, Gray, & Lewis, 2013). DE classes can be taken online, in person at the high school, or in person at the partner college. CCP covers the cost of tuition and fees for high school students who participate, making this a model, college access program to bridge the high school-college divide (Ladd & Goertz, 2015).

Much of the research on the effectiveness of DE nationally has been descriptive in nature that discusses which students participate in DE and their educational outcomes (Ladd & Goertz, 2015; Speroni, 2011a; Tobolowsky and Allen, 2016). Included in these outcomes are access to higher education, success in coursework, credential attainment, and labor market outcomes.

Research on DE has largely shown that the effects of DE on postsecondary attainment are positive (Karp, 2012; Speroni, 2011a; Struhl & Vargas, 2012; Wang & Wickersham, 2014). Most of these studies use administrative data and control for potential confounding variables. Analyzing data without experimental or quasi-experimental methods introduces the risk that results will overestimate the effect of DE on postsecondary attainment because there are inherent and unobservable reasons students self-select into DE. A few quasi-experimental studies have been conducted and show smaller effects or null effects (Speroni, 2011a; Struhl & Vargas, 2012). Additional quasi-experimental research is needed to understand the effects of DE in differing contexts particularly at the state level where investment in DE programs is high.

This dissertation seeks to contribute to previous research by presenting three approaches to answer the question *What is the relationship between dual enrollment in North Carolina and postsecondary attainment?* This dissertation is comprised of three essays where each essay takes a different approach to understanding what the postsecondary outcomes for students are who participate in CCP. Together, the three essays will provide a strong argument about how CCP is affecting postsecondary attainment in North Carolina. This dissertation begins with an introduction to each of the three essays and then presents three essays each using a different methodological approach. The first essay presents a descriptive analysis of the students who are enrolled in CCP compared with the broader population in North Carolina and nationally. A descriptive analysis provides an understanding of the types of students who may benefit from CCP in the context of DE nationally. The next two essays employ quasi-experimental designs to carve out groups of CCP students and comparison students in order to understand the effect of CPP on postsecondary attainment and completion. In particular, the second essay uses a Regression Discontinuity (RDD) design to look at the effect of CCP for students on a college

transfer pathway (CTP) where students take general education courses intended to transfer to a 4-year college. The RDD design uses the 3.0 weighted high school GPA required to participate to compare students just above the threshold who participated in CCP with students just below the threshold who did not participate. The third essay uses the variation in distance to a North Carolina community college as a natural randomizer of students into treatment and comparison groups that can be used as an instrument, allowing examination of postsecondary attainment outcomes for the overall CCP population and a subgroup analysis of students in the CTE pathway.

This conversation about the impact of CCP is of interest to students and parents. Students and parents invest significant time and financial resources into participation in CCP with the hope of long-term college enrollment, completion, and labor market benefits. It is also of interest to policymakers and college administrators who are funding and delivering this opportunity without a full understanding of CCP's impact on postsecondary attainment in North Carolina. These three essays combined will tell the story of the impact of CCP on postsecondary outcomes for DE participants in North Carolina.

Essay One

Trends across the United States show that despite reform efforts, historically underserved students are still disproportionately accessing college (Bailey & Karp, 2003). Dual enrollment (DE), called College and Career Promise (CCP) in North Carolina, is one of the mechanisms by which practitioners and policy makers seek to address the divide between high school and college (Karp, 2012; Ladd & Goertz, 2015; Tobolowsky, 2016). For the purposes of this essay, DE is defined as a high school student who takes college coursework earning college credit while simultaneously fulfilling graduation requirements for high school graduation.

This first essay provides a review of DE literature and Becker's (1993) Human Capital Investment theory which says that investment in the abilities of people will lead to increased productivity and earnings (Becker, 1993). To further understand CCP, a descriptive analysis will be presented about which students are participating in the program and how these students compare to the broader population of juniors and seniors in North Carolina and trends nationally.

Through participation in DE, students learn the social and academic skills needed to be successful in college prior to enrolling in a traditional postsecondary institution (Karp, 2012). Overall the social and cultural preparation students receive through DE indicates improved student outcomes upon enrollment in postsecondary education (Karp, 2012). Wang, Chan, Phelps, & Washbon (2015) show promising evidence that students who are dual enrolled have increased academic momentum; defined by increased credits attempted, higher GPAs, lower time-to-degree, higher retention rates, and higher completion rates. To understand how DE programs increase student educational outcomes, I lean on the premise of Human Capital Investment theory suggesting that early investments made in college coursework for high school students will lead to increased degree attainment and long-term increases in earnings (Becker, 1993). There are some concerns that high school students lack the maturity to succeed in college level coursework or that the content of the courses lacks the same rigor or quality as a course offered to postsecondary students but little research has been conducted in these areas and there is not strong evidence to support these concerns (Tobolowsky & Allen, 2016). This essay descriptively explores postsecondary outcomes for student's participating in North Carolina's CCP program.

Essay Two

Dual enrollment (DE) in North Carolina, called Career and College Promise (CCP) is an opportunity for high school students to earn college credit in courses that also count for high school graduation requirements (North Carolina State Law, 2011). There are two broad pathways within CCP in which students choose to participate, college transfer pathway (CTP) and career and technical education (CTE). In CTP, students take general education courses including math and English meant to fulfill general education requirements at North Carolina community colleges or University of North Carolina System schools (Coltrane & Eads, 2018; Eads, 2018). The admission criteria for students to enroll in CTP is as follows: the student must be a high school junior or senior, have a high school weighted GPA of 3.0, and demonstrate college readiness in math and English (North Carolina State Law, 2011). The CTE pathways are meant to lead to an industry recognized certification that a student can use when seeking employment.

Regression discontinuity design (RD) leverages a threshold that must be met for participation in a program or treatment to compare participant observations above and below this threshold. Participants just above and just below the threshold are likely to have similar characteristics with the difference that some are able to participate in the program. This study uses a fuzzy RD analysis to compare students just above the 3.0 GPA threshold who participate in CTP[1] to students just below the 3.0 GPA threshold to address the following research questions: *What is the effect of CTP on postsecondary enrollment? What is the effect of CTP on number of postsecondary classes taken? What effect does participation in CTP have on student persistence in college? What effect does participation in CTP have on student's college*

[1] CTE pathways have a provision that allows exceptions to the GPA requirement therefore this essay examines only students in CTP (North Carolina State Law, 2011).

credential completion? What is the effect of participation in CTP on number of classes transferred to a UNC school?

The GPA threshold is a determinant for students' participation in CTP. Participation in CTP is exogenously determined by the GPA threshold and allows the postsecondary outcomes of participants and nonparticipants to be compared to each other through a fuzzy RD design. This study uses a fuzzy RD because the data show that there are students participating in the CTP pathway who have less than a 3.0 GPA, fuzzy RD controls for cases where there is not compliance with the assignment threshold. Using observational data introduces concerns about selection bias and omitted variable bias into estimates of program effects. Fuzzy RD narrows the dataset to a treatment and comparison group that are determined exogenously due to a threshold requirement (GPA) that the participants themselves cannot manipulate. When students who have similar GPAs are split into these two groups, one that is able to participate in CTP, we can compare the outcomes of the two groups to each other because this threshold mimics random assignment. Random assignment to a treatment removes concerns about bias, therefore using fuzzy RD allows for causal inferences to be made about the impact of CCP on postsecondary attainment for the group of students around the threshold (i.e. local average treatment effect (LATE)).

Essay Three

Participation in Career and College Promise (CCP) is associated with increased retention, credential completion, and lower dropout rates (Coltrane & Eads, 2018; Eads, 2018). In a presentation to the North Carolina joint legislative committee by the project leads from the Department of Public Instruction (DPI) and the North Carolina Community College System (NCCCS), data from the NCCCS Research and Performance Management office have shown

that students in CCP have higher GPAs and course success rates (Coltrane & Eads, 2018; Eads 2018). While these outcomes are positive, North Carolina, similar to many states, has selection criteria that qualify juniors and seniors to be eligible for CCP. The selection criteria include student's high school GPA and demonstrated college readiness in math and English both of which are predictive of success in college (Bailey, Smith Jaggars, & Scott-Clayton, 2014; North Carolina State Law, 2011). These selection criteria prevent all students from participating in CCP, creating bias in a naïve OLS estimate that would likely overestimate the causal effect of CCP on postsecondary attainment due to selection bias. Further confounding inferences about the impact of CCP is a student's choice or self-selecting to participate in the program. When participants self-select into CCP it is difficult to understand if the outcomes they experience are due to the program or other factors that influence a student's choice to participate such as motivation, social, or cultural capital. Self-selection brings into question if CCP is increasing access to college, or if it is providing a new way to serve students who would have attended college anyway.

This study uses an instrumental variable (IV) analysis to measure the local average treatment effect (LATE) of participation in CCP (both CTP and CTE pathways) on postsecondary attainment. IV predicts the LATE as opposed to the average treatment effect because it narrows the sample from all treatment and comparison students to those whose participation is predicted by an exogenous instrument. This study predicts the LATE of CCP on postsecondary attainment as predicted by the distance (instrument) from their high school to the local community college. Additionally, given that essay two focuses on the CTP pathway, essay three examines outcomes for the subgroup of CTE students. The comparison group will be composed of students who do not participate in CCP as predicted by distance. Students who are

included in the sample are compliers – or students who comply with the treatment condition to which they were assigned (Dunning, 2012).

Through an IV analysis, the following research questions will be answered: *What is the impact of CCP on postsecondary enrollment? What is the impact of CCP on number of credits earned? What is the impact of CCP on semester to semester student persistence? What is the impact of CCP on postsecondary credential completion (inclusive of certificates, diplomas, and degrees)? How do postsecondary attainment outcomes for CTE students compare to the overall CCP population?* Using the distance to a community college as a way to determine a treatment group of CCP participants and a comparison group, this study will examine the causal effects of CCP on postsecondary outcomes.

This study uses an instrumental variable technique to control for these unobserved variables and self-selection that bias the naïve results of CCP's impact on postsecondary attainment and therefore our ability to make causal claims. I will use distance of a student's high school to the local community college as an instrument to predict a student's participation in CCP. Participation in CCP is a student decision because the program is offered in all high schools. In North Carolina there is a community college within a 30-minute drive from more than 99% of residents within the state (NCCCS, 2019). The equi-distant distribution of community colleges results in essentially random variations in the distance from any individual's home (or school) to the nearest community college. The proximity of a community college has been shown as an important predictor of community college enrollment (Dee, 2004; Card, 1995). I use this distance as an instrument to remove selection bias in earlier estimates and to causally examine the effects of CCP on student outcomes. Other studies have used distance as an instrument in similar way (Card, 1995; Dee, 2004; Kane and Rouse, 1993; Mallar, 1979; Xu &

Smith Jaggars, 2013). This instrument will serve as an exogenous and natural randomizer to carve out a subpopulation of participants and nonparticipants where unobserved confounding variables are controlled for (Dunning, 2012). These predicted estimates of participation in CCP will then be used to predict postsecondary attainment outcomes and draw causal links between CCP and postsecondary attainment (Dunning, 2012).

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ESSAY ONE: A DESCRIPTIVE ANALYSIS OF DUAL ENROLLMENT IN NORTH CAROLINA

Introduction

High school graduates are faced with the reality that well-paying jobs are only available to them if they have earned a college degree due to the value of a college degree increasing over the past several decades (Baum, Ma, & Payea, 2013; Jackson, 2014). Despite this increased value of a college education, nationwide trends point to declining college enrollment (Ladd & Goertz, 2015). In particular, low-income, first-generation, and historically underrepresented students are disproportionately accessing college at lower rates (Baum et al., 2013; Ladd & Goertz, 2015). A potential cause of the divergent trend between the value of college and declining college enrollment is a divide between high school and college. A few factors that play a role in this divide include students' differing exposure to a college-going culture in their high school, student academic readiness to succeed in college-level coursework, and federal policies such as No Child Left Behind (NCLB) and Every Student Succeeds Act (ESSA) aimed at helping students succeed (Ardoin, 2017; Karp, 2012).

High school curriculum is often designed to aid student learning through a developmental approach based on student maturity level (Tobolowsky & Allen, 2016). However, students who have only experienced high school curriculum and subsequently attend college are faced with different academic expectations that are not as developmental. Practice with college coursework and academic expectations can help build confidence and maturity in students (Tobolowsky & Allen, 2016). When students are exposed to college-level courses in high school they are introduced to rigorous curriculum that will prepare them academically for college (Bailey & Karp, 2003; Karp & Hughes, 2008; Tobolowsky & Allen, 2016). Students who have

exposure to the campus environment can anticipate challenges and have a more realistic understanding of the college culture (Bailey & Karp, 2003; Karp & Hughes, 2008; Tobolowsky & Allen, 2016). Early exposure to college through dual enrollment (DE) means that when students enroll in college after high school graduation, they can have a more seamless transition to the college environment both academically and socially (Karp, 2012).

Policies such as the NCLB Act and the subsequent ESSA were aimed at setting standards for K-12 curriculum so that all students had the opportunity to be successful and that schools were held accountable for the performance of their students (McGuinn, 2016). Though NCLB and ESSA aim to increase high school graduation rates, there is not a corresponding trend of increased college enrollment (McGuinn, 2016). Integrating academic and social skills needed for a successful transition to college with the curriculum set by these K-12 policies leads to increased college enrollment by bridging the K-12 and college educational systems.

On the postsecondary policy and research agenda, there is a focus on mechanisms by which more students can enroll in and complete a college education. For example, in 2009, in a joint session of Congress, President Obama proposed a challenge for the United States to have the highest proportion of college graduates by 2020 ("Remarks of President Barack Obama in the Address to Joint Session of Congress," 2009, n.p.). This call to action has resonated with state policy makers who are searching for solutions to elevate higher education in their educational systems (Pretlow & Washington, 2014). One of these solutions is DE where a student takes a college class that fulfills graduation requirements for high school (Karp, 2012; Tobolowsky & Allen, 2016). Versions of DE are also called dual credit, concurrent enrollment, and joint enrollment. In response to President Obama's charge and to trends of declining enrollment, states have made DE a priority (Pretlow & Washington, 2014).

Other initiatives that attempt to address the social and academic divide between high school and college include Advanced Placement (AP) and International Bachelorette (IB), both of which provide high school students exposure to advanced coursework in an effort to spur student momentum toward college (Tobolowsky & Allen, 2016; Speroni, 2011a). Enrollment in these programs represents a small portion of the high school population and is not uniformly offered at all high schools (Tobolowsky & Allen, 2016). In comparison to AP and IB programs, DE is seen as a promising mechanism to increase access for groups of students who are not traditionally represented in higher education. In 2013, 82% of all United States high schools offered DE and over 2 million students participated (Tobolowsky & Allen, 2016). This is compared to AP exam offerings which cover only 67% of high schools (Tobolowsky & Allen, 2016; Speroni, 2011a). Further in 2006, IB programs were offered at less than 3% of high schools in the United States (Tobolowsky & Allen, 2016). Not only is DE more widely offered in high schools across the country, it also offers students the opportunity to earn college credit over the course of a semester instead of relying on a one-time test at the end of the course as in the case of AP (Tobolowsky & Allen, 2016). While DE has the potential to open access to underrepresented students, many states have admissions requirements that cause the program to limit enrollment to higher achieving students in similar ways that occur with AP and IB programs (Tobolowsky & Allen, 2016).

Dual Enrollment in North Carolina

In North Carolina, under the program called Career and College Promise (CCP) the legislature funds DE tuition for high school juniors and seniors, notably eliminating tuition costs for all participants (North Carolina State Law, 2011). The goal of CCP was to increase the number of completed degrees for North Carolina citizens to fill an anticipated labor market gap

(North Carolina State Law, 2011). The long-term goal is to keep more talented people in North Carolina and in jobs that earn citizens family sustaining wages (North Carolina State Law, 2011). In turn, having more people in better paying jobs contributes to a higher tax base and should increase revenue for the state above and beyond the cost of the program (Baum et al., 2013). Colleges in the state also seek to benefit from the enactment of this law by way of increased enrollment given declining trends.

Policymakers have invested time and resources into the CCP program with the goal of increasing access to education and helping North Carolina residents earn more degrees to participate in the workforce and earn a family sustaining wage. In 2016, the North Carolina legislature invested approximately $111 million into CCP through the North Carolina Community College System (Coltrane & Eads, 2018; Eads, 2018). Without the state's investment into CCP it is unlikely that the program would reach many students. We know that of the students in 2016-2017 who were enrolled in CCP, 59% were female, 41% male, 62% were White, 14% African American/Black, 12% Hispanic, 2% Asian, and 1% American Indian/Alaskan Native. However, we do not yet know if these resources are reaching students who hadn't considered college an option for them without CCP, or if CCP is serving as a mechanism to serve students who would have gone to college anyway.

To sustain this policy and funding stream long-term, we will need to know who CCP reaches and if postsecondary outcomes are improved for those students. It is also important to know if DE programs like CCP reach growing populations in the United States who are most in need of services, such as the Latinx population. North Carolina's community colleges serve as a national benchmark due to the large number of students served by the system (nearly 700,000)

and the diversity of very rural and urban communities (Bill and Melinda Gates Foundation Website, 2019; North Carolina Community College System [NCCCS] Office Website, 2019).

A descriptive analysis of CCP contributes to a larger question of: *What is the relationship between dual enrollment in North Carolina and postsecondary attainment?* To answer this question, this paper describes student participation in, and the associated outcomes targeted by CCP. The sample in this study is comprised of high school juniors in North Carolina during the 2015-2016 school year and follows them through the 2018-2019 academic year. Students will be followed by leveraging the state's new longitudinal data system, P-20, through completion of an associate's in any of the 58 public North Carolina Community Colleges. Participants in CCP will be descriptively compared to non-participants and to DE enrollment trends nationally.

Theoretical Framework: Becker's Human Capital Investment Theory

This section provides an overview of a Becker's Human Capital Investment (1993) which serves as the foundational theoretical framework for this paper and helps us understand how DE can be a mechanism to affect postsecondary attainment. Next I explore the divide between high school and college curriculum that contributes to disproportionate participation in higher education as well as solutions to bridge this divide. DE is one solution to bridge the divide between high school and college and this section will explore the posited benefits and challenges of implementing DE for individuals, colleges, and society. Finally, I discuss North Carolina's DE program – CCP – as a way in increase postsecondary attainment in the state.

Becker's (1993) theory on human capital shows that investments in education will result in increased earnings on average. DE invests in students early by providing them support while in high school. The goal is to increase academic momentum, degree attainment, and lifetime earnings. Increased earnings allow people to experience economic mobility and to provide for

their families in a sustainable way (Becker, 1993). This theory has come under criticism where skeptics claim that earning a college degree is more of a signal about talents and abilities rather than an actual increase in a person's productivity (Weiss, 1995). While signal versus increased productivity can be debated, the reality is that on average people with a college education earn more over their lifetime than people without college (Weiss, 1995).

A key component of this theory is that individuals weigh decisions about investing their time into education, versus the opportunities they will have to forgo, referred to as opportunity cost (Becker, 1993). When students graduate from high school they are faced with the choice of investing time and sometimes money into college or entering the workforce and earning money right away. Becker (1993) discusses that students and families making the choice to attend college after high school, weigh the benefits of a college education (job stability and higher wages) with the opportunity cost of not entering the workforce directly. Even though it may be known that attending college will lead to a higher paying job later on, for some it is necessary to earn money sooner and the opportunity of college isn't worth the upfront investment.

States like North Carolina are investing in human capital by paying the cost of tuition for students to attend college through DE. When the legislature pays the cost of college tuition and students can earn college credit while in high school, the opportunity cost is lessened. This increased investment and reduction of opportunity cost removes the largest financial barrier to college – tuition – which should increase participation in the program. However, there are additional costs to attending college through DE such as college fees, textbooks, supplies, and transportation. Some colleges and school districts are finding ways to mitigate these additional costs by waiving fees, purchasing textbooks and supplies, and providing transportation to encourage more students to participate.

North Carolina's investment into DE also reduces the time it takes for students to earn a degree. The opportunity cost of time is alleviated through DE because students remain on track to graduate high school while simultaneously earning college credit. Using Becker's (1993) theory, reduction in the opportunity costs to participate, both financial and time, predict an increase in postsecondary attainment for CCP participants. Despite addressing the opportunity costs, and despite students and families understanding the value of higher education, underrepresented students continue to participate at lower and disproportionate rates. If underrepresented students in North Carolina are participating in DE at disproportionate rates, then the investment into human capital is only partial which leaves opportunities to improve on this investment for individuals and for society by getting more people enrolled.

Dual Enrollment Research

Organizations such as the Community College Research Center (CCRC) and Jobs for the Future (JFF) have conducted research on the impact of DE. Most previous research is focused on state level analysis (An, 2013a, 2013b; Pretlow & Washington, 2014; Speroni, 2011a; Struhl & Vargas, 2012; Wang, Chan, Phelps, & Washbon, 2015) or on how DE policy differs nationwide (Fink, Jenkins, & Yanaguira, 2017; Pierce, 2017; Tobolowsky & Allen, 2016). Policy comparisons across states include descriptive analysis of admissions requirements, course offerings, and funding models (Pierce, 2017). State-level analysis describes funding mechanisms for DE ranging from tuition being fully subsidized by the government to hybrid approaches where costs are shared to families fully funding the cost associated with participation (Pierce, 2017; Zinth & Barnett, 2015). Funding varies across states and sometimes across school districts. In some cases, colleges pay the tuition, sometimes school districts pay, and sometimes students and families pay (Pierce, 2017). There are other costs to attendance such as books, supplies and

transportation; some school districts pick up this cost and some pass it along to the student, but these costs can be substantial especially for science, technology, engineering, and math courses (Pierce, 2017). Other research compares states such as Indiana, Tennessee, and Louisiana and focuses on how DE is included as a performance-based funding strategy (Struhl & Vargas, 2012). Fink et al. (2017) compare outcomes across states for DE students but do so with observational data.

Gaps in the research on DE include mechanisms such as admissions requirements, course rigor, and course delivery method by which DE effectively prepares students for college. Admission requirements for students to participate in DE signal a baseline level of preparedness to take college-level courses as a high school student. There is some concern that teaching college curriculum to high school students will result in decreased rigor of the material or that the admissions standards are too stringent and do not allow DE to open access as intended (Tobolowsky & Allen, 2016). Additionally, part of the way DE prepares students for college is through social norming (Karp, 2012). DE courses are delivered in many formats and there are concerns that while online courses introduce students to college content, students are missing out on the social opportunities or introduction to college expectations that would occur if the class was taken in a traditional format (Tobolowsky & Allen, 2016). Research on the course delivery method is lacking, specifically in how online courses affect student outcomes when compared to traditional courses or hybrid (Tobolowsky & Allen, 2016; Speroni, 2011a). Observing postsecondary outcomes such as course success rates and GPA can point to how well participation in DE classes prepares students for college level work.

To understand how DE impacts postsecondary outcomes for diverse groups of students, rigorous research that accounts for state specific context is important given that policies and

implementation vary (Pierce, 2017). A few quasi-experimental studies have been conducted to look at the impact of DE on subsequent participation in college using data from Texas, Florida, and Texas (An, 2013a, 2013b; Speroni, 2011; Struhl & Vargas, 2012). These studies all focus on individual state level analysis and due to variations in DE policy cannot be easily applied in other state contexts such as North Carolina. Additional research at a national level has been conducted about participation rates, enrollment trends, and descriptive outcomes for DE participants (Fink et al., 2017). This descriptive information is helpful in informing which students are being served by DE, but to fully understand who DE is not reaching we need to understand who is not participating and what state specific policy mechanisms are influencing this lack of participation.

Attempts to examine outcomes more rigorously when using observational data have moved from use of descriptive information and regression to propensity score matching. Although there are studies that use propensity score matching (An, 2013a; Struhl & Vargas, 2012) and one study that uses regression discontinuity (Speroni, 2011a), there is a need for even more rigorous research designs to further support or debunk results. Alternate research designs such as randomized controlled trials, regression discontinuity design, difference-in-difference, and instrumental variables should be considered where there is a predetermined treatment and comparison group allowing for stronger causal claims to be made. Additionally, for underrepresented students, propensity score matching may drop participants from analysis due to lack of a suitable match (Silberzahn et al., 2018). While dropping participants is a testable limitation of propensity score matching, other quasi-experimental methods include underrepresented students in the analysis which allows us to examine the outcomes for these students and more fully understand the impact of DE on postsecondary attainment.

Importantly, there is little research about how DE impacts underrepresented students and how the benefits of DE are or are not received (Taylor, 2015; Tobolowsky & Allen, 2016). When research is conducted nationally, these data are not compared to states in the context of their local policy, making it difficult to understand specific state context (Fink et al., 2017). There are studies that have documented the variety of state policies intended to actually increase underrepresented student participation in DE, but these studies have not looked at the ability of a state to increase enrollment to meet these participation goals (Karp & Hughes, 2008).

Longitudinal data are needed to capture the full educational experience as well as factors that influence underrepresented students' participation in DE and postsecondary attainment. Studies have focused on states with existing longitudinal data systems but due to the policy differences between states, it is difficult to generalize findings from other states with differing policy levers to how CCP affects postsecondary outcomes in North Carolina (An, 2013a, 2013b; Speroni, 2011; Struhl & Vargas, 2012; Wang et al., 2015) In many cases we lack the data systems to follow students longitudinally to understand if the programs are effective (Karp & Hughes, 2008; Pretlow & Washington, 2014).

This study will leverage a new North Carolina longitudinal data system (P-20) to understand the relationship between DE on postsecondary attainment for disaggregated by gender, race/ethnicity, and students participating in free and reduced lunch. Policymakers are investing time and resources into creating systems that educate students from Kindergarten through a college degree, but little is known about how these policies impact student outcomes (Tobolowsky & Allen, 2016). In particular, policymakers in North Carolina have invested millions of dollars in providing tuition-free DE for students and previous research hasn't been contextualized to the CCP policy in North Carolina.

High School-College Divide. Data point to a divide between the number of students graduating high school and those who are successful in college. Nationally the six-year college graduation rate is 55% but for underserved populations the disparities are greater (Taylor 2015; Tobolowsky & Allen, 2016). For example, in a study that looked at bachelor degree completion rates 8 years post-high school, White students earned their degree at 39.8% compared to 19.8% for African American/Black students and 18.7% for Hispanic students (Lauff & Ingles, 2014). Additionally, students in the lowest income quartile earned their bachelor's degrees at a rate of 14.5% compared to students in the highest income quartile who earned their degrees at 60.7% (Lauff & Ingles, 2014). Rates are even lower for part time students and students at community colleges (Karp, 2012). These dismal graduation rates are alarming given that students who enter college presumably begin with the goal to complete their degree and the disparities between groups are substantial.

Additionally, historically underrepresented groups of students, such as students of color, continue to experience disproportionate access to college (Tobolowsky & Allen, 2016). For example, in a study looking at the Educational Longitudinal Survey it was found that while overall college attendance has increased from 50.7% in 1975 to 70.1% in 2009, the rate for African American/Black students is only 62.6%, for Hispanic students 61.6%, and for low-income students 54.1% (Taylor, 2015). Some of the hypothesized reasons for these outcomes include student placement in remedial education and student lack of "college knowledge," which can result in barriers to entry, progression, and completion (Karp, 2012; Tobolowsky & Allen, 2016). States are looking for solutions that bridge this high school to college divide, including where curriculum is aligned, and DE offers this opportunity (Taylor 2015; Tobolowsky & Allen, 2016).

Remedial Education. Many students graduate from high school and attend a community college or less selective school only to find they are placed in remedial or prerequisite courses before they are allowed to enroll in math and English courses that count toward their degree (i.e. gateway course). Entering American community college students are placed into remediation at a rate of 75% compared to 50% of students at less selective colleges who are placed into remediation (Bailey, Smith Jaggars, & Scott-Clayton, 2014; Tobolowsky & Allen, 2016). Students in remedial education often do not make it into their gateway courses, instead taking and retaking remedial courses, giving up in favor of registering for courses in their major or ceasing college enrollment altogether (Bailey et al., 2014). When students continue to be reenrolled in remedial education without progressing, this is referred to as a "swirl" (Bailey et al., 2014).

DE can mitigate this "swirl" by preparing students early for future postsecondary math and English courses through high school coursework (Kane, Boatman, Kozakowski, Bennett, Hitch, & Weisenfeld, 2019). States like North Carolina are also aligning remediation with high school graduation requirements. Students are provided mandatory support classes in a student's junior or senior years so that when they graduate high school they will not have to place into developmental education (Zinth & Barnett, 2015). A challenge of this approach is that additional classes outside of the high school graduation requirements can delay high school graduation (Zinth & Barnett, 2015).

College Knowledge. Lack of academic preparedness is not the only reason students do not persist to college after high school; many students who are academically underprepared attend college and are simply placed in remedial classes (Ardoin, 2017; Karp, 2012; Zinth & Barnett, 2015). Another reason for low college persistence is a lack of college knowledge.

Students who lack awareness of the college enrollment process, lack study skills and time management skills, or lack the social networks to support the college going process also struggle. Policymakers promote DE as a way to reduce inequities in accessing college education since it is offered at a free or reduced price and can provide social and cultural capital to students through participation (Taylor, 2015). Advocates of DE for all see it as a way to reduce inequities in postsecondary attainment by giving students first-hand experience with the rigor of college classes and by helping them earn credits (Taylor, 2015; Wang et al., 2015). Earning college credits is a strong predictor of future college success (Taylor, 2015; Wang et al., 2015).

Differential Effects. In an era where higher education is diversifying, corresponding student success rates in college still show gaps in attainment between student populations (Ardoin, 2017; Fink et al., 2017; Tobolowsky & Allen, 2016). For example, national college graduation rates within four years after high school differ by student race/ethnicity where 46.2% of Asians earn a bachelor's degree in four years, 43% of Whites, 29.8% of Hispanics, and 20.8% of African American/Blacks (Taylor, 2015). First generation students lag behind students who had parents that earned a degree: 27.4% of first-generation students graduate with a degree in four years compared to 42.1% of students with parents who had a degree (Taylor, 2015).

Despite the diversification of higher education, students of color still remain underrepresented in higher education (Tobolowsky & Allen, 2016). DE is a strategy that states like North Carolina and policymakers are employing to bridge this divide. Despite these efforts, national enrollment trends point to White students still enrolling in DE in disproportionate numbers compared to students of color (Taylor, 2015, Tobolowsky & Allen, 2016). Taylor (2015) uses descriptive data to show that DE students are also more likely to participate in extracurricular activities, have higher academic preparation, have higher career aspirations, and

are more likely to be White and female perhaps in part due to student self-selection into the program.

Virginia's similar population and proximity to North Carolina make it a rich comparison state. Pretlow and Washington (2014) found that minority groups accessed DE less than nonminority groups after the Virginia Plan for DE greatly expanded the program in that state. Additionally, male participation increased at a higher rate (19.1%) than females (18%) though the overall number of males still trailed the overall number of females (Pretlow & Washington, 2014; Taylor, 2015). African American/Black and Hispanic participation was associated with a 25.6% increase compared to a White participant increase of 16.7% (Pretlow & Washington, 2014). This growth is promising though White participants still made up 81.6% of the overall group, African American/Black students made up 13.1%, and Hispanic students 0.31% (Pretlow & Washington, 2014). While the policy change in Virginia was significant for increasing overall participation, it didn't close the gap in participation between minority and nonminority students (Pretlow & Washington, 2014).

Effects also differ for students depending on the modality and location of the course in which they are enrolled (Speroni, 2011a). A study of Florida high schoolers showed the effect of DE was a 12 percentage points higher likelihood of enrolling in college but only if students took the class at the college versus at the high school or online. More research is needed in the area of outcomes by course modality and location but it can be hypothesized that the more students are engaged with college faculty and with the physical college environment, they will see themselves as a college student and are more likely to pursue college after high school (Speroni, 2011a; Tobolowsky & Allen, 2016). Modality and course location should be an important consideration of statewide analysis on the effects of DE on student success and can shed light into the

mechanisms by which DE increases postsecondary attainment. Observing postsecondary enrollment and success in college courses after high school can point to how well DE classes of differing modalities prepare students for college.

DE has been shown to lead to many positive outcomes including providing advanced educational opportunities for students in resource limited rural areas such as those in North Carolina (Karp & Hughes, 2008). In Virginia, the broadening offerings of DE were associated with an overall increase of 1.75% of credits attempted and 98% of participants earned credit for a course (grade of C or better) (Pretlow & Washington, 2014). DE was predicted to have higher enrollment for the high school 2006 cohort after the policy in Virginia was implemented, with the majority of Virginia community colleges seeing a 38% increase in DE (Pretlow & Washington, 2014). Emerging models of DE focus on low- and middle- achieving students in addition to traditionally-served high-achieving students, which show promise for other groups of underrepresented students in higher education (Tobolowsky & Allen, 2016).

Alternate Paths to Bridge the Divide. Advanced Placement (AP) is another program by which students can earn college credit while in high school. Many think of AP and DE as similar programs but there are many differences. Since the programs are different there is debate over which is better and the way AP and DE are accepted for college credit after high school are often treated differently depending on the state (Speroni, 2011a). For example, some states weight AP classes more heavily in the weighted high school GPA compared to DE (Speroni, 2011a). Another key difference between DE and AP is that AP classes are taught by high school teachers which limit the ability of students to experience college-level coursework and expectations that they might receive in DE (Tobolowsky & Allen, 2016). Additionally, in order to earn credits, students must pay for and pass an exam with a predetermined score. Underrepresented groups of

students continue to access AP classes at lower rates than their majority peers and are less likely to pass the exam (Tobolowsky & Allen, 2016). Research shows that the benefits of GPA and persistence in college are only available to those who successfully pass the exam (Tobolowsky & Allen, 2016). Finally, some colleges choose not to accept AP scores because they feel there is not enough focus on soft skills such as critical thinking (Tobolowsky & Allen, 2016).

An additional way high school students can earn college credit is through International Bachelorette (IB). IB has a focus on creating global-minded citizens. In 2006, only 3% of public high schools in the United States offered IB compared to 82% of high schools offering DE (Tobolowsky & Allen, 2016). IB instructors have special certifications that ensure they are teaching the academic and soft skills at a level consistent with the IB standards at any of its offered locations. In addition, IB is a complete curriculum with very structured courses vs. individual courses as is the case with AP or DE (Tobolowsky & Allen, 2016). IB offers consistency and prestige across programs in a way that is recognizable to those reviewing high school transcripts. It's advantage over AP is that it weaves together coursework and extracurricular activities allowing for a more comprehensive student experience. The drawback of both programs are their limited enrollment opportunities which are primarily aimed at serving high achieving and high-income students, DE is a programmatic solution to open access more broadly to other student populations.

Overview of Dual Enrollment

DE occurs when a student takes a college class that fulfills graduation requirements for high school (Karp, 2012; Tobolowsky & Allen, 2016). Other common terms include dual credit, concurrent enrollment, and joint enrollment, though these terms have different structural meaning in different states. Enhanced or comprehensive DE is a program that encompasses most

of the student's high school experience (Tobolowsky & Allen, 2016). In these instances, there is often support in the form of embedded counselors or mentors who focus on underrepresented students. These are sometimes called early college or middle college high schools. This paper focuses on DE programs that are offered in the traditional high school setting. DE courses differ by the location the course is offered (at the high school, at the college, or online), and by the person who instructs the course (high school teachers vs. college faculty). A key factor in DE is that there are no standardized exams to earn college credit.

The first instance of DE was in partnership with Syracuse University. The university offered college biology over two semesters in the high school (Tobolowsky & Allen, 2016). The program was notable because of the extended length of the college-level biology class; this extension is credited with contributing to the success of the program. Modern DE often does not offer students this extended option which is one example where we see divergence from the original model. This early model faced challenges as well, in that colleges weren't accepting the previous coursework for transfer credit and students were retaking the content in college (Tobolowsky & Allen, 2016). This is a persistent problem today.

DE has grown substantially over the past few decades. In 2013, 82% of all high school nationally offered DE and over two million students took advantage (Tobolowsky & Allen, 2016). Compared to AP exam takers (67% of high schools), DE is more widely offered and available (Speroni, 2011a). Growth has varied by state; for example, in Texas DE increased 137% from 2004-2010, in Illinois it grew about 76% from 2001 to 2008 (Taylor, 2015). In Virginia, Pretlow and Washington (2014) found that from 2004 to 2006, participation in DE increased 15.3% and the number of high schools offering DE rose from 76% to 86%. By 2015, 46 states offered DE to its residents (Pretlow & Washington, 2014).

This exponential growth has the potential to open wide the doors to higher education, but growth in participation has not been even across the board for underrepresented students. Nationwide American Indian/Alaskan Native students represent 0.2% of DE participants, Asian Pacific Islanders 3.4%, African Americans 6.2%, Hispanics 23.9%, low income 17.4%, and limited English proficiency 0.3%, while White participation is 66. 3% (Struhl & Vargas, 2012). Admissions requirements for participation in DE may present barriers to diverse student participation. For admission into DE, colleges or college systems set admission requirements (Pretlow & Washington, 2014). Requirements may include ACT/SAT scores, a certain high school GPA, a letter of recommendation, and an application (Tobolowsky & Allen, 2016). In North Carolina, depending on the type of degree pathway the student is pursuing, the admissions requirements range from open access to a weighted high school GPA of 3.0 to a formal interview for early colleges (North Carolina State Law, 2011).

Potential Benefits of Dual Enrollment

DE introduces students to rigorous curriculum and prepares them to enter the college environment (Karp & Hughes, 2008; Tobolowsky & Allen, 2016). Students who have exposure to the campus environment can anticipate challenges and have a more realistic understanding of the college culture making them more likely to be successful (Karp & Hughes, 2008; Tobolowsky & Allen, 2016). Students participating in DE have the opportunity to take ownership over their learning when placed into a college environment, as opposed to the developmental approach in high school which builds their confidence and maturity (Karp & Hughes, 2008). Additionally, students are able to familiarize themselves with campus resources and the processes entailed with accessing them. This could lead to increased usage of these support services and increased success in college (Karp, 2012; Tobolowsky & Allen, 2016).

Students are able to "try on" the role of a college student and through early exposure to the campus climate can become more comfortable in this role; they learn about college norms and have the opportunity to practice these skills (An, 2013a; Karp, 2012). Enrolling in college can be a more seamless transition for a student when they are not having to acclimate themselves to the college environment both academically and socially due to early exposure through DE (Karp, 2012). College coursework is also sequential in nature; when students have an early start on gateway coursework research has shown that they can progress through to classes in their area of interest more quickly (An, 2013a).

For high achieving students, DE helps prevent boredom and allows them to participate at a higher level than the high school curriculum offers (Karp, 2012; Tobolowsky & Allen, 2016). The experience offers high-achieving students an accelerated path and therefore reduces the cost of college and the time to degree (Karp, 2012; Tobolowsky & Allen, 2016). Research shows that students who participate in DE have 12 percentage points higher post high school college enrollment rates than students who don't take classes that could earn them college credit (Speroni, 2011a). In Florida they found that DE was associated with a higher college attendance rate than AP, though only for community colleges (Speroni, 2011a). Additionally, when articulation agreements are in place and the partnership between the college and the high school is strong there are assurances that the DE credit will be transferred in the student's favor (Tobolowsky & Allen, 2016).

DE has the potential to bridge the high school-college divide for other groups of students by offering career and technical education pathways (Tobolowsky & Allen, 2016; Wang et al., 2015). This is especially true for middle- and low-achieving students who are able to participate in DE programs that will lead to a skilled job in the workforce (Tobolowsky & Allen, 2016).

Some research has shown that opening opportunities to middle- and low- achieving students builds their confidence if the student actively engages in the experience; in turn, this encourages students to attend college where they otherwise would not have (Karp & Hughes, 2008; Tobolowsky & Allen, 2016). DE helps students develop academic skills they need to successfully pursue college (Karp & Hughes, 2008). Research shows that students who participated in college CTE courses had higher GPAs and enrolled in college courses at higher rates than their peers who did not take DE classes (Karp & Hughes, 2008; Wang et al., 2015). In addition to evidence pointing at benefits for students, policymakers believe that DE will improve high school completion rates because the programs are engaging for students (Tobolowsky & Allen, 2016). Karp (2012) found that males and lower-achieving students were 16.8% more likely to attain a postsecondary degree if they participated in DE. First generation and low-income students are also more likely to experience benefits even though they are less likely to participate in DE, a key concern for which DE administrators should seek solutions (Tobolowsky & Allen, 2016).

Economic Benefits. People with college educations earn more over a lifetime and are less likely to be unemployed (Baum et al., 2013). Students from low income backgrounds have more to gain from a college education because it is not the default post-high school path for them (Baum et al., 2013). For example, students who earned an associate's degree earn 27% more than high school graduates, those who earned a bachelor's degree earned 37% more, those who have earned a master's realize an increase of 90%, and even students who have some college but no degree earn 14% more than those with a high school diploma (Baum et al., 2013). The earning potential for those who attempt or earn a degree further strengthens the argument for DE programs that enroll diverse students.

When citizens earn more they also pay more taxes that can be used to further support social services. For instance, college graduates pay on average 78% more in taxes each year compared to high school graduates (Baum et al., 2013). Not all benefits of education can be measured, but other benefits to society may include having improved psychological health and people living healthy lifestyles that reduce medical costs for the government (Baum et al., 2013; Becker, 1993).

Earlier it was presented that nationwide college enrollment is declining which poses a sustainability problem for colleges, in particular open access institutions (Jackson, 2014). The rapid increase in DE also represents increased revenue for colleges and is becoming an increasingly important funding source (Tobolowsky & Allen, 2016). When community colleges offer DE in high schools, they also build strong relationships with K-12 partners and have increased positive community visibility (Tobolowsky & Allen, 2016). DE can also be used as a recruitment strategy to encourage more high school graduates to see the community college as a viable option and choose to enroll after high school (Tobolowsky & Allen, 2016).

Potential Challenges to Dual Enrollment

Similar to the original problems with DE at Syracuse University, when a high school graduate moves to enroll in college they are finding that some colleges don't accept their credit earned because of institutional concerns about quality of the DE classes (Tobolowsky & Allen, 2016). In particular, there are questions about the rigor of courses because they are open to middle- and low- achieving students (Tobolowsky & Allen, 2016). Due to inconsistencies in acceptance of course credit or how classes transfer, students may be limited in choice of major or attending the school of their choice vs. the school that accepts the DE credits (Tobolowsky & Allen, 2016). One study found that the most competitive colleges only accepted 33% of DE

credits, compared to 70% AP or 59% IB, demonstrating that this is a clear opportunity for improvement and opening of access to college (Tobolowsky & Allen, 2016).

Policies on who covers tuition costs vary by state but if they are passed along to the student/parents, this can be a barrier to participation (Pierce, 2017; Tobolowsky & Allen, 2016). In North Carolina the legislature pays for tuition, but fees, textbooks, supplies, and transportation are not covered universally; local school districts may or may not choose to pick up these costs (North Carolina State Law, 2011). Nationally, 60% of colleges expect students to purchase textbooks and course supplies (Tobolowsky & Allen, 2016). This cost is the second largest expense after tuition to participation and can serve as a barrier to DE enrollment. Generally, transportation is not covered either. This is particularly concerning when thinking about participation for rural students or underrepresented students who don't have personal transportation options or availability of public transit (Tobolowsky & Allen, 2016).

Dual Enrollment Policy in North Carolina

Enacted in 2012, a bill called Career and College Promise (CCP) succeeded the former Huskins bill that focused on helping students take college courses (North Carolina State Law, 2011). CCP opened up DE more broadly to students interested in college transfer and focused on creating structured career and academic pathways so students would be taking courses toward a credential (North Carolina State Law, 2011). The immediate short-term goal of the bill was to increase access for underserved populations in North Carolina with the mid-term goal of increasing the number of students earning a degree in order to fill anticipated gap in workforce (North Carolina State Law, 2011). The long-term goal of CCP, similar to many DE programs, is to help North Carolinians earn a family sustaining wage therefore increasing the tax base in North Carolina (North Carolina State Law, 2011).

CCP is open to high school juniors and seniors[2] meeting admissions requirements and traditional high school students can choose one of two pathways; Career and Technical Education (CTE) or College Transfer Pathway (CTP). In North Carolina, the admissions requirements for CTE and CTP pathways in 2015 were a 3.0 weighted high school GPA, demonstration of college readiness in math and English, and completion of a college application (North Carolina State Law, 2011). In some cases, CCP legislation allows high school principals to waive the GPA requirement for CTE pathways. It is important to note that North Carolina also offers the option for students to attend a Cooperative Innovative High School where students attend a high school at which the curriculum is fully integrated with an associate's degree. Cooperative Innovative High Schools are not included in this analysis as they are structurally different than the pathways.

Achievement of a high school diploma has become the norm and college-going is the way to get ahead and ensure job stability (An, 2013a; Baum et al., 2013; Jackson, 2014). Therefore, it matters how all students access and succeed in college. Students who have parents that encourage college and invest in college can benefit from this acquisition of knowledge, but students who do not have parental encouragement are at a disadvantage (An, 2013b). Policies that help introduce college earlier can aid in closing this gap (Bailey & Karp, 2003; Karp & Hughes, 2008; Tobolowsky & Allen, 2016). If DE only increases access for students who are academically motivated while lower-performing students who also have lower socio-economic status, are underrepresented in higher education, and struggle with core curriculum, then DE doesn't really open access to all students (Dowd, 2003). Enrollment structures such as not

[2] At the time this dissertation was written there is a proposal before the State Board of Community Colleges to further expand CCP eligibility for 9th and 10th graders. In 2015-2016, eligibility for the program began in the 11th grade/junior year with the exception of 2 CTE pathways where 9th and 10th graders could enroll (North Carolina State law, 2011).

allowing DE students to take remedial education further limit access to these programs that are meant to increase access (Dowd, 2003; Karp, 2012; Tobolowsky & Allen, 2016). Despite community college's efforts to be open-access and low-cost, being a low-income student is still a barrier to accessing college. DE in North Carolina is tuition-free, but a key question remains: does DE help increase access for all students? In order to fully answer this question, there is a need for rich longitudinal data to fully examine equitable outcomes (Dowd, 2003; Karp & Hughes, 2008; Pretlow & Washington, 2014; Wang et al., 2015). In North Carolina the longitudinal data system, P-20, is new, untested, and ripe with opportunity.

Data

This paper describes CCP participants in North Carolina and explores relationships between CCP and postsecondary attainment. Following Dowd (2003), this paper provides critical preliminary information about the different student groups and context of the policy. This preliminary information is descriptive in nature and in order to understand the relationship between CCP and postsecondary attainment it is important to first understand who the program is serving. After an understanding of who the program serves and who it doesn't serve is examined, quasi-experimental methods can be applied to understand the causality of the CCP's impact on postsecondary attainment outcomes.

This study's sample includes high school juniors and seniors in the academic years 2015-2016 and 2016-2017 year who stayed in the same high school during this time period. The 2014-2015 year is used to identify pre-participation characteristics. I observe students through 2018-2019 through the completion of their associate's at 100% completion time. 100% completion time for an associate's degree is two years, acknowledging that students often take longer to complete their degree (Figure 1.1). Data were obtained through NCCCS and the state's

longitudinal data system, called P-20, that connects data from public K-12 schools with the community college and university systems. Additionally, all North Carolina Public high school students who ever enrolled in community college regardless of CCP participation are matched through National Student Clearinghouse (NSC) data to observe postsecondary enrollment and completion outcomes. This limits observable outcomes to students who appeared in NCCCS and outcomes for students who do not attend a North Carolina community college cannot be observed.

Figure 1.1

Sample Description and Observable Outcomes

YEAR	**2014-2015**	**2015-2016**	**2016-2017**	**2017-2018**	**2018-2019**
OBSERVABLE GROUPS	High School Sophomores	High School Juniors	High School Seniors	1st year Post-High School	2nd year Post-High School
OBSERVABLE OUTCOMES	-Pre-CCP participation characteristics	-High School GPA -CCP Participation -Community College Postsec. Outcomes	-High School GPA -CCP Participation -Community College Postsec. Outcomes	non-CCP: NCCCS outcomes CCP: -Community College Postsec. Outcomes -NSC Outcomes	non-CCP: NCCCS outcomes CCP: -Community College Postsec. Outcomes -NSC Outcomes
DATA SOURCES	P-20	P-20, NCCCS	P-20, NCCCS	P-20, NCCCS, NSC	P-20, NCCCS, NSC

Note. P-20 is North Carolina's state longitudinal system; CCP is Career and College Promise; NCCCS is the North Carolina Community College System, NSC is the National Student Clearinghouse; Postsec. is postsecondary; 2018-2019 is the most recent data available.

This descriptive analysis contributes to a larger questions of *What is the relationship between dual enrollment in North Carolina and postsecondary attainment?* This paper addresses the following research questions:

1. Which students are participating in the North Carolina dual enrollment program and how do these students compare to the broader population of juniors and seniors in North Carolina?
2. What is the relationship between CCP and postsecondary attainment for students who participate?
3. Do descriptive data show that the relationship between CCP and postsecondary attainment is moderated by underrepresented student demographics?
4. How do trends in participation and enrollment in CCP compare to trends in other DE programs nationally?

Tables 1.1 and 1.2 present descriptive statistics where CCP participants are compared and contrasted with non-CCP participants in North Carolina with an emphasis on which students are accessing and succeeding in the program and which students are not. Tables 1.3 and 1.4 present descriptive outcomes for CCP participants and nonparticipants followed by disaggregation of these outcomes in Table 1.5. Following the descriptive data, I present naïve estimates of the effect of CCP on postsecondary attainment using OLS regression methods in Table 1.6.

Results

Career and College Promise Participation Trends

These data describe 10th grade students who remained in the same high school through 12th grade, some of whom participated in CCP and some did not. For those who participated, Table 1.1 outlines demographic, economic, language, and high school GPA on students who participated in CCP at any point during in their junior or senior year and those who participated for the full two years. In North Carolina, the demographic characteristics of participants and nonparticipants reflect those of trends in other states and nationally where female, White, and

middle- to -upper class students make up the majority of participants (Tobolowsky & Allen, 2016; Pretlow & Washington, 2014; Taylor, 2015). About 20% of students (n=16,235) in my sample participate at CCP at some point during their junior and senior year. When I look at those who participate for both years, participation drops to 5% (n=4,254). Similar to other states, 58%

Table 1.1

Descriptive Statistics at the Student Level

	CCP for 2 Years (n=4,254)	Ever in CCP (n=16,235)	Never in CCP (n=66,581)	All Students (n=82,816)
Demographic Characteristics				
Female	60%	58%	48%	50%
White	75%	70%	53%	56%
African American/Black	13%	15%	26%	24%
Hispanic	8%	9%	12%	12%
Socio-Economic Status				
Free and Reduced Lunch	38%	39%	45%	44%
Home Language				
English	92%	90%	85%	86%
Spanish	7%	8%	11%	11%
Other	2%	2%	4%	4%
Mean Weighted High School GPA	3.8	3.6	3.1	3.2

Note. Includes students in traditional North Carolina high schools who were 10th graders in 2014-2015 and stayed through 12th grade. Source: DPI data during the 2014-2015 academic year.

of students who ever participated in CCP are female, 70% white, 15% African American/Black, and 9% Hispanic. Unsurprisingly for students who participate for two years, the percent of females increases to 60%, White students increase to 75%, African American/Black students decrease to 13%, and Hispanic students decrease to 8%. Compared to all North Carolina 10th

graders in 2014-2015, the population of non-participants reflects the overall population where CCP participants tend to be less diverse.

In addition, trends nationally show that students of lower socioeconomic status (SES) access DE at a lower rate than their middle- and -upper class peers even though participation may close postsecondary attainment gaps (An, 2013b; Hoffman, Vargas, & Santos, 2008). I used student participation in the free and reduced lunch program as a proxy for socio-economic status. For these students with lower socio-economic status, CCP reduced the financial barrier by charging no tuition to students. These data show that students who participate in free and reduced lunch programs access CCP at lower rates (39%) compared to students who do not participate in the program and access CCP (61%) (see Table 1.1). It's also notable that more than 90% of participants primarily speak English at home. Finally, on average participants have a higher mean weighted high school GPA (3.6) compared to non-participants (3.1); this trend may be observed in part due to the 3.0 weighted GPA required to access CCP.

When comparing the demographics of students in CCP's two pathways (CTP and CTE) we see that CTP students tend to be whiter (63%) and more female (76%) compared to CTE students (52% and 64%). CTE students tend to be more racially diverse with 20% of students who are African American/Black and 11% who are Hispanic which nears the percentage of the overall population. CTE students also tend to speak different languages at home where 11% speak Spanish compared to 5% of CTP students. CTE students also participate in free and reduced lunch programs at higher rates (48%) than CTP students (30%). Finally, CTP students have a higher average GPA of 4.0 compared to CTE students with 3.2, though both are still relatively high GPAs.

Table 1.2

Descriptive Statistics by Pathway for Students who participated in CCP at any time

	CTP (n=7,446)	CTE (n=8,024)
Demographic Characteristics		
Female	63%	52%
White	76%	64%
African American/Black	11%	20%
Hispanic	6%	11%
Socio-economic Status		
Free and Reduced Lunch	30%	48%
Home Language		
English	93%	87%
Spanish	5%	11%
Other	2%	2%
GPA	4.0	3.2

Note. Includes students who ever participated in CCP, were juniors in 2015-2016 in traditional North Carolina high schools, who stayed in the same high school through 12th grade; GPA is high school mean weighted. CTP is College Transfer Pathway, CTE is Career and Technical Education. Source: DPI data during the 2014-2015 academic year.

Postsecondary Outcomes. Postsecondary outcomes for students who participated in CCP exceed that of students who have never participated. Students who ever participated in CCP enrolled in college, persisted from year one to year two, and earned credentials at higher rates than nonparticipants (see Table 1.3). Of students who participated in CCP for two years, 74% enrolled in college after high school compared to 56% of students who ever participated, and 32% of nonparticipants; this trend holds when observing community college enrollment (vs. any college enrollment). Persistence is defined as a student who was enrolled the first year after high school and then enrolled the second year; students who successfully graduated are included as

successfully persisted. Persistence rates follow the same pattern as postsecondary enrollment with students ever in CCP persisting at 76% compared to never in CCP at 66% and 86% of students who participated in CCP for two years persisted.

Table 1.3

Descriptive Postsecondary Outcomes at the Student Level

Outcome	CCP for 2 Years (n=4,254)	Ever in CCP (n=16,235)	Never in CCP[3] (n=66,581)
Enrolled in Any College	74%	56%	32%
Enrolled in Community College	47%	46%	32%
Persisted Year 1 to Year 2 in Any College (if not graduated)	86%	76%	66%
Graduated Any College by 2018-2019	23%	14%	3%
Earned College Credential in High School	12%	6%	0%
Earned College Credential After High School	10%	8%	3%
Graduated Community College			
Associate's Degree	10%	6%	2%
Diploma	1%	1%	<1%
Certificate	14%	8%	1%

Note. Includes students who ever participated in CCP, were juniors in 2015-2016 in traditional North Carolina high schools, who stayed in the same high school through 12th grade. Source: NCCCS data; outcomes that include "any college" include NCCCS and NSC data.

[3] Outcomes for students never in CCP can only be reported for students who enrolled in a North Carolina Community College.

College completion outcomes for North Carolina's CCP students exceed that of nonparticipants in all categories. Overall, 14% of students who were ever in CCP earned a credential (inclusive of certificates, diplomas, and degrees) by spring 2019 which is the 100% time frame (two years) for a student to earn an associate's degree. This is in comparison to 23% of students who earned a college credential after participating in CCP for two years and 3% who never participated. Data after spring 2019 are unavailable at this time but will be helpful in the future to understand true completion rates since many students take longer than 100% time to graduate. Of students who participated in CCP ever, 6% earned the college credential while in high school and 8% after high school. For students who participated in CCP for two years, 12% earned their college credential in high school and 10% after high school. For students who earned their college credential at a community college, the majority of the credentials were certificates where 14% of two-year CCP students earned a certificate, 8% of ever CCP participants, and 1% of never CCP participants. Diplomas earned remained near 1% for all groups, though this may be a reflection of the limited availability of pathways that lead to this credential. Finally, 10% of two year CCP students earned an associate's degree, 6% of ever CCP students, and 2% of nonparticipants by spring 2019.

Short-term Postsecondary Outcomes. Since this dataset is limited to 100% completion time (two years) to earn an associate's degree, it is helpful to examine short-term outcomes that may indicate how CCP is influencing postsecondary attainment (Table 1.4). First, I looked at number of credits earned. Credits earned are college-level credits that a student enrolled in, and successfully earned a grade that applies these credits toward graduation. The average number of credits earned by students who ever participated in CCP exceed that of nonparticipants where CCP participants earned on average 7.3 credits while in high school and 29.9 after high school

compared to nonparticipants who earned 4.3 in high school and 18.8 after high school (see note in Table 1.4). If a student participated in CCP for two years they, on average, earned more

Table 1.4

Community College Short-Term Outcomes at the Student Level

Outcome	CCP for 2 Years (n=4,254)	Ever in CCP (n=16,235)	Never in CCP[4] (n=66,581)
# Dual Enrollment Credits Earned	13.8 (8.1)	7.3 (6.2)	4.3 (4.8)
# Postsecondary Credits Earned	33.5 (21.4)	29.9 (21.6)	18.8 (19.1)
# Dual Enrollment Classes Taken	5.4 (2.8)	2.9 (2.1)	2.2 (1.9)
# Postsecondary Classes Taken	13.1 (7.6)	12.5 (7.6)	10.2 (6.8)
1st Year Postsecondary GPA	2.8 (1.1)	2.7 (1.1)	2.2 (1.2)
2nd Year Postsecondary GPA	2.9 (1.1)	2.8 (1.1)	2.4 (1.2)

Note. Includes students who ever participated in CCP, were juniors in 2015-2016 in traditional North Carolina high schools, who stayed in the same high school through 12th grade. Source: NCCCS data; outcomes that include "any college" include NCCCS and NSC data.

credits than the other two groups with 13.8 credits earned during high school and 33.5 earned after high school. The second short-term outcome, number of classes taken, reflects the trends observed with credits taken where CCP participants take more classes on average during and after high school compared to nonparticipants and two year CCP participants exceed both groups. Finally, postsecondary GPA observed in the first and second year show that students

[4] There are courses and credits reported but per NCCCS these are due to data reporting errors and these students were likely CCP students who were not coded correctly or where data were reported inaccurately. To maintain consistency with NCCCS reporting, data have not been removed for outliers or students who may be coded incorrectly. In essay 2 and essay 3, these data have been removed from analysis.

who ever participated in CCP had a 0.5 higher GPA after one year and 0.4 higher GPA after two years. Students who participated in CCP for two years had a 0.1 higher GPA both years over ever participants.

Table 1.5

Select Descriptive Postsecondary Outcomes for CCP Students: Disaggregated

Outcome	Female	Male	White	African American/ Black	Hispanic	Free and Reduced Lunch	Not Participating in FRL
Observations	9,428	6,807	11,342	2,503	1,458	6,293	9,942
Enrolled in Any College	59%	52%	58%	49%	56%	54%	57%
Persisted Year 1 to Year 2 in Any College (if not graduated)	77%	75%	77%	67%	81%	73%	78%
Graduated Any College by 2018-2019	13%	16%	14%	11%	18%	13%	16%
# College Credits Earned (DE and Postsecondary)	20.9	18.8	21.2	13.5	21.7	19.3	20.4
1st Year Postsecondary GPA	2.7	2.6	2.8	2.3	2.6	2.5	2.8

Note. Includes students who ever participated in CCP, were juniors in 2015-2016 in traditional North Carolina high schools, who stayed in the same high school through 12th grade. Source: NCCCS data; outcomes that include "any college" include NCCCS and NSC data.

It is important to note that nonparticipants should not be able to earn any credits or take college classes while in high school because the only way to earn credit is through CCP. One possibility is that these credits reflect AP or IB credit, but this credit is not awarded until college after high school versus CCP credit that is awarded in high school. After consulting with NCCCS

and a former Director of CCP, I determined that this is likely due to coding errors where students earning credit and taking classes should be CCP students. To remain consistent with the way NCCCS treats these cases, I have not dropped them or recoded students as CCP which may bias my findings downward.

Disaggregated Postsecondary Outcomes. To examine the differential outcomes of CCP for groups of students, Table 1.5 shows select outcomes by gender, race/ethnicity, and participation in free and reduced lunch (FRL). CCP participants of all genders, races/ethnicities, and SES have similar outcomes to each other though African American/Black students and students with low SES (as determined by FRL status) experience the lowest outcomes. For example, females who participated in CCP enroll in college and persist at rates of 59% and 77%, male students are 7 and 2 percentage points lower for both outcomes but graduate at a rate 3 percentage points higher. White students enroll and persist at 58% and 77%; African American/Black students are about 10 percentage points lower, trail White students by only 2 percentage point in postsecondary enrollment and exceed White students by 4 percentage points in persistence. Students who participate in FRL enroll and persist 3-5 percentage points lower than their nonparticipating peers. A similar trend is observed for college credits earned and postsecondary GPA. Notably, Hispanic students outperform all racial/ethnic groups in persistence, graduation, number of credits earned, and are near the achievement of White students in enrollment in college and first year GPA.

Relationship Between Career and College Promise and Postsecondary Attainment

To examine the relationship between CCP and postsecondary attainment, I focus on students who “ever participated” in CCP in order to consider outcomes for the largest group of students who could be affected by participation in the program. Given that students who “ever

participated" are the largest group which encompasses the students who participated for two years, this group is policy relevant to the program overall. Additionally, I look at outcomes for the CCP program holistically as both CTP and CTE pathways are funded through the same legislation and students are able to move between the two pathways with the help of a college staff member (North Carolina State Law, 2011). To assess the relationship between CCP and postsecondary attainment, I use an OLS regression analysis similar to Xu and Smith Jaggars (2013) and Card (1995) and due to the binary dependent variable of participation in CCP=1, nonparticipation is CCP=0 (Stock & Watson, 2006). This strategy relates the student's postsecondary outcomes to their participation in CCP using the following basic empirical model:

$$Y_{ij} = \beta_0 + \beta_1 CCP_{ij} + \beta_2 X_{\mathrm{i}} + \beta_3 X_{\mathrm{j}} + \beta_4 County + \varepsilon_{\mathrm{ij}}$$

Where β_1 is the coefficient for participation in CCP for student i in school j. Included in the model are a vector of controls for students' demographics ($\beta_2 X_{\mathrm{i}}$) and a vector of controls for the high school(j) they attend ($\beta_3 X_{\mathrm{j}}$). Student demographics include gender, race/ethnicity, participation in the free and reduced lunch program. High school controls include the school performance grade score, percent participation of students, four year cohort graduation rate, and student- to- teacher ratio. I control for the high school specifically because it is the location where students gain access to participate in CCP. The CCP program is set up where community colleges, which are county-based, are paired with all of the high schools within the county. One concern is that some high school – college partnerships may be stronger than others leading to differences in the number and variety of courses available, as well as staff to guide students through the process. A second concern may be that students are encouraged to participate in other college preparatory activities such as advanced placement (AP) or international bachelorette (IB) instead of participating in CCP. Proportionately, enrollment in AP and IB is

much smaller than CCP and does not exist in every high school (Tobolowsky & Allen, 2016). This encouragement is likely driven by school guidance counselors and family members so even though CCP is available, students may choose other paths to earning college credit (AP or IB). Including high school level controls helps address these concerns and further remove bias from the estimation.

To further control for variation in selection into the program related to local conditions that are also related to student outcomes across a large and diverse state, I include county-level controls ($\beta_4 County$) using census data and including rurality designations established by the State of North Carolina. Controls include a designation of the urbanicity versus rurality of the county, employment rate, total number of households, and mean household income. Including these county-level controls addresses concerns that there are county-specific differences that affect participation in CCP and postsecondary attainment outcomes.

I examine the affect of participation in CCP on enrollment in any college, enrollment in a North Carolina community college, persistence, graduation at any college, graduation at a North Carolina community college, number of college credits earned, number of college classes taken, and the first year postsecondary GPA. There are 82,816 students in the sample. When controlling for covariates, participation in CCP is related to a positive and statistically significant relationship ($p<0.001$) with students enrolling in college, persistence, GPA, and graduation from postsecondary compared to nonparticipants.

Table 1.6 shows that students who participated in CCP had a 20.6 percentage point ($p<0.001$) higher probability of enrollment in any college after high school including North Carolina community colleges and colleges reporting student enrollment in National Student Clearinghouse. CCP students had an 11.6 percentage point ($p<0.001$) higher probability of

enrolling in a North Carolina community college and a 9.7 percentage point (p<0.001) higher probability of persisting from the first postsecondary year to the second. Graduation

Table 1.6

Estimated Relationship between CCP and Postsecondary Attainment

Outcome	(1)	(2)
Enrolled in Any College	0.206 (0.004)***	0.239 (0.004)***
Enrolled in Community College	0.116 (0.004)***	0.141 (0.004)***
Persisted Year 1 to Year 2 in Any College (if not graduated)	0.097 (0.004)***	0.114 (0.003)***
Graduated from Any College by 2018-2019	0.101 (0.002)***	0.110 (0.001)***
Graduated Community College	0.099 (0.002)***	0.109 (0.002)***
# College Credits Earned (DE and Postsecondary)[5]	12.022 (0.285)***	13.764 (0.268)***
# College Courses Taken (DE and Postsecondary)[6]	3.294 (0.100)***	3.696 (0.093)***
1st Year Postsecondary GPA	0.418 (0.019)***	0.50 (0.02)***
With Controls	Yes	No
Sample Size	82,816	82,816

Note. Includes students who ever participated in CCP, were juniors in 2015-2016 in traditional North Carolina high schools, who stayed in the same high school through 12th grade. *p < 0.05; **p < 0.01; ***p < 0.001 Source: NCCCS data; outcomes that include "any college" include NCCCS and NSC data.

[5] For students who enrolled in a North Carolina community college
[6] For students who enrolled in a North Carolina community college

outcomes show a 10.1 percentage point ($p<0.001$) higher probability of CCP students graduating from college within two years and 9.9 percentage point ($p<0.001$) higher probability of graduating from a North Carolina community college in this same time frame. CCP students also had a predicted GPA 0.418 points ($p<0.001$) higher than their peers who did not participate in CCP. OLS estimates also show a statistically significant ($p<0.001$) and positive relationship between CCP and total number of credits earned and total number of courses taken. Participation in CCP is related to earning about 12 additional credits compared to their non-CCP peers and CCP students take about 3 additional classes ($p<0.001$). Model 2 provides estimates of the effect of CCP on postsecondary attainment outcomes without control covariates (column 2, Table 1.6). The positive and significant effects were larger without the covariates but follow the same pattern as the OLS model with covariates ($p<0.001$).

Limitations

This descriptive analysis is limited in that the results cannot be considered causal. Subsequent essays on this topic and in this dissertation will attempt to draw causal claims though this essay is strictly descriptive in nature. Additionally, longitudinal data are only available through the 2018-2019 academic year. This means that students who began CCP in 2015-2016 can be followed through the 100% associate's degree completion timeline (two years) acknowledging that students often take longer than two years to earn their degree. The dataset used in this essay is also limited in that it cannot measure student uptake of AP or IB to understand if there are groups of students who are choosing those programs instead of CCP. Finally, the data are limited in that there are 995 students whose records show they attained college credit while in high school. This should not be observed in the dataset, as the only way a student can earn college credit while in high school is through CCP, a fact that I confirmed with

NCCCS. I also reran the OLS results without these students and the results were not substantially different.

Discussion

Overall, North Carolina's trends in participation reflect that of rates nationally and other states by gender, race/ethnicity, and SES. Nationally, and in North Carolina participation by gender is 58% female (Fink et al., 2017). Comparing my sample in North Carolina to national data, participation in CCP by race/ethnicity in North Carolina shows more White students (70% vs. 66.3%), more African American students (15% vs. 6.2%), and fewer Hispanic students (9% vs. 23.9%). In North Carolina, racial/ethnic dual enrollment participation rates have become increasingly White since 2012 where the percent of White students increased from 62% White in 2012 to 70% White in 2015, Hispanic participation decreased from 12% to 9%, and African American/Black participation increased from 14% to 15% (NCCCS, 2019). Compared to the overall population of high school juniors in North Carolina, students who "ever participated" in CCP tend to be more female (58% vs. 50%) and more White (70% vs. 56%). CCP students tend to be less African American/Black (15% vs. 24%), less Hispanic (9% vs. 12%), and fewer participate in free and reduced lunch (39% vs. 44%). Economically, Fink et al. (2017) reported that 37% of dual enrollment students nationally are low-income and in my sample, based on participation in free and reduced lunch, 39% of students are low-income.

However, when looking at the population of students who participate in the CTE pathway, rates reflect that of the overall North Carolina population and are more diverse than students in the CTP pathway (Tables 1.1 and 1.2). For example, 50% of the population of North Carolina high school juniors are female, 52% of CTE students are female, and 63% of CTP students are female. Similarly, 24% of the population is African American/Black, 20% of CTE

students, and 11% of CTP students. This trend continues when looking at all demographics where CTE students similarly reflect the state population. One reason for this trend could be that CTE students are able to have the CCP GPA requirement waived making the program more accessible for students who fall below the threshold (North Carolina State Law, 2011). Additionally, when looking at completion rates of 8,024 CTE students, 8% earned a certificate compared to 6% of CTE students who earned an associate's degree (Table 1.3). CTE pathways have short-term certificates built into the program pathway and CTE could be driving the predicted 9.9 percentage point increase in community college completion rates for CCP students (Table 1.6).

When looking at descriptive and predicted postsecondary outcomes for CCP participants, participants in CCP have greater postsecondary attainment outcomes as compared to nonparticipants. This is not surprising as CCP gives students a head-start on earning college credits and therefore they are closer to earning a college credential. Additionally, students taking college classes become familiar with processes and expectations of the college environment which reduces the adaptation period after high school (Karp, 2012). More importantly however, when disaggregating results by gender, race/ethnicity, and SES we see that outcomes for students are similar. Despite demographic differences in participation rates, descriptive postsecondary outcomes presented in this study suggest that all students who do participate in CCP seems to benefit at similar rates.

It is also notable that outcomes for students who participated for two years are greater than any other group. For example, CCP students who participate for two years enroll in college after high school at rates almost 20 percentage points higher than "ever participants." Results also show this trend in credit earning where students who participate in CCP for two years earn

almost twice as many credits in high school compared to “ever participants” and 4 credits more overall. These finds suggest that encouraging students to maximize participation can further increase postsecondary attainment.

Fink et al. (2017) also documented that 32% of North Carolina dual enrollment students matriculated to a four-year college after high school. Though credits earned and courses taken are observable only at a North Carolina community college these results show that CCP increases the probability of a student enrolling in any college by 20.6 percentage points but only 11.6 percentage points in a North Carolina community college. This points to the hypothesis that some CCP students may be choosing to enroll directly in a four-year school after high school instead of finishing their associate’s degree at the community college before transferring. Additionally, some students are able to finish their associate’s degree while still in high school which is meant for direct transfer into the four-year school.

Implications

These trends, while not unique to North Carolina, indicate that CCP overall is not maximizing its potential to reach groups of students who may not consider college an option and who stand to benefit the most from participation in the program such as low-income and underrepresented students, which is consistent with findings from Fink et al. (2017), An (2013), and Struhl and Vargas (2012). Considering that 2012 was the year that the current CCP program was established and that one of the goals is to broaden access, it seems that further understanding how underrepresented students are recruited and matriculate into CCP is an important policy and practice consideration. For example, if African American/Black students participated at a rate that was proportional to the population (24% compared to the current 15%) this would result in an additional 2,254 students in CCP. If students participating in free and reduced lunch

participated at a rate that was proportional to the population (44% compared to the current 39%), this would result in an additional 9,617 students in CCP. The CTE pathway does appear to increase access to college for students who reflect the overall population (Table 1.2).

There are also implications for these results for the statewide goals to increase the number of North Carolinians with a postsecondary credential (myFutureNC Commission, 2019), CCP seems like a program that can contribute greatly to this goal but there are large groups of students (male, African American/Black, Hispanic, and low income) who are not benefiting from participation (Table 1.1). Notably, participation rates and outcomes for students in the free and reduced lunch program signal a conservative estimate of the future impact of CCP on postsecondary attainment should participation rates grow to reflect the population. Free and reduced lunch participation is an underestimate of the population due to the use of the community eligible provision that allows whole schools to receive federal funding for meals so the number of students in the sample who are low-income is also underestimated (U.S. Department of Agriculture, 2019).

Further, these descriptive results show that CCP is related to an increase in postsecondary attainment of 10.1 percentage points. Therefore, participation in CCP predicts that out of the sample in this study, there will be an additional 8,282 college graduates. Increasing postsecondary attainment can also result in increased earnings and tax contribution to the state economy. Baum et al. (2013) estimated that students who graduated with an associate's degree have 27% increased earnings and pay 78% more in taxes. This means for the 8,282 additional graduates who earned at least an associate's degree, the average annual salary per person increases $13,974 from a base of $51,758 (North Carolina Department of Commerce, 2020).

Furthermore, these additional earnings translate into an additional $6,075,965.07 in revenue generated by state income tax ($13,974 x NC state income tax rate 5.25% x 8,282).

Becker's (1993) theory of human capital investment demonstrates clearly that the state legislature's early investment in education benefits both individuals and the economy in North Carolina. CCP provides early access to college for high school students so they can get ahead on earning college credits. CCP also offers structured pathways that lay out the sequence in which to take classes (North Carolina State Law, 2011). North Carolina has a Comprehensive Articulation Agreement that outlines how classes taken at a community college apply directly to an intended degree at a UNC school. When students are earning credits that apply directly to a degree they are gaining momentum toward their degree (Fink et al., 2017; Karp, 2012; Speroni 2011a). As Becker's (1993) theory of human capital would suggest, the investment made into providing access to college earlier for students in North Carolina is increasing educational attainment across the state.

Future Research

Given the differences in participation rates for low-income and underrepresented students, future research should focus qualitatively on understanding how students are recruited into and enrolled in CTE pathways. This research can provide insight into practices that can be replicated with CTP students. If promising practices can be replicated and extended to CTP students, the CCP program overall can maximize its potential to extend the promise of college to more students. Additionally, while these descriptive results are compelling, further research needs to be conducted because students who participate in CCP may have different, unobservable traits of college-ready students. The unobservable traits could overestimate the effect of CCP on postsecondary attainment and attribute positive and significant effects to the

program, when really students who participated were different, this implication has been documented in previous research (An, 2013a, 2013b; Struhl & Vargas, 2012; Taylor, 2015). Therefore, descriptive data about participation and outcomes for participants may not explain the effect of CCP on postsecondary attainment. The OLS model presented in this paper attempts to control for a rich set of student, high school, and county covariates but it cannot fully address bias caused by student self-selection into the program. Future research should attempt to address this bias by leveraging quasi-experimental research designs to further understand the causal effects of CCP on postsecondary attainment.

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ESSAY TWO: COLLEGE AND CAREER PROMISE LEADING TO TRANSFER OUTCOMES: A REGRESSION DISCONTINUITY ANALYSIS

Introduction

For most students graduating from high school, a college degree is a prerequisite to employment in a stable job and a person's ability to earn family sustaining wages (Pretlow & Washington, 2014). In North Carolina it is predicted that by 2020, 67% of the jobs in the state will require a postsecondary credential compared to less than 50% of the population who currently possess such a credential (myFutureNC Commission, 2019). Despite a clear need for a skilled workforce and the benefits of having a college degree for individuals, college enrollment is declining (Bailey & Karp, 2003). For those students who choose to attend college, graduation rates are low. In 2017, 5.9 million students sought a degree from a community college in the United States (U.S) and if previous graduation trends persist, less than 30% of these students will graduate with their credential within three years (National Center for Education Statistics [NCES], 2019).

One strategy that states across America are employing to address postsecondary enrollment and completion is dual enrollment (DE) (Pierce, 2007). DE is when a high school student takes a college class that fulfills graduation requirements for high school as well as earns the student college credit (Tobolowsky & Allen, 2016). DE spurs momentum in college by helping students earn college credit and college experience earlier (An, 2013a). Generally, research points to DE as having positive outcomes and suggests that states can encourage DE as a college student readiness strategy (Struhl & Vargas, 2012). Benefits of DE may include increased lifetime earnings (Baum, Ma, & Payea, 2013), reduction in the cost of college (Karp &

Hughes, 2008), and preparation academically and socially for college (An, 2013a; Bailey & Karp, 2003; Karp & Hughes, 2008; Tobolowsky & Allen, 2016).

DE has been used as a strategy aimed at helping African American, low-income, and other students from underrepresented groups find success in college (Karp, 2012; Struhl & Vargas, 2012). However, research suggests that DE is not being accessed by underrepresented students at the same rate as majority students (Barnett & Stamm, 2010). This leaves the outstanding question if DE encourages and facilitates the college going process for underrepresented students or if it helps secure the position of students who would have gone to college anyway (An, 2013a).

In 2012, the North Carolina legislature passed a bill funding an expansive DE program called Career and College Promise (CCP). CCP opened access for high school juniors and seniors in one of two pathways: Career/Technical Education (CTE) and College Transfer Pathway (CTP). CTE pathways are meant to lead to industry recognized certifications that can be used to help employ students as a direct result of earning the credential (Eads, 2018). In 2012, CCP created the CTP pathways that allow students to take general education classes intended to transfer to college after high school where a student would choose a more specific majors (North Carolina Community College System [NCCCS] Office, 2019). A key component of the bill is the provision of free tuition for CCP students, therefore reducing financial barriers to participation. Since 2012, the North Carolina legislature has invested more than $111 million annually for tuition costs and the overall CCP program with the goal of increasing the number of North Carolinian's who have earned a college credential (NCCCS, 2019). This paper focuses on the broad effects of CTP on postsecondary attainment and in particular on the number of transfer classes earned.

The College Transfer Pathway (CTP) in North Carolina requires a 3.0 weighted high school GPA to participate which puts barriers in front of students who might benefit from participation (North Carolina State Law, 2011). There are many predisposed characteristics that predict differences in GPA, for instance students from high-income families are more likely to participate in advanced coursework and have more parental involvement in the college-going process (An, 2013a). Thus, descriptively examining participation in DE fails to help us understand how the program affects students' outcomes because students who participate are more likely to be college-ready (Struhl & Vargas, 2012). However, GPA reflects multiple aspects of education and is not quickly manipulated to gain access to the program. Given that CTP was enacted in 2012 and large, state-wide programs take a while to be implemented at scale, it is not likely that students were able to adjust their GPA in order to participate in CCP before 2014 where this study's sample begins.

Essay One descriptively shows the potential for DE in North Carolina to positively impact postsecondary outcomes. This essay builds upon that work through an evaluation of the CTP program in North Carolina on postsecondary attainment using a quasi-experimental approach. The results presented here provide stronger evidence of the effect of DE on postsecondary attainment because it helps rule out preexisting differences and selection effects that bias descriptive results (Struhl & Vargas, 2012). Specifically, the following study aims to understand the impact of participation in the College Transfer Pathway (CTP) of North Carolina's DE program - College and Career Promise (CCP) - on postsecondary attainment. Using a quasi-experimental method, Regression Discontinuity (RD), this study estimates the causal effect of CTP on postsecondary attainment. Results will inform policymakers about how building familiarity with college culture, earning college credit in high school, and early

exposure to support services through participation in the CTP pathway can affect postsecondary attainment. This study leverages the descriptive analysis and data presented in essay one to estimate the causal effect of CCP on postsecondary attainment.

Theory of Change

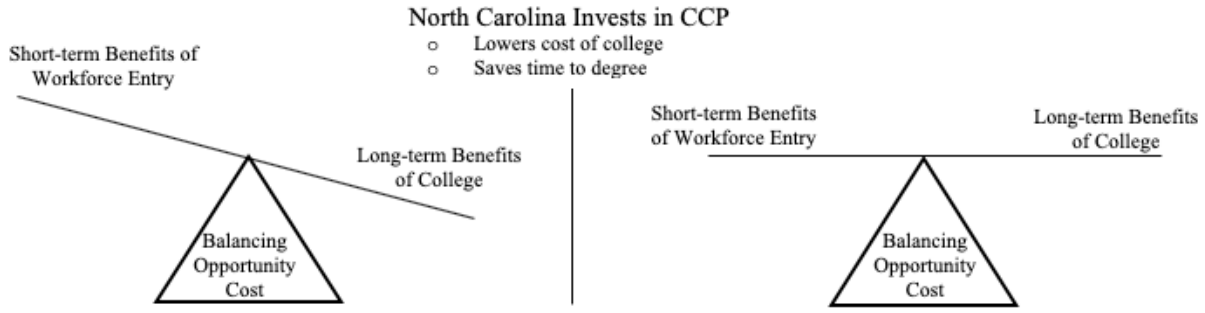
Becker's (1993) Human Capital Investment theory predicts that early investment into student's education will result in the downstream effect of increased productivity and earnings. One of the reasons students choose not to go to college is related to an "opportunity cost" where the immediate cost of foregoing employment or other opportunities is chosen over the long-term benefit of attending college (Becker, 1993). CCP lessens the opportunity cost by offering college coursework concurrently with high school curriculum and at no cost. In this way, we can predict that investing in college classes during high school will lead to increases in participation in the CTP pathway and students transferring to and enrolling in college after high school.

North Carolina's 2012 investment in CCP was intended to allow more students to participate via structured pathways where the courses taken by students lead to a credential. This policy coupled with the formation of stronger partnerships between community colleges and high schools should result in more students viewing CCP and continuing college after high school as a viable option. Evidence of stronger partnerships between high schools and colleges can be seen in the alignment of high school and college curriculum and by implementation of career coaches who are college staff, placed in high schools to counsel students on their pathway choice (Karp & Hughes, 2008; NCCCS, 2019) When students perceive CCP as a viable option and have access to resources to help them get enrolled, a college-going culture is cultivated or enhanced at the high school (Karp, 2012).

Figure 2.1 illustrates a theory of change where students are balancing the opportunity cost of the short-term benefits of entering the workforce to earn money immediately versus the long-term benefits of increased earnings in college that will cost them time and money. North Carolina's investment in CCP lowers the overall cost of college and saves the time it will take to earn a degree. This investment tips the opportunity cost balance for some students where perhaps the short-term and long-term benefits are weighed more equally.

Figure 2.1

Illustrated theory of change. Based on Becker's (1993) Human Capital Investment theory.



Note. CCP means Career and College Promise.

Participation in CCP prepares students with the social skills and academic experience to be successful in college (Bailey & Karp, 2003; Karp & Hughes, 2008; Tobolowsky & Allen, 2016). DE spurs momentum in college by providing students early exposure to the culture of college (An, 2013a; Karp, 2012). "Trying on" college while in high school lessens previous doubts about whether a student is able to "do" college (Tobolowsky & Allen, 2016). Additionally, students earn college credit while in high school serving as a momentum point for students as they transition out of high school and into college (An, 2013a). Essentially students are already partway to a college degree without delaying high school graduation. Students who have experience with the academic rigor of college classes and have had the opportunity to

experience the social norms of college should enroll in and complete college at higher rates than nonparticipants (Tobolowsky & Allen, 2016). Finally, participation in CCP removes part of the financial barrier to college because tuition in CCP is free and students should have fewer requirements to earning the degree after high school therefore making college less expensive. The combination of college experience, earning college credit early, and a decreased cost of college should result in increased postsecondary attainment.

The next section presents literature about DE and what previous research tells us about the differential effects of DE for groups of students. Next, I present other quasi-experimental research about DE though no previous quasi-experimental research on the DE program in North Carolina is available. Then, context is provided about higher education in North Carolina and the college transfer ecosystem. Finally, this paper will describe the RD methodology, results, discussion, limitations, and implications.

Policy Background and Related Research on Dual Enrollment

Students who participate in DE take college classes that simultaneously meet the graduation requirements for high school (Karp, 2012; Tobolowsky & Allen, 2016). DE has grown substantially over the past few decades. In 2013, 82% of all high schools in the U.S. offered DE and over two million students took advantage (Tobolowsky & Allen, 2016). In North Carolina for the 2016-2017 high school graduating class, 60.7% of seniors had earned college credit prior to gradation, which equals 21,784 seniors in a CTE or CTP pathway (Eads, 2018). Comparatively, growth has varied by state. For example, in Texas, DE increased 137% from 2004 to 2010, in Illinois it grew 76% from 2001 to 2008 (Taylor, 2015). In Virginia, Pretlow and Washington (2014) found that from 2004 to 2006, participation in DE increased 15.3% and the number of high schools offering DE rose from 76% to 86%. In 2015, 46 states offered DE to its

residents (Pretlow & Washington, 2014). This exponential growth has the potential to open access to higher education, but growth has not been across the board for underrepresented students. Table 2.1 shows that in 2012, DE participants in North Carolina had larger percentages of African American/Black students, American Indian/Alaskan Native students, and fewer White and Hispanic students compared to a national sample (NCCCS, 2019; Struhl & Vargas, 2012).

Table 2.1

Dual Enrollment Participation by Race/Ethnicity

Race/Ethnicity	% Nationally (2012)	% North Carolina (2012)	% North Carolina (2015)
American Indian/Alaskan Native	<1%	1%	1%
Asian/Pacific Islander	3%	2%	<1%
African American/Black	6%	14%	15%
Hispanic	24%	12%	9%
White	66%	62%	70%

Source. Column 1-Struhl & Vargas, 2012; Column 2-NCCCS, 2019; Column 3-Author's calculations using Department of Public Instruction (DPI) data from 2014-2015 academic year.

Between 2012 and 2015, DE participation in North Carolina saw an increase in the percentage of White students (62% to 70%), slight increases in African American/Black participation (14% to 15%) and American Indian/Alaskan Native (1% to 1.3%), but decreases in Asian/Pacific Islander (2% to <1%) and Hispanic student participation (12% to 9%). In some ways participation rates in North Carolina were more diverse than the national comparison group becoming more homogenized from 2012 to 2015. Additionally, nationwide low-income students represent 17.4% of DE participants and students with limited English proficiency represent 0.3%.

For admission into DE, colleges or college systems set admission requirements (Pretlow & Washington, 2014). Requirements may include ACT/SAT scores, a certain high school GPA, a letter of recommendation, and/or an application (Tobolowsky & Allen, 2016). These

admissions requirements may present participation barriers for underrepresented students. In North Carolina, the admissions requirements for CTE and CTP pathways are as follows: must be a North Carolina high school junior or senior[7], weighted high school GPA of 3.0, and a demonstration of college readiness in math and English (North Carolina State Law, 2011). For CTE pathways, students could also attain a letter of permission from their principal to participate in lieu of the GPA requirement (North Carolina State Law, 2011).

DE has the potential to benefit students academically. High school curriculum has traditionally taken a developmental approach to learning where students have multiple attempts to master a concept and may be able to resubmit assignments (Tobolowsky & Allen, 2016). This developmental approach helps aid student learning and may be the right approach for student's maturity level. However, students who have only experienced high school curriculum and subsequently attend college are faced with different, less developmental, academic expectations. The differing approach in teaching and learning creates a divide between student's understanding of academic expectations in the two different contexts of high school and college. Practice with college coursework and academic expectations can help build confidence and maturity in students (Tobolowsky & Allen, 2016). When students are exposed to college-level courses in high school they are introduced to rigorous curriculum that will prepare students for entering college after high school (Bailey & Karp, 2003; Karp & Hughes, 2008; Tobolowsky & Allen, 2016).

DE can also prepare students for college socially. Through participation in college classes during high school, DE helps students learn about college norms and provides students the

[7] At the time this dissertation was written there is a proposal before the State Board of Community Colleges to further expand CCP eligibility for 9th and 10th graders. In 2015-2016, eligibility for the program began in the 11th grade/junior year with the exception of 2 CTE pathways where 9th and 10th graders could enroll (North Carolina State law, 2011).

opportunity to practice operating within these norms (An, 2013a; Karp, 2012). Students who have exposure to the campus environment can anticipate challenges and have a more realistic understanding of the college culture which can increase their likelihood of success (Bailey & Karp, 2003; Karp & Hughes, 2008; Tobolowsky & Allen, 2016). Colleges commonly offer an array of resources to help students when they are struggling. Through DE, students are able to familiarize themselves with resources and the processes entailed with accessing them which could increase student usage of these support services and lead to increased success (Tobolowsky & Allen, 2016). Early exposure to college through DE means that when students enroll in college they can have a more seamless transition to the college environment both academically and socially (Karp, 2012).

While DE is discussed as a promising practice to smooth the transition from high school to college, there are also challenges associated with this practice. For students, DE is presented as a superior alternative to Advanced Placement (AP) courses as DE grants college credit based on the cumulative work in a course over the semester compared to a one-time exam as is the case with AP (Tobolowsky & Allen, 2016). Additionally, there is a cost to students who take this exam which may result in low-income students opting out of AP (Tobolowsky & Allen, 2016). However, AP has a longer history in the U.S. and colleges have standardized their acceptance of these scores for college credit (Speroni, 2011a). With DE courses, colleges students may be limited in their choice of major or attending their school of choice versus choosing the school that accepts their credits due to the way classes transfer (Tobolowsky & Allen, 2016). One study found that at the most competitive colleges only 33% accepted DE courses compared to 70% who accepted AP (Tobolowsky & Allen, 2016). While this credit acceptance rate presents a challenge, it is important to note that DE (82% of high schools) is more widely available than AP

(67% of high schools) particularly for underrepresented student populations (Tobolowsky & Allen, 2016).

Another set of challenges that DE faces is the cost of participation for states and school districts. Policies on who covers tuition costs vary by state where some states like North Carolina cover the cost of tuition, other states pass this cost along to students and families (Tobolowsky & Allen, 2016). In North Carolina the legislature pays the cost of tuition but funding for textbooks, supplies, and transportation is determined at the school district level (North Carolina State Law, 2011). Tobolowsky and Allen (2016) present that 60% of colleges nationally expect students to purchase textbooks and this is the second largest expense to participation. Generally, transportation is not covered either which is particularly concerning when thinking about participation for rural students or underrepresented students who do not have personal transportation options or access to public transit (Tobolowsky & Allen, 2016).

While only a handful of quasi-experimental studies have been conducted on DE, the majority found positive effects on postsecondary attainment outcomes (An, 2013a; Fink et al., 2017; Pretlow & Washington, 2014; Speroni, 2011a; Struhl & Vargas, 2012; Taylor, 2015). Most of these studies identify effects through propensity score matching. Similar to the method this paper proposes, Speroni (2011a) used RD by leveraging the minimum academic standard for DE participation in Florida to examine effects of DE on college degree completion. Postsecondary outcomes in DE research can be categorized into three areas: DE's impact on enrollment in college post-high school, student outcomes while enrolled in college such as persistence rates, and completion or transfer rates.

Participation in DE should increase a student's likelihood of enrollment in college after high school because students are already partway to earning their degree. Studies that have

examined this outcome show overall increased likelihood of DE students enrolling in any type of college after high school (Taylor, 2015). However, research shows mixed results about the type of college students choose (Table 2.2).

Closely related to enrollment in college is student academic readiness. An (2013a) studied how DE impacts student readiness and academic performance in college coursework. Using propensity score matching and controlling for student background characteristics, An (2013a) found that DE students were less likely to need remedial education in college and increased a student's degree attainment. Student academic preparation specifically related to DE's impact on remedial education is an area in need of additional research. An (2013a) was the lone study identified that measured this outcome and findings show the positive impact an early indicator of student success - academic readiness.

Table 2.2

Findings about Dual Enrollment's Increased Effect on Enrollment by College Type

Study	Increased Overall Enrollment in College	Increased Enrollment at 2-year college	Increased Enrollment at 4-year college
Fink et al.	x	x	N/A
Pretlow & Washington	x	N/A	N/A
Struhl & Vargas	x	N/A	x
Speroni	x	N/A	x

Source. Fink et al., 2017; Pretlow & Washington, 2014; Speroni, 2011a; Struhl & Vargas, 2012

Another important early indicator is student's persistence from term to term. While students are pursuing their credential there is the question of whether or not DE prepared students with the academic and social skills necessary to remain enrolled. Struhl and Vargas (2012) found that DE students were almost two times more likely to persist. While this research suggests that DE does increase student persistence, this was the only study that used quasi-

experimental or observational methods to measure student persistence. These early indicators of academic readiness and persistence are important to understand how a student progresses through college on their way to a degree (An, 2013b; Struhl & Vargas, 2012). Understanding if DE helps students ultimately attain their degree is the primary goal and these interim outcomes impacted by participation in DE help explain why we are observing current completion rates.

Another goal of DE is to help more students complete their credential. Credentials can include industry recognized certifications, associate degrees, and bachelor's degrees. Using propensity score matching An (2013b) found that participation in DE increased attainment of any postsecondary degree by 8 percentage points. Speroni (2011a) found similar results in a regression discontinuity study where DE students were 8.9 percentage points more likely to earn a bachelor's degree. Struhl and Vargas (2012) also used propensity score matching and found similar completion results where students who completed at least one DE class were 50% more likely (at least 1.66 times more likely) to complete a college degree in 6 years. This is a notable finding because they were able to follow students through 150% completion time which is a more common time to degree for students than 100% which many studies measure. Fink et al. (2017) compared completion outcomes across most states and found that 46% of DE students who enrolled in a community college subsequently earned their degree within five years whereas 64% of students who enrolled at a four-year school completed their degree within five years.

Previous research suggests that DE has an overall positive effect on student's postsecondary outcomes. Though the number of quasi-experimental studies on DE is low, many examine the heterogeneous effects of DE and most find statistically significant differences by student background characteristics and by the amount (dosage) of DE in which the student participated. Quasi-experimental studies that examine heterogeneous effects of DE on

postsecondary outcomes have had varied results (An, 2013b; Fink et al., 2017; Struhl & Vargas, 2012; Taylor, 2015). For example, Struhl and Vargas (2012) found that economically disadvantaged students who participated in DE were 2.41 times more likely to attend versus economically advantaged students who were only 2.03 times more likely to attend, indicating that DE helps economically disadvantaged students at a higher rate. Taylor (2015) found similar results where lower-income students were 30% more likely to enroll in college and 16% more likely to complete college compared to lower-income students who did not participate. In a national sample of data, An (2013b) found that DE did not close the degree attainment gap between higher-income and lower-income students and hypothesized that a focus on increased participation in DE by lower-income students may result in increased degree attainment. Fink et al. (2017) found that DE increased lower-income students' likelihood of attaining an associate's degree but this group lagged behind higher-income students on bachelor's degree attainment and persistence. Overall the research points to DE benefitting lower-income students but only if these students access DE.

DE outcomes also differ for students of different races and ethnicities. African American students who participated in DE are more likely to enroll in college after high school than African American nonparticipants (Struhl & Vargas, 2012; Taylor, 2015). However, African American students did not benefit from participation as much as White students. In a 2006 sample of Virginia students, Pretlow and Washington (2014) found that while White students made up 64% of the population, they represented 80% of the DE students. Conversely, African American students comprised 23% of the population but represented 14% of DE participants. These data suggest that DE programs meant to increase access to college for underrepresented students are not fully realizing the potential to benefit these students.

It is also important to consider how courses transfer to college after high school and what are the right number of courses for a student to take. Additionally, it is important to consider if the makeup of the courses plays a role in positive outcomes for DE. If courses do not transfer effectively there is the potential that participation in DE may not help the student earn their college degree more quickly. Due to the complications of how classes transfer, students may be limited to choosing a specific major or school that accepts their credits (Tobolowsky & Allen, 2016). This suggests there might be an optimum number of DE courses prior to the completion of high school (Tobolowsky & Allen, 2016).

Finally, there is the question of how many classes does a student need to realize the benefits of DE. Struhl and Vargas (2012) found evidence of a dosage effect where a student who participated in any amount of DE were 1.67 times more likely to enroll and 1.43 times more likely to complete a degree. Another result was that when students took more rigorous DE classes such as English language arts (ELA) or math they were 1.78 times more likely to enroll, 1.72 times more likely to complete a degree (Speroni, 2011a). If a student took two or more of these courses they were 1.89 times more likely to enroll and 1.83 times more likely to complete a degree (Speroni 2011a). Given that these more rigorous courses are those that students in North Carolina's CTP pathway are more likely to be taking, further research about the dosage and makeup of the DE courses and how these impact outcomes are important considerations. The CTP pathway is particularly important to CCP as it was the primary expansion of the program beginning in 2012 and has been a part of the larger policy effort within North Carolina to meet the state's college completion goal.

Policy Context

To understand how CTP can affect postsecondary attainment in North Carolina, it is important to understand the ecosystem of postsecondary education in the state. In North Carolina, there are 58 public two-year community colleges that each operate under the leadership of a Board of Trustees and a President. While daily operations of the college are largely at the discretion of local leadership, the North Carolina Community College State Board of Education establishes curriculum standards and policy, as well as funds the colleges based on their full-time enrollment (FTE). There are also 16 public four-year colleges and universities in North Carolina that operate in a similar structure to NCCCS with individual Boards of Trustees, Presidents, and oversight from the University of North Carolina System Office.

North Carolina has taken measures to ensure that North Carolina Community College System (NCCCS) and the University of North Carolina schools (UNC) are well aligned. Evidence of this began in 1996 with the establishment of a common course catalog for each system (NCCCS, 2019). This laid the foundation for the latest transfer agreement established in 2014 under the Comprehensive Articulation Agreement (the "agreement"). The "agreement's" goal is to ensure the "maximum transferability of credits" so that students taking a course at any community college would know what courses they would receive credit for at a UNC school. Students taking DE courses through the community college are able to benefit from this credit articulation that enables a smoother credit transition and is a strength of the education ecosystem in North Carolina.

North Carolina is also unique from other states because NCCCS was established to be accessible to all students across the state. Community College campuses were intentionally placed so that they would be within a 30-minute drive for more than 99% of residents in the state

(NCCCS, 2019). This distribution of colleges is meant to increase access to a college education, particularly for rural communities. As evidence of this broad access, NCCCS serves nearly 700,000 students annually at the 58 community colleges in the state. To support students in higher education, North Carolina has been a leader in national postsecondary initiatives such as statewide adoption of the completion by design practices, movement toward corequisite remediation for math and English, and implementation of guided pathways.

Methods

The process of student enrollment in DE programs and college is not observable. As described above, the selection process is likely driven by other characteristics and experiences that are also related to postsecondary outcomes. For example, students are more likely to select to enroll in college if they have more social capital available to them, have more or less financial ability to pay for college, and have differing college options available to them (Goodman, Hurwitz, & Smith, 2017). Thus, comparing naïve estimates of students who participate in CCP to students who do not participate will not accurately estimate the effect of the program on postsecondary attainment because they are biased by this selection process. Previous studies have used propensity score matching (An, 2013a, 2013b; Taylor, 2015) to minimize the bias introduced by student background characteristics. These student background characteristics can lead to overestimated effects in naïve estimates of DE on postsecondary attainment if not controlled for in experimental or quasi-experimental research design. Research that uses rigorous methods can reinforce or disprove findings particularly when replicated in different policy contexts such as North Carolina. I address this challenge by using a Regression Discontinuity (RD) design to examine the causal effects of the CTP program.

This study provides rigorous evidence of the effects of the CTP pathway by using an RD design that exploits the GPA based criterion for admission into the program to address the question of *What is the relationship between of dual enrollment in North Carolina and postsecondary attainment?* Specifically, this paper addresses the following research questions:

1. What is the effect of CTP on postsecondary enrollment?
2. What is the effect of CTP on number of postsecondary classes taken?
3. What effect does participation in CTP have on student persistence in college?
4. What effect does participation in CTP have on student's college credential completion?
5. What is the effect of participation in CTP on number of classes transferred to a UNC school?

The criterion for enrollment is based on a student's weighted high school GPA of 3.0 or above. Thus, students earning a 2.99 or below are not allowed to participate. GPAs are assigned by a cumulation of grades assigned by different teachers at the high school. GPAs are recorded at the end of each high school academic year. The GPA used in this study is the 10th grade weighted, cumulative, high school GPA which is used to determine eligibility for participation in CCP for the 11th grade year. The main identifying assumption is that the students who have a GPA around this threshold are not substantively different in their knowledge, interest in college, and later performance in postsecondary without participating in CTP. Below, I test this assumption by examining observable data for students who fall just above and just below the GPA threshold. By using the GPA cut score for enrollment, I am able to identify the causal effects of North Carolina's CTP program on postsecondary attainment.

Because the GPA threshold establishes participation eligibility externally from the selection bias introduced by student choice, motivation, and encouragement to participate from

family, I am able to exploit the threshold and assume that the students on either side of the threshold are as good as randomly assigned (Goodman et al., 2017; Speroni, 2011a). This approach requires the assumption that students do not manipulate their GPA in order to participate in the program.

The approach I employ is similar to the RD specification used in Speroni (2011a) where minimum academic requirements for participation in DE were used to explore the effect of DE on postsecondary attainment in Florida. It is assumed that other determinants of participation such as student motivation or maturity vary smoothly over the GPA cutoff while participation in CCP varies discontinuously at the 3.0 point. As shown in Figure 2.2, participation in CTP is not perfectly predictable by GPA. In other words, there were students who fell below the cutoff that were still able to gain access to the CTP program and participate. In order to control for the bias created by this non-compliance to assignment, I employ a two-stages least squares approach to estimate a "fuzzy" RD model. This model uses a system of two equations to only examine the impact of the program on the students who participated in CTP and held a GPA of 3.0 or high at the time of assignment.

Data and Sample

I use data from a longitudinal database called P-20 that connects the North Carolina K-12 Department of Public Instruction (DPI) data to NCCCS data, UNC, and North Carolina Commerce data through a unique identifier at the student level and is jointly overseen by these organizations. My access to the data are through the Research and Performance Management department at NCCCS. DPI data contain student background characteristics, high school academic information, free and reduced lunch status, and high school information. The DPI file is matched to NCCCS data which indicates which students enrolled in CCP, as well as college

academic information. Additionally, Research and Performance Management submitted community college student records to the National Student Clearinghouse that allows me to observe enrollment, persistence, and completion outcomes for CTP participants and nonparticipants at any postsecondary institution if it is available.

The treatment and comparison variable will be defined as 1=participation in CTP, 0=nonparticipation in any CCP pathway (CTP or CTE). Students are eligible to participate in CTP when they have a 3.0 weighted high school GPA. Students must be a high school junior or senior at a public North Carolina high school. In this analysis, the running variable is the weighted high school GPA as determined by the high school at the end of each term. For my sample of 10th graders in 2014-2015, high school GPAs in North Carolina are based on a ten point scale (North Carolina Public Schools, 2014). Honors courses and college courses were weighted with one quality point where advanced placement (AP) and international baccalaureate (IB) courses received two quality points (North Carolina Public Schools, 2014). This GPA calculation is mandated by DPI for all public high schools in North Carolina (North Carolina Public Schools, 2014).

The population consists of juniors and seniors in traditional North Carolina high schools who stayed in the same high school from 10th to 12th grade. Students are eligible to enroll in CTP every semester beginning their junior year. The sample includes students who participated in CTP at any point in high school, defined as the treatment group, and students who did not participate in either CTP or CTE, defined as the comparison group during academic years 2015-2016 and 2016-2017. Baseline characteristics from academic year 2014-2015 are used as control variables because they were determined the year prior to realization of the treatment as described in Lee and Lemieux (2010).

To observe community college outcomes during CCP and after high school, my data contain postsecondary enrollment, classes taken, persistence, and credential completion outcomes through academic year 2018-2019. Additionally, my data include the number of classes taken that transfer to a University of North Carolina school under the "agreement." For students who enrolled in a community college through CCP or after high school, postsecondary enrollment and completion outcomes are included in the data through the National Student Clearinghouse.

The sample includes students enrolled in traditional public high schools who remain in the same school during the 2014-2015, 2015-2016, 2016-2017 academic years. Movers who changed high schools anytime during these academic years are excluded including students who moved between North Carolina high schools, moved into North Carolina from another state, or students who left North Carolina. This is similar to the approach taken by Struhl and Vargas (2012) where researchers confined analysis to students enrolled in high schools within the state. Limiting the analysis to students who stay in the same high school creates a sample where students have similar levels of access to CTP due to the strength of the high school and college partnership and availability of the program extending only to students within North Carolina.

Approach to Causal Identification

To estimate the effect of CTP, I focus on students whose weighted GPAs fall near the 3.0 cutoff – an approach referred to as local linear regression because estimates of RD impact are "local" to the cutoff and within a narrow bandwidth. To identify optimal bandwidth around the cutoff, I use Calonico, Cattaneo, Farrell, and Titiunik's (2017) optimal bandwidth selection procedure. This approach is also used by Schudde and Scott-Clayton (2016). RD relies on the assumption that students who have GPAs that are just above the cutoff and just below are not

substantively different from each other and students' characteristics will be equally distributed across the "treatment" threshold (3.0 GPA) (Lee & Lemieux, 2010).

Compliance with the assignment rules was imperfect, where students who had below a 3.0 GPA were able to participate in CTP (Figure 2.2). I use a fuzzy RD design by implementing a two-stage least squares approach to estimate the effect of CTP on various outcomes for students who complied with assignment based upon GPA (Imbens & Lemieux, 2008). In the first stage, the threshold provides exogenous variation in the probability that a student participates in CTP. I use local linear regression so that the first stage takes the form:

$$Takeup_i = \alpha_0 + \alpha_1 CTPEligible_i + \alpha_2 GPA_i + \alpha_3 X_j + \alpha_4 County + \mu_i$$

Where *Takeup* indicates that student *i* participated in CTP and the variable *CTPEligible* indicates whether a student was above the CTP eligibility threshold. The running variable GPA is re-centered on the 3.0 cutoff. Coefficient α_1 represents the difference in participation probabilities between students just above and just below the threshold. High school level ($\alpha_3 X_j$) and county level covariates ($\alpha_4 County$) are included to control for differences between high schools and for differences between counties as described in essay one. Data for these controls are from DPI's publicly available reporting information. Additional covariates at the county level are included to control for differences in rurality (locale), differences in economic factors (employed percentage and mean household income), and differences in population density (total number of households). These data were obtained from the most recently available American Community Survey through the U.S. Census Bureau conducted in 2015. I use the predicted values from the first stage to estimate the following second-stage equation:

$$Y_i = \beta_0 + \beta_1 Takeup_i + \beta_2 GPA_i + \beta_3 X_j + \beta_4 County + \varepsilon_i$$

where Y_i are the outcomes of postsecondary enrollment in college, number of courses taken, term-to-term persistence, degree completion, and number of courses that transfer to a UNC school for student i. The coefficient β_1 estimates the impact of the takeup of CTP for compliers, those students whose CTP status was affected by the eligibility threshold; $\beta_3 X_{\mathrm{j}}$ is a vector of high school level covariates and $\beta_4 County$ is a set of county level controls. To control for differences between schools, high school level variables include the school performance grade, the percentage participation for student attendance, and the four-year graduation rate. These estimates represent local average treatment effects (LATE) for students near the 3.0 GPA cutoff.

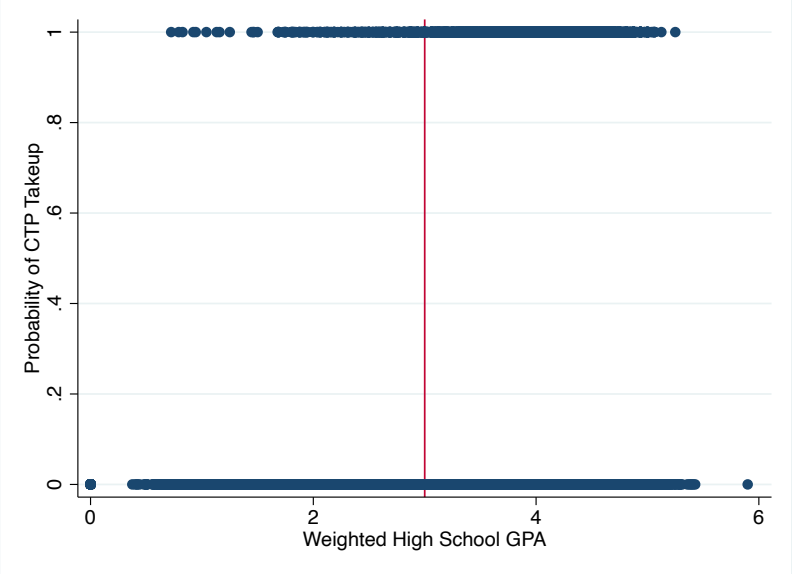
RD Validity Checks. This study uses a fuzzy RD design to control for imperfect compliance with the assignment rule of a 3.0 weighted high school GPA. Figure 2.2 shows that there are students with less than a 3.0 participating in CTP. The CCP legislation requires the 3.0 GPA for participation but includes a clause that allows principals to override the minimum GPA requirement for CTE pathways which may impact CTP. Imperfect assignment to CTP is problematic for an RD estimate because it violates the assumption that assignment to the treatment is as good as random. Fuzzy RD analysis can be used if the probability of assignment remains different for treatment and comparison groups (Imbens & Lemieux, 2008). Figure 2.3 presents evidence that CTP takeup differs where a there is nearly a 0.5 visible jump in the predicted takeup to the right of the 3.0 cut point. Given that I observe a difference in probability of assignment for the treatment and comparison groups I can proceed with a fuzzy RD which uses a treatment on the treated approach similar to instrumental variables and to account for noncompliance in the assignment variable (Imbens & Lemieux, 2008).

Additionally, for RD analysis to be valid, the assumption that there is smoothness in the density of observations must be met as outlined by Lee and Lemieux (2010). When smoothness

is observed it can be assumed that students cannot manipulate their GPA to gain access to CCP. Figure 2.4 presents visual evidence demonstrating smoothness in GPA across the cutoff with a +/- 0.549 bandwidth.

Figure 2.2

CTP Takeup by Weighted High School GPA: Evidence of Imperfect Assignment



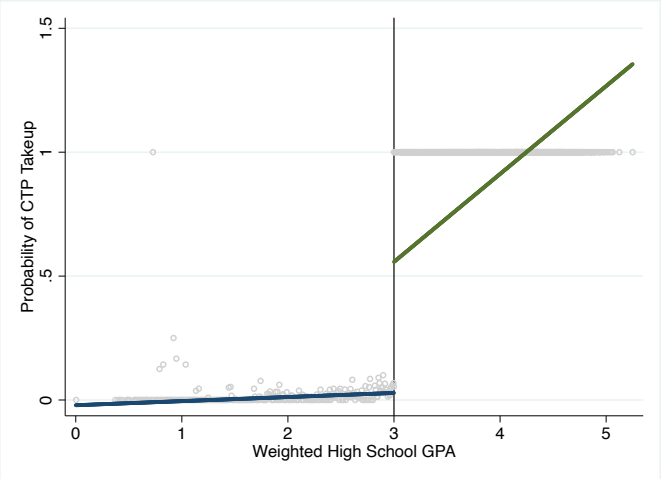
Note. Author's calculations based on student's 10th grade demographics in 2014-2015, were juniors in 2015-2016 in traditional North Carolina high schools, who stayed in the same high school through 12th grade. Sample is also limited to treated students enrolled in the CTP pathway.

Another assumption of RD is that the threshold assignment to the treatment or to standard practice is as good and random around the cut off (Lee & Lemieux, 2010). To test the extent to which participants are randomized around the 3.0 GPA cutoff, I present baseline characteristics for my population of interest in the year prior to their eligibility for CTP, characteristics include gender, race/ethnicity, participation in free and reduced lunch, school performance grade, four year high school graduation rate, rural and city locale, and mean household income (see Figure 2.5). Figure 2.5 demonstrates visual evidence of smoothness in the distribution of some

Figure 2.5.

Figure 2.3

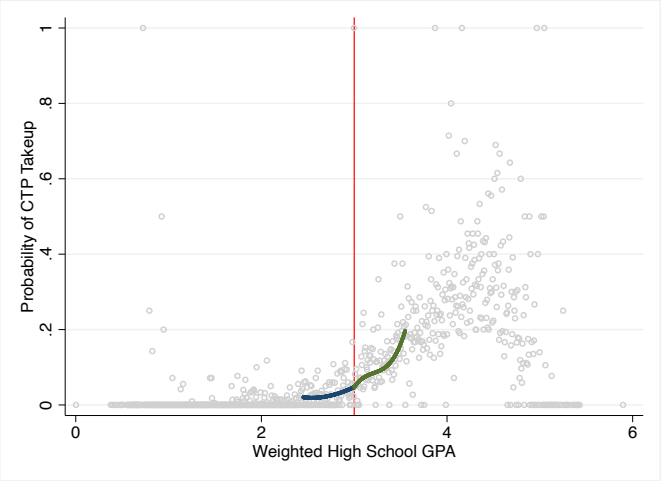
Predicted CTP Takeup by Weighted High School GPA: Demonstration of Discontinuity at the 3.0 cut point



Note. Author's calculations using fuzzy RD, based on student's 10th grade demographics in 2014-2015, were juniors in 2015-2016 in traditional North Carolina high schools, who stayed in the same high school through 12th grade.. Students with above 3.0 GPA who do not participate in CTP were dropped.

Figure 2.4

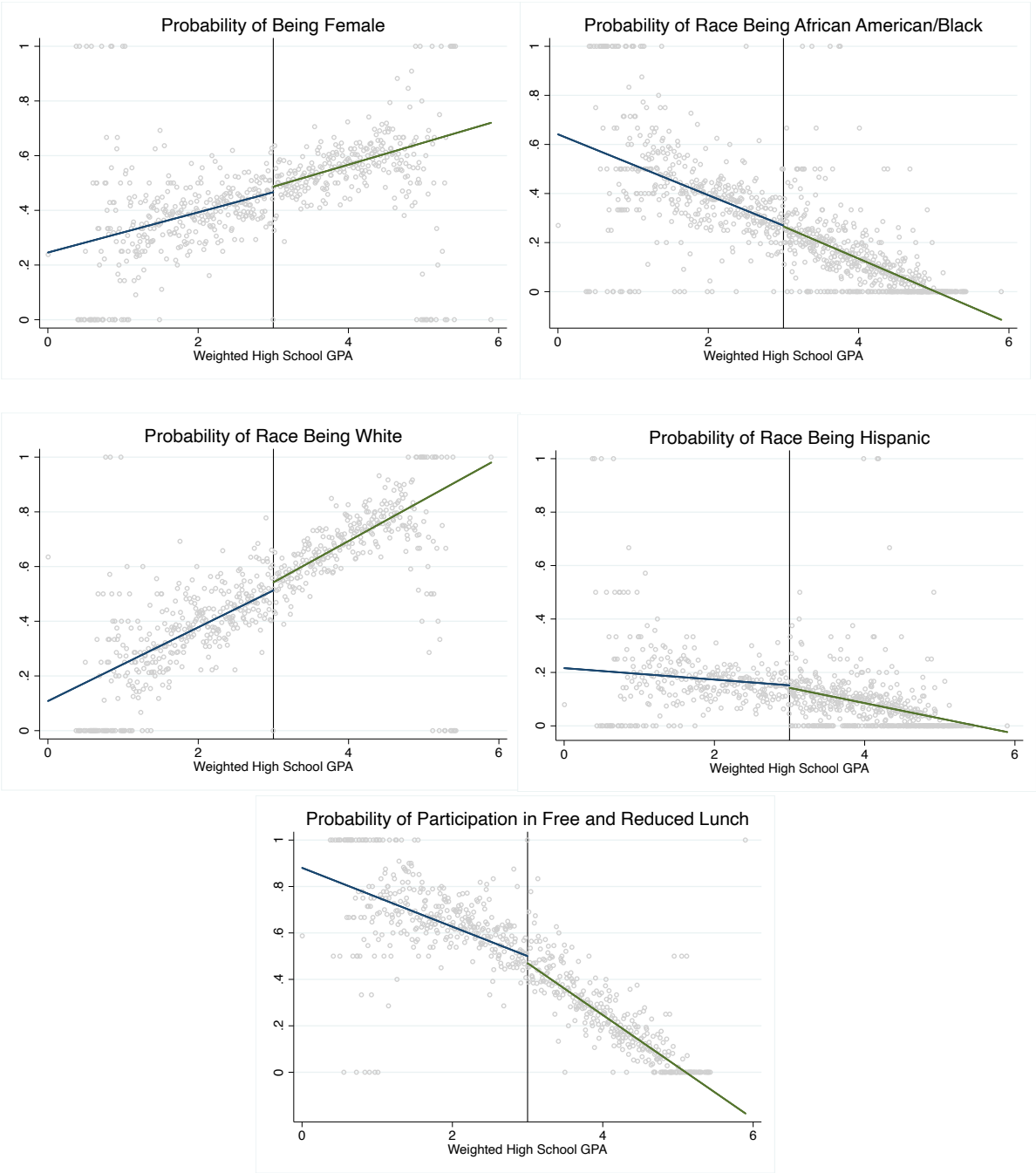
Smoothness of Weighted High School GPA Around +/- 0.549 Bandwidth



Note. Author's calculations based on student's 10th grade demographics in 2014-2015, were juniors in 2015-2016 in traditional North Carolina high schools, who stayed in the same high school through 12th grade. Cubic regression lines show sample within +/- 0.549 bandwidth.

Figure 2.5

Estimated Fuzzy RD Observable Characteristics



Note. Author's calculations based on student's 10th grade demographics in 2014-2015, were juniors in 2015-2016 in traditional North Carolina high schools, who stayed in the same high school through 12th grade. Sample is also limited to students who enrolled in the CTP pathway vs CTE pathway. Linear regression lines show sample within +/- 0.549 bandwidth.

characteristics around the cutoff, additional figures can be found in Appendix A. This visual evidence of balance in observed covariates across the threshold supports the use of GPA in an RD model and suggests the weighted high school GPA cutoff of 3.0 is as good as random (Lee & Lemieux, 2010) for student characteristics and some high school characteristics but is not smooth for rural versus urban local and household income.

To further explore smoothness across the threshold, I provide two tests for balance. In Table 2.3, I compare the full sample's mean characteristics compared to the sample around a +/- 0.549 bandwidth for the both treated and comparison groups. Rubin (2001) says that if the standardized difference is less than +/- 0.25 or the variance ratio is near 1.0 than the covariates are sufficiently balanced. In the full sample, the bolded numbers demonstrate that all observable characteristics except four year high school graduation rate are unbalanced indicated by the standard difference and/or the variance ratio. Within the bandwidth sample the only observable characteristic that narrowly shows unbalance is the race/ethnicity of White. This is unsurprising given descriptive evidence that CCP participation among White students exceeds that of other racial/ethnic groups (Table 1.1).

Further evidence of balance is presented in Table 2.4 where the probability of student's having certain observable student demographics are estimated using Fuzzy RD methods. Of the student level characteristics presented none show statistical significance. However, high school level and county level characteristics show statistically significant relationships ($p<0.001$) between weighted high school GPA and school performance grade, four year high school graduation rate, rural and urban locales, and mean household income. One potential reason for these observed differences are that schools that were reporting less than 2% of student GPAs were excluded from analysis, these schools may be different in ways that are unobservable in my

Table 2.3

Covariate Balance

Outcome	Full Sample				Within 0.549 Bandwidth			
	Treated Mean	Comp. Mean	Stand. Diff.	Var. Ratio	Treated Mean	Comp. Mean	Stand. Diff.	Var. Ratio
Female	62%	41%	**0.423**	0.998	53%	44%	0.181	1.008
White	73%	41%	**0.698**	**0.807**	60%	48%	**0.250**	0.959
Black	12%	37%	**-0.586**	**0.467**	21%	30%	-0.206	0.793
Hispanic	9%	17%	**-0.252**	**0.556**	13%	16%	-0.078	0.853
Free and Reduced Lunch	29%	60%	**-0.651**	0.858	42%	53%	-0.220	0.974
School Performance Score	74%	69%	**-0.464**	1.054	71	69	0.210	0.897
4-year High School Graduation Rate	89%	88%	0.208	0.892	89%	88%	0.129	0.955
Rural Locale	48%	35%	**0.258**	0.892	41%	37%	0.092	1.042
Urban Locale	18%	31%	**-0.308**	**0.685**	24%	28%	-0.091	0.908
Mean Household Income	$63,113	$68,283	**-0.370**	0.890	$66,928	$67,764	-0.057	1.090
Sample Size	6,419	21,826			1,716	8,526		

Note. Bolded data indicates violation of Rubin's (2001) balance rule that a standard difference less than 0.25 is acceptable and a variance ratio close to 1 is acceptable. Source: Author's calculations based on student's 10th grade demographics in 2014-2015, were juniors in 2015-2016 in traditional North Carolina high schools, who stayed in the same high school through 12th grade. Treated students are limited to those enrolled in the CTP pathway.

Table 2.4

Covariate Balance with Fuzzy RD Estimates

Outcome	Baseline RD-IV Bandwidth: 0.549	
Female	0.094	(0.620)
White	0.064	(0.734)
Black	0.152	(0.374)
Hispanic	-0.167	(0.206)
Free and Reduced Lunch	-0.236	(0.216)
School Performance Grade	23.809	(4.398)***
4-year High School Graduation Rate	7.103	(1.132)***
Rural Locale	-0.714	(0.188)***
Urban Locale	0.529	(0.179)**
Mean Household Income	$36,593	(6,362.4)***
Sample Size	10,242	

Note. Author's calculations based on student's 10th grade demographics in 2014-2015, were juniors in 2015-2016 in traditional North Carolina high schools, who stayed in the same high school through 12th grade. High schools are limited to those report at least 98% of student's GPAs. Treated students are limited to those enrolled in the CTP pathway. $p< 0.10$*, $p< 0.05$**, $p< 0.001$***

dataset compared to schools that did report GPAs. However, using Rubin's (2001) rule these high school and county characteristics do not show unbalance (Table 2.3). Alternative bandwidth specifications for balance tests are presented in Appendix B.

RD Power and Sensitivity Checks. To demonstrate that this study has sufficient power, a power analysis was conducted using Stata's rdpower package as described by Cattaneo, Titiunik, & Vazquez-Bare (2019). Running rdpower at a significance level of $p< 0.05$, a

bandwidth of +/- 0.549, 8,525 observations to the right of the cutoff and 1,716 to the right of the cutoff produces a power calculation of 1.00 which is well above the typical power of 0.80 (Cattaneo et al., 2019) and with an effect size of 0.09.

Results

The first column of Table 2.5 presents the mean of the outcome variables at the 3.0 weighted GPA cutoff to help interpret the magnitude of effects for students near the cutoff. The first line presents the first stage results showing that takeup of the CTP pathway has a positive relationship with and is predicted by weighted high school GPA, significant at $p< 0.001$. Results from my preferred fuzzy RD specification are presented in column 2 of Table 2.5 and column 3 shows the same results without control covariates.

The second row of Table 2.5 shows the proximal outcome of enrollment in college after high school, which is a positive and large result, where students who participate in CTP are 24.3 percentage points more likely to enroll in college. Using RD, Speroni (2011a) also found positive effects on postsecondary enrollment with an 11.3 percentage point increase. For every outcome when using RD there is an optimal bandwidth, Column 4 lists the bandwidth as determined by Stata (rdbwselect) and the resulting sample size (Calonico et al., 2017). Following Imbens and Lemieux (2008), I focus on a simple kernel bandwidth but also verify robustness of results with different choices of bandwidth (Appendix B).

I find no significant effect of CTP on persistence, the number of courses taken in the first postsecondary year, or graduation inclusive of associate's degrees, diplomas, and certificates within 100% time (two years) to graduation. The third row measures persistence defined as students who enroll in college after high school and remain enrolled in the second year or successfully graduate; this result shows a small, positive relationship but a null effect. Next, I

look at the number of cumulative courses taken at a community college by the end of the first postsecondary year; this result is also null. The fifth line shows a small, positive relationship and null results for if a student graduated from a community college by the end of academic year 2018-2019 with any credential including associate's degree, diploma, or certificate.

Table 2.5

Fuzzy RD estimates of the Effect of CTP on Postsecondary Attainment

Outcome	(1) Mean GPA = 3.0	(2) RD-IV	(3) RD-IV No covariates	Bandwidth	Sample Size
First-stage Estimates of CTP Takeup	5.4%	0.143 (0.008)****	0.136 (0.008)***	+/- 0.657	12,379
Enrollment at Any College	40.7%	0.243 (0.134)*	0.261 (0.141)*	+/- 0.657	12,379
Persisted Year 1 to Year 2 in Any College (if not graduated)	21.3%	0.089 (0.102)	0.076 (0.106)	+/- 0.728	13,169
# College Courses Taken 1 Year Postsecondary	2.1	0.119 (1.010)	0.001 (1.058)	+/- 0.673	12,587
Graduated by 2018-2019	2.7%	0.012 (0.074)	-0.014 (0.080)	+/- 0.507	9,505
UNC Transfer Courses	3.7	2.711 (0.333)****	2.921 (0.372)****	+/- 0.419	3,650

Note. *p< 0.10; **p < 0.05; ***p < 0.01; ****p < 0.001 Source: Author's calculations based on student's 10th grade demographics in 2014-2015, were juniors in 2015-2016 in traditional North Carolina high schools, who stayed in the same high school through 12th grade. Treated students are limited to those enrolled in the CTP pathway.

The last outcome shows the impact of participation in CTP on the number of classes that transfer to a UNC school where students who participate in CTP transfer 2.711 more courses. The number of courses that transfer is calculated by comparing the courses that a student took in

the CTP pathway with the courses that would be accepted at a UNC school. Students in CTP take almost 3 classes that transfer to the UNC system which reduces the number of classes they will need to take for their bachelor's degree. This outcome has a large, positive effect that is significant at $p<0.001$. This outcome supports a hypothesis that students who are taking CTP through the community college may be choosing to enroll directly in UNC or other schools after high school instead of continuing on at the community college. In my dataset, the number of classes that transfer to a UNC school is the only non-community college outcome I can observe for students in both the treatment and comparison groups.

Subgroup Analysis

To understand if CTP has the potential to increase postsecondary attainment across North Carolina, it is important to understand who benefits from participation in the program. To understand which students benefit from participation, I present subgroup heterogeneous effects of participation in the CTP pathway on postsecondary attainment. Table 2.6 shows that some of the effects on different groups of students are masked by the aggregated results in Table 2.5. Importantly in Column 5, for Hispanic students there is a positive and statistically significant effect of CTP on postsecondary enrollment, persistence, and UNC transfer courses where Hispanic CTP participants are 69.7 percentage points more likely to enroll in college after high school ($p<0.05$), 59.8 percentage points more likely to persist ($p<0.05$), and have 1.44 more classes transfer to a UNC school ($p<0.10$). Hispanic students are the only group to have significant graduation results where they are 36.4 percentage points more likely to have earned a credential from a community college ($p<0.10$). It's noteworthy that my results have larger standard errors and therefore the results are less precise.

Table 2.6

Fuzzy RD estimates of the Heterogeneous Effects of CTP on Postsecondary Attainment

Outcome	(1) Female	(2) Male	(3) White	(4) African American/ Black	(5) Hispanic	(6) Free/Reduced Lunch	(7) Rural
Enrollment at Any College	0.326 (0.160)**	0.112 (0.233)	0.617 (0.919)	0.522 (0.458)	0.697 (0.345)**	0.475 (0.227)**	0.220 (0.153)
Persisted Year 1 to Year 2 in Any College (if not graduated)	0.733 (0.124)	0.117 (0.175)	0.316 (0.794)	0.046 (0.300)	0.598 (0.284)**	0.404 (0.166)***	0.056 (0.121)
# College Courses Taken 1 Year Postsecondary	-3.065 (1.053)***	-2.558 (1.417)*	-7.655 (6.952)	-1.854 (2.663)	1.672 (2.251)	-1.839 (1.466)	-2.839 (1.066)
Graduated by 2018-2019	-0.008 (0.091)	0.438 (0.122)	0.163 (0.411)	-0.104 (0.196)	0.364 (0.217)*	0.109 (0.118)	-0.015 (0.083)
UNC Transfer Courses	2.870 (0.468)****	2.619 (0.465)****	3.942 (1.437)****	3.161 (1.394)**	1.443 (0.837)*	2.548 (0.651)****	2.742 (0.436)****

Note. *p<.10; **p < .05; ***p < .01; ****p < .001 Source: Author's calculations based on student's 10th grade demographics in 2014-2015, were juniors in 2015-2016 in traditional North Carolina high schools, who stayed in the same high school through 12th grade. Treated students are limited to those enrolled in the CTP pathway.

Column 1 shows that female students who participate in CTP are 32.6 percentage point more likely to enroll in college after high school ($p<0.05$) and transfer 2.870 classes to UNC ($p<0.001$). Results also show that female students take 3.065 fewer classes by the end of their first postsecondary year compared to male students ($p<0.01$). African American/Black students have the fewest significant effects of any subgroup where the only statistically significant effect is for CTP on UNC transfer courses where African American/Black students transfer 3.161 classes ($p<0.001$). The number of transfer classes for African American/Black students is larger than any other subgroup and larger than the aggregate results presented in Table 2.5. These results differ from previous research where significant effects on postsecondary enrollment and graduation were found (Struhl & Vargas, 2012; Taylor, 2015).

Column 6 shows low-income students who have the free or reduced lunch program also have greater effects from participation in CTP where they are 47.5 percentage points more likely to enroll in college ($p<0.05$) consistent with the findings of Fink et al. (2017). Students with free or reduced lunch also are 40.4 percentage points more likely to persist in college ($p<0.01$) and transfer 2.548 courses to UNC ($p<0.001$). I find no statistically significant effects of CTP on courses taken or graduation for low-income students. There is a positive and statistically significant effect of CTP for students in rural high schools where rural students transfer 2.742 courses to UNC ($p<0.001$). There are no statistically significant effects for rural students on postsecondary enrollment, persistence, courses taken, or graduation. Overall, this RD analysis demonstrates that participation in CTP has a positive and significant impact on postsecondary attainment for subgroups of students near the cutoff. In particular results are positive and significant for Hispanic students and for students transferring courses to a UNC school.

Robustness Checks

I chose the initial bandwidth presented in Table 2.5 using Stata (rdbwselect) where the fuzzy variable is "takeup" and the bandwidth selection (msesum) specifies the sum of the regression estimates on either side of the cut point. This bandwidth selection accounts for how well the regression line fits the data and allows more students to be included in the analysis compared to the default bandwidth (Calonico et al., 2017). Initial bandwidths produced for each outcome range from +/- 0.419 to +/- 0.728 which consistent with Schudde and Scott-Clayton (2016) who also use GPA in RD calculations. The results from this bandwidth robustness check are available in Appendix C. To test the robustness of the bandwidth selection, I use a second bandwidth (mserd) which specifies one common mean squared error, measuring how close the regression lines above and below the cutoff are to my data (Calonico et al., 2017). Results using the alternative bandwidth selection do not differ substantively from those presented in Table 2.5 but include fewer students. In addition to testing the validity of the RD assumptions, I evaluated the sensitivity of results to alternative specifications such as variations in bandwidth, squared and functional forms (Appendix C). I also present results with uniform kernel specifications. Finally, I test the validity of the 3.0 cutoff by examining whether RD produces similar results at the alternative GPA cutoff of 2.0 finding no discontinuity at this cutoff (Appendix C).

Delimitations and Limitations

Delimitations of this study are the groups of students who have not been included for analysis. First, I delimit analysis to students who remained in the same high school during academic years 2014-2015, 2015-2016, and 2016-2017. I also removed charter schools from my analysis. In the year 2014-2015 within my date the majority of the charter schools had more than 98% missing academic data including high school GPA. Finally, my sample is limited to the

CTP pathway though many students participate in the CTE pathway they were not included in this analysis due to the GPA exception high school principals can make to allow participation for GPAs below 3.0.

As is the case with all RD studies, this study is limited in the ability to extrapolate results to students who have weighted high school GPAs outside of my bandwidth. RD studies estimate a local average treatment effect (LATE) and therefore students with a very high or very low GPA may have different outcomes. This study offers inference into the causal effect of CTP on postsecondary attainment for students near the threshold of a 3.0 weighted high school GPA. This is important to understand the effects of students who just made the cutoff and can open discussions about if the cutoff of 3.0 is the appropriate metric, opening to students at a lower GPA could allow CTP to serve more students and have a positive impact.

My data are also limited because the outcome data available from NCCCS are mostly limited to individuals who had enrollment records at a community college and therefore outcomes such as enrollment at a UNC school would exclude students in my comparison group. The outcome of UNC transfer courses had records for both my treatment and comparison groups. Finally, it is common for students to take longer than two years to earn an associate's degree and the most recent data available limits my observation of student degree attainment past two years postsecondary.

Discussion

In this paper, I provide evidence regarding the effect of participation in the CTP pathway on postsecondary outcomes using a state longitudinal database that follows students from high school through college. The national trends I discuss in the introduction suggest that participation in DE program increases postsecondary attainment. Yet while participation in DE programs

increases postsecondary attainment; the programs may not always reach students who are most in need of increased access to education. My results show promising impact of the effects of CTP on postsecondary attainment particularly for Hispanic and low-income students who are near the GPA threshold. Results show that these students are realizing more positive effects than other groups of students though the overall aggregated effects show little statistical significance. These results are consistent with descriptive outcomes that show Hispanic students have the highest persistence rates (81%) of any subgroup in the CCP program (Essay One, Table 1.5). North Carolina's CTP program is designed for students to take college classes in high school tuition free, where the courses articulate to associate's and bachelor's degrees within the state. This articulation agreement (the CAA) provides clear application of credit that should benefit students and prevent the loss of college credit as students transfer.

Effects are also consistent with my earlier application of Becker's Human Capital Theory (1993) that early investments in education will lead to increases in postsecondary enrollment and transfer. The theory of change, based on Becker's (1993) theory, hypothesizes that investment into CCP will lessen the perceived benefits of a student's direct entry into the workforce and will increase the perceived benefits of pursing postsecondary education. This study shows how the investment into the CCP program can shift the balance of opportunity cost by helping students by saving time - earning college credit in high school and by saving money – where CCP is offered tuition free. Results show that for some students' participation in the CTP pathway increases postsecondary enrollment, persistence, and the number of courses that transfer to UNC when students could have chosen to enter the workforce directly after high school.

Results show that African American/Black students and rural students do not have the large effects in this study as compared to Hispanic and low-income students who are also less

likely to access higher education and but could realize similar benefits. The gap between African American/Black students and other students is consistent with previous research that suggests there is a 15-20 percentage point gap between African American/Black students and White students (Fink et al., 2017; Shapiro et al., 2017). Other groups of students that this study can extend to are first-generation college students though they are difficult to systematically identify. However, first-generation college students are likely to be low-income (An, 2013a, 2013b) and this study does demonstrate that students participating in free and reduced lunch are more likely to enroll in community college, persist in community college, and transfer courses to a UNC institution. Previous research used propensity score matching and found that first-generation students of all races who participated in DE were equally likely to attain a degree compared to non-first-generation students after controlling for other background characteristics (An, 2013a, 2013b). Other characteristics included in the model were parental education, parental occupation, family income, family structure, significant influences from others in the student's life, college aspiration and expectations, and academic performance. These controls are robust and are informative of how this study controls for factors beyond a student's own demographics; these controls provide evidence that the positive and significant results observed here are due to participation in CTP and not another unobservable characteristics.

An important finding from this study are the large and positive effects of CTP on number of courses that transfer to a UNC institution. Across all models, the number of UNC transfer courses were positive and statistically significant ($p < 0.001$) where students who participate in CTP take about two more classes than non-participants. In real dollars at North Carolina State University, a member of the UNC system, this would result in a savings of $2,275.15 (North Carolina State University, 2020). The CTP pathway is designed for students to transfer credit

directly to both the community colleges but importantly to the UNC schools as well. The results of this study show promise that the impact of CTP could extend beyond community college outcomes and that CTP could also have a positive and significant impact for students on bachelor's degree attainment.

Implications and Future Research

This manuscript offers five recommendations that will offer additional detail for researchers and policy makers. Two recommendations for future research include following students through graduation of a bachelor's degree and understanding how CTP effects additional UNC outcomes. Three recommendations for policy and practice include equity considerations in the pipeline to enrollment in CTP, how CTP contributes to statewide completion goals, and how the CAA influences postsecondary attainment through CTP. Finally, this manuscript offers a recommendation for replication of this study based on the new GPA requirement for CCP entry due to changes in state policy.

Main results of this study show a positive relationship between participation in CTP and college persistence and graduation (Table 2.5, Column 2) however subgroup analyses show the relationship between CTP and graduation is negative (Table 2.6). Though my results do not show significant effects on persistence or graduation and results are mixed, other quasi-experimental research has found positive effects of DE on persistence (Struhl & Vargas, 2012) and graduation (Speroni, 2011a; Taylor 2015). Based on my descriptive analysis it is my hypothesis that this study doesn't show effects on persistence and graduation because the majority of students accessing CTP are pursuing a bachelor's degree after high school and this study does not follow the students long enough to measure bachelor's degree outcomes. For the graduation outcome in particular, further research should follow this cohort of students through 2020-2021 (two years

postsecondary), to provide a clearer picture of the impact of CTP on credential attainment. This research should include an examination of additional student outcomes at UNC schools such as students who are taking general education classes in CTP with the hopes of applying those courses to a more specific major at a senior institution. It would be helpful to better understand the relationship between CTP and how courses taken are applied in practice to specific majors. Additionally, it would be helpful to understand if CTP reduces a student's time to degree. For example, do CTP students who go on to UNC schools earn their bachelor's in 3.5 years vs. 4 years since they are bringing in credits.

Additionally, previous research and this study point to DE benefiting low-income and underrepresented students but only if those students are able to access the program. Essay one shows that students with lower socio-economic status access CTP at a much lower rates (30%) than the overall population (44%) (Tables 1.1 and 1.2). This trend holds where African American/Black CTP students (11%) and Hispanic CTP students (6%) are also underrepresented compared to the population (24% and 12%) (Tables 1.1 and 1.2). However, for underrepresented students who do participate results show that Hispanic and lower income students experience greater effects from participation in CTP is policy relevant given the stated goals for postsecondary attainment in North Carolina and for the CCP program where the state aims to increase the number of students who have earned a credential by 2030 (myFutureNC Commission, 2019). For CCP, it is important that such a large investment by the legislature provides postsecondary opportunities for students who may not already be college bound because nationally we know that Hispanic and low-income students are among the groups of students less likely to access higher education (Fink et al., 2017). In North Carolina, more research needs to be done about why lower income, first-generation, and African American

students are not choosing CTP. If the pipeline to enrollment was more equitable we would have a better understanding about how CTP benefits all students and begin to address these inequitable outcomes.

As noted earlier, North Carolina has spent substantial effort into aligning the community college and UNC curriculum to facilitate transfer through the CAA. These results suggest that these efforts are useful in helping students articulate their credit earned in CTP to their postsecondary aspirations. The alignment of coursework is important and staff who are in positions to advise CTP students should be well-versed in the CAA to ensure students maximize their articulation of credits. To help students maximize credit, staff can help high school students weigh the opportunity costs and benefits of participation in CTP on bachelor's degree attainment. Previous research has explored the mechanism by which DE influences postsecondary attainment including building familiarity with college culture, earning college credit in high school, and early exposure to support services (Bailey & Karp, 2008; Karp, 2012; Tobolowsky & Allen, 2016). Extending this research to the results of this study can help policymakers better understand how participation in the CTP pathway can positively affect postsecondary attainment and move the state toward its completion goals.

Finally, in 2019-2020 the academic requirements to access CCP changed to a weighted high school GPA of 2.8 as a result of the state's movement toward co-requisite remediation and away from pre-requisite developmental education. The movement to a 2.8 GPA aligns the requirements for entry into CTP with the GPA standards for college readiness in gateway math and English courses. This RD analysis should be replicated to understand the impacts of this new threshold and how they compare to the 3.0 threshold. My dataset suggests that in the 2015-2016 academic year alone, 3,892 additional students would have been eligible to participate in CTP if

the GPA threshold had been a 2.8 rather than a 3.0. This policy change creates the opportunity for an additional comparison group of students and can provide insight into the impact of CTP on this group of students who fall between the new and old GPA cutoffs. Many states have minimum academic requirements for participation in DE. Research can explore how these requirements might serve as a barrier for lower achieving students who now benefit from participation. CCP remains a promising program and while these results provide insight into its impact on postsecondary attainment for students, recent policy changes provide opportunity for further inquiry using RD and other quasi-experimental methods to weave together an impact story of CCP on postsecondary attainment in North Carolina.

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ESSAY THREE: THE EFFECT OF COLLEGE AND CAREER PROMISE ON POSTSECONDARY ATTAINMENT: AN INSTRUMENTAL VARIABLES APPROACH

Introduction

Postsecondary attainment in North Carolina lags behind the predicted need for workers with a college credential (myFuture NC Commission, 2019). In response to this predicted need, North Carolina set the ambitious goal for 2 million North Carolinians to hold a postsecondary credential by 2030 (myFuture NC Commission, 2019). This represents double the population of projected degrees earned if current trends in college attainment persist. To reach this goal, policymakers and practitioners are prioritizing programs that create collaborative opportunities between the K-12 and postsecondary sectors to provide support for and incentivize college completion. Dual Enrollment (DE) as described in essay one (p. 42) is a strategy used nationwide that allows high school students to take college classes to earn credit that will count both towards a college degree and high school graduation (Karp, 2012).

In 2012, North Carolina implemented Career and College Promise (CCP) to provide college transfer and career and technical degree pathways for high school students (North Carolina State Law, 2011). The new pathways are structured so that the courses taken by students lead to a credential (certificate, diploma, or associate's degree) earned at the community college. CCP is a comprehensive dual enrollment program that provides free college tuition for eligible high school juniors and seniors and is a partnership between local community colleges and high schools (North Carolina State Law, 2011).

The CCP program in North Carolina has bi-partisan support amongst the legislature as funding and support staff continue to increase (North Carolina State Board of Community Colleges, 2018). For example, in 2015-2016 the legislature funded 28 Career Coaches who serve

as support staff for CCP students, by 2018-2019 there were 70 funded Career Coaches (North Carolina State Board of Community Colleges, 2016; 2019). Additionally, in 2016-2017 funding for CCP totaled over $111 million dollars which represents over 10% of the North Carolina Community College System's (NCCCS) budget (North Carolina State Board of Community Colleges, 2018). Enrollment in CCP statewide increased 258% between 2008-2009 to 2016-2017 demonstrating the recognition of the program's value with students and their families as well as for enrollment purposes at community colleges (Coltrane & Eads, 2018; Eads, 2018).

Research of the impact of dual enrollment programs on postsecondary attainment show positive relationships between participation and postsecondary attainment (An, 2013a, 2013b; Speroni 2011b; Struhl & Vargas, 2012, Taylor, 2015; Wang et al., 2015). Much of this research leverages state data to understand the effects of dual enrollment within the state specific policy context (An 2013a, 2013b; Taylor, 2015, Wang et al., 2015). This study leverages state longitudinal data within North Carolina to understand the effect of CCP on postsecondary attainment situated within this state's context.

The instrumental variables (IV) technique used in this paper leverages an exogenous source of variation in CCP participation, distance to a community college, to estimate the effect of CCP on postsecondary attainment. Participation in CCP is associated with increased retention, credential completion, and lower dropout rates (Coltrane & Eads, 2018). Students in CCP have higher GPAs and course success rates (Coltrane & Eads, 2018). This paper uses an IV technique to control for unobserved confounding variables and to estimate the causal effect of participation in CCP on postsecondary attainment.

This study builds upon previous research about the effect of DE on postsecondary attainment by using an IV technique that adds strength to previous research findings. This study

is also the third of three essays in this dissertation exploring how North Carolina's DE program (CCP) effects postsecondary attainment. While essay one focused on a descriptive analysis, and essay two used regression discontinuity to estimate the causal effect of CCP on students in the CTP pathway, this essay estimates the causal effect of CCP on postsecondary attainment for both the CTP and CTE pathways and includes a subgroup analysis on the effects for CTE students. The three studies together will provide a strong foundation of evidence for the effectiveness of the CCP program and contribute to our understanding of the impact of DE programs nationally.

Overview of Career and College Promise

Enacted in 2012, CCP provided pathways that were intentionally structured to lead to a credential at the community college as opposed to students taking courses ad hoc. (North Carolina State Law, 2011). The immediate short-term goal of CCP was to increase access for underserved populations in North Carolina with the mid-term goal of increasing the number of students earning a degree in order to fill the anticipated gap in workforce (North Carolina State Law, 2011). The long-term goal of CCP, is to help North Carolinians earn a family sustaining wage thereby increasing the tax base in North Carolina and increasing overall funding available for educational initiatives (North Carolina State Law, 2011).

High school juniors and seniors who meet admissions requirements are eligible[8] for the program and have the option to choose one of two pathways; Career and Technical Education (CTE) or College Transfer Pathway (CTP). The CTE pathway is designed to prepare students for skilled employment. Classes within the CTE pathway are vocationally focused and lead to an industry recognized credential (North Carolina State Law, 2011). CTE pathways are often in

[8] At the time this dissertation was written there is a proposal before the State Board of Community Colleges to further expand CCP eligibility for 9th and 10th graders. In 2015-2016, eligibility for the program began in the 11th grade/junior year with the exception of 2 CTE pathways where 9th and 10th graders could enroll (North Carolina State law, 2011).

partnership with local employers whereby students, as a part of their curriculum, participate in internship, apprentice, or work-based experiences. The CTP pathway is intended to prepare students for transfer to a four-year college. Courses within CTP pathways are general education such as math, English, liberal arts, social sciences, and physical sciences (North Carolina State Law, 2011). CTP courses fall under the Comprehensive Articulation Agreement (the "agreement") in place between the North Carolina community colleges and the 16 University of North Carolina (UNC) System schools which allow for community college courses to articulate to specific courses at the senior institution (North Carolina State Law, 2011).

In 2015-2016, the criteria for admission to CCP included a 3.0 weighted high school GPA which could be waived by high school principals for students interested in participating in CTE pathways (North Carolina State Law, 2011). CCP courses are taught at the high school, online, and at the community college dependent on the agreement made between the high schools and the college. Importantly, the CCP legislation covers tuition costs for students to participate but does not cover ancillary costs such as fees, textbooks, supplies, and transportation (North Carolina State Law, 2011). Though not all costs are covered, tuition is the largest financial barrier for students who are interested in participating (Pierce, 2017; Tobolowsky & Allen, 2016).

CCP is offered in North Carolina high schools and through partnership between paired high schools and community colleges. The 58 North Carolina community colleges are comprehensive institutions offering college transfer degrees, career and technical degrees, and two-year allied health degrees. Table 3.1 describes the 58 North Carolina community colleges' institutional characteristics from the 2014 cohort, based on statistics reported to the Integrated Postsecondary Education Data System (IPEDS) database. Compared to the national sample of

public two-year colleges where the highest degree granted is an Associate's, NCCCS serves more White and Black students and fewer Asian, Hispanic, Native American/Alaska Native, and Native Hawaiian/Pacific Islander students. On average, the time to degree completion is similar to national sample but the total average enrollment is much lower pointing to the fact that North Carolina has more institutions but smaller enrollment at each college.

Table 3.1

Characteristics of North Carolina community colleges vs. All U.S. public two-year colleges

Variables	All U.S. public two-year colleges	North Carolina public community colleges
Student demographics		
% White	55.04 (24.80)	61.37 (16.73)
% Black	12.64 (15.12)	20.49 (13.58)
% Asian	3.71 (5.93)	1.57 (1.61)
% Hispanic	17.68 (19.50)	7.69 (4.21)
% Native American/Alaska Native	2.9 (12.28)	2.24 (6.26)
% Native Hawaiian/Pacific Islander	0.25 (0.60)	0.18 (0.37)
Academics		
Graduation Rate (150% time)	27.51 (12.18)	25.34 (8.39)
Average Total Enrollment	6705.82 (7514.95)	3839.07 (3980.82)
Number of Institutions (N)	818	58

Note. Standard deviations for continuous variables are in parentheses. Only U.S. public two-year colleges where the highest degree granted at the institution is an Associate's are included.
Source: Statistics reported to the Integrated Postsecondary Education Data System (IPEDS) database for 2014 cohort.

Research on the Impact of Dual Enrollment

The notion that CCP increases postsecondary attainment rests on two assumptions: first, that completion of some college credit will increase the chances a student will continue enrolling in college; and second, that students who begin college through DE are more likely to complete their college credential. Descriptive evidence on other DE programs indicate that earning college credit earlier in a student's academic career through CCP, without losing progress toward high school graduation, is associated with increased persistence and college completion (An, 2013a, 2013b; Bailey & Karp, 2003; Karp & Hughes, 2008; Tobolowsky & Allen, 2016). There is little rigorous evidence on the causal impact of programs of this kind on critical outcomes for students and the economy more broadly, particularly in the North Carolina context. DE and CCP are attractive options for students who plan to attend college and many quantitative studies have been limited to observational data (Fink, Jenkins, & Yanagiura, 2017; Pretlow & Washington, 2014; Wang & Wickersham, 2014).

Most quasi-experimental research on the topic has used propensity score matching to create comparison groups to examine the effects of DE. While this model is designed to address endogeneity related to selection into treatment, the approaches are not able to fully control for the social and cultural capital available to students that influences their postsecondary outcomes. Propensity score matching, like other quasi-experimental research, is able to control for some omitted variable bias from estimates of impact but is often unable to control for unobserved characteristics that lead to selection bias (An, 2013a, 2013b; Struhl & Vargas, 2012; Taylor, 2015). Together this body of research suggests that DE, and therefore CCP, has positive outcomes for students but without additional rigorous research it cannot be ruled out that these outcomes are a result of other unobservable variables.

Studies have examined how completion of college credit through DE will increase the chances of a student enrolling in college after high school (Fink et al., 2017; Pretlow & Washington, 2014; Speroni, 2011a; Taylor, 2015). For example, some studies that have examined postsecondary enrollment show an overall increased likelihood that DE students will enroll in college after high school (Taylor, 2015). However, the type of college that students choose has mixed results. Some studies have shown that DE propels students toward a four-year college (Speroni, 2011a ; Struhl & Vargas, 2012); others found that more students attended community college after high school (Fink et al., 2017). Pretlow and Washington (2014) found no difference in enrollment between two-year and four-year colleges for Virginia's DE students. For students choosing to enroll in a four-year college after participating in DE there is the risk that community college credit that students earn in high school may not transfer. Additionally, if the credit doesn't apply toward the student's intended degree after high school, it may negatively impact their completion outcomes and increase students taking credits in excess of what they need. Under the "agreement" credits earned through CCP should increase other postsecondary outcomes because the application of credit to a degree after high school is clearly defined (North Carolina State Law, 2011).

Students who participate in DE programs are two times more likely to persist in postsecondary, returning for their second year of college (Struhl & Vargas, 2012). Persistence serves as an important shorter-term indicator of the rate at which students will graduate because it measures student's accelerated momentum toward their degree (An 2013b, Struhl & Vargas, 2012). An (2013a) and Speroni (2011a) found that participation in DE programs increased attainment of a postsecondary degree by at least 8 percentage points in Florida. Struhl and Vargas (2012) measured college completion for DE participants at 6 years post enrollment

(instead of 4 years) and found that students who completed at least one DE class were 50% more likely to complete a degree in Texas. Fink et al. (2017) found similar results nationally where 46% of students who attended a community college and 64% of students who attended a four-year college completed their degree within 5 years. Each of these studies points toward the finding that DE increases postsecondary attainment, but only one of these studies (Speroni, 2011a) uses a quasi-experimental method (regression discontinuity) other than propensity score matching. Additional quasi-experimental studies that replicate and expand upon these methods are needed to explore DE outcomes in different states. Research that is state specific can aid in understanding the effectiveness of DE within that state's policy context.

In this study, I use an IV technique with a state-wide, student-level, longitudinal dataset to estimate the effects of CCP on student outcomes in North Carolina. To my knowledge, IV techniques have not been previously used to examine the impact of DE on postsecondary attainment or in the state of North Carolina. An IV approach allows me to use the exogenous variation in the distance between a student's high school and a community college as an instrument so I can compare postsecondary outcomes of participants in the CCP program to students who do not participate. This study will measure the local average treatment effect (LATE) of participation in CCP as predicted by distance.

Methods

Research that uses observational data must account for the possibility that the outcome of interest may be influenced by the same forces that influence participation in the treatment (Bound, Jaeger, & Baker, 1995). In estimating the effects of CCP (CTP and CTE pathways) on postsecondary attainment, we must consider that a student's likelihood of attending college is influenced by family educational background, access to advanced coursework, and socio-

economic status. It is plausible that if a student's parents attended college, that their child may be influenced to attend college at a higher rate than a first-generation student. When estimates of effects of CCP on postsecondary attainment do not account for these background characteristics, the results will be biased.

In this paper, I rely upon the distance between high schools and community colleges to predict participation in CCP to produce unbiased estimates of the effect of CCP on postsecondary outcomes (Bound et al., 1995; Dunning, 2012). In this approach, distance is considered an "instrument" because it is exogenous, or uncorrelated with the outcome, but it can be used to predict the takeup of the treatment (Bound et al., 1995). I use distance from the high school to the main campus of the community college as the instrument to identify causal impacts because North Carolina Community Colleges were designed to be within 30 minutes for more than 99% of residents (NCCCS, 2019). This near random placement of community colleges establishes a plausible causal pathway so that participation in CCP can be used to estimate the causal effects of CCP on postsecondary attainment outcomes and contribute additional understanding to the field on the potential of DE policies and investments.

This study builds on other educational studies that use distance is an instrument for the exogenous variation in treatment to estimate effects on various outcomes. Xu and Smith Jaggars (2013) used distance to the local college as an instrument to predict the effect of online course delivery on student outcomes. They found that OLS regression underestimated results and IV analysis revealed nearly double the observed effect (Xu and Smith Jaggars, 2013). Similarly, Card (1995) used college proximity as an instrument to estimate the returns to education, as OLS methods similarly underestimated impacts and IV improved the estimates 25-60%, depending on the controls used (Card, 1995).

Finding a strong instrument to use in an IV analysis is difficult (Stock, Wright, Yogo, 2002). IV is often used to estimate the treatment effect on the treated in randomized controlled trials though it can be used when a randomizer within the environment, such as distance, creates a natural experiment (Bound et al., 1995; Dunning, 2012). Other studies have used geographic distances to college as a strong instrument including Dee (2004), Kane and Rouse (1993) and Mallar (1979). These studies demonstrate that distance to college creates a natural randomizer to measure educational and civic outcomes. For example, Dee (2004) shows that distance to community colleges can predict educational attainment which can in turn be used to predict civic engagement outcomes such as voting.

This study uses distance as an instrument in an IV strategy to assess the effect of CCP on postsecondary attainment and to contribute to the larger question: *What is the relationship between dual enrollment in North Carolina and postsecondary attainment?*, and to address the following research questions:

1. What is the impact of CCP on postsecondary enrollment?
2. What is the impact of CCP on number of credits earned?
3. What is the impact of CCP on semester to semester student persistence?
4. What is the impact of CCP on postsecondary credential completion (inclusive of certificates, diplomas, and degrees)?
5. How do postsecondary attainment outcomes for CTE students compare to the overall CCP population?

Data and Institutional Characteristics

Using a combined longitudinal dataset from North Carolina's K-12 system (DPI), NCCCS, and the National Student Clearinghouse, I will use the distance from a student's high

school to the community college as an instrument to predict enrollment in CCP which will then predict postsecondary attainment in community colleges, controlling for student background characteristics. The data provided by the Department of Research and Performance Management at NCCCS contains students who were enrolled in traditional public North Carolina high schools as 10th graders in 2014-2015 and who stayed in the same high school through 12th grade (2016-2017). Academic year 2014-2015 will be used for pre-CCP characteristics for 10th graders who are eligible to participate in CCP as juniors in 2015-2016 and as seniors in 2016-2017. DPI records contain student high school information including race/ethnicity, gender, age, free and reduced lunch status, and high school GPA. These records are joined to NCCCS data to confirm enrollment in the community colleges through CCP, track college course grades, credits attempted and earned, as well as completion of a credential. NCCCS records are also matched to National Student Clearinghouse data to observe additional postsecondary enrollment at other colleges of NCCCS.

Sample Description

To ensure all students in the sample have consistent participation in and access to CCP, I focus in on students who attended a traditional North Carolina high school as 10th graders in 2014-2015 and stayed through their senior year (2016-2017). While it is unlikely that a student under the age of 18 can choose to move to a different school district, it is possible that parents and family members may choose to move so their student can have access to different educational opportunities. To address this concern, the sample in this study is limited to students who were enrolled in the same high school the year prior to participation in CCP (10th grade) and during the two years of eligible participation (11th and 12th grades). If a student moved in or out of the school district including out-of-state students, they are excluded from the sample.

This dataset includes students who are enrolled at traditional public high schools where CCP is offered alongside high school classes as an option for students who meet the admissions criteria. The final analysis sample includes 57,315 students who were high school juniors in North Carolina during the 2015-2016 academic year. The junior year is when students are first eligible to participate in CCP and students will be followed through the 2018-2019 academic year. The dataset contains key variables including enrollment in CCP, race/ethnicity, gender, free and reduced lunch status, high school and community college GPA, and latitude and longitude coordinates for high schools and community colleges which I use to calculate distance.

An Instrumental Variables Approach

I use the distance from a student's high school to the main campus of the local community college as an instrument for the student's likelihood of enrolling in CCP to estimate the effects of the program on postsecondary outcomes. North Carolina community colleges often have multiple satellite or branch campuses, the main campus of the local community college is designated by NCCCS and is used in this study to measure distance (NCCCS, 2019). Similar to the approach taken by Xu and Smith Jaggars (2013), I identify the latitude and longitude for each high school and community college and then use Stata's geodist command (Picard, 2010) to calculate the distance between the high school and the main campus of the local community college. Given that the community college partners with the high school to deliver CCP, those high schools who are closer in proximity to the college might be more likely to have a stronger and more robust CCP partnership than those high schools that are farther away (Card, 1995; Dee, 2004).

Using distance as an instrument, I modify the following basic empirical model in essay one to for a two-stages least squares (2SLS) IV approach:

$$\text{First Stage: } \Pr\left(CCP_{ij} = 1\right) = \beta_0 + \beta_1 Dist_{ij} + \beta_2 X_{\mathrm{i}} + \varepsilon_{\mathrm{ij}}$$

$$\text{Second Stage: } Y_{ij} = \beta_0 + \beta_1 \widehat{CCP}_{ij} + \beta_2 X_{\mathrm{i}} + \varepsilon_{\mathrm{ij}}$$

Using 2SLS, the first stage model is the probability of participation in CCP predicted by the distance of the student (*i*) in a school (*j*) to the community college. Added to this prediction is a vector of student demographics ($\beta_2 X_{\mathrm{i}}$) plus a random error term ($\varepsilon_{\mathrm{ij}}$). The second stage model takes the results of the first stage and regresses the these predicted values ($\beta_1 \widehat{CCP}_{ij}$) on outcomes Y_{ij}. The second stage model produces the outcome results of postsecondary attainment for student (*i*) in a school (*j*) predicted by participation in CCP plus a vector of student level demographics ($\beta_2 X_{\mathrm{i}}$) and a random error term.

In Table 3.2 I present 2SLS estimates of the effect of participation in CCP on postsecondary attainment including postsecondary enrollment, total number of postsecondary credits earned, persistence in college, and earning a postsecondary credential. The results indicate that CCP has positive and statistically significant effect on these measures of postsecondary attainment. For example in model 1, which includes student level controls, IV estimates indicate that participation in CCP results in a 58.7 percentage point change in the probability of postsecondary enrollment ($p < 0.001$). These results also suggest that CCP students are likely to earn 24.048 credits more than nonparticipants ($p < 0.001$). A standard number of credits for an associate's degree is about 60 and a bachelor's degree is about 120 putting CCP students close to halfway to earning the associate's and about one quarter of the way to a bachelor's degree in raw credits attained. 2SLS estimates also suggest that participation in CCP increases the probability of persistence in college by 36.6 percentage points ($p < 0.001$) and increases the probability of graduation by 30.7 percentage points ($p < 0.001$).

Table 3.2

2SLS Estimates of the Effect of Career and College Promise on Postsecondary Attainment

Outcome	(1)	(2)
Enrollment at Any College	0.587 (0.090)***	0.591 (0.125)***
# Postsecondary Credits Earned[9]	24.048 (4.144)***	12.259 (5.049)*
Persisted Year 1 to Year 2 in Any College (if not graduated)	0.366 (0.073)***	0.323 (0.100)***
Graduated Any College by 2018-2019	0.307 (0.040)***	0.322 (0.056)***
Student Controls	Yes	No

Note. *p < 0.05; **p < 0.01; ***p < 0.001, n=57,315

Table 3.3

2SLS Estimates for the Career and Technical Education Pathway

Outcome	(1) OLS Estimates	(2) Baseline IV Estimates	(3) CTE Pathway
Enrollment at Any College	0.206 (0.004)***	0.587 (0.090)***	0.731 (0.115)***
# Postsecondary Credits Earned[10]	12.022 (0.285)***	24.048 (4.144)***	31.624 (5.426)***
Persisted Year 1 to Year 2 in Any College (if not graduated)	0.097 (0.004)***	0.366 (0.073)***	0.461 (0.090)***
Graduated Any College by 2018-2019	0.099 (0.002)***	0.307 (0.040)***	0.363 (0.048)***

Note.: *p < 0.05; **p < 0.01; ***p < 0.001, OLS estimates in column 1 are presented in Essay 1, Table 1.5; column 2 estimates are from Essay 3, Table 3.2.

[9] For students who enrolled in a North Carolina community college
[10] For students who enrolled in a North Carolina community college

Table 3.3 presents IV results for the CTE pathway where students take classes that are structured to lead toward a credential that is recognized within the industry. These results show that CTE students are 73.1 percentage points more likely to enroll in college after high school ($p < 0.001$), earn 31.624 more credits than nonparticipants ($p < 0.001$), are 46.1 percentage points more likely to persist in college ($p < 0.001$), and are 36.3 percentage points more likely to graduate ($p < 0.001$).

Robustness Checks

When using an IV approach there are five concerns that threaten the validity of the estimates. These are that the instrument (Z) affects the predictor variable (X), the independence assumption, the monotonicity assumption, exclusion restriction, and stable unit treatment value assumption (SUTVA). Each of these must be tested and addressed or theoretically argued for the results of the IV to stand. Robustness checks for this study demonstrate that distance is a strong instrument to predict participation in CCP to estimate the effect of participation on postsecondary attainment outcomes.

Distance affects Career and College Promise Participation. A key to distance from a high school to the main campus of the local community college being a valid instrument is that distance affects participation in CCP. Community colleges partner with high schools to deliver CCP and high schools are automatically affiliated with the community college that serves their county i.e. any student attending high school in Lee county would participate in CCP offered through the community college in Lee county (North Carolina State Law, 2011). To test whether or not the instrument (distance) affects participation in CCP, I test the first stage of the IV estimation.

Table 3.4 shows the first stage results indicating that the distance between a student's high school and the local community college is a significant and inverse predictor of participation in CCP where increases in distance are associated with decreased participation in CCP. These findings are similar to Dee's (2004) first stage results where the coefficient of distance on college is -0.007. Additionally, I ran an additional model to include a quadratic term to test for a non-linear relationship between distance and CCP participation. The quadratic terms on row 2 of Table 3.4 show results that are smaller in magnitude but remain statistically significant ($p<0.001$). I note the r-squared measuring the strength of the relationship between distance and CCP participation in this first stage. With student level controls the r-squared (0.031) is in line with Dee (2004) (0.022). Finally, I conduct F tests on the strength of the instrument and in all models the f-statistic exceeds 10 demonstrating that distance is a strong instrument (Stock et al., 2002). F-statistics in models 1 and 2 are in line with Dee (2004) who found Prob > F = 114. These results indicate that distance addresses the bias associated with student selection to participate in CCP so that unbiased effects of the program are estimated.

Table 3.4

Results of Model for First Stage IV (probability of participating in CCP)

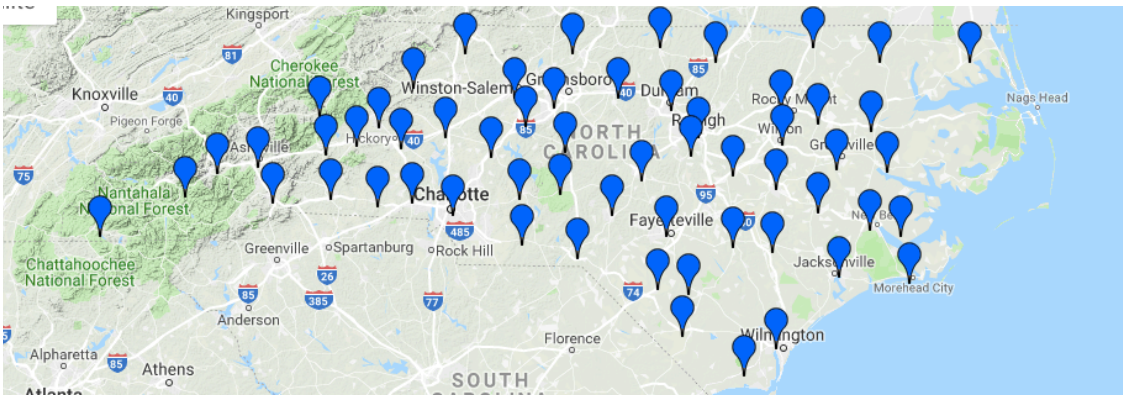
	(1)	(2)
Distance to College	-0.008 (0.001)***	-0.011 (0.001)***
Distance Squared	-0.004 (0.000)***	-0.005 (0.000)***
Student Controls	No	Yes
R-squared	0.002	0.031
Prob > F	96.26	138.45

Note. n=57,315, *p < 0.05; **p <0 .01; ***p < 0.001

Independence Assumption. The NCCCS system was designed so that distance to a community college is equally distributed across the state. Thus, distance in this context is as good as randomly assigned among the population. This aspect is critical to meet the independence assumption of instrumental variables because the instrument must be as good as randomly assigned (Dunning, 2012). When the community college system was formed there was a substantial effort to ensure that an institution would be accessible to all residents (NCCCS, 2019). On the NCCCS website under "Get the Facts" the first fact stated is that "community colleges in North Carolina are within a 30-minute drive of its citizens" (NCCCS, 2019). In my sample of 57,315 only 367 (<1%) students have a distance that exceeds 30 miles. Figure 3.1 presents visual evidence of the 58 North Carolina community college main campuses and their distribution throughout the state. In addition to the 58 main campuses, North Carolina's community colleges have a total of 165 satellite or remote locations (Figure 3.2).

Figure 3.1

North Carolina Community College Main Campus Locations



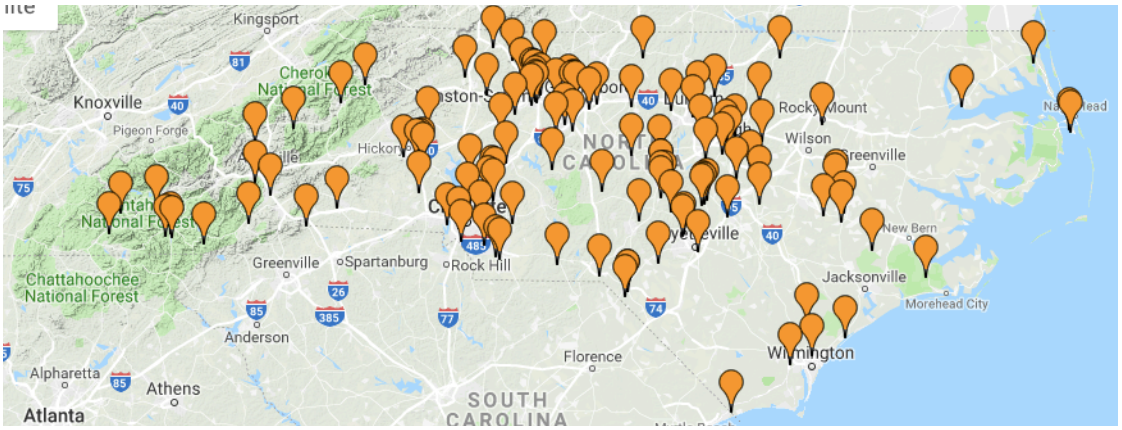
Note. Retrieved from Google Maps on April 13, 2019
https://www.nccommunitycolleges.edu/about-us/main-campuses

While the remote locations do not coordinate CCP with high schools, these locations are important to further emphasize the fact that where families choose to live is not related by

proximity to a community college given how equally distributed they are across the state, making distance to a North Carolina community college a particularly strong instrument. Dee (2004) conducts robustness tests on the use of distance to four-year versus two-year colleges as instruments and chooses two-year colleges for this reason. Card (1995) and Xu and Smith Jaggars (2013) also choose distance as an instrument for similar reasons. To partially test the independence assumption balance tests showing the distribution of subgroups at different distances can be found in Appendix D.

Figure 3.2

North Carolina Community College Remote Locations



Note. Retrieved from Google Maps on April 13, 2019
https://www.nccommunitycolleges.edu/about-us/remote-locations

Exclusion Assumption. For the exclusion assumption to hold, there must be a convincing argument that distance to a community college has no direct effect on postsecondary attainment and only through participation in CCP should postsecondary attainment outcomes change. As presented above in Figure 1 and Figure 2, the distribution of community colleges across the state of North Carolina leaves the maximum amount of driving time for more than 99% of citizens at 30 minutes (NCCCS, 2019). This means that all citizens of the state have arguably easy and proximate access to postsecondary education, they are likely familiar with the

community college, know faculty and staff who work there, and are more likely to have interacted with the college in some way. Due to this close proximity, distance to a community college likely doesn't affect outcomes such as postsecondary enrollment and credential attainment at a community college. Additionally, community college credit can only be earned for high school students by participation in CCP; therefore, there is no other way for distance to the community college to influence postsecondary attainment for students while in high school except through CCP.

It should be noted that this differs from what Dee (2004) and Card (1995) argue where proximity to college is related to measures of educational achievement. The national datasets used by these researchers leveraged distance to colleges that were not equally distributed as is the case in North Carolina. Additionally, Dee (2004) and Card (1995) were not examining the effects of postsecondary attainment rather using distance to predict postsecondary attainment. Due to the unequal distribution of colleges in other states or in national datasets, this IV approach and use of this instrument may not be replicable other places as distance to a community college in other contexts may directly influence postsecondary attainment. To replicate this and show that distance to a community college does not directly affect postsecondary attainment (in the North Carolina context) and is therefore a valid instrument for this study, I conduct sensitivity analyses by regressing distance to a community college on indicators of postsecondary attainment for the population of students who do not participate in CCP. If distance effects postsecondary attainment, results would show a statistically significant relationship between those who do not receive the treatment (CCP) and postsecondary attainment.

Though the exclusion restriction is not directly testable (Dunning, 2012), results of distance on postsecondary attainment outcomes demonstrate that for students who have not participated in CCP there is no relationship between distance and postsecondary enrollment, postsecondary persistence, or graduation measured through 2018-2019 which is the most recent data available (Appendix E). When CCP students are added to the sample these results show a positive and statistically significant relationship ($p<0.001$), further suggesting that distance does not affect postsecondary attainment directly but rather distance affects outcomes through CCP.

Monotonicity. For monotonicity assumption to hold, distance to a community college must affect enrollment in CCP in the same direction for everyone. More than 99% of citizens in North Carolina are within a 30-minute drive of a community college and the colleges are equally distributed across the state as illustrated in Figure 1 and Figure 2 (NCCCS, 2019). This is a unique context to North Carolina where other states may not experience this equi-distant proximity between the citizens and the community colleges (Card 1995; Dee, 2004; Xu & Smith Jaggars, 2013).

Community colleges in North Carolina are funded through and have a service area that encompasses the county or counties in which they are located (NCCCS, 2019). High schools in each county are partnered with the community college to deliver CCP to the high school students (North Carolina State Law, 2011). While every high school is paired with a community college, the strength of this partnership can vary based on a number of factors including physical proximity between the high school and college, capacity or will of the college to build program pathways and work with the high school, or availability of support staff to help students learn about and enroll in CCP. Though the strength of this partnership varies by high school, the partnership does exist in each location and therefore a catalyst exists for every student to enroll

in CCP. Therefore, the probability of being near a community college does not make a student less likely to enroll in CCP but the system is set up to gently nudge students toward participation.

While there are not robust methods to test this theory, I conduct subgroup analysis to check for the positive or negative relationship at the first stage (Appendix F). I include subgroups female, White, African American/Black, Hispanic, and participation in free and reduced lunch. I also test the models with and without student level covariates. Across both models and for all subgroups the relationship with distance and participation is negative meaning that as distance increases the probability of participating in CCP declines for everyone. These results are an indicator that the monotonicity assumption holds that distance effects participation in the same direction for all subgroups.

Stable Unit Treatment Value Assumption. For SUTVA to hold, one student's enrollment in CCP should not impact another student's participation. There are two ways that a student's enrollment might affect another student's enrollment: that one student's distance to the community college (instrument) and/or CCP participation (treatment) could influence another student. This study used distance from the high school to the community college as an instrument. Since high schools enroll students within a defined district, one student's distance to the community college isn't impacted by another student's distance to the college as a student's high school of attendance is predetermined. The second way that SUTVA could be violated is if one student's enrollment affect's another student's enrollment. Enrollment in CCP is limited only by the program's admission criteria but there are no caps on how many students can participate or limited resources that would direct the number of students eligible. Each student who meets the admission criteria is eligible regardless of whether or not their peers participate.

Limitations and Delimitations

A primary limitation of IV methods is that it is a local average treatment effect (LATE) which describes only the effect of CCP on postsecondary attainment that are affected by the instrument of distance to a community college. IV estimates may have reduced external validity as results may only hold for students in the United States where community colleges exist and in this study may only hold for outcomes in North Carolina given the unique distribution of community colleges. IV estimates also apply to students who are willing to accept their assignment to participate in the treatment (CCP) or not participate in the treatment. The effects of treatment on the treated can be extended to students who comply with their treatment assignment. Delimitations of this study include the exclusion of "movers" and students in nontraditional high schools. Therefore, results can only be applied to students who remain in the same traditional high school within North Carolina. Though IV estimates and this study's delimitations may limit the external validity of results, comparisons between the DE outcomes in North Carolina can be made to other state and policy contexts due to the community colleges serving a large number of students through a diverse set of institutions.

Discussion

In this study, I present an empirical analysis of one of the fundamental relationships that is motivation behind DE policies: the effects of CCP on postsecondary attainment. In particular, I assess whether increases in participation of CCP have causal effects on postsecondary attainment in community colleges by exploiting possibly exogenous sources of variation in participation, distance to a community college, that should otherwise be unrelated to postsecondary attainment. Estimates suggest that participation in CCP has a significant ($p<0.001$), positive impact on postsecondary enrollment, number of college credits, persistence in college, and credential

attainment. These findings imply that the growing investment by North Carolina's legislature in the CCP program result in returns to education.

In particular, results show that the IV analysis yields stronger results by addressing omitted variable bias and student self-selection compared to the corresponding naïve OLS estimates (Essay 1, Table 1.5) and similar to the results of Xu and Smith Jaggars (2013), Dee (2004), and Card (1995). These results support research that has shown DE increases postsecondary enrollment, progress, and completion (An, 2013a, 2013b; Fink et al., 2017; Pretlow & Washington, 2014; Speroni, 2011a; Struhl & Vargas, 2012; Taylor, 2015). IV estimates were consistently stronger than corresponding OLS estimates across all model specifications. As a result, descriptive comparisons are likely to underestimate rather than overestimate the gap between CCP and non CCP postsecondary outcomes.

Results show that CCP students are more likely to enroll in college after high school. Baseline IV estimates predict a stronger likelihood of postsecondary enrollment when compared to OLS estimates (58.7 percentage points compared to 20.6 percentage points). These results are similar to other studies that have shown increased overall enrollment in college where it is hypothesized that because students are already part-way to earning their degree they will enroll in college after high school to finish (Fink et al, 2017; Pretlow & Washington, 2014; Speroni, 2011a; Struhl & Vargas, 2012). Results of this study show that CCP students are 36.6 percentage points more likely to persist than nonparticipants in college which supports other research that suggests DE programs are preparing students socially and academically for college after high school (Karp, 2012; Struhl & Vargas, 2012).

Interestingly results of this study show that the effects of CCP on postsecondary attainment are even larger for CTE students who are 14.4 percentage points more likely to enroll

in college than the overall CCP population. Results are similar for other outcomes where CTE students exceed the overall CCP population. CTE students are predicted to earn about 7 credits more, the probability of CTE students persisting is 9.5 percentage points higher, and the probability of CTE students graduating is 5.6 percentage points higher. This observed increase in CTE outcomes could be due to their structured pathways where there are short-term certificates and diplomas built into program of study on the way to the degree (North Carolina State Law, 2011). Wang et al.'s (2015) research in the Wisconsin Technical System, which is structured similarly to CTE pathways, show results similar to this study where participation in DE showed a positive relationship with increased persistence and completion. This is different than CTP students were the only credential is an associate's degree (North Carolina State Law, 2011).

Estimates also suggest that as a result of participating in CCP students are better prepared to succeed in college after high school. IV estimates predict that CCP participants earn 24 credits more than nonparticipants. Earning more credits increases the opportunity for students to be exposed to additional college faculty which may suggest that CCP students are better prepared because they are familiar with the expectations of college faculty and structures of college courses (Tobolowsky & Allen, 2016). Taking CCP classes in high school also means that they will be part-way to earning a degree, which accelerates their time to degree after high school. That CCP increases the number of postsecondary credits earned, is consistent with literature that shows DE accelerates momentum toward postsecondary credential completion (Fink et al., 2017; Karp, 2012; Speroni 2011a). Specifically, previous research showed that students who completed just one DE class were 50% more likely to complete college (Struhl & Vargas, 2012). This study contributes to the literature by showing that participation in CCP, like other DE programs across the country, accelerates student's momentum toward postsecondary attainment.

Given that CCP students are more likely to enroll in college after high school and are more likely to persist, it's unsurprising that they are also more likely to graduate. This study shows that CCP students are 30.7 percentage points more likely to graduate from college at 100% time and CTE students are 36.3 percentage points more likely to graduate. These results are higher than previous research in Florida which indicated DE increased degree attainment by 8 percentage points (An, 2013a; Speroni, 2011a). These results are also much larger than those observed in Texas where participation in DE increased graduation 23 percentage points (Taylor, 2015). The North Carolina results suggest that the CCP legislation requiring pathways to be organized into a structured series of courses leading to a credential has been effective in increasing the completion rate.

Implications

North Carolina's investment in CCP's structured, extensively available for high school students, and free program, leads to increased educational attainment as demonstrated in this study. These results have implications for policy and for practice. One policy implication is the extent to which CCP increases enrollment for community colleges. This study confirms that CCP opens access to college and increases postsecondary attainment which policymakers in North Carolina observe given the rapid increase in enrollment and increasing investment in the program (NCCCS, 2020). Recent dashboard data released by NCCCS shows that in Fall 2019 most of the 58 community colleges saw an increase in enrollment (NCCCS, 2020). However, when removing CCP students from the enrollment count, only a handful of colleges had increased enrollment (NCCCS, 2020). This points to CCP driving enrollment increases across the state and that CCP students are becoming a larger share of the community college population overall.

A second policy implication is the way that CCP pathways are built which can point to the higher rates of postsecondary attainment found in this study when compared to Florida (Speroni, 2011a) and Texas (Taylor, 2015). The structured pathway policies are a key component of the 2012 legislation where courses are planned in a sequence that students follow, and which minimized the number of electives a student chooses from (North Carolina State Law, 2011). Additionally, the results that show CTE students experience greater postsecondary outcomes could be a result of having stackable credentials within the CTE pathway. CCP pathways are also aligned directly with the community college degrees, given that the community college administers the program. More importantly the community colleges are governed under the CAA for how CCP and community college courses and pathways transfer to UNC institutions in the state. Having clearly defined pathways could be a key policy reason for why returns to education observed in this study are larger when compared to other states.

For practitioners, it is important to understand the effects of CCP so that when guiding students in their choice of whether or not to participate they help students understand the positive impacts of the program and the cost savings involved. It is also important for practitioners to understand the policy mechanisms behind why CCP is working so that adherence to the pathway structure can be a priority. Finally, investing in training for Career Coaches and other advisors to be attuned to students' pathway decisions. Ensuring students are on the right pathway that will further accelerate CCP students and help even more students realize the benefits of participation. Career Coaches advise students in pathway decisions and ensure the transition from high school to college is smooth. It is important that Career Coaches and other advisors are trained in the benefits of CCP, as presented in this study, so that all students who are eligible to participate are receiving proactive messaging about the opportunities available through CCP.

A second implication for practice is to leverage the close proximity between high schools and community college to strengthen collaboration. This study leverages the unique and equi-distant distribution of community colleges in North Carolina. My data suggest that over 50% of the high schools are within 10 miles of their local community colleges (Appendix D). This close proximity not only provides a strong instrument for this study of CCP, but also presents opportunities for collaboration between high schools and community colleges. To strengthen this collaboration there should be statewide professional development that facilitates the sharing of promising practices in partnership between administrators in high schools and community colleges particularly those who are located within 10 miles of each other. Goals of the convening should focus on further alignment of curriculum and students supports that help students transition smoothly and lead to increased postsecondary enrollment.

Predicted increases in postsecondary enrollment as shown in this study, where students in CCP enroll in the community college after high school, point to a strong curriculum and support transition where students continue on to complete the credential they started in high school. Curriculum alignment should go beyond courses and focus on alignment of learning outcomes between high school courses, CCP courses, and upper level community college courses to ensure that students are gaining the prerequisite knowledge they need to be successful. Student supports ensure that the social transition occurs smoothly and that there are no support service gaps for students as they graduate from high school and matriculate into the community college. Data presented in this study predict that CCP increases graduation by 30.7 percentage points overall and 36.3 percentage points for CTE students. Curriculum alignment and student supports can be two reasons the CCP students' postsecondary enrollment leads to graduation, but further alignment in these areas can increase this graduation rate.

Future Research

Research points to two additional questions that would add to the discussion about the impact of CCP on postsecondary attainment. The first question is about how further investments by the legislature can be most effective. Conducting this research through a cost analysis or return on investment study could build upon these results to understand returns more fully. Early investment will increase outcomes but does not help us understand how additional financial, academic, and social supports can further accelerate student momentum along their pathway (Becker, 1993; Fink et al., 2017; Karp, 2012; Speroni 2011a). In particular, investigating the impact of the additional costs to students such as transportation, books, and supplies on student success can provide additional information to policymakers about where investments could further increase postsecondary attainment (Tobolowsky & Allen, 2016). Currently only some school districts absorb these costs which can serve as barriers to participation in CCP (North Carolina State Law, 2011). However, further research into the how investment could alleviate these costs could allow CCP to grow, particularly for underrepresented populations.

The second question for further research is to better understand how and why CCP accelerates students toward postsecondary attainment. Using qualitative inquiry into the mechanisms by which CCP students transition from the program into postsecondary college can offer additional policy relevant insights. Mechanisms may include availability and effectiveness of Career Coaches who are helping more students make the transition from high school to college. As mentioned earlier, the legislature is funding increasing numbers of Career Coaches so understanding the ways in which they are effective can increase our understand of how this investment is further accelerating student momentum toward postsecondary attainment through CCP. In addition, many high schools have other college type counselors such as College

Advising Corp members or TRIO counselors. Knowing more about how these support systems work together to benefit students would be helpful. In addition, know more about whether these support systems are directly relating to increases in access and enrollment would also be helpful to understand.

This study uses an IV technique that uses exogenous variation in the distance to a community college to demonstrate that participation in CCP increases postsecondary attainment for students in North Carolina. As CCP continues to grow, this research can be leveraged to support policy decisions and to demonstrate the success that students experience in college and subsequently that all of North Carolina benefits from because of this key investment by the legislature and the strong partnership between high schools and community colleges within the state.

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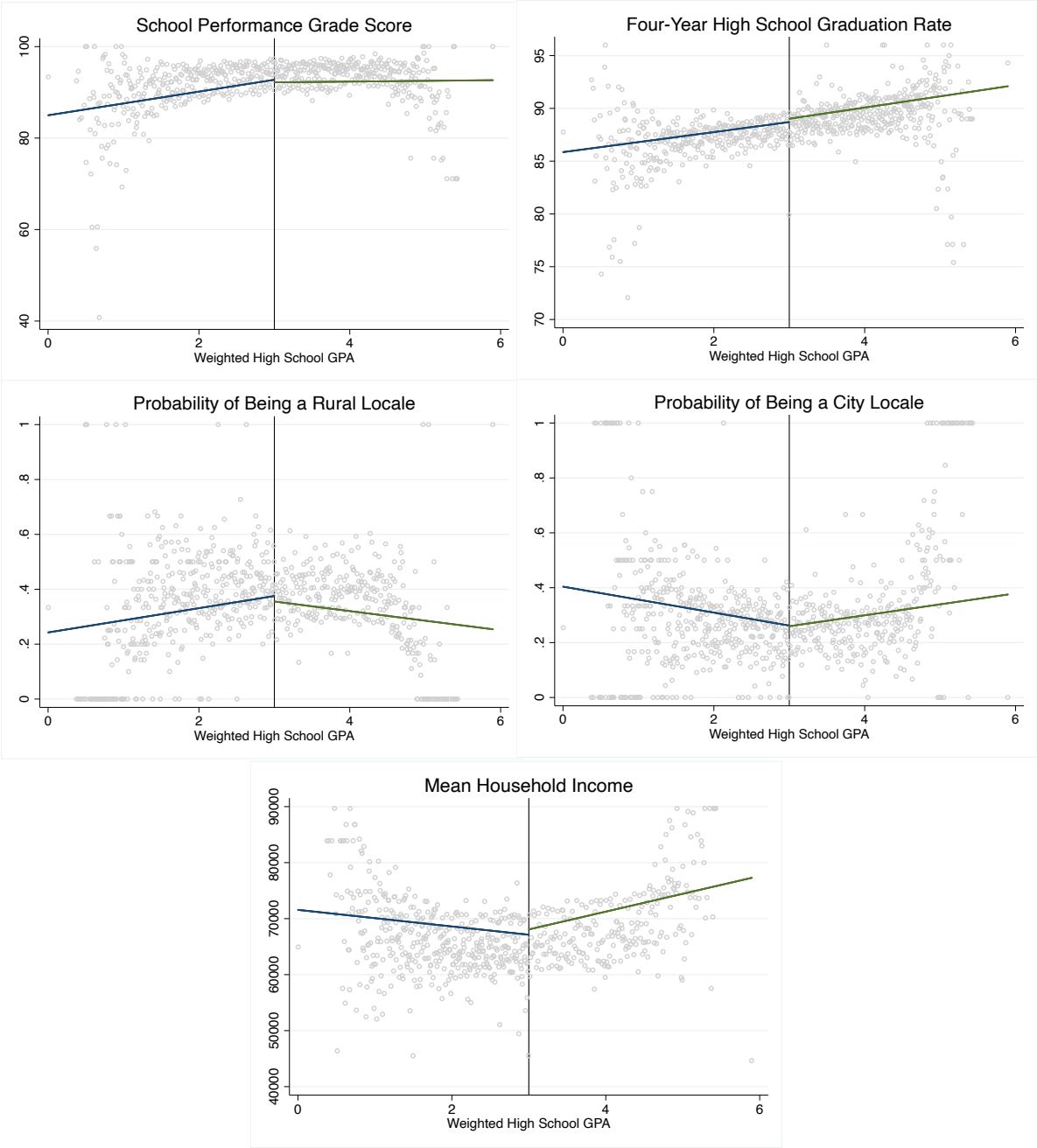
APPENDICES

Appendix A

Figure A1.

Estimated Fuzzy RD Observable Characteristics



Note. Author's calculations based on student's 10th grade demographics in 2014-2015, were juniors in 2015-2016 in traditional North Carolina high schools, who stayed in the same high school through 12th grade. Sample is also limited to treated students enrolled in the CTP pathway. Linear regression lines show sample within +/- 0.549 bandwidth.

Appendix B

Table A1.

Covariate Balance: Bandwidth: +/- 0.495

Outcome	Within 0.495 Bandwidth			
	Treated Mean	Comp. Mean	Stand. Diff.	Var. Ratio
Female	53%	45%	0.167	1.008
White	60%	49%	0.225	0.957
Black	21%	29%	-0.117	0.816
Hispanic	12%	15%	-0.082	0.842
Free and Reduced Lunch	42%	51%	-0.186	0.975
School Performance Score	72	70	0.173	1.120
4-year High School Graduation Rate	89%	88%	0.111	0.965
Rural Locale	40%	37%	0.060	1.030
Urban Locale	26%	28%	-0.063	0.937
Mean Household Income	$67,284	$67,778	-0.034	1.093
Sample Size	1,003	8,103		

Table A2.

Covariate Balance with Fuzzy RD Estimates: Bandwidth: +/- 0.495

Outcome	Baseline RD-IV Bandwidth: 0.495	
Female	0.083	(0.227)
White	0.032	(0.227)
Black	0.220	(0.205)
Hispanic	-0.120	(0.159)
Free and Reduced Lunch	-0.256	(0.229)
School Performance Grade	29.043	(5.508)***
4-year High School Graduation Rate	8.634	(2.602)***
Rural Locale	-0.864	(0.231)***
Urban Locale	0.654	(0.218)**
Mean Household Income	$45,979	(8,099.6)***
Sample Size	8,837	

Note. *p < 0.05; **p < 0.01; ***p < 0.001

Table A3.

Covariate Balance: Bandwidth: +/- 0.359

Outcome	Within 0.359 Bandwidth			
	Treated Mean	Comp. Mean	Stand. Diff.	Var. Ratio
Female	53%	46%	0.143	1.005
White	59%	50%	0.172	0.971
Black	22%	28%	-0.140	0.854
Hispanic	13%	15%	-0.052	0.900
Free and Reduced Lunch	42%	51%	-0.165	0.978
School Performance Score	72	70	0.200	1.045
4-year High School Graduation Rate	89%	88%	0.129	0.960
Rural Locale	37%	38%	-0.018	0.991
Urban Locale	27%	28%	-0.007	0.994
Mean Household Income	$68,442	$67,661	0.053	1.103
Sample Size	681	6,098		

Table A4.

Covariate Balance with Fuzzy RD Estimates: Bandwidth: +/- 0.359

Outcome	Baseline RD-IV Bandwidth: 0.359	
Female	-0.028	(0.393)
White	0.453	(0.363)
Black	-0.064	(0.392)
Hispanic	-0.322	(0.279)
Free and Reduced Lunch	-0.253	(0.396)
School Performance Grade	50.866	(11.792)***
4-year High School Graduation Rate	14.312	(4.891)**
Rural Locale	-1.385	(0.443)**
Urban Locale	1.104	(0.408)**
Mean Household Income	$82,232	(17,943)***
Sample Size	6,779	

Note. *p < 0.05; **p < 0.01; ***p < 0.001

Appendix C

Table A5.

Alternative RD specifications

Outcome	(1) Alternative Bandwidth	mserd Bandwidth	(2) Uniform Kernel	(3) Squared Polynomial	(4) Cubed Polynomial
Enrollment at Any College	0.260 (0.171)	+/- 0.549	0.246 (0.087)***	0.324 (0.369)	0.352 (0.730)
Persisted Year 1 to Year 2 in Any College (if not graduated)	-0.014 (0.176)	+/-0. 495	0.138 (0.067)**	-0.196 (0.275)	-0.871 (0.639)
# College Courses Taken 1 Year Postsecondary	-1.071 (1.724)	+/- 0.463	0.760 (0.659)	-3.227 (2.854)	-9.960 (6.518)
Graduated Any College by 2018-2019	-0.001 (0.086)	+/- 0.454	0.030 (0.047)	-0.061 (0.195)	0.011 (0.288)
UNC Transfer Courses	2.705 (0.330)****	+/- 0.423	2.523 (0.253)****	3.266 (0.748)****	2.827 (0.884)****

Note. *p< 0.10; **p < 0.05; ***p < 0.01; ****p < 0.001 Source: Author's calculations based on student's 10th grade demographics in 2014-2015, were juniors in 2015-2016 in traditional North Carolina high schools, who stayed in the same high school through 12th grade. Treated students are limited to those enrolled in the CTP pathway. My preferred specification uses the rdrobust default settings with a linear prediction, triangular kernel matching, and nearest neighbor matching for the variance-covariance matrix estimator. I differ from the default by using the msesum bandwidth because it uses the sum of the regression estimates rather than the difference, the default bandwidth mserd is presented above.

Figure A2.

Alternative Cut point Weighted High School GPA=2.0

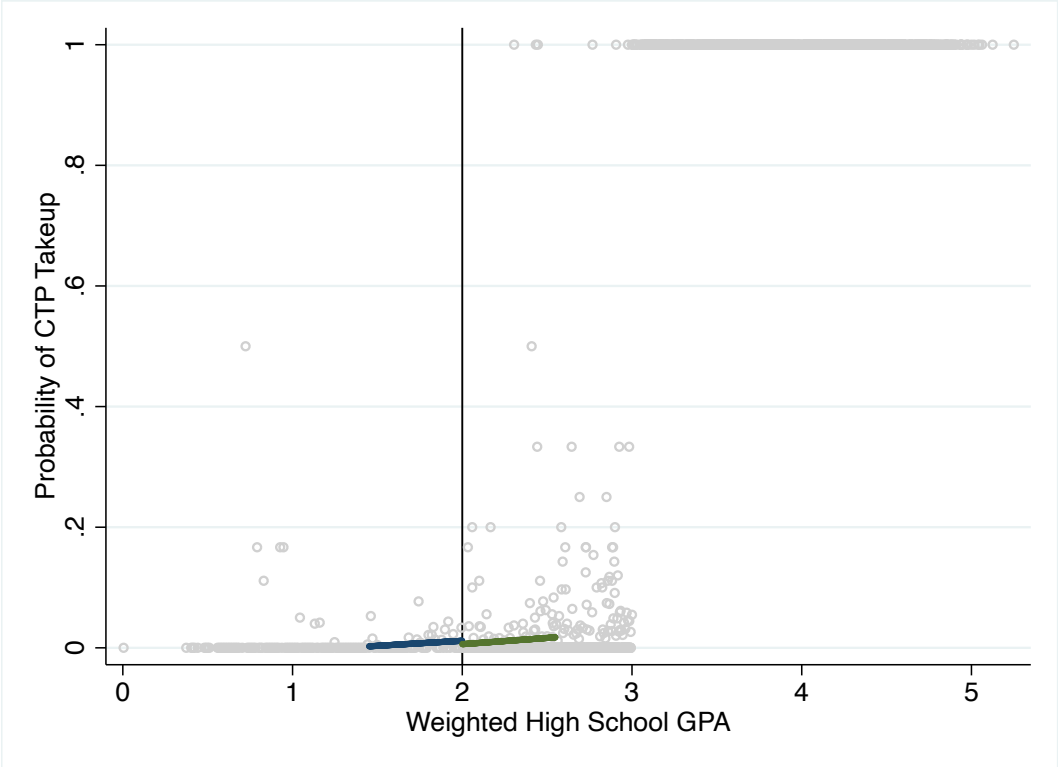


Table A6.

Results at Alternative 2.0 Cut point

Outcome	(1) RD-IV	
Enrollment at Any College	-0.769	(3.678)
Persisted Year 1 to Year 2 in Any College (if not graduated)	-1.800	(2.938)
# College Courses Taken 1 Year Postsecondary	-8.681	(16.518)
Graduated Any College by 2018-2019	0.195	(1.091)
UNC Transfer Courses	-0.501	(1.959)

Appendix D

Independence Assumption

Table A7.

Balance Table for Subgroups at Different Distances

Subgroup	<10 Miles	11-20 Miles	21-30 Miles	>30 Miles
Female	50.02%	49.90%	50.09%	45.23%
White	54.04%	64.80%	66.39%	85.29%
African American/Black	26.59%	16.11%	16.71%	6.27%
Hispanic	12.75%	11.16%	11.17%	3.00%
Free and Reduced Lunch	45.98%	34.18%	28.01%	3.27%
% of Sample	55.37%	26.85%	9.23%	0.64%

Note. Authors calculations based on ten mile increments in distance between high school and local community college.

Appendix E

Exclusion Restriction

Table A8.

Estimated Effect of Instrument Distance on Postsecondary Attainment Outcomes

	Comparison Group Only		Sample with CCP Students	
Outcome	Probit	Prob > Chi2	Probit	Prob > Chi2
Enrolled in Any College	-0.001 (0.001)	0.108	-0.004 (0.001)***	0.000
Persisted Year 1 to Year 2 in Any College (if not graduated)	-0.001 (0.001)	0.538	-0.002 (0.001)***	0.001
Graduated Any College by 2018-2019	-0.003 (0.002)	0.080	-0.008 (0.001)***	0.000
Sample Size	45,749		57,315	

Note. *p < 0.05; **p < 0.01; ***p < 0.001

Appendix F

Monotonicity Assumption

Table A9.

Subgroup First State IV Results: Probability of Participating in CCP Predicted by Distance

	(1)	(2)
Female	-0.004	-0.006
	(0.001)***	(0.001)***
White	-0.015	-0.013
	(0.001)***	(0.001)***
African American/ Black	-0.003	-0.004
	(0.002)	(0.002)
Hispanic	-0.003	-0.003
	(0.003)	(0.003)
Free and Reduced Lunch	-0.004	-0.007
	(0.002)*	(0.002)***
Student Controls	No	Yes

Notes. n=57,315, *p < 0.05; **p < 0.01; ***p < 0.001