Unpacking Variation in College Effectiveness: An Instrumental Variables Approach

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Abstract

The question of why postsecondary institutions produce different labor market outcomes has been difficult to answer due to unobserved student characteristics that drive institutional choice as well as earnings. I leverage students' geographic proximity to three types of U.S. postsecondary institutions —competitive institutions, institutions associated with higher earnings for students from low-income backgrounds, and Historically Black Colleges and Universities. Using a nationally representative sample of tenth graders tracked for ten years, I estimate the plausibly causal effects of first attending each institution type on outcomes such as credits completed in science and humanities, bachelor's degree completion, pursuit of post-baccalaureate education, and hourly wages. Attending an institution previously linked to high wage mobility raises wages in respondents' mid-20s, whereas underrepresented students' attendance at an HBCU lowers wages. Initial attendance at all three focal types relative to other institutions yields substantial increases in bachelor's degree completion and pursuit of postbaccalaureate education.

Highlights

- Geography influences which colleges and university types students choose.
- Competitive and earnings-enhancing colleges raise attainment but reduce STEM credits.
- Colleges linked to students' wage mobility boost earnings by students' mid-20s.
- HBCU attendance raises attainment but lowers wages for underrepresented students.
- For geography-sensitive students, wage benefits are driven by graduate-level study.

Keywords: human capital, salary wage differentials, institutional effects, instrumental variables, college proximity
JEL codes: I23, I26, R32

Abbreviations: *BIH*: Black, Indigenous, or Hispanic/Latinx; *BT3*: Barron's Top 3 Selectivity Tier Institution; *HBCU*: Historically Black College or University; *HSI*: High-Success Institution; *STEM*: Science, Technology, Engineering, and Mathematics

1 Introduction

Since the early 2000s, about two-thirds of graduating high school seniors in the U.S. have matriculated directly into postsecondary institutions the same year, with roughly a third of those enrolling in two-year institutions, and the rest in four-year institutions ((National Center for Education Statistics, 2019)). In doing so, they chose from among more than 4,000 degree-granting postsecondary institutions in the U.S. The choice set they faced is complex. The question of which postsecondary institution will offer not only an optimal college experience but also the best professional payoff for their needs is so individualized as to be nearly unanswerable. Still, students and their families seek guidance, and extant research does offer insight about the returns to a college degree and to particular attributes of the degree. For instance, we know from syntheses of returns-to-college estimates that each additional year of postsecondary schooling raises earnings by about 8-9% on average, across countries and postsecondary sectors ((Card, 2001; Cellini and Chaudhary, 2014; Psacharopoulos and Patrinos, 2018)). We have evidence from a large regression discontinuity study in Florida that the economic returns to a bachelor's degree for those on the margins of four-year college attendance are about 22%, and even larger for students from socioeconomically disadvantaged backgrounds ((Zimmerman, 2014)). Similar findings about the graduation benefits of access to higher-versus lower quality institutions, especially for socioeconomically disadvantaged students, have been found in Georgia, where SAT thresholds restricted access to four-year institutions ((Goodman et al., 2017)). A regression discontinuity study in France found that test-based access to higher-quality institutions for disadvantaged students increased peer quality and STEM coursetaking and raised earnings by 12.7%, though in that case, institutional quality had little effect on amount of education attained ((Canaan and Mouganie, 2018)). And selection-adjusted studies of access to highly competitive colleges in the U.S. have found null-to-modest earnings returns overall, but notable benefits for Black and Hispanic students ((Dale and Krueger, 2002, 2014)). Finally, we know from regression discontinuity studies in Chile and Norway, and from selection-adjusted models in the U.S., in that students' earnings are highly dependent on their academic major, with marked earnings benefits to STEM careers ((Hastings et al., 2013; Kirkeboen et al., 2016; Webber, 2014)).

One reason that higher-prestige institutions may confer earnings benefits is that their name and what it represents may provide a positive signal to potential employers. But are there human capital explanations as well for why some institutions may confer greater labor market value than others? This question is important for at least two reasons. First, if students knew about institutional attributes linked to higher earnings, they could prioritize these attributes in their selection of colleges. Second, if we could causally identify institutional attributes that were within institutions' control and could improve students' labor market outcomes, institutions could cultivate these attributes and potentially raise the value of the education programs they offer.

Fortunately, students do have greater information than those in past generations about how much graduates of particular institutions can expect to earn after college. The College Scorecard, which was launched by the U.S. Department of Education in 2015, provides public data about costs, graduate earnings, and loan default rates for more than 5,000 U.S. postsecondary institutions, including two-year and four-year institutions. Of course, the earnings data reflect not only institutions' contributions, but also the baseline knowledge, skill, motivation, and social networks of the individuals who are admitted to and graduate from a given institution. Studies using College Scorecard data to isolate institutional contributions to earnings by adjusting for students' academic majors and observable attributes have shown that institutions with higher "value-added" are those with a higher share of graduates in Science, Technology, Engineering, and Mathematics (STEM) fields, higher completion rates, and higher faculty salaries, on average ((Rothwell, 2015)). However, these factors may not indicate the causal impact of attending a given institution on future earnings, since adjusting for observable student attributes does little to address the unobserved baseline characteristics that may influence graduates' performance in the labor market.

In larger study using individual-level earnings data, Chetty et al. ((2017)) found variation among postsecondary institutions in the economic mobility of the students who attended them. Linking federal tax return data for 30 million U.S. adults to those of their parents, the authors found that college choice strongly mediated the positive association between parents' and children's earnings. Overall, parents' earnings rankings were positively linked to those of their adult offspring, with a coefficient of about 0.29, but within the offspring's postsecondary institutions, this relationship largely disappeared. The study also sought to examine the attributes of institutions in which a large share of students from bottom-quintile socioeconomic backgrounds moved to the top quintile by their early 30s. The authors termed the fraction making this transition as the "success rate" of a given institution. But in contrast to the College Scorecard analysis by Rothwell ((2015)), Chetty et al. ((2017)) did not find institution-level covariates, such as share of STEM graduates, that strongly predicted institutions' success rates. [1]

Prospective college students may also consider the extent to which institutional attributes support salient aspects of their identities. Institutions that historically served only students of color or women, for instance, may hold strong appeal for students whose identities align with those institutional foci. This alignment may, in turn, promote stronger labor market outcomes. For instance, Black students' enrollment at Historically Black Colleges and Universities (HBCUs) in lieu of Predominantly White Institutions (PWIs) has been linked to higher college persistence and graduation ((Franke and Deangelo, 2018; Fryer and Greenstone, 2010)), to higher socioeconomic status over time ((Price et al., 2011)), to higher earnings in the 1970s and more recently for female graduates ((De Zeeuw et al., 2020)), but

[1] Chetty et al. ((2017)) also found high variation in the "mobility rates" of institutions, which they defined as the product of institutions' success rates and the fraction of bottom-quintile students enrolled in them.

also to earnings disadvantages in the 1990s and in STEM fields more recently ((De Zeeuw et al., 2020; Fryer and Greenstone, 2010)). One constraint of these studies is that they have largely employed propensity score matching or weighting methods. Such methods address selection on observable but not on unobservable student attributes, and thus may be confounded by any baseline student attributes that are correlated with both institutional choice and the outcomes of interest ((Angrist and Pischke, 2008; Steiner et al., 2011)). Still, survey-based and qualitative research has shed light on instructional practices at HBCUs that may promote strong outcomes for Black students, including higher rates of undergraduate participation in faculty research ((Kim and Conrad, 2006; Perna et al., 2009)), as well as institutional practices, such as small class sizes, supportive faculty outreach, accessible faculty offices, and available peer tutoring, that facilitate strong student performance, especially in STEM fields ((Palmer and Gasman, 2008; Perna et al., 2009)). Qualitative studies have also pointed to supportive and collaborative peers as contributors to student success in HBCUs ((Palmer and Gasman, 2008; Perna et al., 2009)).

1.1 Why Institution Types May Matter

Human capital theory suggests that the link between labor market earnings and educational attainment is driven by the skills students acquire through schooling and on-the-job training ((Becker, 1993)). In this view, differences in institutional effects on earnings reflect differences in institutions' ability to increase students' skills. Institutions differ in their course offerings, course requirements, class sizes, general academic expectations, and emphasis placed on teaching relative to research, as well as in level and quality of academic support they offer outside the classroom, such as career advising, academic tutoring, mental health services, etc. Any of these, or combinations thereof, may influence student outcomes. Institutional effects on human capital may also include peer effects, as the average preparation level of students' peers can affect the level of academic performance that professors expect and encourage, as well as what students come to expect of themselves. Peers may also influence students' course-taking, study habits, and career expectations through modeling of norms as well as comparisons of relative performance. For instance, Stinebrickner and Stinebrickner ((2014)) used longitudinal student surveys to show that students adjust their own goals based on what they learn about their academic performance and preparation relative to peers in their first year of college. Meanwhile, Palmer and Gasman ((2008)) used student interview data to illustrate how students at HBCUs may provide direct mentoring and support to their peers. In particular, researchers have theorized that HBCUs and other minority-serving institutions may emphasize students' identification with values of the institution ((Akerlof and Kranton, 2002)), help students to integrate their ethnic and academic self-concepts ((White et al., 2019)), and, as noted above, provide additional learning opportunities and academic resources, as well as supportive peers ((Perna et al., 2009; Palmer and Gasman, 2008)).

A prominent alternative explanation for differences in institutional effectiveness lies in heterogeneous labor market signaling ((Weiss, 1995)). From a signaling perspective, the academic prestige of a given institution may yield higher earnings for its graduates, especially early in their careers, by indicating to potential employers that they were able to meet competitive admission requirements. It serves, in other words, a screening function ((Stiglitz, 1975)). In support of this perspective, Arcidiacono et al. ((2010)) find that, in comparison to high school graduates, college graduates can more precisely signal their level of skill to the labor market though the details of their degree attainment, including not only academic major and grade point average, but also institutional prestige.

In addition, social network effects may function as a special case of labor market signaling. If, for instance, alumni or friends of a particular institution are well-positioned in the labor market, their preference for hiring graduates of that institution or institutional type could confer an earnings advantage for those graduates. Individuals from Ivy League institutions, for instance, are well-represented in the nation's most powerful institutions and fall disproportionately among the top 1% of earners in the U.S. ((Chetty et al., 2017; Wan, 2018)). Along similar lines, graduates of HBCUs are well-represented among Black professionals in high-prestige positions and institutions ((Fryer and Greenstone, 2010; Kim and Conrad, 2006)). Such patterns may yield labor market advantages for graduates.

This paper aims to help illuminate human capital pathways between students' institutional choice and their earnings in their mid-20s. Examining the effects of three institution types on attainment measures (indicators of human capital accrual) as well as labor market earnings makes plausible pathways easier to understand. Specifically, I examine how initial enrollment at the High-Success Institutions (HSIs) as conceptualized by Chetty et al. ((2017)) or at HBCUs predicts and plausibly influences differentials in attainment and earnings in 2012, about 10 years after the survey sample's tenth grade year, when most respondents were about 26 years old. To help distinguish how HSI and HBCU effects may differ from institutional selectivity effects, I compare HSI and HBCU effects to the estimated effects of first attending a postsecondary institution rated in the Top 3 selectivity tiers of the Barron's Admissions Competitiveness Index in 2004 (BT3). These comparisons of course do not truly disentangle human capital from signaling effects, since both types of effects may be in play at all three institution types, but they may still shed new light on the question of plausible mechanisms by which postsecondary institutional attributes can influence labor market outcomes.

BT3 institutions here represent institutions that are comparatively selective, helping us understand the extent to which the effects of HSIs and HBCUs align with or diverge from the effects of relatively selective institutions as a group. Barron's rates four-year institutions based on entrance examination requirements and average scores, high school grade point averages of entering students, and admissions rates. The rating tiers in 2004 ranged from 1 (most competitive) to 6 (non-competitive), with the tier of 7 indicating special institutions to whom the criteria did not apply, such as art or music schools that do not base their admissions on academic criteria *per se* ((Schmitt, 2016)). I impute a rating of 8 to institutions, including all two-year institutions, that did not receive Barron's ratings in 2004. I define HSIs as institutions that Chetty et al. ((2017)) identified with IRS data as having success rates in the top quartile of four-year institutions in 2000, four years before students in the current study typically enrolled in postsecondary education. The success rate is defined as the fraction of students from families with incomes in the bottom U.S. quintile who have earnings in the top quintile by their 30s. HBCUs, which opened postsecondary pathways to Black students when other paths were foreclosed by segregation, and which continue to serve large shares of Black students, are identified as such through their 2004 classification in the Integrated Postsecondary Education Data System (IPEDS) produced by the National Center for Education Statistics.

The aim of this analysis is thus to estimate the effects of first-postsecondary institution type on various measures of attainment, including STEM and humanities credit completion, bachelor's degree attainment, pursuit of postbaccalaureate education, and earnings in 2012. Of course a key challenge of estimating such effects is that the choice of institution type is endogenous. Attainment and earnings may reflect not only institutional effects, but also the effects of pre-existing, unobservable attributes of the students who choose them. If the measures of students' pre-existing skills and family and community resources in high school do not fully capture pre-college determinants of the outcomes, then ordinary least squares (OLS) regression models may lead us to erroneously ascribe these factors to the institutions rather than the students.

To address this problem, I take advantage of variation in tenth graders' geographic distances to their nearest postsecondary institution and to that institution's attributes of interest, as well as its tuition relative to the average institution in the state. The analysis rests on the notion that there is some degree of random chance in any students' choice of first institution, and that such randomness may yield consequential differences in students' education and life outcomes. If I can capture a source of randomness that affects students' institutional choices but is conditionally uncorrelated with their pre-college preparedness or motivation, then I can estimate the ways in which institution types influence student outcomes at the margin. One instrumental variable (IV) that has been used for this purpose in prior studies is students' geographic proximity to postsecondary institutions. For instance, Rouse ((1995)) used proximity to students' nearest two-year college to estimate access and diversion effects of two-year college enrollment on educational attainment, finding that it increased educational attainment by 1 to 1.5 years, though effects on bachelor's degree completion were less evident. Card ((1999)) found that geographic proximity to a four-year college and the interaction of this proximity with parental education strongly predicted educational attainment. From this, he estimated an earnings return of 9.7% to to each year of schooling. Adapting a geography-based IV strategy to study preschool rather than postsecondary effects, Herbst and Tekin ((2016)) used the distance families lived from social service agencies as an instrument for subsidy use. They identified negative initial effects of subsidized pre-K effects on children's cognitive skills and behavior in kindergarten, a finding they speculated may have been due to the low quality of many subsidized pre-K slots.

In this study, my IV estimates pertain to students whose probability of choosing a given institution type is increased by geographic proximity. As noted by Card ((2001)), such students may be of special concern to institutions and policymakers because they may be more credit-constrained and risk-averse than the average first-time college entrant. IV methods do not allow me to directly observe the *identities* of individuals who were influenced by geographic proximity (compliers) versus individuals who would have chosen their institution types anyhow (always-takers) ((Angrist and Pischke, 2008)). However, I observe that within the analytic sample in the current study, students who enrolled in the institution closest to their tenth grade zip codes—about 12.7% of individuals who had enrolled in postsecondary by age 2012—had a composite socioeconomic status level that was 0.3 SD below that of the analytic sample as a whole, as well as tenth grade math scores that were 0.22 SD below that of the full sample. They were also 2 percentage points more likely to be Black, Indigenous, or Hispanic, and 2 points less likely to be Asian, than the sample as a whole. (Descriptive statistics for this subset are available from the authors.) These measures imply that students whose choices are geographically sensitive may have greater needs for college information and support than their college-going counterparts, on average.

1.2 Overview of the Paper

In applying the IV approach, I find that the set of geographic instrumental variables reliably predicts enrollment in an HSI. The instruments also predict entry into a BT3 institution and—among Black, Indigenous, and Hispanic/Latinx (BIH) respondents—into an HBCU, but with somewhat less precision than for HSIs. IV estimates of the effects of institution type suggest that, consistent with Card's 2001 findings from a synthesis of IV studies, naive OLS models may bias toward 0 the causal effects of HSIs and HBCUs on earnings for students whose entrance to these institution types is influenced by geographic proximity. OLS estimates may similarly understate the causal effects of all three institution types (HSIs, HBCUs, and BT3s) on bachelor's degree completion and pursuit of postbaccalaurete education. For BIH students who are geographically induced to attend HBCUs, I find that this inducement increases the number of STEM credits completed, the probability of bachelor's completion, and the probability of postbaccalaureate education, but it reduces wages at age 26, suggesting the possibility of systemic bias against HBCU credits in the labor market. Meanwhile, geographically based IV estimates of the causal effects of STEM credits, bachelor's degree completion, and postbaccalaurete education suggest that pursuit of postbaccalaureate training raises earnings at age 26 by 1.2 to 1.5 standard deviations (SDs), or about \$12 to \$15 dollars per hour in 2012 dollars. Also, IV-estimated effect of bachelor's degree completion for BIH students whose degree completion is influenced by geographic variables (including their nearest institution being an HBCU) is about 1.1 SD, or roughly $11.50 an hour. The notion that bachelor's degree earnings benefits in general may be especially high for BIH students is consistent with the work of Arcidiacono et al. ((2010)), who, using National Longitudinal Study of Youth 1979 (NLSY79) data, found that labor market signaling benefits from bachelor's degrees are larger for Black than for white survey respondents.

The paper is organized as follows. In the next section, I describe my my data sources, including geographic proximity indicators, outcome variables in terms of attainment and wages by roughly age 26, and a variety of student-level and school-level control variables. This is followed by a description of my analytic approach. In the subsequent section, I present results from the first-stage, OLS, and second-stage IV models. I then report IV estimates of educational attainment milestones effects on wages eight years after high school for those at the margin of reaching those milestones. Finally, I discuss the implications of these results for higher education practice and suggest questions for future studies to examine.

2 Data

I use data from a restricted-use version of the ELS:2002, a nationally representative, longitudinal sample of individuals surveyed for the first time as tenth graders in the spring of 2002, and then in three subsequent waves in the spring of 2004, 2006, and 2012. High school and postsecondary transcript data were collected from the students' institutions in 2005 and 2013, respectively. As with many NCES surveys, sampling for the ELS:2002 proceeded in two phases ((Ingels et al., 2004)). First, 976 schools serving tenth graders were randomly sampled across 50 states and the District of Columbia, with probability proportional to their size. Sampling was stratified by school sector (public, Catholic, private), U.S. Census division, and urbanicity, and school participation was about 77%. Approximately 26 tenth grade students were then randomly sampled from each participating randomly drawn school. Student sampling was stratified by race and ethnicity, with oversampling of Asian and Hispanic students. Participating students (about 87.3%) completed a survey about their school experiences, educational plans, and career goals, as well as cognitive tests in reading and mathematics. Parents, teachers, school administrators, and school librarians of selected students were also surveyed. The full ELS:2002 dataset includes 16,197 students. [2]

To measure the demographics of the zip codes in which students lived when they were in tenth grade and of the first postsecondary institutions they attended, I use selected economic and demographic data from the 2000 decennial U.S. Census. I employ 5-digit Zip Code Tabulation Areas within the United States and Puerto Rico, retrieved from the American FactFinder (U.S. Census Bureau, 2020).

Data on postsecondary institutional characteristics are drawn from the IPEDS, which as noted above is a national dataset of characteristics for postsecondary institutions in the U.S. I focus on IPEDS data from the year 2004, which is the anticipated high school graduation year for students in the ELS:2002 sample. Data on Barron's college selectivity come from a supplement to the restricted-use version of the ELS:2002 provided by the National Center for Education Statistics, and also pertain to the year 2004. In classifying undergraduate courses as STEM, I follow the U.S. Department of Education SMART grant definitions ((U.S. Department of Education, 2010)) to include agriculture and natural resources, computer and information sciences; engineering and engineering technologies, mathematics and statistics,

[2] ELS:2002 provides cross-sectional base-year weights for each school and student to reflect both the inverse probability of selection, which is known from the sampling design, and the probability of nonresponse, which is estimated from student and school attributes at baseline. The dataset also includes panel weights for use in longitudinal analyses across the other survey waves, reflecting probability of non-response in each wave. I do not employ the ELS weights in this analysis because my identification strategy, instrumental variables analysis, in effect assigns greater weight to respondents who are sensitive to the set of geographic instrumental variables. Applying sampling and non-response weights may therefore distort the internal validity of the IV analysis ((Solon et al., 2015)). My chief concern in this analysis is on the internal validity of college-attribute effect estimates rather than on presenting a nationally representative picture of tenth graders' career trajectories in the U.S.

biological and biomedical sciences, physical sciences, science technology and technicians, and health professions and clinical sciences. Because STEM majors at the institution level are reported by IPEDS only in the four core STEM areas of engineering, biological and biomedical sciences, mathematics/statistics, and physical sciences, I use this definition to calculate the percentage of undergraduate STEM majors and STEM-specific field majors by institution.

2.1 Measures

Descriptive statistics for variables in the analytic samples are displayed in Table 1. The analytic sample is limited to ELS:2002 respondents who reported that they had ever attended a postsecondary institution as of 2012 and who had complete data in terms of the variables in Table 1. The means and standard deviations for each variable in the analytic sample are shown in the first two data columns, respectively. The right-hand data columns provide the range of each variable in the full analytic sample. The middle two columns present means and standard deviations only for members of the analytic sample who hail from Black, Indigenous (American Indian or Alaska Native), or Hispanic (including Latinx) backgrounds, which I collectively term BIH, as noted above. I report BIH students' descriptive statistics separately because I treat them as a distinctive subgroup in the analysis and limit the HBCU-effect estimates to this subgroup. I combine Black, Indigenous, and Hispanic students into a single group to preserve statistical power for the subgroup analysis, and because these groups have been similarly underserved and underrepresented in postsecondary settings. (Constraining the subgroup analyses to Black students yields similar results, but with less statistical precision.)

Among the individual attributes, the socioeconomic status variable (SES) and base math score variable are each standardized within the full set of ELS respondents to have a mean of 0 and a standard deviation of 1. The SES composite is constructed by the ELS to include

Table 1: Descriptive statistics for full (n=7,650) and BIH (n=2,228) analytic samples

	Mean All	SD All	Mean BIH	SD BIH	Min All	Max All
Individual Attributes						
Female	.55	.5	.58	.49	0	1
BIH	.29	.45	1	0	0	1
Asian	.098	.3	0	0	0	1
White	.61	.49	0	0	0	1
English Speaker	.85	.36	.75	.43	0	1
Age Feb '02	16.0	0.49	16.0	0.58	14.1	19.1
Stdzd. SES	.17	1	-.21	.98	-2.9	2.6
Base Math	.22	.95	-.28	.91	-3.2	3.6
HS GPA	2.9	.83	2.5	.81	0	4.6
High School Attributes						
HS % FRL	20	23	31	29	0	100
HS % AP	13	14	11	12	0	81
% Professional Jobs	9.2	5.3	8.2	5.3	.69	1
First-College Attributes						
BT3	.25	.43	.14	.34	0	1
HSI	.22	.42	.15	.36	0	1
HBCU	.021	.14	.06	.24	0	1
High-STEM	.14	.35	.1	.31	0	1
Zip Med. Income	39,460	29,918	40,228	31,005	0	213,520
Zip Inc. Missing	.2	.4	.21	.41	0	1
Geographic Instruments						
Nearest is BT3	.09	.29	.096	.29	0	1
Nearest is HSI	.098	.3	.12	.33	0	1
Nearest is HBCU	.03	.17	.054	.23	0	1
Nearest is HiSTEM	.037	.19	.039	.19	0	1
State Share 4 Yr.	.57	.091	.56	.1	.32	1
Tuitition Ratio	.88	.81	.9	.91	0	6.3
Miles to Nearest	7.2	10	6.3	9.1	0	158
Dependent Variables						
Bach Degree	.51	.5	.35	.48	0	1
Post Bac. Pursuit	.15	.36	.084	.28	0	1
Credits - Humanities	34	34	29	32	0	329
Credits - STEM	28	35	23	31	0	409
Hourly Wage	17	10	15	9.4	0	125

parents' income, occupation, and levels of education. Because the analytic sample is limited to individuals who had enrolled in some type of postsecondary education by 2012, it is not surprising that the mean SES score of 0.17 is slightly above the full dataset mean of 0, though the subsample mean for BIH respondents, -0.21, falls below the full dataset mean. The mean tenth grade math score for the full sample is also greater than 0, at 0.22, and -0.28 for the BIH subgroup. The high school attributes denote the percent of students in respondents' tenth grade school who qualified for subsidized meals and took at least one Advanced Placement (AP) or International Baccalaureate (IB) course during high school as of 2004. They also capture the percent of jobs in the student's residential zip code in 2002 that were classified by the Bureau of Labor Statistics as being in the professional, scientific, or technical services sector (sector 54). The first-college attributes indicate the share of the analytic sample whose first college was classified in 2004 as a BT3, an HSI, an HBCU, or what I call a high-STEM institution, meaning it ranked in the top quartile of institutions in the sample in the percentage of STEM majors. I also include statistics on the 2004 median incomes in dollars within the zip code of the first institution attended (a proxy for earning potential in the institution's local labor market), and an indicator of missingness on this variable. The geographic instruments include dichotomous indicators of whether the institution nearest the student is an HSI, a BT3, an HBCU, or a high-STEM institution, as well as the share of institutions in the students' tenth-grade residential state that were four-year institutions in 2002, and the ratio of the tutition at the nearest institution to that of the state average, both of which were procured from IPEDS. They also include the distance in miles from the student's tenth grade residence to the nearest postsecondary institution. I observe that 9-10 percent of students had an HSI or BT3 institution as their nearest institution, whereas only 3 to 4 percent had a high-STEM institution or HBCU as their nearest institution. These percentages were slightly higher among BIH respondents than among the sample as a whole. Finally, the dependent variables demonstrate that only about half of the full analytic sample had obtained a bachelor's degree or higher by 2012, despite the sample being limited to those who had enrolled in a postsecondary institution at some point in time between 2002 and 2012. Only 15% had pursued postbaccalaureate education. Their average number of humanities and STEM credits were 34 and 28, respectively, and their average hourly wage in 2012 was $17. The dependent variable means were modestly lower in the BIH subsample.

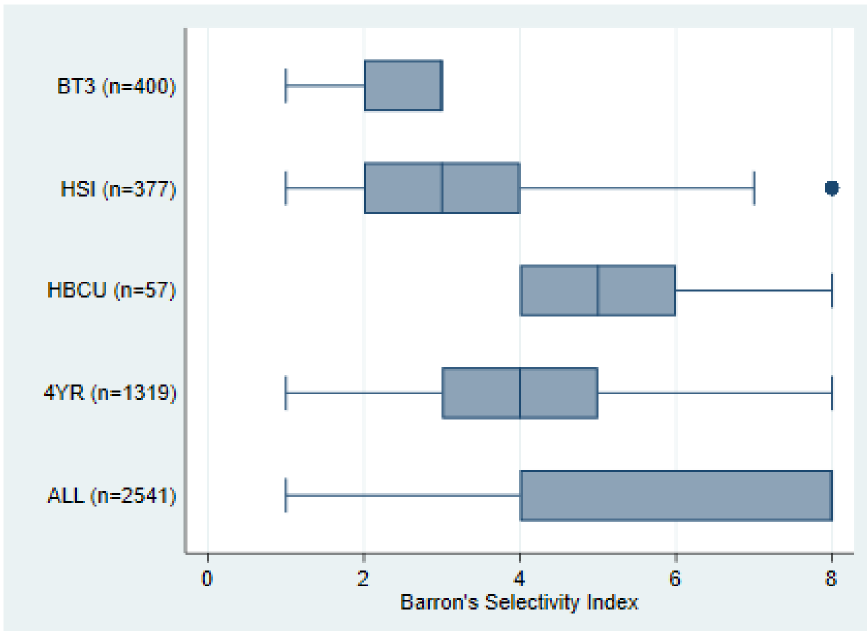

Figure 1: Barron's selectivity ratings of postsecondary institutions attended by ELS:2002 respondents

Figure 1 presents the institutional sample size and Barron's rating distribution of each of these institutional types in the student-level dataset, alongside those of all four-year institutions and all postsecondary institutions, two-year and four-year, in the dataset. The shaded boxes show the interquartile range of the Barron's ratings, where a vertical bar in the midst of a shaded box indicates the median, and the bar and whiskers outside the boxes, where visible, extend to the 5th and 95th percentiles, respectively. By definition, BT3 institutions have ratings of 1 to 3; their median and lower quartile are 3. HSIs are relatively competitive but have a broader distribution of ratings than the BT3s, and the HBCUs have a distribution that reflects their mission of expanding postsecondary access to Black students whose educational pathways may have been constrained by unequal elementary and secondary school opportunities.

3 Analytic Strategy

To estimate the causal effects of the attributes of students' first postsecondary institution, I leverage the attributes of the postsecondary institution that is geographically nearest to their residential zip code in tenth grade. The rationale is that students do not typically choose where they live in high school, and that families of tenth graders are unlikely to have chosen their residences based on their proximities to particular postsecondary institutions that they aspired for their children to attend. Meanwhile, several studies have shown that geographic proximity does influence college going by partially determining the cost of college, in terms of housing and commuting costs as well as informational access Card ((2001)); Rouse ((1995)). I use the `geonear` command in Stata to calculate geodetic distances between 2004 IPEDS institutional zip codes and the tenth grade residential zip codes of each student in the ELS:2002 sample of students who attended any postsecondary institution between 2002 and 2012. I instrument for the attributes of the student's first postsecondary institution using attributes of the geographically closest institution, including whether it is a BT3, an HSI, or an HBCU. [3] The full set of instruments includes miles to nearest postsecondary institution, a dichotomous indicator of whether the nearest institution matches the focal type in the analysis (HSI, BT3, or HBCU), the ratio of the tuition at the nearest institution to the average tuition of postsecondary institutions in the state, the interaction of this ratio with the institution focal type indicator, and a measure of the share of postsecondary institutions in the state that are four-year institutions (as opposed to less-than-four-year). The latter is

[3] I attempted to instrument for entry into a high-STEM institution as well, but the set of geographic instruments did not predict entry into this type of institution.

included because the average state tuition may be partly determined by the share of four-year institutions in the state. All of these instruments are arguably determined by the set of higher education options in the student's residential zip code and state in tenth grade. I establish the joint strength of the instruments using an F test, where a F of 10 is generally considered to meet the strong instrument threshold. Instrument strength is important so that noisy and trivial associations between instruments and endogenous predictors of interest are not exaggerated and interpreted as large causal effects ((Card, 2001; Small, 2008)).

The two-stage instrumental variable model is specified as in the following pair of equations:

$$m^r_{ik4} = \alpha_2 + \beta_2 N_{ik0} + \delta_2 X_{ik} + \epsilon_{2ik4} \tag{1}$$

$$y_{ik4} = \alpha_3 + \nu_3 \hat{m}^r_{ik4} + \delta 3 X_{ik} + \epsilon_{3ik4} \tag{2}$$

In the first stage equation, the dependent variable m_{ik4} is a dichotomous indicator of whether student i from tenth grade school k first enrolled in a postsecondary institution of type r, conditional on having ever enrolled in a two-year or four-year institution by 2012, when most survey participants were about age 26. The types of r are BT3, HSI, and HBCU, and the model is estimated separately for each type. The set of aforementioned, geographically based instrumental variables is included in vector N_{ik0}. Control vector X_{ik0} includes controls for individual attributes of race/ethnicity; gender; a standardized family socioeconomic status composite based on parents' occupation, earnings, and education levels; an indicator of whether the student's first language is English; and a standardized mathematics skills score on a test administered in tenth grade. The control vector also includes school-based controls for share of students in the school who qualified for subsidized meals, and the share enrolled in Advanced Placement or International Baccalaureate courses in high school, and a measure of the share of employers in the student's residential zip code that were in the professional sector. The latter serves as a control for the socioeconomic milieu of the residential zip code, to help disentangle effects of geographic proximity to college attributes from the effects of the geographic socioeconomic environment. Models in which the dependent variable is hourly wage also adjust for the median income of the zip code in which the postsecondary institution is located, as a control for local labor market conditions. The standard errors in the model are clustered at the base high school level.

In the second-stage equation, the predicted probability of initially enrolling in institution type r from the first stage, $\hat{m}^r_{ik4}$, becomes the substantive predictor of interest. Its coefficient, ν_3, captures the Local Average Treatment Effect (LATE) of first enrolling in institution type r on each dependent variable of interest, adjusting for the other variables in the model. The LATE in this context refers to the causal effect for students whose choice of first institution is influenced by the geographic proximity and type of the institution nearest their tenth grade residence. Because local proximity influences cost and convenience of college, it is likely to be most influential for students who are less-affluent and who are on the margin of college attendance in general, as noted above. Estimates of the LATE may be especially relevant for students who are already at higher risk of not earning a postsecondary credential, and thus to policy decisions about institutional support and financial aid for particular types of institutions and institutional practices. The dependent variables in the second-stage include the number college credits obtained by 2012 in (1) humanities and (2) STEM courses (respectively); dichotomous indicators of whether the participant had (3) obtained at least a bachelor's degree by 2012, or (4) had ever pursued post-baccalaureate study by 2012, and an indicator of the participant's (5) hourly wages from work (scaled in 2012 \$) in the year leading up to the 2012 survey. In stage two, the error term is given by ϵ_{3ik4}, and the intercept by α_3, with corresponding parameters shown for the first stage as well. Standard errors are clustered at the base high school level as an adjustment for possible interdependence of students' postsecondary decision-making within schools.

4 Findings

4.1 First-stage Estimates Predicting Enrollment into Focal Institution Types

Table 2 reports results from fitting equation 1, the first-stage in the two-stage least squares model. In each column, I am estimating relationships between the set of geographic instruments and the enrollment variables of interest—that is, initial enrollment in a BT3, HSI, or HBCU—adjusting for the effects of the aforementioned control variables whose coefficients are not shown. The set of instruments is strong in predicting enrollment in an HSI, where the joint F-statistic on the instruments is 13. The set is moderately weaker in predicting enrollment in a BT3 institution, with an F-statistic of 7.7, and enrollment in an HBCU among BIH students, with an F-statistic 4.8. The weaker F-statistic for BT3 enrollment may reflect the comparative selectivity of the BT3 institutions, which may mitigate proximity effects. The weaker F-statistic for HBCU enrollment among the BIH subset may in part reflect the size of the subset, because the magnitude and direction of the effects are in keeping with the other models.

Across the first-stage models, having a given institution type as one's nearest institution is strongly predictive of initially enrolling in an institution of that type. For BT3s, the nearest-institution effect, adjusting for the other terms in the model, is an additional 10 percentage points ($p<0.05$); it is an additional 12 percentage points for HSIs ($p<0.01$) and an additional 14 points for HBCUs ($p<0.1$). Also looking across models, the distance from nearest institution has a statistically significant negative relationship to the probability of enrolling in such an institution, at -0.1 to -0.2 percentage points per mile. For BT3s and HSIs, the probability of enrollment also rises notably with the fraction of institutions in the state that are four-year, which is consistent with there being proportionally fewer two-year alternatives in the state, as all BT3s and the vast majority of HSIs are four-year institutions.

Table 2: First-Stage Estimates of Instrument Effects on Category of Initial Institution

	(1) BT3	(2) HSI	(3) HBCU
Miles to Nearest	-0.002***	-0.002***	-0.001*
	(0.000)	(0.000)	(0.000)
Share 4-Yr in State	0.129+	0.308***	0.101
	(0.073)	(0.085)	(0.166)
Nearest is BT3	0.097*		
	(0.039)		
Nearest is HSI		0.119***	
		(0.032)	
Nearest is HBCU			0.141+
			(0.078)
Tuition Ratio of Nearest to State Avg.		0.002	
		(0.008)	
Tuition Ratio x Near is HSI		-0.022	
		(0.015)	
Tuition Ratio: Near Not BT3	0.017*		
	(0.007)		
Tuition Ratio x Near is BT3	-0.017		
	(0.017)		
Tuition Ratio: Near Not HBCU			-0.003
			(0.005)
Tuition Ratio x Near is HBCU			0.036
			(0.068)
Obs. All	8,073	8,073	2,333
Schools All	702	702	565
F-instrum	7.690	13.31	4.796
df (5, df_resid)	694	694	548

Cluster robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.1
Controls include race/ethnicity where possible, gender, family SES composite, first language not English, subsidized meal share in baseline high school, share of students in AP or IB classes in baseline high school, honors-weighted GPA in high school, 10th grade math test score, share of employers in professional sector in baseline residential zip code, median zip code income of baseline postsecondary institution, and zip code income missingness indicator. BT3=first institution is in Barron's top 3 selectivity tiers; HSI=first institution is a high-success institution; HBCU=first institution is a Historically Black College or University. Note that HBCU models are limited to Black, Indigenous, and Hispanic/Latinx respondents.

Adjusting for the other terms in the model, tuition ratios of the nearest institution to the rest of the state do not appear linked to enrollment at the institution types of interest, *except* that an additional unit in the tuition ratio of nearest institution to the state average (indicating a higher relative cost of the nearest institution) is linked to an additional 1.7 percentage-point chance of BT3 enrollment if the nearest institution is *not* a BT3.

4.2 OLS Estimates of Institution Type Relationships to Courses, Attainment, and Earnings

Next I turn to the relationships of substantive interest: how first-institution type is linked to course taking patterns, educational attainment, and labor market earnings ten years after tenth grade. First I focus on Ordinary Least Squares (OLS) estimates of these relationships, in which I include statistical controls for all aforementioned covariates, including the joint set of geographic predictors highlighted in Table 2. OLS estimates express correlations between first institution type and the outcomes of interest, holding constant student, school, and high school zip code attributes and (in the case of earnings) college zip code median incomes. If these variables captured all relevant differences between students choosing different institution types, they would provide causal estimates. Because students and colleges choose one another based on many considerations, only some of which are captured in large datasets, OLS estimates cannot be construed as causal. Instead, we would expect that unobserved differences between people who choose particular first institution types will play a substantial role in their course-taking, educational attainment, and labor market earnings. Table 3 thus presents OLS estimates as an initial examination of adjusted correlations between the independent and dependent variables of interest.

In Table 3, I find strong and statistically significant associations between initial attendance at a BT3 and the outcomes of interest in terms of coursework, postsecondary edu-

Table 3: OLS Estimates Relating Institutional Attributes to Outcomes

	(1) Humanities	(2) STEM	(3) Bachelor	(4) Postbac	(5) Wage
Barron's Top 3	2.192+	-2.937**	0.184***	0.130***	2.526***
	(1.130)	(1.118)	(0.013)	(0.012)	(0.332)
High-Success Inst.	-1.116	-2.159+	0.169***	0.093***	2.483***
	(1.031)	(1.116)	(0.013)	(0.012)	(0.346)
HBCU (BIH Subset)	2.708	6.750*	0.081*	0.017	-1.192+
	(2.652)	(2.621)	(0.038)	(0.021)	(0.632)
Obs. BT3/HSI	8,359	8,359	8,342	8,976	8,257
Obs. HBCU	2,387	2,387	2,379	2,652	2,497
R^2 HSI	0.133	0.127	0.365	0.144	0.107
R^2 BT3	0.134	0.128	0.368	0.152	0.096
R^2 HBCU	0.166	0.147	0.312	0.119	0.089

Cluster robust standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Controls include race/ethnicity where possible, gender, family SES composite, first language not English, subsidized meal share in baseline high school, share of students in AP or IB classes in baseline high school, honors-weighted GPA in high school, 10th grade math test score, share of employers in professional sector in baseline residential zip code, median zip code income of baseline postsecondary institution, and zip code income missingness indicator. BT3=first institution is in Barron's top 3 selectivity tiers; HSI=first institution is a high-success institution; HBCU=first institution is a Historically Black College or University. Note that HBCU models are limited to Black, Indigenous, and Hispanic/Latinx respondents. N schools $\simeq$ 710 for HSI and BT3, and $\simeq$ 575 for HBCU.

cational attainment, and wages. Initially enrolling at a BT3 versus a different institution type is linked to an additional 2 humanities credits (p¡0.1) and 3 fewer STEM course credits (p¡0.01) ten years after tenth grade, adjusting for the other terms in the model. These relationships are interesting, as they suggest that humanities credits may be disproportionately popular, and STEM credits disproportionately unpopular, at BT3 institutions relative to other institution types. Initial BT3 enrollment is also linked to an 18-point higher probability of earning a bachelor's degree by 2012, and a 13-point higher probability of pursuing postbaccalaureate training. The latter two relationships are unsurprising, not only because students who receive admission to BT3 institutions are those with relatively strong academic skills who are likely to persist in college and pursue education after college, but also because BT3s are four-year institutions by definition. Students who initially enroll elsewhere include those who first enroll at two-year institutions, many of whom may not intend to pursue four-year degrees or postbaccalaureate training. Finally, initial enrollment at a BT3 institution is linked to an additional $2.53 in hourly wages in 2012, or about a quarter of the hourly wage standard deviation.

In examining how these associations may differ with initial entry into an HSI, I am interested in how relationships to course-taking, attainment, and earnings may differ in institutions defined by Chetty et al. ((2017)) as those from which students from bottom-quintile income backgrounds are especially likely to reach the top quintile in adulthood. Are these institutions different from BT3s, with which they have only partial overlap, in terms of the courses students choose, the attainment levels they reach, and the early-career earnings they receive? In column 2 of Table 3, the estimates for HSIs are similar to those for BT3s, but more muted. Having an HSI as one's first institution has no statistically significant relationship to humanities credits but is linked to 2 fewer STEM credits ($p<0.1$) earned by 2012. The associations between initial HSI entry and bachelor's degree completion, postbaccalaurate pursuit, and hourly wages are similar to, but slightly smaller than, the estimates for

BT3 institutions, with the most notable difference between coefficients for postbaccalaureate pursuits, where HSI enrollment is linked to only a 9-point higher probability.

OLS estimates for initial enrollment in an HBCU (limited to the subsample of BIH students) take on a different pattern from BT3 and HSI relationships. For BIH students, attending an HBCU as the first institution relative to other institutions is linked to an additional 6.8 STEM credits (about 2 additional STEM courses, p¡0.05), an additional 8 points in probability of earning a bachelor's degree by 2012 (p¡0.05), and $1.2 less in hourly wages in 2012 (p¡0.1). Initially attending an HBCU bears no statistically significant relationship to humanities course credits earned or to pursuit of postbaccalaureate training. Of particular note is the difference between BT3 and HSI institutions as compared to HBCUs in the number of STEM credits earned, which is negative for students attending BT3s or HSIs, but strongly positive for HBCUs. This finding is consistent with longstanding evidence that HBCUs are especially effective at producing graduates in STEM fields ((Kim and Conrad, 2006; Perna et al., 2009)).

4.3 IV Estimates of Institution Type Effects on Courses, Attainment, and Earnings

We now turn to Table 4, which presents the IV estimates corresponding to the OLS estimates in the previous table. The IV estimates capture only those effects that are driven by variation in students' geographic proximity to institutions and institution types in grade 10. They are plausibly causal estimates for "compliers," meaning for students whose initial enrollment in a given institution type is influenced by living closest to an institution of that type, along with proximity to the nearest institution, relative tuition of the nearest institution, and concentration of four-year institutions in the state.

Comparing estimates in Tables 3 and 4, the coefficients in the IV analysis are markedly

Table 4: Instrumented Effects of Institutional Attributes on Outcomes

	(1) Humanities	(2) STEM	(3) Bachelor	(4) Postbac	(5) Wage
Barron's Top 3	10.634	-29.644*	0.745***	0.327*	3.322
	(14.711)	(13.951)	(0.219)	(0.127)	(3.745)
High-Success Inst.	2.893	-21.357**	0.457***	0.197*	6.475**
	(8.859)	(8.241)	(0.124)	(0.078)	(2.439)
HBCU (BIH Subset)	23.432	26.085*	0.482+	0.219+	-7.072*
	(18.126)	(12.954)	(0.251)	(0.123)	(3.477)
Obs. BT3/HSI	7,749	7,749	7,734	8,317	7,650
Obs. HBCU	2,153	2,153	2,146	2,388	2,248
R^2 BT3	0.125	0.047	0.199	0.114	0.094
R^2 HSI	0.131	0.085	0.321	0.134	0.087
R^2 HBCU	0.140	0.127	0.273	0.086	0.066

Cluster robust standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Controls include race/ethnicity where possible, gender, family SES composite, first language not English, subsidized meal share in baseline high school, share of students in AP or IB classes in baseline high school, honors-weighted GPA in high school, 10th grade math test score, share of employers in professional sector in baseline residential zip code, median zip code income of baseline postsecondary institution, and zip code income missingness indicator. BT3=first institution is in Barron's top 3 selectivity tiers; HSI=first institution is a high-success institution; HBCU=first institution is a Historically Black College or University. Note that HBCU models are limited to Black, Indigenous, and Hispanic/Latinx respondents. N schools $\simeq$ 696 for HSI and BT3, and $\simeq$ 551 for HBCU.

larger than in the OLS analysis. If we presume that OLS estimates are biased away from 0 by unobserved ability and motivation, then this finding is counterintuitive. On the other hand, Card ((2001)) observe that numerous studies of returns to postsecondary education have found IV estimates that exceed OLS estimates. They note that a possible explanation is that benefits may be larger for the subset of students who are particularly sensitive to quasi-random facilitators of education access, such as (in this case) geographic proximity. In this case, it suggests that students on the margin of choosing a particular institution type are especially sensitive to institutional effects on coursetaking, attainment, and earnings, whereas students' whose decisions are less geographically dependent may also be less susceptible to the effects of other institutional factors on their educational choices.

Specifically, in Table 4 I observe strong and negative IV-estimated effects on STEM coursework, such that first enrollment in a BT3 institution is linked to nearly 30 fewer STEM credits (10 courses), and even first enrollment in a HSI is linked to nearly 21 fewer STEM credits (about 7 fewer courses). On the other hand, among BIH students, first attendance at an HBCU predicts an additional 26 STEM credits, or almost 9 additional courses. For both BT3s and HSIs, estimates of this size imply differences in choice of STEM major driven by first enrollment at each type, implying that enrolling at an HBCU increases STEM course-taking and major behavior for BIH students, whereas enrolling in a BT3 reduces it. This might be the case if STEM-leaning students who would have gone that direction at many institutions find that other highly capable students are majoring in non-STEM subjects at BT3s and HSIs, and if these students, when enrolled in HBCU institutions, find greater support for pursuing STEM courses and majors than they would in other institution types. In other words, these could plausibly be due to peer effects in both cases. First enrolling in a BT3 institution predicts much higher probabilities of bachelor's attainment and postbaccalaurete pursuit, which seems plausible only if students who are geographically induced to attend such institutions would have had quite low probabilities of these outcomes by default. For HSIs, the IV-estimated effects are smaller but still remarkable, at an additional 46 and 20 points, respectively, in HSIs (p¡0.001 and p¡0.05). In HBCUS, effect estimates for BIH students are similar in magnitude to those of the HSIs overall at 48 and 22 points, respectively, albeit with statistical significance at only the 10 percent level.

The IV estimates of institution types on wages are the most heterogeneous. I see no effect of BT3 institutions on wages in 2012, whereas effects of HSIs are substantial, yielding an additional $6.48 per hour, or about 65% of an SD. This finding consistent with the Chetty et al. ((2017)) identification of these institutions in IRS data as those that yield especially high earnings. But I observe a different pattern for IV effects of HBCUs, where the causal effect on earnings appears to be negative and substantial, at about -$7.07 per hour, or about 0.7 SDs. Thus, for BIH students geographically induced to attend HBCUs, I observe a paradox, which includes large positive effects on STEM course-taking, bachelor's degree completion, and pursuit of postbaccalaureate training, but negative effects on earnings. This finding suggests that employer bias against credentials from HBCUs may be in play, as I discuss further below.

4.4 IV Estimates of Coursework and Attainment Effects on Wages

In the final section of the analysis, I use the sets of geographic instruments to estimate plausibly causal effects of postsecondary coursetaking and attainment—namely, STEM credits earned, bachelor's degree completion, and pursuit of a postbaccalaureate degree—on hourly wages in 2012.

The first-stage estimates predicting each coursetaking or attainment measure as a function of the geographic instruments (and other control variables) can be found in Appendix Table A1. Note that the strongest predictors of attainment in the first-stage models tend to be the relative availability of four-year colleges in the state. For BT3 and HSI instrument sets, students' distance from the nearest postsecondary institution is also a strong attainment predictor. For the HBCU instrument set, the tuition ratio of the nearest institution to the average institution is a strong predictor of STEM coursetaking if the nearest institution is an HBCU, but not otherwise. This first stage is consistent with estimates in Tables 2 and 4 suggesting that geographically related instruments do affect HBCU attendance, which in turn raises the number of STEM credits that BIH students earn. On the other hand, Appendix Table A1 offers a caveat to the IV estimates in this section, because the F-statistics in all of the models range generally from about 3 to 5. The fact that they are weaker than the initial enrollment F-statistics in Table 2 is unsurprising since coursetaking and attainment are more distal behaviors than initial choice of a postsecondary institution. Comparing among columns, the F-statistics are modestly stronger for attainment in the BT3 and HSI proximity models and for STEM course completion in the HBCU model.

IV estimates of each coursetaking or attainment measure from each of the three geographic instrument sets are shown in Table 5. Columns 1 and 2 should be understood as attempts at estimating the same parameters—the effects of each coursetaking or attainment measure on wages—and column 3 is estimating a similar parameter, which is the effect of each of these measures on earnings just within the subgroup of BIH respondents. Columns 1 and 2 may therefore be thought of as robustness checks on each other, and column 3 as a special case of the same estimates pertaining to BIH students.

The estimates in columns 1 and 2 of Table 5 are similar to one another, which suggests that they are similarly capturing effects of geographically induced variation in coursetaking and attainment. This is to be expected given that the first-stage coefficients in Appendix Table 1 are similar whether the nearest tenth grade institution was a BT3 or an HSI. Because the estimates in the first two columns of Table 5 are so similar, I will focus on column 2, whose instrument set included an indicator that the nearest institution was an HSI. There I find that the plausibly causal effect of each STEM credit and of the bachelor's degree are null, but that postbaccalaureate effort is linked to an additional \$12.73 per hour. These

Table 5: Instrumented Effects of Attainment Measures on Hourly Wages (2012$)

	(1) IV ⊃ Nearest is BT3	(2) IV ⊃ Nearest is HSI	(3) IV ⊃ Nearest is HBCU
STEM Credits	0.020	-0.082	-0.143+
	(0.092)	(0.086)	(0.078)
Bachelor	4.603	6.776	11.588*
	(4.089)	(4.207)	(5.588)
Postbac Effort	12.461+	12.733+	14.926+
	(7.189)	(7.532)	(8.344)
Obs.	7,119	7,119	1,970
Schools	687	687	527
R^2 STEM	0.093	0.021	
R^2 Bachelor	0.102	0.083	
R^2 Postbac	0.004		

Cluster robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.1
Controls include race/ethnicity where possible, gender, family SES composite, first language not English, subsidized meal share in baseline high school, share of students in AP or IB classes in baseline high school, honors-weighted GPA in high school, 10th grade math test score, share of employers in professional sector in baseline residential zip code, median zip code income of baseline postsecondary institution, and zip code income missingness indicator. BT3=first institution is in Barron's top 3 selectivity tiers; HSI=first institution is a high-success institution; HBCU=first institution is a Historically Black College or University. Note that HBCU models are limited to Black, Indigenous, and Hispanic/Latinx respondents. Sample sizes pertain to bachelor's equation but are nearly identical in the other equations.

estimates imply that the returns to educational attainment that are driven by students' geographic proximity to postsecondary institutions take shape largely through effects on postbaccalaureate education rather than through STEM credit completion or bachelor´s degree attainment. However, this is not to say that STEM credits and bachelor's degree attainment do not causally affect wages. Given considerable quasi-experimental evidence that they do ((Avery and Turner, 2012; Webber, 2014; Zimmerman, 2014)), it is best to interpret the null estimates in Table 5 for these variables as estimates for the fraction of coursetaking and attainment that are induced by geographic proximity in tenth grade.

For BIH respondents, we see a somewhat different pattern. STEM credit effects seem negative but small, at 14 cents per credit (p¡0.1). It is not clear why BIH students would receive a modest disadvantage from STEM credit accrual, raising the possibility either that the estimate is affected by a weak first-stage or that BIH individuals' STEM credits are devalued in the labor market. We do see a brighter picture for BIH students in terms of estimated bachelor's attainment and postbaccalaureate earnings, where completion of the former appears to drive an additional $11.59 per hour in earnings, and where postbaccalaureate effort appears to lead to an additional $15 per hour. These estimates suggest that returns to postsecondary education that are driven by geographic proximity may be higher for BIH students than for their white and Asian counterparts, an encouraging finding. Due to a relatively weak first-stage model, I treat these estimates with caution, but they may help illuminate educational effects insofar as students' attainment levels are influenced by their geographic institutional proximity as tenth graders.

5 Discussion

We have long known that educational attainment is not only associated with higher earnings but also produces higher earnings, and that this relationship depends in part on the content students choose to study in college as well as the prestige of the colleges they attend. This study attempts to shed new light on why some postsecondary institutions produce higher-earning graduates than others. Examining institutions rated in the top 3 selectivity categories by Barron's, in comparison to institutions defined by Chetty et al. ((2017)) as boosting the earnings of individuals from lower-income backgrounds (HSIs), and, among the subset of BIH students, institutions defined as HBCUs, I estimate plausibly causal effects of first attendance at each institution type on average coursetaking, attainment, and earnings in the decade following students' tenth grade year of high school. Using tenth graders' residential proximity to higher education institutions and institutional attributes, I estimate plausibly causal effects of each institution type on attainment and earnings outcomes. I find that first attendance at a BT3 and HSI yield fewer STEM credits but to substantially higher rates of bachelor's degree attainment and pursuit of postsecondary education. Still, it is initial attendance at an HSI and not a BT3 institution that appears to increase earnings in one's mid-20s. There are at least two possible explanations for this discrepancy. One possibility is that as-yet-unidentified facets of HSIs themselves are preparing students for higher-earning jobs through mechanisms other than STEM coursetaking and higher rates of degree completion. I can rule out the possibility that this discrepancy is due to average zip code compensation differences between BT3s and HSIs, since my earnings models adjust for median earnings in the zip code of the postsecondary institution. It may be, for instance, that HSIs promote higher earnings through alumni networks, career center services, industry outreach, peer norms, or other institutional attributes and practices. But an alternative explanation is that capturing wages in 2012, when the average survey respondent was 26 years old, is too soon to fully capture the effects of higher-prestige institutions on earnings. This interpretation receives some support from Chetty et al. ((2017)), who show that earnings for students from most four-year and two year colleges stabilize by age 25, but that average earnings rise until about age 30 for students at Ivy League and Barron's tier 1 colleges. The explanation is that students from these institutions are especially likely to pursue postbaccalaureate education. Though my analysis finds plausibly causal effects of BT3 and HSI attendance on postbaccalaureate study, and of postbaccalaureate study on earnings in 2012, it remains possible that the earnings gains from longer-term postbaccalaureate study accrued disproportionately in the BT3 category at ages of 30 onward, beyond the final wave of ELS:2002 data collection.

Moreover, when I focus on the subset of survey respondents of BIH heritages, I find that initial attendance at an HBCU appears to increase STEM course-taking, bachelor's degree completion, and postsecondary pursuits, but paradoxically to lower earnings. The reason that first attendance at an HBCU would reduce wages despite having raised STEM course-taking and educational attainment on average is not clear. One possibility is that employers are systematically biased against credits and credentials from HBCUs, meaning that the higher rates of STEM coursework and educational attainment that students acquire as a result of attending an HBCU are undervalued by the labor market. The systematic bias explanation is all the more likely given that respondents' academic skills in high school (mathematics scale scores and grade point averages) are held constant in all of the statistical models.

On the other hand, the returns-to-attainment estimates in Table 5 suggest that overall attainment of bachelor's degrees and postbaccalaureate training among BIH individuals are strongly rewarded by the labor market. For college attendees whose attainment is influenced by their geographic institutional proximity in high school, wage returns to bachelor's and postbaccalaureate training appear to be higher among BIH students than among the full sample, meaning that higher educational pursuits are not only worthwhile but may contribute to the closure of earnings disparities.

As highlighted by Card ((2001)), an important question in any IV analysis based on geographic proximity is whether such proximity is actually an exogenous predictor of first postsecondary institution. Hillman ((2016)) finds that geographic access to colleges is not equally distributed in terms of student-level variables, like ethnicity and socioeconomic status, though Rouse ((1995)) and Card ((1999)) find that it is plausibly exogenous, conditional on families' socioeconomic status. This study holds race/ethnicity and socioeconomic status constant, alongside the labor market composition of students' residential zip codes in high school, to adjust for family and residential milieu apart from proximity effects. An additional limitation is that the data focus on the 2002 tenth-grade cohort of high school students. It is possible that the labor market has changed since this time. Future analyses should update this work using newer data from the NCES High School Longitudinal Study of 2009 (or related surveys) when data become available about respondents' earnings into their mid-20s.

6 Conclusion

As the U.S. economy has shifted from industrial to knowledge-and-service-based, returns to postsecondary education have risen ((Goldin and Katz, 2008)), and U.S. education policy has increasingly emphasized the aim of postsecondary education for all ((Carnevale and Strohl, 2010; Oreopoulos and Petronijevic, 2019; Perna, 2015)). But postsecondary education is not just a dichotomous measure. Student outcomes vary substantially as a function of education level, institution, and program of study ((Dale and Krueger, 2014; Webber, 2014)). Using longitudinal, student-level data, I estimate plausibly causal institutional effects on the coursetaking, attainment, and earnings of individuals in their mid-20s. This work complements the college value-added analyses of Rothwell ((2015)) and the college mobility scorecard work of Chetty et al. ((2017)) to further unpack the role that institutional attributes play in raising students' attainment levels and earnings capacity, including the role that coursework in STEM and humanities fields may play in mediating institutional effects on earnings. Specifically, the current study differs from that of Rothwell ((2015)) in that he examines college scorecard data to identify average earnings differentials and their correlation with institution-level attributes, such as share of STEM majors. Meanwhile, this study builds on the the work of Chetty et al. ((2017)) by examining the effects of institutions they find to have top-quartile success rates on the actual coursetaking, attainment, and earnings of individuals geographically induced to attend them. This upacking effort is important if we take seriously the question of what colleges can do to raise students' human capital.

My findings do not suggest definitive answers, but they do point to the importance of all three distinctive institution types in promoting bachelor's degree completion and post-baccalaureate attainment. They also imply that the relationship of institutional practices to earnings is complex. Though my findings align with the Chetty et al. ((2017)) success rates, corroborating the role of HSIs in causally promoting higher earnings, they leave open the question of what, if at all, these institutions are doing differently from BT3s and HBCUs to facilitate higher earnings among their alumni. My findings also suggest a marked under-valuing of HBCU credentials by the labor market, despite evidence that these institutions substantially raise STEM coursetaking and postsecondary attainment levels for students of BIH heritages. In other words, they suggest new work is needed to examine heterogeneity in earnings outcomes among institutions that seem to similarly affect attainment-based measures of human capital.

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Table A1: First-Stage Estimates of Instrument Effects on Key Attainment Measures

	Nearest is BT3			Nearest is HSI			Nearest is HBCU		
	(1) STEM Credits	(2) Bachelor's	(3) Postbac Effort	(4) STEM Credits	(5) Bachelor's	(6) Postbac Effort	(7) STEM Credits	(8) Bachelor's	(9) Postbac Effort
Miles to Nearest	-0.029	-0.001**	-0.001***	-0.032	-0.001**	-0.001***	0.021	-0.001	-0.001
	(0.042)	(0.001)	(0.000)	(0.041)	(0.001)	(0.000)	(0.064)	(0.001)	(0.000)
Share 4-Yr in State	-5.778	0.212**	0.088*	-5.034	0.208**	0.091*	1.256	0.262**	0.162**
	(5.503)	(0.066)	(0.040)	(5.474)	(0.066)	(0.040)	(8.171)	(0.098)	(0.050)
Nearest is BT3	-1.084	0.018	0.014						
	(2.684)	(0.036)	(0.024)						
Nearest is HSI				-4.418*	0.018	0.010			
				(1.797)	(0.025)	(0.019)			
Nearest is HBCU							-2.008	0.011	-0.010
							(3.239)	(0.072)	(0.040)
Tuition Ratio: Nearest to St. Avg.				-1.181*	0.011	-0.002			
				(0.535)	(0.007)	(0.006)			
Tuit. Ratio x Near is HSI				0.316	0.007	-0.010			
				(0.954)	(0.014)	(0.009)			
Tuit. Ratio x Near not BT3	-0.688	0.016*	-0.004						
	(0.572)	(0.007)	(0.006)						
Tuit. Ratio x Near is BT3	-1.638	-0.004	-0.007						
	(1.143)	(0.017)	(0.011)						
Tuit. Ratio x Near not HBCU							-0.108	0.013	0.003
							(0.726)	(0.010)	(0.006)
Tuit. Ratio x Near is HBCU							7.145***	0.059	0.040
							(2.034)	(0.048)	(0.037)
Obs.	7,522	7,507	8,073	7,522	7,507	8,073	2,098	2,091	2,333
Schools	693	693	702	693	693	702	543	542	565
F-instrum	3.546	4.743	4.011	3.183	4.474	4.047	5.476	2.446	3.562

Robust standard errors in parentheses; controls are the same as for Table 2.
*** p<0.001, ** p<0.01, * p<0.05, + p<0.1