UTAH SYSTEM OF HIGHER EDUCATION

ISSUE BRIEF

December 2020

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# Technical College Students and Intergenerational Poverty: Odds of and Time to Graduation

Utah's public technical colleges offer vocational certificate programs at a low cost to students, as required by statute. Certificates are accredited by the Council on Occupational Education and provide students with competencies necessary for entry into gainful employment. Certificate programs can vary from short-term Phlebotomy or Certified Nurse's Assistant programs (typically requiring 60 and 100 hours to complete, respectively) to longer Practical Nursing or Cosmetology programs (typically requiring 900 and 1,600 hours, respectively). The ability of students to attain marketable skills at a low cost and in a short time has long made the technical colleges valuable partners to the Department of Workforce Services as it assists clients in becoming self-sufficient.

Previously, the then-UTech Board of Trustees established a goal that 75% of enrolled underrepresented students successfully graduate from their respective vocational programs.[1] The former trustees' definition of *underrepresented* included students of ethnic/racial minority status, those of limited English proficiency, single parents, individuals with disabilities, students who have been out of the workforce for prolonged periods, and those demonstrating financial need (as indicated by Pell Grant or DWS sponsorship). Substantial progress was made, as the graduation rate of underrepresented students rose steadily from 50% in 2014 to 59% in 2019.[2] Technical colleges achieved this increase by seeking out and providing new resources to help underrepresented students overcome barriers to success. For example, some colleges provide students with bus passes, while others partner with community mental health services to provide counseling to students in need. Each effort is designed to help students reach graduation, thereby facilitating entry into the workforce and their ongoing ability to provide for themselves and their families.

One potential way to help underrepresented students, and particularly those demonstrating financial need, is to ensure that they graduate on time or even early. Technical colleges generally operate on an open-entry/open-exit basis, meaning students can start or complete a certificate program on virtually any day of the week and in a competency-based format. Students can progress through core requirements at their own pace, devoting time and attention to those competencies needing it most. If students already

[1] The technical colleges' Board of Trustees was dissolved on July 1, 2020, and superseded by the Utah Board of Higher Education. The Board of Higher Education's goals and definitions surrounding underrepresented students and access to higher education have not yet been finalized.
[2] Utah System of Technical Colleges. (2019). Annual report. https://ushe.edu/wp-content/uploads/pdf/utech_docs/annual-reports/2019_utech-annual-report.pdf.

have prior skills required of graduates, they can demonstrate those competencies and skip redundant training modules. Since technical college tuition is based on hours enrolled, quickly progressing through a curriculum and skipping already-mastered subject material can save students significant amounts of money.

However, quickly passing off program requirements to thereby save in tuition may not be an option for economically disadvantaged students. Academic literature (a sample of which is discussed below) is replete with evidence of the harmful effects of economic distress on educational and vocational outcomes. Perhaps, compared with students of more affluent backgrounds, less-resourced students may have fewer previously mastered skills, and thus, fewer opportunities to have program requirements waived. Utah's technical colleges have not previously analyzed time to graduation stratified by socioeconomic status, and thus have no insight whether economically distressed individuals avail themselves of competency demonstrations (required to skip already mastered competencies) to the extent that wealthier students might.

In the present treatise, researchers utilize survival analysis to examine students' required time to graduation stratified by three groups: students experiencing intergenerational poverty (IGP), students who are receiving public assistance but who are not experiencing IGP, and comparable students who are not receiving public assistance. Kaplan-Meier failure functions and median times to graduation are analyzed. Cox proportional hazards models are further employed to show the relationship between one's socioeconomic status and his or her odds of graduating while controlling for other important factors. Various analyses herein point to the same conclusion: that the time to and odds of graduation from a technical college are significantly longer and lower, respectively, for students currently receiving public assistance than for those who are not. That disparity is even wider when considering students affected by intergenerational poverty.

## Literature Review

The disparate educational and vocational outcomes of economically distressed individuals are well-established. Even from the earliest stages of life, economic disparities between groups produce significantly different outcomes. Children from poorer homes have been shown to have less access to books and other learning materials than non-poor children. They also have fewer experiences of learning foundational knowledge (e.g., numbers, shapes, etc.) from parents. During infancy and early childhood (age 0-5), non-poor parents are more than twice as likely to read to their children more than three times a week than are poor parents. Non-poor families are also twice as likely to encourage children in developing hobbies, provide special lessons, or discuss television programming with their children. These differences are consistent across all racial/ethnic groups.[3] Such differences in learning resources and environments strongly correlate with children's initial reading abilities observed in kindergarten.[4]

The differences in educational outcomes arising from economically distressed and non-distressed homes persist throughout the primary and secondary education experience. One study in England found that only 48% of students receiving free school lunches reached expected levels of proficiency on standardized tests by age seven, while 77% of non-recipient students managed the same.[5] In the United States, students from economically disadvantaged homes enter high school with reading abilities that average five years behind those of wealthier students.[6] These gaps are not unique to the United Kingdom and the United States; the Organisation for Economic Co-operation and Development found that in 31 of 31 countries analyzed, students in the top quarter of its socioeconomic index outscored students from the bottom quarter in reading, math, and science.[7]

Gaps in educational outcomes at the secondary level translate to further differences at the postsecondary level and in the workforce. High school dropout rates differ significantly between poor and non-poor students; this difference reached as high as 8.8% in 2014.[8] Without a high school diploma, many opportunities for higher education are foreclosed, and students may be relegated to low-wage jobs with diminished potential for upward mobility. The Bureau of Labor Statistics noted that in 2017, median weekly earnings for those with doctoral or professional degrees were more than three times that of those who did not complete high school. And the median bachelor's degree recipient earned $267 more each week than the overall median employee in the economy irrespective of educational level.[9] Within Utah, the Utah System of Higher Education has long shown that graduates' wages steadily increase with each successive level of postsecondary educational attainment.[10]

The articles referenced above illustrate pieces of a continually repeating cycle. Children who grow up in underprivileged homes perform worse in schools, obtain postsecondary education in fewer numbers, and earn far less income during their careers than their more affluent peers. Many of their children

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[3] Bradley, R. H., Corwyn, R. F., McAdoo, H. P., & Coll, C. G. (2001). The home environment of children in the United States part 1: Variations by age, ethnicity, and poverty status. Child Development 72(6), 1844-1867.

[4] Aikens, N. L. & Barbarin, O. (2008). Socioeconomic differences in reading trajectories: The contribution of family, neighborhood, and school contexts. Journal of Educational Psychology, 100(2), 235-251.

[5] United Kingdom Department for Education. (2007). National curriculum assessments, GCSE and equivalent attainment and post-16 attainment by pupil characteristics in England 2005/06 (revised). Statistical first release 08/2005.

[6] Reardon, S. F., Valentino, R. A., Kalogrides, D., Shores, K. A., & Greenberg, E. H. (2013). Patterns and trends in racial academic achievement gaps among states, 1999-2011. https://cepa.stanford.edu/sites/default/files/reardon%20et%20al%20state%20achievement%20gaps%20aug2013.pdf.

[7] Organisation for Economic Co-operation and Development. (2001). Knowledge and skills for life: First results from the OECD Programme for International Student Assessment (PISA) 2000. http://www.oecd.org/education/school/programmeforinternationalstudentassessmentpisa/33691620.pdf.

[8] American Psychological Association (APA). (2017). Education and Socioeconomic Status. https://www.apa.org/pi/ses/resources/publications/education.

[9] Torpey, E. (2018). Measuring the value of education. Bureau of Labor Statistics. https://www.bls.gov/careeroutlook/2018/data-on-display/education-pays.htm.

[10] Utah System of Higher Education (USHE). (2020). Wage information. https://ushe.edu/wage-information/.

subsequently repeat this cycle of intergenerational poverty. Breaking the cycle requires inventive education and policy solutions.

Competency-based education and the ability to index the cost of a postsecondary award with a student's seat time (allowing students to progress quickly and pay less in tuition through demonstrating already-mastered competencies) may prove as innovative tools toward enhancing access to higher education credentials among underrepresented student populations. The present analysis focuses exclusively on competency-based postsecondary certificates offered at Utah's public technical colleges and the differences in their attainment by students experiencing economic distress. Researchers herein demonstrate that overall, those receiving public assistance (and specifically students experiencing intergenerational poverty) still perform at lower levels relative to their more resourced peers in terms of time to and odds of graduation. If competency-based education will, indeed, help break the cycle of intergenerational poverty, institutions must first solve the underlying inequities demonstrated through disparate student performance.

**Data and Methodology**

Enrollment periods, completion statuses, areas of study, and demographic information (gender, race, ethnicity, and age) were collected from technical college enrollment records spanning July 1, 2012, through June 30, 2019, from the Utah System of Higher Education. The present analysis examines only those individuals identified as credential-seeking students at the colleges. Technical college data were matched with intergenerational poverty participant and reference adult cohorts spanning the same period provided by the Utah Department of Workforce Services (DWS).

Individuals appearing in DWS' intergenerational poverty data are divided into two categories:

1. **IGP Adults:** Any individual aged 21-42 who received public assistance for twelve or more months as a child and who has currently been receiving public assistance for twelve or more months as an adult; and
2. **Reference Adults:** Any individual, aged 21-42, who has utilized public assistance for fewer than twelve months as an adult, or who utilized public assistance for twelve or more months as an adult but fewer than 12 months as a child.

Additionally, we compared the above two cohorts with technical college enrollees aged 21-42 who were *not* included in DWS' IGP and reference rolls. This third cohort of students is referred to as Non-recipient Adults. Headcounts and proportional sizes for each group are provided in Table 1 below.

In preparing student data for analysis, researchers determined students' final exit dates and dispositions (graduate, nongraduate, or still enrolled at the end of the temporal window) in all certificate programs in which they enrolled. Students were treated distinctly for each accredited certificate program in which they enrolled. Accordingly, if a student graduated from a Certified Nursing Assistant program then re-enrolled and graduated from a Medical Assisting program, the student was counted as two separate subjects with two positive outcomes in the analysis.

In addition to program exit dates, researchers derived training start dates for each subject analyzed. This process is challenging due to the inherent nature of open-entry/open-exit institutions. Unlike traditional colleges and universities with defined calendars and requirements that students defer enrollment over semesters in which they are absent, most technical college programs allow students the flexibility of choosing their schedules and working at their own pace. This can result in several enrollment periods observed for a single student in a single program. A student may enroll for a few months, stop out for health, financial, or other reasons, then return months later and continue studying where he/she left off, only to repeat this cycle again and again. In this example, researchers could use the most recent enrollment's starting date, or they could consider a prior enrollment's starting date as the official beginning of the student's studies in a program. This judgment requires consideration of the length of the stop-out, the length of the program enrolled, whether the student was required to update his or her training plan to a newer one with different competencies, etc.

Another challenge in deriving training starting dates stems from the technical colleges' data structure itself. Program names and CIP codes (standardized numeric codes maintained by the U.S. Department of Education and used to describe competencies taught within a given program) vary over time, with shifts used to indicate changes to training lengths or required curricula. Sometimes students may request, or colleges may require, that a student switch to an updated set of program requirements after previously enrolling under a different set. In this example, students are enrolled in the same program throughout, but college data imply otherwise as the student may have one enrollment under one program name or CIP code, and a second enrollment under a different name or CIP code.

Ultimately, researchers elected to count students' earliest credential-seeking enrollments observed within a specific CIP code as their training starting dates. Therefore, students who stopped-out and re-enrolled multiple times throughout their courses of study have significantly higher training duration periods than students who graduated or otherwise ceased their studies all at once. One negative consequence of this approach is the combination of multiple certificate programs under one umbrella that share the same CIP code. For example, a college may offer beginning, intermediate, and advanced welding certificate programs, all sharing CIP 48.0508 (Welding Technology). Some students may be observed to graduate after four months, while others may require years to graduate. In this analysis, these students are considered part of the same program, when, in reality, one may have enrolled in the beginning welding program and the other in the advanced. Though this phenomenon may be observed in some programs like Welding or Automotive Mechanics at specific institutions, the majority of a technical college's programs are unique in terms of assigned CIP codes. Researchers also elected to limit students' maximum training durations, excluding those influential student outliers requiring longer than five years to complete a vocational program.

In this analysis, researchers elected not to consider cohort years as found in DWS' intergenerational poverty data. If a student was coded as affected by intergenerational poverty in any year between 2013 and 2019, the student was added to the IGP adult group in this analysis, regardless of whether the student's enrollment at a technical college was prior to or subsequent to his or her IGP designation. The same can be said for reference adult students or those receiving public assistance but who were not classified as IGP. This decision was made due to the high number of students from DWS' IGP adult and reference rolls belonging to multiple annual cohorts and the relatively small number of years analyzed. In fact, of all students matched between technical colleges' and DWS' data, 73% belonged to multiple annual IGP or reference adult cohorts, with students appearing in public assistance rolls for an average of three out of the seven years analyzed.

We use survival analysis (also known as "time to failure analysis") to examine students' relative odds of and time to graduation. In survival analysis, *failure* is an agnostic term indicating the observance of an event of interest, and all test subjects are assumed to fail at some point. Where a subject has not yet failed and is no longer under observation, the individual is said to be *censored*. Though counterintuitive, in this analysis, non-graduation is considered *survival*, while graduation from a technical program is considered *failure* (hence, "time to failure" becomes "time to graduation"). As students are counted distinctly *within given programs* (i.e., CIP codes), multiple failures are not allowed in the data; students cannot graduate from the same program multiple times. Those who withdraw from the college prior to graduation and those who are still enrolled at the end of 2019 (the last year for which data are available) are censored. Gaps in observation time are also not relevant, as there exists only one row per individual per program enrolled, and that row contains overall training starting and exit dates regardless of any intervening lapses in enrollment.

**Results**

*N*-sizes are provided in Table 1, showing headcounts in the IGP adult, reference adult, and non-recipient adult cohorts at each technical college. Proportionally speaking, Southwest Technical College in Cedar City, UT, serves more students in financial distress than any other public technical college in Utah. Fully 47.22% of its adult certificate-seeking population age 21-42 received some form of public assistance in 2013-19. Tooele Technical College follows closely behind at 46.98%. Conversely, Bridgerland and Mountainland Technical Colleges in Logan and Lehi, UT, respectively, serve a lesser proportion of disadvantaged students than other institutions, with those receiving public assistance comprising only 28.02% and 29.44% of their student populations, respectively.

| Table 1: Cohort Headcounts by Technical College | | | | |
|---|---|---|---|---|
| **Technical College** | **IGP Adult** | **Reference Adult** | **Non-recipient Adult** | **Total** |
| Bridgerland Technical College | 246 (5.26%) | 1,064 (22.76%) | 3,365 (71.98%) | 4,675 |
| Davis Technical College | 994 (10.85%) | 2,597 (28.35%) | 5,571 (60.81%) | 9,162 |
| Dixie Technical College | 81 (6.34%) | 322 (25.22%) | 874 (68.44%) | 1,277 |
| Mountainland Technical College | 260 (5.61%) | 1,105 (23.84%) | 3,271 (70.56%) | 4,636 |
| Ogden-Weber Technical College | 691 (8.98%) | 2,077 (27.01%) | 4,923 (64.01%) | 7,691 |
| Southwest Technical College | 158 (11.27%) | 504 (35.95%) | 740 (52.78%) | 1,402 |
| Tooele Technical College | 124 (10.71%) | 420 (36.27%) | 614 (53.02%) | 1,158 |
| Uintah Basin Technical College | 279 (10.71%) | 704 (27.04%) | 1,621 (62.25%) | 2,604 |
| **Total** | **2,833 (8.69%)** | **8,793 (26.97%)** | **20,979 (64.34%)** | **32,605** |

Difference of means tests were performed to examine whether students receiving public assistance are statistically different than non-recipient adults across several demographic characteristics. The IGP adult and reference adult cohorts were combined within these tests, with results displayed in Table 2.

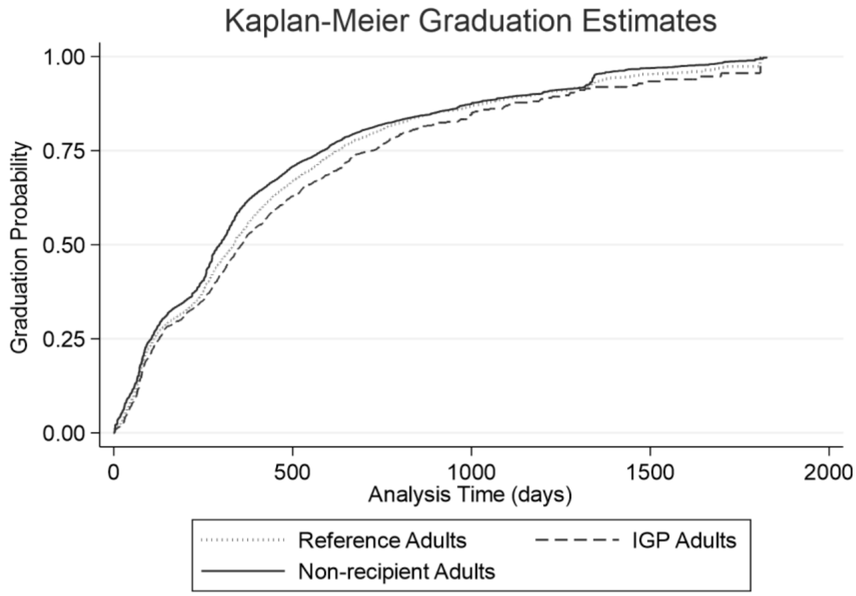
| Table 2: Difference of Means Tests by Public Assistance Recipients | | | | | |
|---|---|---|---|---|---|
| | **Non-recipient Adults** | | **Public Assistance Recipients (IGP & Reference Adults Combined)** | | |
| **Covariate** | **Mean** | **Standard Deviation** | **Mean** | **Standard Deviation** | **2-sided *p*-value** |
| Age at training start date | 27.66 years | 0.04 years | 30.01 years | 0.05 years | 0.0000*** |
| Male | 63.33% | 0.33% | 49.36% | 0.46% | 0.0000*** |
| Graduated | 61.31% | 0.34% | 48.37% | 0.46% | 0.0000*** |
| Hispanic | 11.49% | 0.22% | 12.18% | 0.30% | 0.0648* |
| Multiracial | 1.38% | 0.08% | 1.57% | 0.12% | 0.1849 |
| Asian | 1.39% | 0.08% | 0.79% | 0.08% | 0.0000*** |
| Black | 1.43% | 0.08% | 2.55% | 0.15% | 0.0000*** |
| Native American | 1.26% | 0.08% | 2.25% | 0.14% | 0.0000*** |
| Pacific Islander | 0.81% | 0.06% | 1.15% | 0.10% | 0.0021*** |
| White | 78.64% | 0.28% | 76.11% | 0.40% | 0.0000*** |

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

On average, adult public assistance recipients at Utah's technical colleges are approximately 2.5 years older than non-recipient adults and are more diverse in terms of ethnic or racial background. While 78.64% of non-recipient adults are white, this number drops to 76.11% when viewing recipients of state aid. These differences are significant at the 99% level. In examining educational outcomes, 61% of non-recipient adults analyzed successfully graduated from their respective vocational programs, whereas only 48% of their under-resourced counterparts accomplished the same.

Turning to students' time required to graduate from a technical college, Figure 1 displays the Kaplan-Meier failure (i.e., graduation) functions of the three student cohorts analyzed. Though differences appear small, note the scale of the x-axis spans 1,826 days (five years). Very few students require five years to complete programs that typically require 12-18 months. Remember, though, that many students are not continuously enrolled. Instead, they exhibit a pattern of repeatedly stopping out and returning to the technical college to continue their studies in the same program as before.

*Figure 1: Kaplan-Meier Failure (i.e., Graduation) Estimates*




Note that in Figure 1, the best outcomes are associated with adults who are not receiving public assistance, as that cohort has a consistently higher probability of graduating at any given time than groups that are receiving state aid. Students affected by intergenerational poverty unvaryingly have the lowest probabilities of graduating. The median time to graduation for students in the IGP adult cohort is 358 days (see Table 3), while reference adults, those receiving public assistance but who are not in intergenerational poverty, have a median graduation time of 336 days. Non-recipient adults graduated the fastest, with the median student completing his or her certificate program in only 295 days.

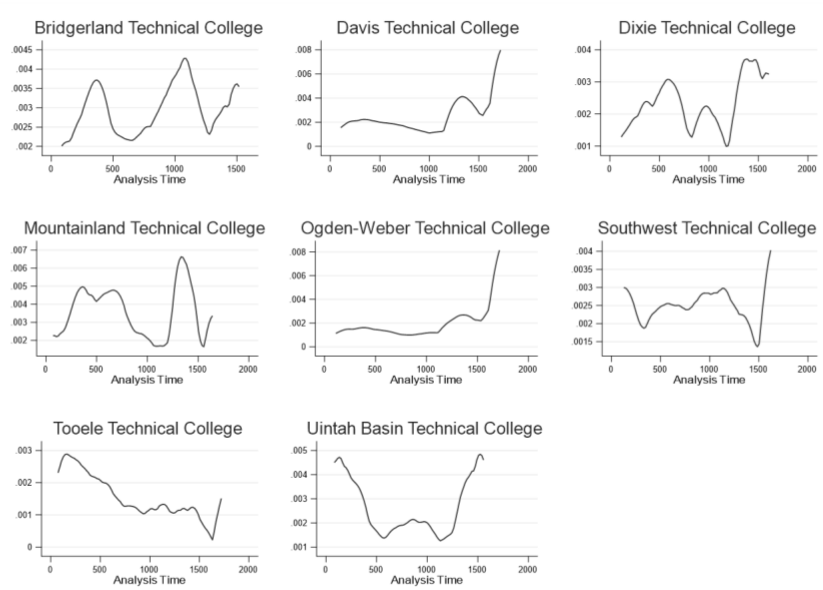
Table 3: Median Graduation Times

| Cohort | # Observations | Median Graduation Time | Standard Error | 95% Confidence Interval | |
|---|---|---|---|---|---|
| Non-recipient Adult | 20,904 | 295 days | 2.266 | 289 days | 302 days |
| Reference Adult | 8,742 | 336 days | 5.141 | 325 days | 343 days |
| IGP Adult | 2,808 | 358 days | 10.976 | 338 days | 373 days |

Performing Wilcoxon tests on these cohorts confirms that their survival functions are significantly different at greater than the 99% level ($chi^2 = 74.74$; $p = 0.0000$). Further stratification of Wilcoxon tests by gender and the 2-digit CIP families to which students' programs belong continues to show significant differences in the survival functions associated with these three groups. In fact, excluding those CIP families with small *n*-sizes (agricultural, paralegal, ASL, police/fire science, and interior design programs all had fewer than 10 IGP adult students enrolled between 2013 and 2019), the three cohorts' survival functions are significantly different at the 99% level within seven of the remaining ten CIP families observed. Only within Information Technology, Engineering, and Precision Production programs are the three student cohorts' probabilities of graduation not significantly different over time.

To view how individual student characteristics correlate with odds of graduation, a Cox proportional hazards model may be employed. Proportional hazards models assume that various groups' risks of graduation are proportional, or multiplicative transformations of one another, through time. Figure 2 displays the hazard functions observed at each of Utah's eight technical colleges. Though some institutions' hazards may satisfy this proportionality assumption (e.g., compare Davis Technical College and Ogden-Weber Technical College), most institutions' functions are dissimilar. In analyzing the schools' students under one model, the proportional hazards assumption is not met.

*Figure 2: Smoothed Graduation Hazards, by Technical College*




The disparity of hazard functions observed at different institutions is not unexpected. Regional characteristics (e.g., rural/urban, per capita household income), institutional policies (e.g., tuitional collection schedules, programmatic structure), and student resources (e.g., prevalence of mental health or transportation services) vary across technical colleges, with these differences likely to influence a student's odds of graduating. Because of these disproportionate hazards, researchers derive a Cox proportional hazards model individually for each institution. The Breslow approximation is employed in instances of tied failure. Relevant findings are included in Table 4.

| Table 4: Cox Proportional Hazards Models | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Covariates** | **Bridgerland Tech** | **Davis Tech** | **Dixie Tech** | **Mountainland Tech** | **Ogden-Weber Tech** | **Southwest Tech** | **Tooele Tech** | **Uintah Basin Tech** |
| Age | -0.0113 | 0.0949*** | 0.00984 | 0.0102 | 0.0608* | -0.0110 | -0.00312 | 0.0572 |
| | (0.0372) | (0.0291) | (0.0653) | (0.0332) | (0.0326) | (0.0606) | (0.0694) | (0.0424) |
| $Age^2$ | 0.000195 | -0.00146*** | -0.000115 | -9.71e-05 | -0.000800 | 0.000283 | 0.000200 | -0.000726 |
| | (0.000611) | (0.000475) | (0.00105) | (0.000544) | (0.000529) | (0.000977) | (0.00111) | (0.000681) |
| Male | -0.153*** | 0.196*** | -0.111 | -0.0110 | -0.122** | -0.0640 | -0.120 | 0.152* |
| | (0.0523) | (0.0417) | (0.113) | (0.0518) | (0.0513) | (0.0903) | (0.155) | (0.0850) |
| Hispanic | -0.101 | -0.128 | -0.222 | -0.184*** | 0.0116 | 0.151 | 0.400* | -0.236** |
| | (0.122) | (0.0798) | (0.179) | (0.0504) | (0.133) | (0.203) | (0.231) | (0.0921) |
| Non-resident Alien | -33.08 | -0.495 | | -0.668 | -0.844 | | | |
| | (5.406e+07) | (0.711) | | (1.003) | (0.720) | | | |
| Multiracial | -0.0685 | -0.0585 | 0.212 | 0.0345 | 0.201 | -0.0828 | 0.335 | -0.0902 |
| | (0.223) | (0.135) | (0.290) | (0.135) | (0.195) | (0.318) | (0.395) | (0.253) |
| Asian | -0.363* | -0.0150 | 0.162 | -0.196 | 0.239 | -0.0791 | 0.102 | -0.00581 |
| | (0.212) | (0.144) | (0.539) | (0.167) | (0.182) | (0.372) | (0.467) | (0.306) |
| Black | -0.329 | -0.0468 | -1.011* | -0.225 | -0.222 | -0.130 | -0.535 | -0.105 |
| | (0.229) | (0.111) | (0.530) | (0.200) | (0.196) | (0.425) | (0.560) | (0.188) |
| Native American | 0.00597 | 0.0808 | -0.122 | 0.0148 | 0.204 | -0.0683 | 0.899* | -0.238** |
| | (0.253) | (0.139) | (0.330) | (0.190) | (0.238) | (0.267) | (0.477) | (0.106) |
| Pacific Islander | -0.0226 | -0.418* | -0.327 | -0.0407 | 0.0316 | 0.513* | 1.036* | 0.291** |
| | (0.351) | (0.215) | (0.441) | (0.161) | (0.268) | (0.312) | (0.557) | (0.134) |
| White | 0.0639 | 0.0431 | 0.0514 | | 0.268** | 0.228 | 0.262 | |
| | (0.0973) | (0.0656) | (0.139) | | (0.126) | (0.178) | (0.203) | |
| IGP Adult | -0.253*** | -0.129* | -0.348** | -0.254*** | -0.326*** | -0.175 | 0.357** | -0.158* |
| | (0.0952) | (0.0673) | (0.158) | (0.0810) | (0.0703) | (0.126) | (0.147) | (0.0856) |
| Reference Adult | -0.221*** | -0.102** | -0.0959 | -0.193*** | -0.182*** | -0.177** | 0.0209 | -0.0993* |
| | (0.0492) | (0.0400) | (0.0909) | (0.0442) | (0.0435) | (0.0823) | (0.0901) | (0.0571) |
| Observations | 4,655 | 9,026 | 1,272 | 4,611 | 7,672 | 1,400 | 1,151 | 2,566 |

Standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 5: Corresponding Hazard Ratios

| Covariates | Bridgerland Tech | Davis Tech | Dixie Tech | Mountainland Tech | Ogden-Weber Tech | Southwest Tech | Tooele Tech | Uintah Basin Tech |
|---|---|---|---|---|---|---|---|---|
| Age | 0.989 | 1.100*** | 1.010 | 1.010 | 1.063* | 0.989 | 0.997 | 1.059 |
| | (0.0368) | (0.0320) | (0.0660) | (0.0335) | (0.0346) | (0.0599) | (0.0692) | (0.0449) |
| $Age^2$ | 1.000 | 0.999*** | 1.000 | 1.000 | 0.999 | 1.000 | 1.000 | 0.999 |
| | (0.000611) | (0.000475) | (0.00105) | (0.000544) | (0.000529) | (0.000977) | (0.00111) | (0.000681) |
| Male | 0.858*** | 1.217*** | 0.895 | 0.989 | 0.886** | 0.938 | 0.887 | 1.165* |
| | (0.0449) | (0.0508) | (0.101) | (0.0513) | (0.0454) | (0.0847) | (0.138) | (0.0991) |
| Hispanic | 0.904 | 0.880 | 0.801 | 0.832*** | 1.012 | 1.164 | 1.492* | 0.790** |
| | (0.110) | (0.0702) | (0.143) | (0.0419) | (0.135) | (0.237) | (0.345) | (0.0727) |
| Non-resident Alien | 0 | 0.609 | | 0.513 | 0.430 | | | |
| | (2.33e-07) | (0.433) | | (0.514) | (0.310) | | | |
| Multiracial | 0.934 | 0.943 | 1.236 | 1.035 | 1.222 | 0.921 | 1.398 | 0.914 |
| | (0.208) | (0.127) | (0.359) | (0.140) | (0.238) | (0.292) | (0.552) | (0.231) |
| Asian | 0.696* | 0.985 | 1.176 | 0.822 | 1.270 | 0.924 | 1.107 | 0.994 |
| | (0.148) | (0.142) | (0.633) | (0.138) | (0.231) | (0.344) | (0.517) | (0.304) |
| Black | 0.720 | 0.954 | 0.364* | 0.799 | 0.801 | 0.878 | 0.585 | 0.900 |
| | (0.165) | (0.106) | (0.193) | (0.160) | (0.157) | (0.373) | (0.328) | (0.170) |
| Native American | 1.006 | 1.084 | 0.885 | 1.015 | 1.226 | 0.934 | 2.456* | 0.788** |
| | (0.254) | (0.150) | (0.292) | (0.193) | (0.292) | (0.250) | (1.172) | (0.0836) |
| Pacific Islander | 0.978 | 0.658* | 0.721 | 0.960 | 1.032 | 1.671* | 2.817* | 1.338** |
| | (0.343) | (0.141) | (0.318) | (0.154) | (0.277) | (0.521) | (1.570) | (0.180) |
| White | 1.066 | 1.044 | 1.053 | | 1.307** | 1.255 | 1.300 | |
| | (0.104) | (0.0685) | (0.146) | | (0.164) | (0.224) | (0.264) | |
| IGP Adult | 0.776*** | 0.879* | 0.706** | 0.776*** | 0.722*** | 0.839 | 1.429** | 0.854* |
| | (0.0739) | (0.0592) | (0.112) | (0.0628) | (0.0508) | (0.106) | (0.210) | (0.0730) |
| Reference Adult | 0.801*** | 0.903** | 0.909 | 0.824*** | 0.834*** | 0.838** | 1.021 | 0.905* |
| | (0.0394) | (0.0361) | (0.0826) | (0.0364) | (0.0363) | (0.0690) | (0.0920) | (0.0517) |

Standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$

The most obvious covariate impacting a student's time to graduation is conspicuously absent from the model in Table 4. Program lengths at technical colleges may vary from as few as 60 hours (e.g., phlebotomy) to as many as 1,600 hours of required instruction (e.g., cosmetology), yet the number of required hours is noticeably omitted from the model. This is due to weaknesses in technical college data observed prior to 2018. Before that time, certificate lengths were included in annual college data submissions only when a student graduated. For non-graduates or those still enrolled, data do not easily indicate the length of the credential sought.

Researchers accounted for this by stratifying Cox Proportional hazards models on the CIP codes associated with students' programs. Because stratification allows for different programs to have different baseline hazards (rather than requiring all programs' hazards to be multiplicative versions of each other), and because only a small portion of programs at each technical college share the same CIP code (making CIP code an adequate substitution for individual programs), stratifying on CIP code allowed researchers to account for differences in program length when viewing other covariates' relationships with a student's relative odds of graduation. Also accounted for through allowing varying hazard functions are programs' other unique and unmeasured characteristics related to graduation, like a program's rigor.

Students' demographics are included in the proportional hazards models above, with gender and race and ethnicity fields each taking Boolean forms. Age is the only covariate analyzed that is interval-level data. $Age^2$ is also included to measure the extent to which any potential effect of age on a student's odds of graduating changes over time. Also included in the model are indicators of IGP adult and reference adult cohort membership.

Cox proportional hazards models show changes to a student's *relative* odds of graduating associated with a one-unit increase in each covariate, holding all else constant. Rather than estimating a given student's graduation probability given known characteristics, Cox models only allow for comparisons against a baseline student (hence, the relative odds mentioned above). Table 5 provides relative hazard ratios corresponding to the respective covariates from Table 4, and it is with these ratios that we can make comparisons against the baseline. Ratios in Table 5 are derived by exponentiating the covariate's coefficient ($e^{\beta_1}$) in Table 4. For example, consider the coefficient associated with Hispanic ethnicity at Mountainland Technical College:

$$\beta_{Hispanic} = -0.184$$

$$e^{\beta_{Hispanic}} = \frac{1}{e^{0.184}} = 0.832$$

Interpreting this number, a one-unit increase in the covariate Hispanic (a categorical variable taking values one or zero) is associated with a 16.8% decrease in a student's hazard of graduating (1 – 0.832 = 0.168) relative to the baseline student. Herein, the baseline student in all models is a female of unknown racial/ethnic identity whose age is set to the mean age observed within each technical college, and who is not part of the IGP adult or reference adult cohorts. Relative to her, a Hispanic student's odds of graduating are significantly less at the 99% level.

Interestingly, not a single covariate analyzed is significantly correlated at all eight technical colleges with a student's relative odds of graduating. Not only that, but covariates' correlations switch from positive to negative as one looks from one college to the next. For example, relative to the baseline student, males at Bridgerland Technical College have log hazards of graduation that are 14.2% lower ($p < 0.01$), while males at Davis Technical College have log hazards that are almost 21.7% higher ($p < 0.01$). And Hispanic students have lesser odds of graduation than the baseline student at Mountainland Technical College ($p < 0.01$), but they enjoy higher relative odds at Tooele Tech ($p < 0.1$).

Tooele Technical College stands apart from the rest in terms of unique and unexpected results. Relative to the baseline student, students of Hispanic, Native American, and Pacific Islander heritage all have higher log odds of graduating. However, these results surrounding ethnic and racial groups are questionable due to small sample sizes. Only seven students of Pacific Islander heritage ages 21-42 were credential seekers between 2013 and 2019, and only 15 Native American students. Tooele Tech also shows a positive increase in the relative odds of graduation associated with receipt of state aid, with IGP adults' log odds of graduating 43% higher than those of the baseline student, this difference significant at the 95% level. With 124 students belonging to the IGP adult cohort, and an additional 420 reference adults, sample sizes of economically distressed individuals are of a lesser concern in this context. Further analysis of Tooele Technical College's programs, support services, and institutional policies is warranted to identify reasons why students in intergenerational poverty are seemingly outperforming non-recipient adults upon controlling for other factors.

Classification in the intergenerational poverty cohort and membership in the reference adult cohort are both significantly and negatively correlated with a student's relative hazard of graduating at six of Utah's other seven technical colleges (though not the same six institutions), with significance ranging from the 90% to 99% level. Among these institutions, IGP adult cohort membership is associated with between a 12.1% and 29.4% decrease in the relative odds of graduating, and reference adult cohort membership is associated with a reduction of between 9.5% and 17.6%. Students in economic distress are experiencing significantly lower odds of graduating than their more affluent peers. This disparity is even wider when considering public assistance recipients who were also consistently receiving help as children.

**Limitations**

The underlying structure of technical college data presents challenges that must be mitigated for any analysis to be valid. The absence of critical variables herein is glaring. Required program lengths, students' full-/part-time statuses (or more granularly, their number of scheduled hours per week), further indicators of underrepresented status (e.g., disability status, limited English proficiency, etc.), and the availability of specific college services (e.g., bus passes, pantries for those experiencing food insecurity, etc.) may all influence students' relative hazards of graduating and their time to graduation. Though some of these fields are existent within technical college enrollment data, they are omitted from the model because their validity cannot be fully verified at this time. Business rules impacting the reporting of full-/part-time status, for example, differ from college to college based on how they utilize their student information systems. These rules affect how data are recorded, how many rows of data are observed for each student, and how gaps in enrollment may be interpreted. Standardization of how each college structures programs within information systems will allow future analyses to include these important covariates.

As mentioned previously, this analysis considers a student's first enrollment in a technical program as his or her training start date, while the exit date is the student's last recorded exit from a college campus. Intervening exits and entries, and changes to students' weekly scheduled hours of instruction are not considered. This is again due, in part, to differences in how the colleges utilize their student information systems and the impact those differences had on the richness of data submitted to the Utah System of Higher Education. But also, the lack of intervening exits and re-enrollments is due to the inherent nature of open-entry/open-exit institutions. The scheduling flexibility and open-enrollment nature associated with these schools can easily result in dozens of records per student spanning multiple years. At some point, researchers must make a subjective decision when to consider a student as truly starting a program. Is it when the student first started studies at a technical college ten years ago, or is it the first start after his or her six-year absence? Should this determination be based on the length of the credential sought? Researchers herein did not examine the lengths of enrollment gaps or the lengths of credentials sought. Instead, we looked at students' earliest known enrollments and latest known exits within a given program, as this was the easiest way to treat technical college data.

Future analyses of students' odds of and time to graduation are likely to be undertaken, as technical colleges are now recording specific data elements that were unavailable in the colleges' 2013-19 data, and that can mitigate several of the limitations described above. These elements will make it easier to incorporate program lengths into future analyses, as well as identify name and CIP code changes resulting in duplication of programs. Future studies should allow for gaps in observation as students stop-out then later re-enroll so that researchers can examine enrolled time in addition to total analysis time.

Utilizing more variables of an interval or continuous nature will dramatically increase the predictive power the of colleges' proportional hazards models examined above. Age is the only field shown in Table 4 that is not Boolean in nature. Consequently, though models suggest a significant correlation between economic distress and odds of graduation, their predictive power is lacking. Survival models' predictive abilities can be judged with Harrell's concordance statistic, which shows the percentage of paired observations, the ordered failure of which can accurately be predicted. Random chance should predict 50% of ordered failures for paired observations. Hence, concordance statistics greater than 0.5 demonstrate added predictive power. Somers' delta statistics range from negative one to one to also demonstrate predictive ability and are an ordinal alternative to Pearson's $r$. Table 6 displays the eight models' Harrell's and Somers' values, showing that the above models add predictive power over random chance, but only marginally so.

*Table 6: Harrell's Concordance Statistics and Somers' Delta Values*

| College | Harrell's Concordance Statistic | Somers' Delta |
|---|---|---|
| Bridgerland Technical College | 0.5411 | 0.0822 |
| Davis Technical College | 0.5457 | 0.0914 |
| Dixie Technical College | 0.5437 | 0.0874 |
| Mountainland Technical College | 0.5435 | 0.0870 |
| Ogden-Weber Technical College | 0.5620 | 0.1241 |
| Southwest Technical College | 0.5242 | 0.0484 |
| Tooele Technical College | 0.5393 | 0.0785 |
| Uintah Basin Technical College | 0.5696 | 0.1391 |

While researchers call for the addition of new covariates, particularly those of an interval or continuous nature, there is no indication that their inclusion should have an appreciable impact on the magnitude or significance of the IGP cohort coefficients derived above. For example, researchers see no indication that students experiencing intergenerational poverty are more prone to enroll in shorter programs than the baseline student as measured by required hours. If anything, additional covariates should improve the models' predictive powers while leaving unaffected the significance and direction of the observed IGP cohort correlations.

Lastly, future analyses should incorporate variables that can easily be changed by the college or a student themself, and that can influence more efficient outcomes. Consider that it is impossible to adjust students' racial/ethnic backgrounds or ages, and students are unlikely to drop out and re-enroll in a new technical college where the odds of graduation may be higher. None of the covariates from the models above can easily be changed by policy or personal choice to then influence a student's relative hazard of graduating. Future analyses should incorporate as covariates specific data elements that are tied to changeable behavior or policy. For example, where the number of scheduled hours of instruction per week included in the models and shown to significantly increase the relative hazards of graduating, a college could implement a minimum hours rule for all students in an effort to increase graduation rates.

## Conclusion

Notwithstanding the above limitations, the present model does offer insights into the differences between baseline and other student populations and their relative hazards of graduating. Significant differences exist between the survival functions of students experiencing intergenerational poverty, other adults receiving public assistance, and adult students who are not recipients of state aid. These differences persist even after stratifying the survival functions based on students' gender and their selected programs of study. Time to graduation was measured for each cohort, with the median student affected by intergenerational poverty requiring 63 more days to graduate than the median non-recipient adult. Lastly, Cox proportional hazards models were employed for each of Utah's eight technical colleges to show that in six of the institutions, students who experience economic distress have odds of graduating that are significantly lower than the baseline student who is not receiving public assistance funds. These under-resourced students' odds of graduating are between 9.5% and 29.4% lower than the baseline, with students experiencing intergenerational poverty displaying the lowest odds of the three cohorts analyzed.

This analysis serves as a starting point, laying the groundwork for future research into poverty's effects on student success in Utah's vocational certificate programs. Questions abound surrounding Tooele Technical College and its relationship between a student's economic condition and his or her odds of graduating. Perhaps the observed correlation is spurious, or perhaps, the college has identified specific tactics or institutional policies to best serve underrepresented student populations. Though no evidence thereof is observed, another possibility is a campus policy driving disadvantaged students to specific programs enjoying high graduation rates. Whatever the reason, Tooele Tech's proportional hazards model above provides hope that the college is doing something right in serving underrepresented student populations. If successful and effective strategies can be exported to other technical colleges, perhaps educational leaders can close the gap between financially distressed students' odds of graduating and those of their more affluent peers.

This analysis falls in line with the general literature discussed above, showing lesser educational outcomes for students coming from low-income backgrounds. While the analysis excludes covariates that can easily be manipulated to hopefully induce better outcomes, it is nonetheless helpful in concluding that those in financial distress generally face increased barriers to educational attainment beyond those of a typical student. Competency-based education may prove an effective tool in ameliorating intergenerational poverty by providing low-cost education that can be completed quickly and that can facilitate entry into gainful employment. But before this tool can become effective, underlying inequities shown through disparate student outcomes must first be resolved. Equitable access to higher education requires that underrepresented students' barriers be removed through egalitarian campus policies, expanded student services, and concerted efforts to help these students graduate. It falls to policymakers to craft solutions and to future analyses to gauge those efforts' impacts.