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More Money for Less Time? Examining the Relative and Heterogenous Financial Returns to Non-Degree Credentials and Degree Programs

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More Money for Less Time?

Examining the Relative and Heterogenous Financial Returns to Non-Degree Credentials and Degree Programs

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Abstract. There is a large and growing number of non-degree credential offerings between a high school diploma and a bachelor's degree, as well as degree programs beyond a bachelor's degree. Nevertheless, research on the financial returns to non-degree credentials and degree-granting programs is often narrow and siloed. To fill this gap, we leverage a national sample of individuals across nine MSAs and four industries to examine the relative financial returns to a variety of non-degree credentials and degree programs. Leveraging a semi-parametric difference-in-difference model advanced by Callaway and Sant'Anna (CS-DID), we explore the relationship between completing a credential or degree and earnings premiums. We find that earnings premiums were not always commensurate with the time it takes to complete various credential and degree programs and that the earnings trajectories varied substantially across these credential and degree programs. Subsample analyses reveal significant differences across gender, race/ethnicity, and industry.

Keywords. Education economics; financial returns; non-degree credentials

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Elevators, Escalators, or Both?

Examining the Relative and Heterogenous Financial Returns to Non-Degree Credentials and Degree Programs

INTRODUCTION

Post-secondary education has been historically and causally linked to higher incomes (Card, 1999). In 2021, the median annual income for a year-round worker aged 25-34 with a high school diploma was $39,700, while a worker of the same age with a bachelor's degree earned $61,600 (National Center for Education Statistics, 2023). Indeed, having a bachelor's degree is often a good investment when compared to having no post-secondary education or training—especially over the life course (Deming, 2023). Unsurprisingly, large public investments, such as federal and state funding, have been made in educational institutions that offer bachelor's degrees. However, having a bachelor's degree does not necessarily guarantee getting a job that benefits from the earnings premium commonly associated with the degree. Although the unemployment rate for bachelor's degree holders is only one-third that of non-bachelor's degree holders, a significant portion of graduates still face *under*employment. One analysis found that 52 percent of bachelor's degree holders were underemployed one year after graduation, and even after 10 years, 45 percent remained in jobs that did not fully utilize their degrees (Burning Glass Institute and Strada Institute for the Future of Work, 2024). Furthermore, there are large opportunity costs associated with earning a bachelor's degree—both in terms of time (e.g., most bachelor's degree programs take 4 years) and money (e.g., the average cost of attendance for a student living on campus at a public 4-year in-state institution is $104,108; Hanson, 2024). For instance, in a recent survey of high school students, nearly half of them believed they could achieve professional success with education programs that lasted under 4 years (ECMC Group, 2022).

As a result, policymakers and researchers have continued to examine the economic returns of bachelor's degrees. Nevertheless, the perennial question of "Is college still worth it?" is limited in that it implies only a partially true counterfactual assumption; it relies on a comparison between having a bachelor's degree and having no post-secondary education and training whatsoever. However, there is a large and growing number of post-secondary education and training opportunities *between* a high school diploma and a bachelor's degree. Indeed, while Carnevale and his colleagues (2023) estimate that 72 percent of jobs will require some form of post-secondary education or training by 2031, not all these jobs will require a bachelor's degree. Even managerial and professional occupations (e.g., occupations in science, technology, engineering, and mathematics, social sciences, education, and healthcare), of which the vast majority—95 percent—require at least some form of post-secondary education and/or training, many of these jobs do not require a bachelor's degree (Carnevale et al., 2023). Rather, there is a substantial proportion of "middle-skill" jobs in the managerial and professional economy—that can be obtained with post-secondary education and training opportunities *between* high school diploma to bachelor's degree, such as associate's degrees and non-degree credentialing programs that provide, for example, job- or industry-specific certifications. For instance, 23% of healthcare professional and technical occupations are projected to represent middle-skill jobs by 2031 (Carnevale et al., 2023).

At the same time, there is a large and growing number of jobs that require advanced skills, and subsequently, a large and growing number graduate degree programs. For example, when compared to the 7-percent average growth projection for employment in all occupations, employment in master's-level occupations was projected to grow by roughly 17 percent from 2016 to 2026, while employment in doctoral- and professional-level occupations was projected to grow by roughly 13 percent (BLS).

When considering the importance of post-secondary education and training *between* a high school diploma and a bachelor's degree, as well as *beyond* a bachelor's degree, a more comprehensive research approach is needed. Therefore, instead of interrogating whether college is still worth it, we examine the relative economic returns of a variety of non-degree credential programs and degree-granting programs. Furthermore, as earnings premiums can change over time, we examine both short- and long-term effects, examining the degree to which credentials and degree programs operate as "elevators", "escalators", or both.

Moreover, given the potential for education to close gender and racial/ethnic equity gaps, we explore the heterogenous returns across various aspects of identity as well. Given changing labor market dynamics across industries, we explore the heterogenous returns across industries as well. To that end, we ask the following research questions:

1. What are the short-term and long-term earnings premiums associated with earning a non-degree credential and completing a degree program?
2. How do the earnings premiums associated with degree completion and non-degree credentials differ by the recipients' gender and race/ethnicity?
3. How do the earnings premiums associated with degree completion and non-degree credentials differ across industries?

In doing so, our analysis reflects the complexity of the educational choices, and their relative costs and benefits, faced by individuals, who are not just prospective students deciding between a high school diploma and a bachelor's degree, but are, instead, considering a range of post-secondary education and training opportunities over their life course. Although the evidence remains strong that increased educational attainment is associated with improved economic outcomes, it is essential to examine the returns of the full array of education and training opportunities available.

BACKGROUND

As described by Deming (2022) education, training, and experience—often referred to as human capital—explain a substantial share of the variation in earnings both within and across countries. While novel methods have been used to estimate earnings (e.g., instrumental variable approaches, regression discontinuity designs, etc.), Deming notes that these estimates often match those produced by foundational methods (*ibid*). For example, the "Mincer Equation" (Mincer, 1976) specified an additive function for annual earnings that was linear in years of education and quadratic in years of work experience (Deming, 2022). Here, an additional year of schooling is estimated to produce a 6-18 percent increase in earnings, which has been largely replicated in more recent studies leveraging novel methods (*ibid*). Unsurprisingly, the earnings returns of associate's, bachelor's, master's, and doctoral degrees—which are incremental in the number of years to complete—demonstrate incremental earnings returns that follow the Mincer Equation. Indeed, Deming demonstrates these incremental returns with the 1979 National Longitudinal Survey of Youth (Bureau of Labor Statistics, 2019): when controlling for ability, each additional year of schooling is associated with a 7 percent increase in earnings. Similarly, relative to not graduating high school, graduating high school is associated with a 13 percent increase in earnings; having some college (e.g., associate's degree) is associated with a 25 percent increase in earnings; having a bachelor's degree is associated with a 48 percent increase in earnings; and having a graduate degree is associated with a 54 percent increase in earnings (*ibid*).

Given the prevalence of degree-granting programs in the U.S., primarily consisting of associate's, bachelor's, master's, and doctoral degrees, it is unsurprising that the research on the economic returns to education often focuses on these programs. However, much of the literature on these programs tends to focus on short-term earnings premiums, which can obscure the long-term returns on investment. For example, Cohn (2024), leveraged College Scorecard and ACS data to demonstrate that earnings trajectories are somewhat similar across bachelor's, master's, and professional degrees in the first five years, but differ substantially afterwards, with professional degree holders continuing to experience large increases in year six through ten.

Moreover, there is an increasing number of non-degree credentials offered by various school- and non-school-providers. In 2023, Credential Engine, a non-profit organization that maps the terrain of credentials in the United Sates, estimated that there are roughly 1.076 million credentials offered by roughly 59,690 providers (Credential Engine, 2023). Non-Degree Credentials have been operationalized by National Skills Coalition (Duke-Benfield et al., 2019) as including (a) sub-baccalaureate credit bearing certificates that are earned from education institutions, (b) non-credit bearing certificates that are earned from community organizations (e.g., coding boot camps), (c) apprenticeship certifications that are earned through work-based learning opportunities and typically apply to industry trades and professions, (d) industry-recognized certifications that are earned from an industry certification body and typically demonstrate the ability to perform a specific job, and (e), licenses earned from a government agency based on a set of criteria that typically include some combination of degree attainment, certification, and assessment (Duke-Benfield et al., 2019, p. 6).

It is possible that non-degree credentials, which often entail one year (or less) of schooling, produce economic returns somewhere between a high school diploma and an associate's degree, and thus follow the Mincer Equation. However, many of these credentials are structured differently than traditional degree-granting programs. For example, Coding Bootcamps attempt to condense the most applicable computer science skills into a 3-month credential program and often provide direct connections to employment (e.g., through an apprenticeship). Recent research demonstrates that these non-degree credentials produce earnings returns that far exceed the estimates that we might expect from a Mincerian distribution. For example, Jabbari et al. (2023) found that a Coding Bootcamp produced a roughly 70 percent increase in earnings. Moreover, while degree programs are often sequential (e.g., in order to have a master's degree, one must first have a bachelor's degree) and onetime (e.g., it is rare for someone to earn two bachelor's degrees at two different time-points), non-degree credentials are often non-sequential and stackable. Indeed, both sub- and post-baccalaureate certificates are offered at many educational institutions, and non-degree credentials can be "stacked" on top of each other to demonstrate multiple domains of expertise.

In addition to the unique structure of non-degree credentials, the underlying mechanisms and subsequent populations are also distinctive. For example, because non-degree credentials are shorter than degree programs, they can often be more responsive to labor markets demands. In fact, many non-degree credentials are not offered by traditional education institutions and are instead offered by non-profit organizations and industry certification bodies. Moreover, as the opportunity costs—both in terms of time and money—are often lower in non-degree credentials, these credentials tend to serve a broader population of students. Indeed, many individuals who earn non-degree credentials are adults working full-time.

Given these dynamics, it is possible that the economic returns to non-degree credentials—relative to degree-granting programs—do not follow a Mincerian distribution. For instance, Jepsen, Troske, and Coomes (2014) leveraged fixed effects models with a sample of roughly 25,000 students from technical and community colleges in Kentucky, finding that non-degree certificates were associated within increased earnings; yet, the relative returns of non-degree certificates were substantially lower than the returns of an associate's degree. Men experienced a quarterly increase of $297 for earning a certificate compared to $1,484 for earning an associate's degree and women experienced a quarterly increase of $299 for earning a certificate compared to $2,363 for an associate's degree. Here, while earning a certificate represented a roughly 6 percent increase for men, earning an associate's degree represented a 29 percent increase; similarly, while earning a certificate represented roughly an 8 percent increase for women, earning an associate's degree represented a 65 percent increase. If a certificate, in theory, took half the time to complete as an associate's degree, then we might expect the percent increases for earning a certificate to be half of the percent increases for earning an associate's degree.

Additionally, Xu and Trimble (2016) leveraged fixed-effects models with a sample of roughly 230,000 students from 81 community colleges in Virginia and North Carolina to estimate the impact of sub-baccalaureate certificates, finding positive impacts on earnings. Quarterly earnings increased from $278 for earning a short-term certificate (i.e., a certificate lasting less than 1 year) to $953 for earning a long-term certificate (i.e., a certificate lasting 1-2 years) to $1,256 for earning an associate's degree in North Carolina. However, in Virginia, the economic returns to long-term certificates ($200) were considerably less than an associate's degree ($773) and only slightly more than a short-term certificate ($153).

Similarly, Bettinger and Soliz (2016) leveraged fixed-effects models with a sample of roughly 51,000 students from both technical and community colleges in Ohio, finding mostly positive impacts on earnings across multiple industries. However, while long-term certificates were associated with economic returns that were slightly less than associate's degrees, this was not the case for men or short-term certificates. Rather, men did not experience any significant economic returns for earning a long-term certificate, yet experienced economic returns for short-term certificates that were nearly twice the economic returns of an associate's degree. Further analyses demonstrated that the returns of short-term certificates were largely a byproduct of being offered by technical, rather than community, colleges.

Finally, Darolia, Guo, and Kim (2023) add nuance to the literature on economic returns of non-degree credentials by focusing on *very* short-term credentials. Leveraging fixed-effects models with matched samples of 108,000 students from community colleges in Kentucky, the authors found that very short-term credentials (requiring 6 credits or less) produce initial economic returns that are similar to short-term credentials (requiring 6-36 credits). In addition to research on initial economic returns to non-degree credentials, research has also examined long-term economic trajectories associated with non-degree credentials. For example, Minaya and Scott-Clayton (2022), leveraged fixed-effects models with roughly 92,000 students from community colleges in Ohio, finding that the economic returns to a long-term certificate remained flat when compared to the economic returns to an associate's degree, which grew over time.

The recent research on non-degree credentials provides three additional insights on human capital:

1. The relative economic returns to non-degree credentials do not necessarily follow a Mincerian distribution: the economic returns to non-degree credentials are often *not* proportional to the time it takes to complete them.
2. The relative economic returns to non-degree credentials are context specific: the economic returns to non-degree credentials are informed by the industry and the geography in which they are used.
3. The relative economic returns to non-degree credentials have different earnings trajectories in the long-term than more traditional degree-granting programs.
4. The relative economic returns to non-degree credentials are moderated by gender, meaning they are different for males and females.

As a result, it is important to consider both the short- and long-term economic returns of both non-degree credentials and degree-granting programs, to take into account contexts relating to industry and geography, and to consider heterogeneous treatment effects across different dimensions of identity.

In this regard, we consider the relative returns of both non-degree credentials and a wide range of degree-granting programs. We also consider differences between non-degree credentials offered by educational institutions and industries. Additionally, we include a population of individuals across four unique industries and nine unique Metropolitan Statistical Areas (MSAs), and we consider differences by gender, race/ethnicity, and industry. In doing so, we provide one of the first studies that (a) includes a range of degree granting programs and non-degree credentials from both educational institutions and industries, (b) includes a sample from a diverse array of U.S. cities, (c) and examines heterogeneities across multiple dimensions of identity.

METHODS

Data

Our research focuses on individuals who obtained a non-degree credential or completed a degree program between 2017 and 2023. To obtain data for our analyses, we utilize two main sources: the National Student Clearinghouse (NSC) and a large credit bureau. The NSC provides comprehensive information on non-degree credentials (e.g., school-based undergraduate certificates and non-school based certificates) and degree granting programs (e.g., associate's degree, bachelor's degree, master's degree, and doctoral/professional degrees), along with the month and year it was earned. Both non-degree credential and degree information extend from both academic institutions (i.e. school-based) that are nearly universally represented in NSC's database, and non-academic institutions (i.e., non-school-based) that are not universally represented but still provide substantial amounts of issued credentials[1].

Through their online platform, the partnering credit bureau receives observed income—total gross annual earned income—directly from over 2.8 million businesses. In addition to income, the partnering credit bureau contains detailed employer information, including their North American Industry Classification System (NAICS) code. Due to data sharing arrangements across both the partnering credit bureau and NSC, our study sample originated on the credit bureau side; NSC data was then merged with the credit bureau data using individuals' personally identifiable information (PII); finally, the merged data was anonymized and shared with the research team through the credit bureau's online platform.

Sample

Our sample had four main selection requirements:

- To ensure that earnings data was collected by the partnering credit bureau, individuals had to have observed income during the study period (i.e., 2017-2023);
- To ensure a variety of industries with adequate matches with credentials and degree programs, individuals had to have worked in one of the following industries in 2023: education, manufacturing, STEM, and health care;
- To ensure our sample was reflective of a broad array of geographic and economic contexts, individuals had to be working in one of nine metropolitan areas across the U.S. in 2023: San Francisco, CA; Denver, CO; Austin, TX; St. Louis, MO; Chicago, IL; Nashville, TN; Boston, MA; Philadelphia, PA; and New York City, NY.
- To ensure reasonable comparisons and adequate earnings trajectories, individuals had to be born in 1981 or later.

For those that meet the three requirements, our analytic models focus on two groups of individuals as follows:

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[1] While we can assume that if someone is not in NSC's database they likely did not earn a degree from an academic institution, we cannot assume that they did not earn a non-degree credential from another non-school-based entity.

- Treatment sample: Those who earned any certificate(s) and/or degree(s) collected by the NSC between 2017-2023 (i.e., those whose certificates/degrees status has changed during the study period)
- Comparison sample: Those who never earned either a certificate or a degree collected by the NSC as of 2023 (i.e., those who are "unmatched" in the NSC sample).

Variables

Educational attainment. The educational attainment information comes from the NSC. In our analysis, we consider two types of non-degree credentials: school-based certificates (SC) and non-school-based certificates (NC). Additionally, we examine four types of degree programs: associate's degree (AA), bachelor's degree (BA), master's degree (MA), and doctoral/professional degree (Doc). These credentials and degrees are treated as independent but not mutually exclusive, allowing individuals to earn multiple types of credentials and degrees within the same year.

We conceptualize educational attainment in two ways: as a flow, which counts the credentials/degrees earned in a given year, and as a stock, which accumulates these credentials and degrees over a certain period. For our primary analysis, utilizing the Callaway and Sant'Anna Difference-in-Differences (DID) method (discussed in the next section), we focus on the flow information to estimate the marginal and lagged effects of earning an additional credential/degree in a given year. Additionally, as a robustness check, we control for other types of credential/degree attainments as stocks when analyzing the impact of a specific credential/degree attainment as a flow.

Income. To construct individual annual income, we construct total gross annual earned income as of the end of a year (December) from the partnering credit bureau. Due to some extreme outliers, which hamper our statistical analysis, we winsorized the annual earned income at the upper 99th percentile, for each industry and metropolitan area and in each year. Note that our analytic model includes observations with zero annual gross income. Therefore, our outcome is not simple income effects, but the combination of income and employment effects.

Other variables. In addition to the educational attainment and income data, the partnering credit bureau provides basic demographic information such as gender and race/ethnicity in addition to their employment industry—i.e., manufacturing, education, health care, and STEM—and metropolitan areas, listed above. After removing missing cases, our analytical sample consists of 1,128,758 yearly observations from 201,378 individuals for seven years.[2] Table 1 reports a summary of the the variables used in our analytical model.

** Table 1 is about here **

[2] Although our panel dataset is relatively well-balanced, it is not perfectly "rectangular" (i.e., person*year), meaning that full seven-year trajectories are not observed for all individuals. The missing data rate is 19.9%, primarily due to two factors: (1) age limitations, where individuals who turned 18 during the study period do not have complete trajectories so that we could not capture their income before 18, and (2) temporary gaps in income data resulting from employers being outside the data providers' pool.

Empirical model design

To estimate the returns of various educational attainments—both credentials and degrees, we employed the Callaway and Sant'Anna Difference-in-Differences (CSDID) model (Callaway & Sant'Anna, 2021). The CSDID approach is designed to evaluate treatment effects in contexts where individuals may receive different treatments at different time points. Callaway and Sant'Anna's method can be viewed as an advanced DID design that addresses several limitations inherent in traditional TWFE estimators, such as handling staggered treatment adoption and heterogeneous treatment effects across cohorts and calendar years, as well as over time (lagged effects). The CSDID model estimates the average treatment effect on the treated group (ATT) for all treatment cohorts across all periods. It also accommodates heterogeneous treatment effects and staggered treatments, which are essential in complex scenarios. This approach decomposes the overall ATT effect into effects by temporal dynamics—how much time has passed after treatment, by cohort—when people received the treatment at different times, and by calendar year—what the effects are at a specific time. Additionally, the CSDID model utilizes "not-yet-treated" units (those in the treatment sample but not yet treated) alongside "never-treated" units as a control group, thus enhancing the robustness of the estimates.

In this study, we applied the Callaway and Sant'Anna Difference-in-Differences (CSDID) model to examine the impact of educational attainment on annual gross income. Given that the CSDID framework can estimate only one type of treatment at a time, we implemented a series of CSDID models for each type of certificate or degree. In these models, we compared the returns to education for individuals holding specific credentials or degrees against two reference groups: (i) individuals without any postsecondary certificates or degrees (i.e., those with a high school degree or less) and (ii) individuals who had not yet attained the specific certificate or degree of interest ("not-yet-received" group, See Table 2). To assess the robustness of our findings, we conducted a series of additional analyses (See Appendices C). Specifically, for each certificate or degree type, we estimated CSDID models using the entire analytic sample while controlling for other types of educational credentials as cumulative stock variables—representing the total number of degrees or certificates earned up to a given year. This approach accounts for the cumulative effects of multiple educational attainments, thereby isolating the specific impact of each credential[3][4].

Each CSDID model provides estimates of the overall treatment effect (ATT) as well as lagged effects (dynamic ATT), capturing the prolonged impact of educational attainment on income over time. These dynamic treatment effects enable us to assess whether the financial returns to education persist, increase, or diminish as individuals progress in their careers.

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[3] For a robust ATT estimate, we adopted the inverse probability weighting (IPW) approaches. The IPW approach leverages the conditional probability of belonging to the treatment group—based on observed covariates—to enhance pre-treatment balance, thereby improving counterfactual assumptions (Callaway and Sant'Anna, 2021).

[4] Additionally, as mentioned above, the "not-yet-treated" option was applied, designating those who had not yet earned a certain degree/certificate as the control group, thus mitigating biases from differential timing in staggered treatment adoption—a common challenge in traditional DID models.

RETURNS OF EDUCATION

Figure 1 (and **Appendix A**, which reports the ATT estimates) examines the overall ATT estimates, which indicate that attaining a credential or degree yields statistically significant positive returns on income, with all estimates significant at the 0.001 level. However, the magnitude of these gains varies across credential and degree types. SC holders experience an average income increase of $5,279.2 ($p < 0.001$), whereas NC recipients exhibit a substantially higher return of $8,249.7 ($p < 0.001$). Among degree holders, AA degrees yield an ATT of $6,903.8 ($p < 0.001$), while BA and MA degrees show considerably larger effects of $22,030.4 ($p < 0.001$) and $17,839.4 ($p < 0.001$), respectively. The highest returns are observed among doctoral degree holders, with an estimated ATT of $29,911.6 ($p < 0.001$).

It is important to note that ATT estimates should not be directly compared across different credential and degrees due to variations in baseline educational attainment. For example, although the ATT estimate for BA is greater than MA degrees (BA: ATT = +$22,030.4, $p < 0.001$; MA: ATT = +$17,839.4, $p < 0.001$), this does not imply that BA degree holders receive greater financial returns than MA degree holders. The key distinction lies in the reference period: the ATT for a BA degree is based on pre-BA annual income, which includes earnings from periods when individuals may have held an associate's degree or only a high school diploma. In contrast, the ATT for an MA degree is based on pre-MA annual income, reflecting the period when individuals held a bachelor's degree. Thus, ATT estimates should be interpreted as the marginal effect of attaining an additional degree rather than the cumulative impact of all credentials earned over time.

*** Figure 1 is about here ***

Dynamic returns of education

Figure 2 (and **Appendix A**, which reports the ATT estimates) graphically represent the dynamic treatment effects on income before and after obtaining various educational credentials. For *SC* recipients, the pre-treatment period reveals a consistent decline in income, with ATT values decreasing from approximately -$2,448.5 ($p < 0.001$) five years prior to earning a SC (t-5) to -$3,332.8 ($p < 0.001$) at t-1. These negative estimates indicate that SC recipients experience substantial earnings losses before completing (or starting) their credential. This decline may reflect their lower-paying jobs in the pre-period in addition to their reduced working hours (e.g., opportunity costs) incurred while undergoing training. However, in the post-treatment period, earnings increase significantly, reaching an ATT of +$5,963.3 ($p < 0.001$) one year after certificate attainment (t+1). These post-treatment effects suggest that SC credentials yield strong short-term financial returns. The effects persist over time, peaking at $8,963.8 ($p < 0.001$) at t+4. This pattern suggests that SC holders initially experience financial gains, and the long-term stability of these benefits remains.

For *NC* recipients, no significant ATT estimates are observed during the pre-treatment period. This suggests that NC programs allow individuals to upskill without incurring substantial opportunity costs. In the post-treatment period, earnings increase steadily, starting at +$8,330.8 (p

< 0.001) one year after NC attainment and remaining significant for four years, peaking at an ATT of +$14,780.5 (p < 0.001) at t+4. These findings indicate that NC credentials can provide strong financial returns. However, the ATT estimates become insignificant at t+5, suggesting that the long-term benefits of NC credentials may be limited.

For *AA* recipients, substantial earnings declines are observed in the pre-treatment period, with ATT estimates decreasing from -$3,861.9 (p < 0.001) at t-5 to -$4,720.9 (p < 0.001) at t-1. The these income losses suggest that some AA students may transition to a part-time job while enrolled, causing earnings reductions. Post-treatment, the ATT estimates turn to positive at +$9,028.7 (p < 0.001) one year after degree attainment (t+1). These findings confirm that AA credentials provide substantial short-term wage benefits. Just as NC, whose earnings at t+1 are comparable to those of AA recipients, AA degree earners exhibit stable ATTs over time (e.g., ATT=+$11,032.1, p<0.001 at t+4), though the estimates slightly decrease at t+5 (ATT=+$9,556, p<0.001).

For *BA* recipients, we observe pre-treatment income reductions (ATT=-$3,220.4, p<0.001 at t-5; ATT=-$1,381.0, p<0.001 at t-1). This trend is expected, as many students reduce working hours or otherwise exit the labor force to pursue full-time education, and this confirms the substantial opportunity cost of obtaining a BA. The post-treatment effects are positive and statistically significant, demonstrating a continuous increase over time. One year after graduation, the ATT is +$23,082.7 (p<0.0011) and continues to rise, peaking four years post-graduation at ATT = +$32,046.0 (p<0.001). This contrasts with the previously mentioned certificates/degrees (SC, NC, and AA) that exhibit an ATT increase only in the immediate year of attainment, followed by a plateau in subsequent years. This trend underscores the increasing earnings premium for BA holders. Although the effect stabilizes after reaching its peak, it suggests that BA graduates experience sustained career growth and long-term stability.

The earnings trajectories for *MA* and *Doc* recipients reveal not only the highest returns among all credentials and degrees, but also a pronounced upward trend over time. Negative ATT estimates during the pre-treatment period for MA (t-2 and t-1) and doctoral degrees (t-4 to t-1) reflect the opportunity costs of postgraduate education. In particular, PhD candidates experience prolonged income losses before graduation due to extended academic commitments. Post-treatment, however, both MA and doctoral recipients experience significant and sustained earnings growth. At t+1, the ATT estimates for MA and doctoral degree recipients are +$18,386,4 (p < 0.001) and +$30,325.2 (p < 0.001), respectively, confirming the substantial economic returns to graduate education. Five years after degree completion, the earnings gains continue to increase, with ATT estimates reaching +$33,621.0 (p < 0.001) for MA holders and +$55,320.9 (p < 0.001) for doctoral recipients. These results indicate that graduate degrees command a strong and persistent wage premium, justifying their longer duration and higher costs.

In sum, the dynamic analysis highlights key trends in the financial returns to education. Short-term credentials and degrees, such as SC, NC, and AA offer immediate earnings benefits but tend to plateau in the long term. In contrast, BA and graduate degrees demonstrate greater returns that increase over time.

*** Figure 2 is about here ***

Heterogeneous Returns of education

Figure 3 (and Appendix B, which reports the ATT estimates) presents the heterogeneity in the Average Treatment Effects on the Treated (ATT) estimates by gender, race/ethnicity, and industry. The results indicate significant variations in the economic returns to educational credentials across demographic groups and industry sectors.

*** Figure 3 is about here ***

By gender

The earnings effects of educational credentials vary significantly by gender. Among both male and female/non-binary recipients, the ATT estimates are highest for doctoral degrees (Male: $29,609.6, p < 0.001; Female/non-binary: $29,910.8, p < 0.001), with no statistically significant difference in the marginal ATT between the two groups. Similarly, BA holders exhibit comparable returns across gender groups (Male: $22,960.3, p < 0.001; Female/non-binary: $21,467.7, p < 0.001). However, notable discrepancies emerge in the income effects of MA, AA, and both SC and NC. For MA degrees, male recipients experience significantly greater earnings gains ($21,843.5, p < 0.001) compared to their female/non-binary counterparts ($15,341.9, p < 0.001), suggesting potential gender-based differences in labor market returns to graduate education. In contrast, the earnings effects of an AA degree are higher for female/non-binary recipients ($7,393.6, p < 0.001) than for male recipients ($5,826.2, p < 0.001), indicating that AA degrees may yield stronger wage benefits for women and non-binary individuals.

For certificate and credential attainment, gender disparities are also observed. Although the difference is not statistically significant at the 0.05 level, male holders of SC exhibit higher returns ($6,875.2, p<0.001) than their female/non-binary counterparts ($4,469.3, p<0.001). Meanwhile, NC show a stronger and highly significant earnings effect for female/non-binary individuals ($9,389.5, p < 0.001) compared to male individuals, whose earnings gains are smaller and less statistically significant ($6,019.8, p < 0.01).

By race/ethnicity

The returns on education vary across racial and ethnic groups (Figure 4B). Among non-Hispanic white (White) individuals, earnings increase substantially with higher educational attainment, particularly at the bachelor's (BA) level and beyond. The earnings premium for White individuals earning a BA degree is $24,368.4 (p<0.001), with even greater returns for those a earning an MA ($17,786.6, p<0.001) degree. However, the financial benefits associated with lower educational credentials, including SC ($5,124.0, p<0.01), NC ($9,218.9, p<0.001), and AA ($7,985.0, p<0.001), are relatively modest. This suggests that entry-level degrees or alternative credentialing pathways may not be as lucrative for White individuals as more advanced degrees. Hispanic individuals exhibit very similar earnings trajectories to their non-Hispanic White counterparts across all certificates and degrees.

For non-Hispanic Black (Black) individuals, the highest wage premium is observed at the doctoral level ($31,824.0, p<0.001), the largest among all racial groups. Earnings gains are also evident for those with an BA degree ($17,212.6, p<0.001) and MA degree ($15,561.8, p<0.001), indicating strong returns to higher education. Notably, Black individuals exhibit the highest returns to NC ($13,581.6, p<0.001), despite its wide confidence interval. These findings suggest that while educational credentials can yield significant economic benefits for Black individuals, disparities in access to and completion of advanced degrees—as noted in other literature—may contribute to persistent wage gaps.

Non-Hispanic Asian (Asian) individuals display a distinct earnings pattern, with lowest returns to NC than others ($2,023.7, not significant) and negative returns to AA (-$1,763.0, not significant), potentially indicating overqualification or barriers to the labor market integration at these educational levels levels. However, earnings premiums emerge at higher levels of education, with positive returns beginning at the BA level ($18,912.0, p<0.001) and increasing for advanced degrees (MA: $15,972.4, p<0.001; Doc: $29,237.1, p<0.001). Despite these gains, the returns to education for Asian individuals are the lowest among the four racial/ethnic groups. These findings suggest that while higher education is crucial for economic mobility among Asian individuals, the labor market may undervalue their credentials and degrees, relative to other racial/ethnic groups.

By industry

The financial returns to education vary significantly across industries, with notable differences in earnings effects based on degree type and sector. In the manufacturing sector, doctoral/professional degrees yield the highest earnings returns ($46,340.8, p < 0.001), followed by BA degrees ($25,505.7, p < 0.001) and MA degrees ($24,812.1, p < 0.001). However, individuals with associate degrees experience significant earnings losses (-$603.9, not significant), suggesting that an AA degree does not provide a clear wage advantage in this industry. Similarly, in STEM fields, doctoral degrees generate the highest financial returns across all sectors (and all degrees/certificates), with an ATT of $59,847.9 (p < 0.001), followed by MA degrees ($36,096.3, p < 0.001) and BA degrees ($29,495.5, p < 0.001). However, the returns to AA degrees in STEM are negative (-$8,195, p < 0.001), indicating that sub-baccalaureate degree holders may face substantial barriers in securing high-paying employment in this industry. In both the manufacturing and STEM sectors, both credential types (SC and NC) provide substantial wage gains, suggesting that alternative credentialing pathways can be financially rewarding for individuals pursuing careers in these fields.

In the health care industry, the highest earnings returns are observed for doctorate ($30,735.4, p < 0.001) and bachelor's degrees ($21,869.3, p < 0.001). Unlike manufacturing and STEM fields, in health care field, AA degrees also yield significant positive returns ($9,866.8, p < 0.001), underscoring their value in health care professions where technical expertise and licensing requirements often result in competitive wages. In contrast, NC credentials do not produce statistically significant effects, suggesting that these credentials may not substantially impact earnings in the health care sector. Lastly, earnings returns in the education sector are comparatively lower than in other industries. Doctoral/professional degrees yield the highest ATT ($17,714.7, p < 0.001), reflecting the wage premium associated with advanced academic positions and roles. MA and BA degrees also generate positive but modest returns (\$47,849.5, $p < 0.001$ and \$12,818.4, $p < 0.001$, respectively) in education. Similar to those in health care field, AA degree holders in education experience positive ATT estimates (\$2,641.0, $p < 0.05$), suggesting that AA degrees may provide a substantial wage advantage in this field. Similarly, SC and NC credentials yield statistically significant effects (SC: \$5,312.3, $p<0.001$; NC: \$5,659.2, $p<0.05$), indicating that these short-term credentials may have labor market value in the education sector.

In sum, these findings suggest that the economic value of educational credentials is highly industry-dependent. While traditional degree pathways (particularly bachelor's, master's, and doctoral degrees) provide strong returns in manufacturing, STEM, and health care, AA degrees yield negative or insignificant effects in certain industries, particularly manufacturing and STEM. The mixed results for credentials (both SC and NC) suggest that while they may be valuable in certain technical and vocational fields, their impact on earnings is industry-specific. These insights highlight the importance of aligning educational pathways with labor market demands to maximize the financial benefits of credential attainment.

DISCUSSION

In addition to low-skill jobs (e.g., that are typically filled with high school diploma holders) and high-skill jobs (e.g., that are typically filled with bachelor degree holders), there is a large and growing number of jobs that require "middle", as well as "advanced", skills. In response to these jobs, there is a large and growing number of educational offerings *between* a high school diploma and a bachelor's degree, as well as degree programs *beyond* a bachelor's degree. Nevertheless, research on the financial returns to non-degree credentials and degree-granting programs is often narrow, siloed, and focused on short-term outcomes. As a result, it is difficult to ascertain the relative returns to a variety of post-secondary educational options. We, therefore, leverage a national sample of individuals across nine MSAs and four industries to examine the relative financial returns to a variety of non-degree credentials and degree programs. Noting the limitations of fixed effect modeling strategies, we employ a semi-parametric difference-in-difference model advanced by Callaway and Sant'Anna (CS-DID).

Summary of findings

First, we explore the average earnings premiums across our study period resulting from an individual earning various credentials and degrees. Linear models of financial returns based on the number of years of schooling (e.g., Mincer model) are often measured statically, or at a particular point in time. In these models, we might expect to see Figure 4A. However, our models are not static, but rather dynamic, as individuals are earning degrees during our study period. In doing so, we provide *marginal* returns to educational attainment. If we consider individuals to earn degrees sequentially—particularly those earning an Associate's degrees and beyond, *and* if we consider these degrees to take a similar amount of additional time for full-time students (e.g., a bachelor's degree taking two more years than an associate's degree, a master's degree taking two more years than a bachelor's degree, and a doctorate/professional degree taking two more years than a master's degree[5]), then we might expect to see a marginal-sequential model in Figure 4B. However, this is likely not the case for the majority of students, as many students earn Bachelor's degrees without first earning an Associate's degree, and many students earn Doctorate degrees without first earning Master's degrees. Thus, a marginal-traditional model of educational returns might resemble Figure 4C. However, this is not what we observe. Rather, non-degree credentials, appear to demonstrate similar and—in the case of non-degree credentials from industry—*greater* earnings increases when compared to two-year degree programs, despite often taking one year to complete. This suggests higher proportional earning premiums for non-degree credentials from industry relative to the time it typically takes to complete these programs. Nevertheless, time-to-completion is difficult to verify for sub-baccalaureate certificates and post-baccalaureate certificates. While the literature would suggest that these certificates tend to require between 6 and 18 months to complete, the range of potential completion times is large. Future research is needed to better understand time-to-completion among these programs. Future research is also needed to better understand the types of credentials earned from educational institutions and industry. For example, the relative earnings increase of non-degree credentials from industry when compared to those from educational institutions may be due to the type of credentials earned, which may be more closely connected to the labor market.

*** Figure 4 is about here ***

At the same time, earning premiums for Bachelor degree completers appear to exceed earnings premiums for those who completed an Associate's degree *beyond* the additional time it takes to complete a Bachelor's degree. Here, we might expect the marginal returns to a Bachelor degree to be twice that of an Associate's degree, but it's over three times that of an Associate's degree. The same can be said of Master's degrees, which were almost comparable to that of a Bachelor's degree despite taking half of the time, as well as that of Doctorate degrees which had earnings premiums that were 1.3 times greater than that of a Bachelor's degree. These findings demonstrate that—with the exception of Associate's degrees—additional educational attainment pays exceedingly large dividends relative to the time it takes to complete them.

Our findings also demonstrate that timing matters: short-term earnings boosts and long-term earnings trajectories varied substantially across different credential types and degree programs. Associate's degrees offered initial boosts, but eventually plateaued, resembling a short elevator ride, followed by a long walkway. Results were most mostly similar for non-degree credentials, with the exception of a slightly higher peak in t+4 for those who earned a non-school based certificate.

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[5] Here, it is important to note that there are a variety of factors that can influence time-to-degree completion for students pursuing master's and doctorate/professional degrees, including type of degree, area of study, student status (e.g., full-/part-time), etc. For example, completing a law degree typically takes three years; completing a medical degree typically takes four years, and completing a PhD degree typically takes six years.

Next, we consider the trajectories for Bachelor's, Master's and Doctorate degree attainment. Given that individuals in these groups may be working less (or not at all) while in school, post-completion trajectories may be better gauges of their long-term earnings premiums. In this regard, Bachelor degrees combine initial boosts with a relatively a modest upward trajectory that eventually plateaus, representing an elevator, followed by a slow shallow escalator, and a walkway. However, Master's and Doctoral degrees combine initial boosts with a large incline, representing an elevator, followed by a steep escalator. Here, it is important to note that there is no "tapering off" in the earnings trajectories of Master's and Doctoral degrees, as seen in the earnings trajectories of Bachelor degree completers. When combined with the average distribution of earnings, advanced degrees appear to offer the greatest financial returns. Overall, while time and tuition are needed to gauge the costs of these programs, these trends suggest that further education is generally worth it in the short-, medium-, and long-term.

Regarding differences in financial returns according to gender, there were notable differences across degree programs, with females receiving greater returns for Associate's degrees and males receiving greater returns for Master's degrees. Here, men appear to out-earn women when the rewards are higher. Additionally, in terms of race/ethnicity, White students experience an advantage in Bachelor's degrees, while Black students experience an increase in non-school-based certificates and doctorate degrees. However, as Black students are often underrepresented in non-degree credentials and doctorate degrees, educational attainment—in aggregate—may effectively maintain inequality for marginalized individuals, despite increasing social mobility across the board. Finally, individuals working in manufacturing and STEM industries experienced the largest returns to non-degree credentials, as well as Bachelor's, Master's, and Doctorate degrees, potentially reflecting labor market demands. Somewhat surprisingly, these returns were negative for Associate's degrees. Here, it could be the case that individuals working in Manufacturing and STEM who earn an Associate's degree may be more likely work within specific occupations that experienced wage declines. More research is needed to further unpack these industry-specific results.

Finally, our robustness check demonstrates that comparisons group matter. While high school diploma holders often represent the most straightforward counterfactual to credential and degree completers, additional comparisons can provide important nuances. Unsurprisingly, when we broaden our comparison groups and account for other degree attainment, the relative earnings premiums for non-degree credentials form educational institutions and Associate's degrees decrease more rapidly over time, reflecting more positive trajectories of non-degree credentials from industries and more advanced degrees.

Implications

These findings have significant implications for education finance, policy, and research. Concerning education finance, our findings suggest that not all non-degree credentials are created equally. Indeed, non-degree credentials from industry tend to be associated with steadier increases, leading to greater earnings premiums than non-degree credentials from education institutions. Our findings also represent a departure from a linear distribution of income according to years of schooling (e.g., like those based on the Mincer model). For example, non-degree credentials from industry demonstrate greater earnings increases than two-year degree programs despite often taking less time to complete. As a result, policymakers should consider making public investments across a range of non-degree programs, especially those from industry. At the same time, earnings increases of Bachelor degree completers appear to exceed those who completed an Associate's degree beyond the additional time it takes to complete a Bachelor's degree. The same can be said of Master's degrees relative to Bachelor's degrees, and to an even greater extent, Doctorate degrees relative to Master's degrees. Thus, policy-makers should also recognize the earnings premiums for Bachelor's and advanced degrees, considering ways to increase access (e.g., through student aid and scholarships). Furthermore, even when accounting for industry and region, the returns to Master's degrees were higher for males, while the returns to Bachelor's degrees were higher for White. Thus, policy-makers should also consider ways to better support groups that have been historically marginalized in the labor market, particularly as they move from education to employment. Moreover, as our findings demonstrate that timing matters, researchers should be weary of using short-term earnings premiums to measure educational returns; indeed, longer-term premiums provide a more accurate picture of education returns. Additionally, our findings demonstrate the importance of advanced difference-in-difference modeling in observational research, as we are able to better meet some of the core assumptions of comparison groups (e.g., similar pre-treatment trend lines). Finally, our findings demonstrate the potential of leveraging and merging large sources of administrative data from credit agencies with administrative education data to demonstrate financial returns. While many studies rely on records from state unemployment insurance and individual education institutions, these data are often confined to particular states and schools, which can limit generalizability.

Limitations

While our study offers one of the first nation-wide reports on the relative returns of both degree programs and non-degree credentials across multiple industries, it is not without limitations. Concerning external validity, our sample originated from a large credit bureau, and although it is extensive, it is not exhaustive. It is also important to note that our sample consisted of individuals with observed income in 2023, which does not include individuals who were unemployed throughout the year, and thus does not represent the entire adult population. In addition, we only consider individuals working in four specific industries; thus, it is possible that the economic returns to both degree programs and non-degree credentials are different in other industries. Another limitation is the use of NAICS codes, which are employer-specific, to identify employee industries. Indeed, one can work for an employer in a specific industry, yet not perform a core industry duty (and vice-versa).

Concerning internal validity, while our CS-DID model ensures similar pre-treatment trend lines, it is likely that students "select" certain degree programs and non-degree credentials based on a variety of observed and unobserved characteristics. Future research should consider leveraging additional pre-treatment information relating to interest and ability, such as academic course-taking and performance in high school. It is also important to note that we cannot identify the length of time it takes for each individual to complete their respective degree or earn their respective credential in our data, which limits our ability to factor in exact opportunity costs related to time. Future research should consider ways to capture length of credential/degree completion to better understand these costs.

CONCLUSION

In 2021, only 37.9 percent of adults aged 25 and older had a bachelor's degree (Schaeffer, 2022), and nearly 40 percent of all students that started a bachelor's degree program failed to graduate (National Center for Education Statistics, 2021). Given the growing economic opportunities for middle-skill workers and the deleterious effects of student debt—especially for individuals who fail to earn a degree (Jabbari et al., 2023), research on non-degree credentials is particularly important for increasing social mobility. In addition to increasing social mobility, research on non-degree credentials is also important for increasing racial equity. As only 28.1 percent of Black adults and only 20.6 percent of Hispanic adults have a bachelor's degree (Schaeffer, 2022), post-secondary education and training *between* a high school diploma and a bachelor's degree may represent a viable and desirable educational opportunity for groups that have been historically excluded. Finally, broader educational attainment can also increase community prosperity, as research demonstrates that employers tend to locate to areas with large pools of skilled labor (Takatsuka, 2011) and local sectors tend to attract new firms when training costs are borne by workers (Almazan et al., 2007).

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TABLES AND FIGURES

Table 1. Summary statistics of the variables in use

	All (n= 113,032)		Health care (n= 55,277)		Education (n= 23,390)		Manufacturing (n= 22,574)		STEM (n= 11,791)	
	2017	**2023**	**2017**	**2023**	**2017**	**2023**	**2017**	**2023**	**2017**	**2023**
Credentials										
School-based Certificate (SC)	0.0001	0.024	0.0001	0.028	0.0001	0.025	0.0003	0.015	0.000	0.017
	(0.011)	(0.153)	(0.011)	(0.167)	(0.008)	(0.156)	(0.016)	(0.124)	(0.006)	(0.130)
Non-school-based Certificate (NC)	0.001	0.005	0.001	0.005	0.0003	0.004	0.0006	0.007	0.0001	0.004
	(0.024)	(0.074)	(0.024)	(0.069)	(0.023)	(0.071)	(0.029)	(0.089)	(0.011)	(0.067)
Degrees										
Associate's Degree (AA)	0.0002	0.072	0.0003	0.112	0.0002	0.047	0.0003	0.034	0.0002	0.030
	(0.016)	(0.261)	(0.016)	(0.317)	(0.014)	(0.212)	(0.180)	(0.184)	(0.013)	(0.172)
Bachelor's Degree (BA)	0.001	0.115	0.001	0.107	0.001	0.132	0.002	0.099	0.002	0.142
	(0.035)	(0.322)	(0.029)	(0.311)	(0.0.35)	(0.341)	(0.046)	(0.300)	(0.039)	(0.349)
Master's Degree (MA)	0.0002	0.130	0.0001	0.101	0.0002	0.204	0.0004	0.096	0.0003	0.162
	(0.014)	(0.337)	(0.010)	(0.302)	(0.014)	(0.404)	(0.021)	(0.295)	(0.018)	(0.369)
Doctoral Degree (DR)	0.0000	0.055	0.000	0.060	0.0000	0.094	0.0000	0.022	0.0000	0.023
	(0.004)	(0.230)	(0.003)	(0.239)	(0.005)	(0.293)	(0.005)	(0.146)	(0.000)	(0.150)
Income										
Annual Income	22210.5	95281.9	21208.7	87235.1	17799.4	72028.5	25051.7	120233.3	22758.8	125746.6
	(45163.5)	(393468.7)	(32545.5)	(211408.8)	(70286.1)	(583580.3)	(40854.6)	(326606.1)	(39878.9)	(554362.8)
Gender										
Male	0.350		0.232		0.328		0.561		0.489	
	(0.477)		(0.422)		(0.462)		(0.499)		(0.499)	
Female/non-binary	0.650		0.768		0.672		0.439		0.511	
	(0.477)		(0.422)		(0.462)		(0.499)		(0.499)	
Race										
White, non-Hispanic	0.511		0.518		0.527		0.498		0.480	
	(0.499)		(0.500)		(0.499)		(0.500)		(0.500)	
Black, non-Hispanic	0.095		0.119		0.083		0.078		0.054	
	(0.293)		(0.324)		(0.276)		(0.269)		(0.227)	
Hispanic	0.135		0.160		0.100		0.146		0.089	
	(0.342)		(0.367)		(0.300)		(0.354)		(0.285)	
Asian, non-Hispanic	0.126		0.097		0.145		0.128		0.197	
	(0.332)		(0.296)		(0.352)		(0.334)		(0.398)	
Other	0.132		0.106		0.145		0.150		0.180	
	(0.339)		(0.308)		(0.352)		(0.357)		(0.384)	

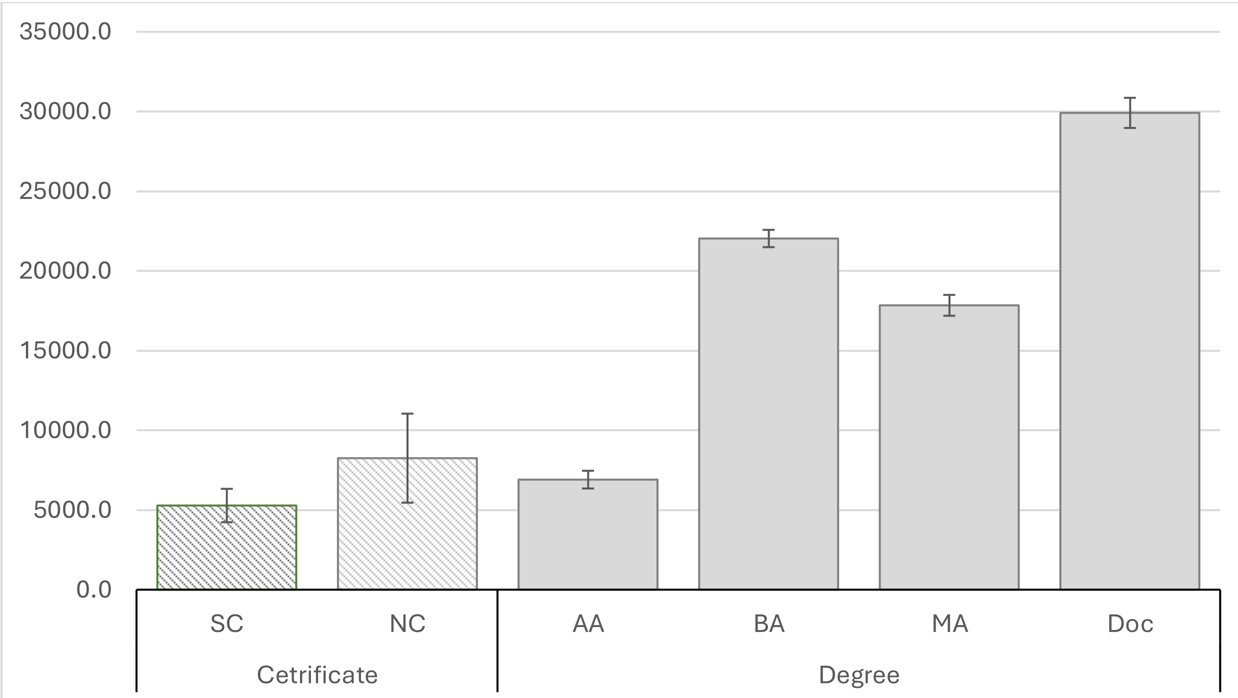
Note: Standard errors in parenthesis

Table 2. Analytic sample compositions

	Certificate/degree of interest					
	SC	**NC**	**AA**	**BA**	**MA**	**Doc**
Main model	HSD+SC (n=723,523)	HSD+NC (n=703,479)	HSD+AA (n=776,676)	HSD+BA (n=811,697)	HSD+MA (n=845,914)	HSD+Doc (n=759,409)
Robustness check	All (n=1,128,758; with other degree attainment status as stock controls)					

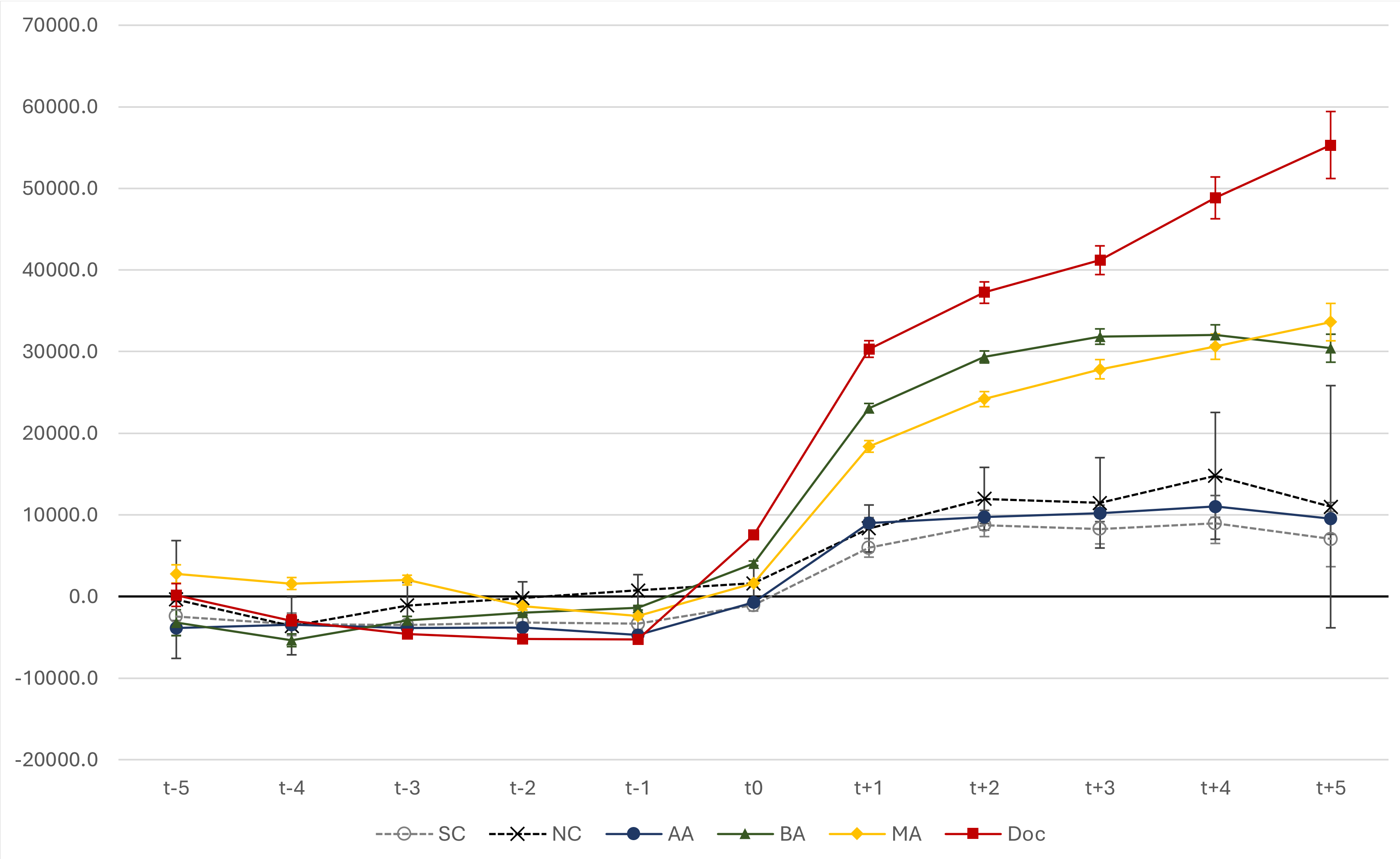
Notes: Calculations are person*year;
HSD: High school diploma (n=697,531); SC: School-based certificate (n=25,992); NC: Non-school based certificate (n=5,948); AA: Associate degree (n=79,145); BA: Bachelor's degree (n=114,166); MA: Master's degree (n=148,383); Doc: Doctorate/professional degree (n=61,878)

Figure 1. Returns of education (ATT estimates, CSDID)



Note: 0.05 level of confidence interval reported
SC: School-based certificate; NC: Non-school based certificate; AA: Associate degree; BA: Bachelor's degree; MA: Master's degree Doc: Doctorate/professional degree

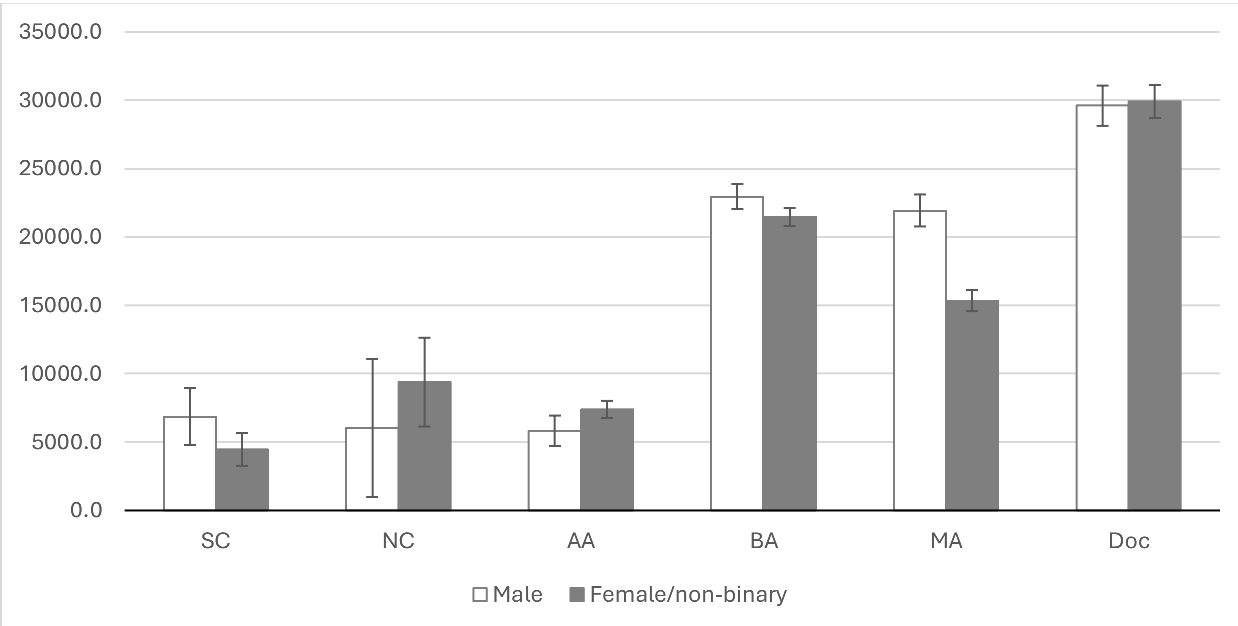
Figure 2. Dynamics of the returns of education (ATT estimates, CS-DID)



Note: 0.05 level of confidence interval reported
SC: School-based certificate; NC: Non-school based certificate; AA: Associate degree; BA: Bachelor's degree; MA: Master's degree Doc: Doctorate/professional degree

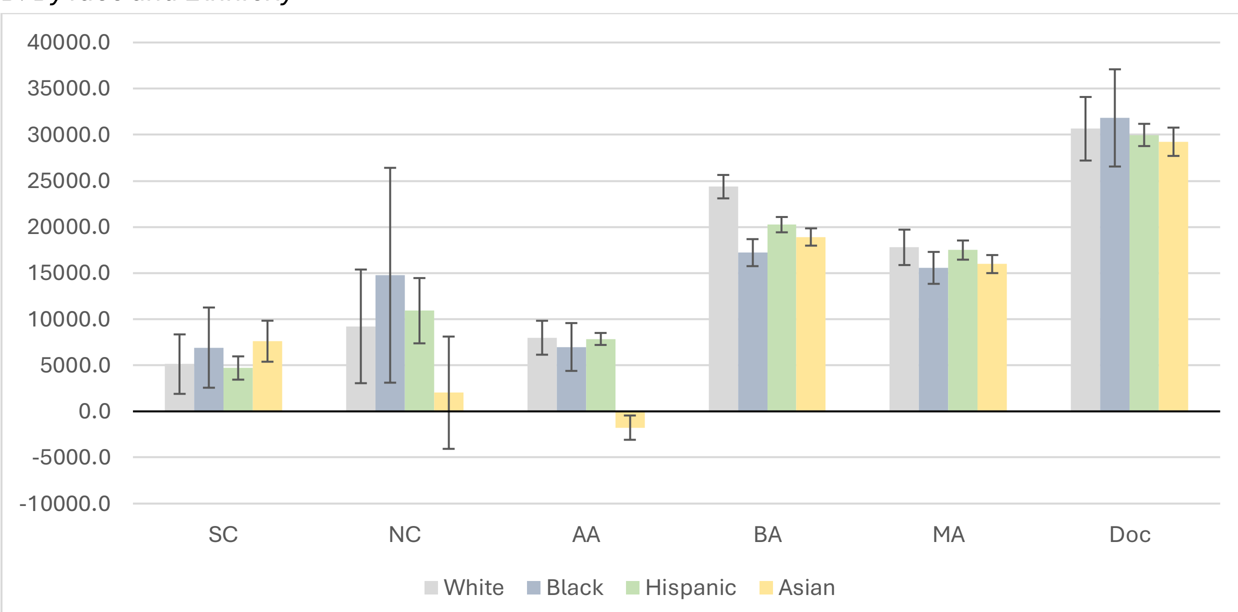
Figure 3. Heterogeneous returns of education (ATT estimates, CSDID)

A. By Gender



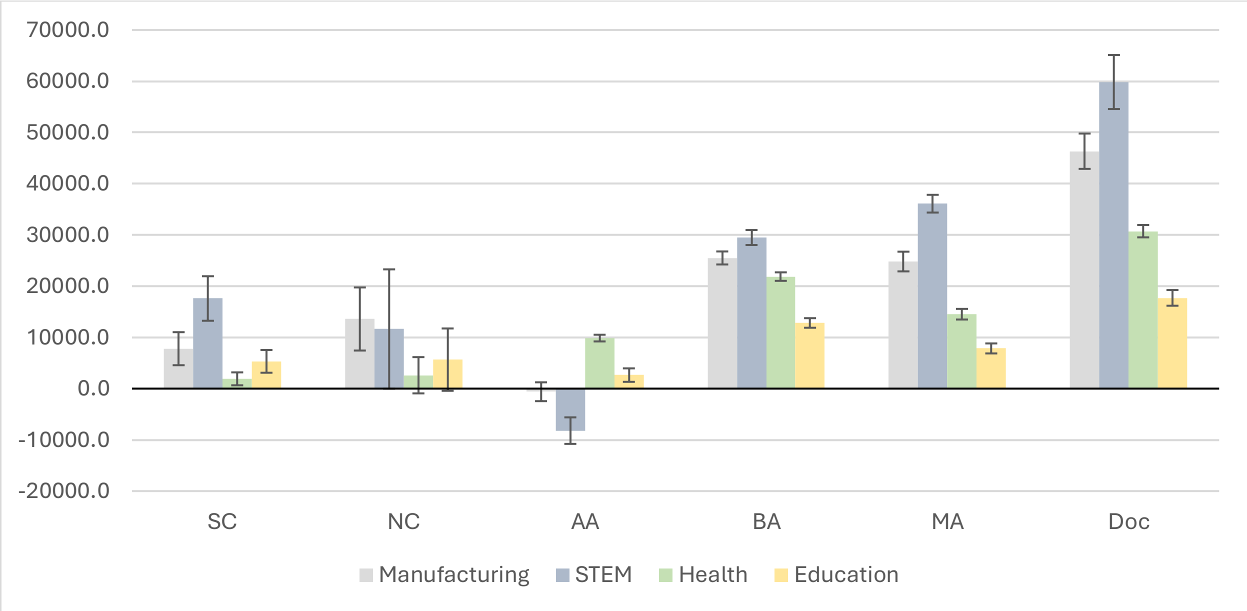
Note: 0.05 level of confidence interval reported
SC: School-based certificate; NC: Non-school based certificate; AA: Associate degree; BA: Bachelor's degree; MA: Master's degree Doc: Doctorate/professional degree

B. By race and Ethnicity



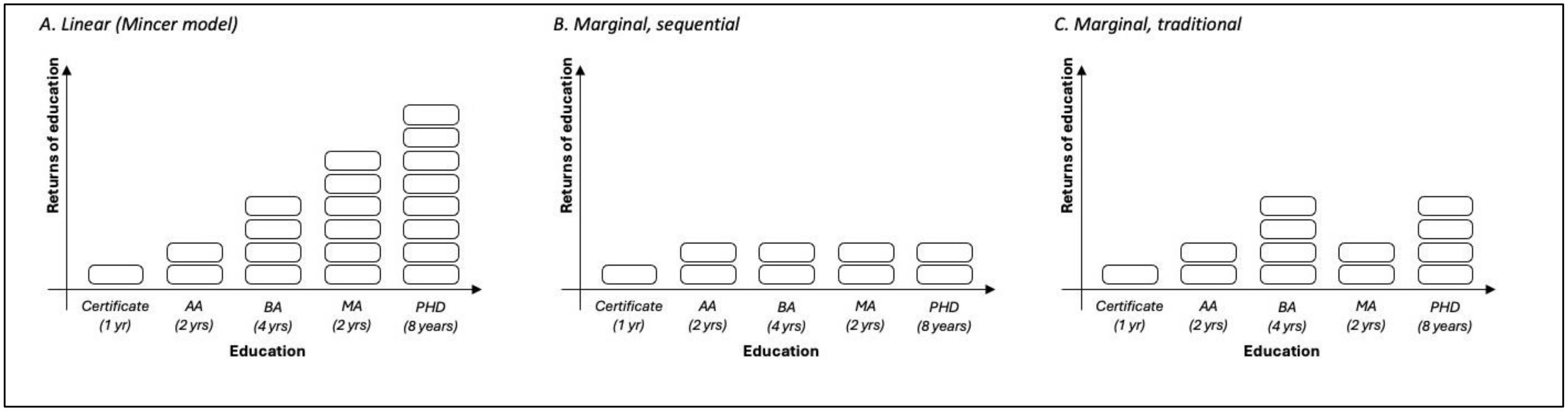
Note: 0.05 level of confidence interval reported
SC: School-based certificate; NC: Non-school based certificate; AA: Associate degree; BA: Bachelor's degree; MA: Master's degree Doc: Doctorate/professional degree

C. By Industry



Note: 0.05 level of confidence interval reported
SC: School-based certificate; NC: Non-school based certificate; AA: Associate degree; BA: Bachelor's degree; MA: Master's degree Doc: Doctorate/professional degree

Figure 4. Returns of education models



APPENDICES

Appendix A. CSDID results (ATT estimates, CSDID)

	Certificate				Degree							
	SC		**NC**		**AA**		**BA**		**MA**		**Doc**	
<u>Overall</u>	5279.2	***	8249.7	***	6903.8	***	22030.4	***	17839.4	***	29911.6	***
	(534.7)		(1424.8)		(283.4)		(276.3)		(333.5)		(482.3)	
<u>Dynamic</u>												
t-5	-2448.5	**	-373.8	-	-3861.9	***	-3220.4	***	2758.5	***	179.5	-
	(926.3)		(3681.8)		(463.7)		(812.9)		(572.3)		(712.3)	
t-4	-3413.5	***	-3614.3	*	-3462.0	***	-5369.7	***	1587.7	***	-2997.4	***
	(705.0)		(1803.4)		(323.6)		(399.3)		(373.7)		(385.6)	
t-3	-3498.0	***	-1090.6	-	-3893.9	***	-2912.9	***	2006.8	***	-4597.8	***
	(545.0)		(1431.3)		(235.3)		(236.1)		(303.7)		(298.8)	
t-2	-3177.8	***	-200.8	-	-3821.0	***	-2004.2	***	-1176.5	***	-5196.3	***
	(450.6)		(1018.9)		(194.2)		(168.8)		(257.0)		(230.1)	
t-1	-3332.8	***	738.2	-	-4720.0	***	-1381.0	***	-2396.3	***	-5270.0	***
	(383.7)		(987.6)		(167.0)		(142.9)		(227.4)		(205.0)	
t0	-1069.6	**	1593.0	-	-741.8	***	4062.9	***	1628.3	***	7519.9	***
	(366.9)		(1116.6)		(169.0)		(143.4)		(218.0)		(279.6)	
t+1	5963.3	***	8330.8	***	9028.7	***	23082.7	***	18386.4	***	30325.2	***
	(583.8)		(1468.4)		(321.5)		(290.3)		(363.2)		(518.4)	
t+2	8760.8	***	11975.4	***	9744.4	***	29348.1	***	24180.1	***	37236.6	***
	(725.9)		(1960.8)		(410.5)		(376.1)		(470.9)		(669.8)	
t+3	8278.0	***	11471.7	***	10182.1	***	31847.8	***	27848.5	***	41205.6	***
	(937.0)		(2825.1)		(514.8)		(480.4)		(601.5)		(898.0)	
t+4	8963.8	***	14780.5	***	11032.1	***	32046.0	***	30611.9	***	48844.4	***
	(1259.9)		(3964.6)		(682.4)		(633.9)		(793.9)		(1307.2)	
t+5	7034.0	***	10997.2	-	9557.0	***	30420.8	***	33621.0	***	55320.9	***
	(1727.5)		(7571.1)		(995.6)		(875.0)		(1169.0)		(2094.5)	
N	723,523		703,479		776,676		811,697		845,914		759,409	

Note: * p<0.050; ** < 0.010; ***<0.001
Standard error in parentheses
SC: School-based certificate; NC: Non-school based certificate; AA: Associate degree; BA: Bachelor’s degree; MA: Master’s degree Doc: Doctorate/professional degree

Appendix B. Heterogeneous returns of education (ATT estimates, CSDID)

	Certificate						Degree					
	SC		NC		AA		BA		MA		Doc	
By Gender												
Male	6875.2	***	6019.8	**	5826.2	***	22960.3	***	21943.5	***	29609.6	***
	(1065.6)		(2571.5)		(569.5)		(469.7)		(597.2)		(749.1)	
Female/non-binary	4469.3	***	9389.5	***	7393.6	***	21467.7	***	15341.9	***	29910.8	***
	(609.3)		(1658.2)		(323.5)		(341.2)		(394.4)		(622.3)	
By Race/ethnicity												
White	5124.0	***	9218.9	***	7985.0	***	24368.4	***	17786.6	***	30646.4	***
	(755.0)		(2044.8)		(411.0)		(363.2)		(430.7)		(631.2)	
Black	6914.1	***	14761.8	***	6981.9	***	17212.6	***	15561.8	***	31824.0	***
	(1779.5)		(3886.8)		(723.0)		(992.2)		(1146.8)		(2106.7)	
Hispanic	4703.5	***	10917.2	***	17212.6	***	20247.5	***	17490.2	***	29975.4	***
	(1219.9)		(3472.0)		(992.2)		(764.0)		(1102.0)		(1809.6)	
Asian	7607.9	**	2023.7	-	-1763.0	-	18910.2	***	15972.4	***	29237.1	***
	(2560.2)		(4496.9)		(1343.3)		(1052.1)		(1122.9)		(1061.2)	
By Industry												
Manufacturing	7794.9	***	13595.8	***	-603.9	-	25505.7	***	24812.1	***	46340.8	***
	(1645.1)		(3144.1)		(939.2)		(647.9)		(980.0)		(1758.3)	
STEM	17593.7	***	11634.0	*	-8195.1	***	29495.5	***	36096.3	***	59847.9	***
	(2218.6)		(5943.7)		(1322.0)		(746.8)		(882.6)		(2690.0)	
Health	1914.7	**	2613.9	-	9866.8	***	21869.3	***	14525.9	***	30735.4	***
	(643.5)		(1805.0)		(331.8)		(423.7)		(530.2)		(615.4)	
Education	5321.3	***	5659.2	*	2641.0	***	12818.4	***	7849.5	***	17714.7	***
	(1134.8)		(3106.2)		(671.1)		(478.2)		(499.0)		(782.3)	

Note: * p<0.050; ** < 0.010; ***<0.001
Standard error in parentheses
SC: School-based certificate; NC: Non-school based certificate; AA: Associate degree; BA: Bachelor's degree; MA: Master's degree Doc: Doctorate/professional degree

Appendix C. Robustness check (with Full sample)

	Certificate				Degree							
	SC		**NC**		**AA**		**BA**		**MA**		**Doc**	
Overall	1361.3	**	7874.6	***	3972.3	***	18498.8	***	13503.5	***	25400.6	***
	(526.7)		(1579.2)		(280.4)		(268.6)		(330.2)		(477.8)	
Dynamic												
t-5	-1973.6	*	9352.0	*	-3666.5	***	-3306.2	***	3392.5	***	190.9	-
	(923.6)		(4935.3)		(461.0)		(810.9)		(568.5)		(706.2)	
t-4	-3233.9	***	7307.6	*	-3404.6	***	-5396.2	***	1904.7	***	-3057.6	***
	(703.2)		(3516.9)		(321.6)		(397.0)		(370.7)		(378.0)	
t-3	-3615.3	***	8067.2	***	-4008.7	***	-3072.0	***	1959.3	***	-4932.1	***
	(543.5)		(2414.1)		(233.4)		(232.5)		(300.6)		(293.7)	
t-2	-3665.1	***	2764.6	*	-4218.5	***	-2398.5	***	-1748.8	***	-5984.7	***
	(447.9)		(1287.0)		(192.0)		(165.0)		(254.6)		(226.0)	
t-1	-4219.0	***	4280.8	**	-5410.4	***	-1992.5	***	-3536.3	***	-6530.8	***
	(382.7)		(1389.3)		(165.6)		(140.0)		(226.2)		(201.6)	
t0	-2549.3	***	1790.7	-	-1826.5	***	3267.5	***	-171.9	-	5589.7	***
	(367.6)		(1143.5)		(168.3)		(143.3)		(217.9)		(279.2)	
t+1	3067.0	***	8100.2	***	6840.6	***	21050.7	***	14789.6	***	26596.1	***
	(578.7)		(1741.7)		(318.2)		(287.0)		(359.6)		(511.8)	
t+2	4293.9	***	11061.9	***	6415.3	***	25587.2	***	19113.2	***	31902.2	***
	(714.5)		(2157.1)		(406.2)		(367.3)		(465.2)		(660.5)	
t+3	2623.6	**	10427.2	***	5873.7	***	26279.7	***	21535.7	***	34728.5	***
	(921.8)		(3003.5)		(510.5)		(467.5)		(593.7)		(886.2)	
t+4	1890.9	-	13958.3	***	5730.4	***	24791.2	***	23089.2	***	41422.3	***
	(1241.3)		(3941.3)		(680.5)		(622.1)		(786.4)		(1288.7)	
t+5	-1315.3	-	12243.5	*	3385.0	***	21021.3	***	25031.1	***	47140.6	***
	(1700.2)		(7370.7)		(998.7)		(867.4)		(1161.9)		(2075.2)	
	1,128,758		1,128,758		1,128,758		1,128,758		1,128,758		1,128,758	

Note: * p<0.050; ** < 0.010; ***<0.001
Standard error in parentheses
Other types of educational attainments (stock) are controlled
SC: School-based certificate; NC: Non-school based certificate; AA: Associate degree; BA: Bachelor's degree; MA: Master's degree Doc: Doctorate/professional degree