Does merit-based aid promote degree attainment?*

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Abstract

This study examines whether receiving merit-based aid affects the bachelor's degree attainment in the fourth, fifth, and sixth year of initial enrollment in the case of Tennessee. Using the fuzzy frontier discontinuity method, I compare graduation rates of students who initially received the state's merit-based aid to those of students who did not. Results show that receiving merit-based aid increased the probability of earning a bachelor's degree in the fourth year. However, it did not affect degree attainment in the fifth or sixth year. This paper also discusses possible explanations regarding why merit-based aid may not influence degree attainment.

Keywords: merit-based aid, degree attainment, graduation, time to degree, regression discontinuity

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^{*} This study is a chapter from Lee's (2014) doctoral dissertation which has not been published elsewhere.

Introduction

Statewide merit-based aid has been prevalent across the United States since the early 1990s. Statewide merit-based aid generally covers more than half of tuition and required fees for in-state public colleges and universities although the exact aid amount and eligibility requirements vary across states (Domina, 2014). Statewide merit-based aid is eligible for students with solid academic records (based on standardized test scores and/or high school grades) who attend one of the in-state colleges and universities. That is, if students are academically prepared, a substantial portion of tuition costs is subsidized by their state government.

Merit-based aid aims to keep the best and brightest students within their states and increase the number of college graduates that are crucial for the state economy (Hu, Trengove, & Zhang, 2012). Previous research consistently shows that merit-based aid increases college enrollment (e.g., Cornwell, Mustard, & Sridhar, 2006), but relatively fewer studies have examined its effect on graduation (Dynarski, 2005; Scott-Clayton, 2011). Considering that college graduation is crucial not only for individual students but also for the state economy, it is important to examine whether the state's effort has translated into persistence and degree attainment.

This study examines whether merit-based aid affects the probability of earning a bachelor's degree within six years in the case of Tennessee. I use the regression discontinuity method that minimizes selection bias by comparing scholarship recipients to non-recipients who are very similar to each other. This study adds to the literature by empirically examining the relationship between merit-based aid and graduation. Results from this study will inform policy makers who might consider adopting merit-based aid for improving college graduation rates.

Tennessee Educational Lottery Scholarships

In the fall of 2004, the Tennessee Educational Lottery Scholarships (TELS) were first awarded for the incoming cohort. There are five programs under the Scholarships based on a student's family income, academic achievement, and institution type: HOPE base, ASPIRE, GAMS, Access award, and Wilder-Naifer technical skills grant. Table 1 shows the eligibility requirement and aid amount for all these programs. Some of these rules and aid amount have changed over time. In this paper, I only describe the rules applied to the fall 2004 entering cohort, which is the main focus of this paper.

	HOPE base	ASPIRE	GAMS	Access	Wilder-Naifeh
Amount (for 4-year college students)	\$3,000	\$4,000	\$4,000	\$2,000	N/A
Minimum HS GPA	3.0	3.0	3.75	2.75	N/A
Minimum ACT composite score	or 19	or 19	and 27	and 18	N/A
Family income requirement	N/A	\$36,000 or less	N/A	\$36,000 or less	N/A

	Table 1. Tennessee	Education	Lottery	Scholarship	Eligibility	and	Aid	Amount
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Note. Rules and aid amount here were applied to the 2004 entering cohort only. The only eligibility requirement for Wilder-Naifeh is to enroll in a certificate or diploma program at a Tennessee Technology Center.

The HOPE base program was awarded to students who met either the minimum high school GPA of 3.0 or ACT scores of 19. If students met one of these criteria and came from a low-income family (with an annual family income below \$36,000), they were eligible for ASPIRE. For highest-achieving students with a 27 ACT score and a 3.75 high school GPA or above, they were eligible for GAMS. Students who were eligible for ASPIRE or GAMS received an additional \$1,000 in addition to their HOPE base aid. Students who failed to meet the academic criteria for the HOPE base program, but came from a low-income family were eligible for the Access award if their ACT score was at least an 18 and their high school GPA is at least a 2.75. These four programs were eligible for students enrolled in a public or private college within the state, while the Wilder-Naifer Techinical Skills Grant was eligible for students enrolled in one of the state's technology centers. Once students receive any of these scholarships (except the Widler-Naifer grant), they must renew their scholarship eligibility by maintaining a 3.0 cumulative GPA in the semesters when they complete 24, 48, 72, 96, and 120 course credits. The scholarships can be renewed for up to five years or until students earn 120 college credits, whichever comes first.

Of these five programs, this study only looks at the first two programs (HOPE base and ASPIRE) that were available for college students who met at least a 19 on the ACT or a 3.0 GPA in high school. GAMS recipients were excluded because they were highest-achieving students compared to HOPE or ASPIRE students. Access recipients were excluded because it was difficult to find a counterfactual for these students given the lack of detailed data for family income. I also excluded the Wilder-Naifer recipients because this grant was available only for students enrolled in a certificate or a diploma program at one of the state's technology centers.

TELS has relatively lower cut-off scores and a bonus award for low-income students. As opposed to other states that require both standardized test scores and high school GPAs, Tennessee only required either one of the criteria. The ACT cut-off score in the first year of the implementation was as low as 19 in Tennessee, while its neighboring states had relatively higher cut-off scores (e.g., 20 in Florida and Louisiana or 22 in West Virginia). In addition, low-income students who failed to meet the base criteria were still eligible for TELS. For low-income students who slightly miss the base criteria, the Access grant is eligible. When low-income students meet the base criteria, an additional aid (\$1,000 for the

2004 entering cohort) is provided as a supplement (ASPIRE).

The income supplements as well as the relatively lenient academic standards are designed to address one of the key limitations of merit-based aid: the disproportionate distribution of merit-based aid to students from wealthy families (Heller & Marin, 2002, 2004). Approximately 27% of scholarship recipients who started at public 4-year colleges in the fall semester of 2004 came from families with a family income of \$36,000 or less (Tennessee Higher Education Commission [THEC], 2011, p. 65). However, it is not yet clear if receiving these scholarships leads to degree attainment. The 6-year graduation rates of the Access grants and ASPIRE recipients are 30% and 44%, respectively. These rates are lower than the state's average graduation rates by more than 10 percentage points.

Theoretical background and literature review

This study is grounded on human capital theory. According to human capital theory, students are assumed to be rational. They weigh benefits to costs of college enrollment and decide to enroll in college only when the benefits are greater than the costs (Schultz, 1961). According to the theory, receiving statewide merit-based aid will increase the probability of getting another year of college education by reducing the direct costs of college education, when other things are held constant.

Financial aid can increase college enrollment and graduation in the following ways. First, financial aid decreases the direct costs of college education that students pay. This monetary support allows students to postpone participating in the labor market and spend more time on campus. When students spend more time on campus, they are academically and socially more integrated into their institutions, which increases their odds to re-enroll in college until graduation (Tinto, 2010).

In addition to the monetary and social frameworks, state merit-based aid provides students with an incentive to work hard in college. In West Virginia, students are required to complete at least 30 credits per year with a minimum of 3.0 cumulative GPA to renew their scholarship eligibility. Using regression discontinuity and cohort analysis methods, Scott-Clayton (2011) finds that scholarship recipients were more likely to meet these renewal requirements and graduate compared to non-recipients. Interestingly, recipients were not more likely to meet the renewal requirements after their junior years because they could receive the merit-based aid for only four years. This evidence suggests that students are well aware of scholarship eligibility and respond to incentives embedded in it.

Some researchers find a positive effect of receiving merit-based aid on college completion. For example, receiving a Cal Grant, which is eligible for California state residents who meet high school GPA and family income criteria, increases the probability of completing college (Bettinger, Gurantx, Kawano, & Sacerdote, 2016). In Georgia, Henry, Rubenstein, and Bugler (2004) found that HOPE scholarship recipients completed more credits, received higher grades, and were more likely to graduate compared to non-recipients. However, the positive effect of HOPE scholarships disappeared if students failed to renew their scholarship eligibility and lost them while in college.

The effect of merit-based aid varies depending on the amounts awarded. In Florida, there are two types of merit-based scholarships that cover either 100% tuition and fees (the Florida Academic Scholars) or 75% of tuition and fees (the Florida Medallion Scholars). The former one is eligible to highest-achieving students (e.g., 1270 on SAT and 3.5 high school GPA in 1997), while the latter one targets students with solid academic records (e.g., 970 on SAT and 3.0 GPA in 1997). According to Castleman (2013), receiving the Academic Scholars increased the probability of degree attainment more than not receiving scholarships, while receiving the Medallion Scholars made no difference.

Recently, there are two empirical studies that examine the effect of the Tennessee HOPE base scholarship on college completion. Welch (2014) examines the effect of receiving the HOPE base scholarship on community college students and finds that the scholarship had no significant effect on students' persistence, degree attainment, or post-graduate earnings. Similarly, Carruthers and Özek (2016) demonstrate that losing the HOPE scholarship (failing to renew the scholarship eligibility) had no significant impact on on-time graduation although it slightly decreased the probability of re-enrolling in the subsequent semester. Both studies suggest that the Tennessee HOPE scholarship has a small or null effect on college persistence and completion although they focus on a population (community college students) or a treatment (losing aid as opposed to initially receiving it) that are slightly different from those in my study.

At the state level, there are mixed results about the effect of merit-based aid on average completion rates. Employing the difference-in-differences method, Dynarski (2005) shows that the percentage of young adults with college degrees in Arkansas and Georgia has increased since the inception of their merit-based aid. The positive impact was observed in all racial groups. Zhang (2011) also demonstrates that the number of bachelor's degree holders increased in Georgia and Florida since the adoption of merit-based aid in these states. Zhang emphasizes that the adoption of merit aid increased those who majored in science, technology, engineering, and math, as well.

In contrast, Sjoquist and Winters (2014) report that there is no empirical evidence that adopting merit-based aid has increased the proportion of college graduates at the state level. This contrasting result may be attributable to the number of states and the length of time period studied. While Dynarski and Zhang focus on two states, respectively, Sjoquist and Winters examine the impact of merit-based aid for 24 states from 2000 to 2010. One potential limitation of state-level studies is that it is not yet clear how statewide merit-based aid increases degree production, if any. As these studies focus on aggregated outcomes at the state level, they can increase the number or the proportion of college graduates by retaining the best and bright students within their states instead of subsidizing students who would not have gone to and finished college in the absence of merit aid.

To summarize, there are mixed results as to the effect of merit-based aid on college completion. The effect also varies depending on the awarding rules and amounts. Moreover, most of the studies in this area focus only on a few states that adopted merit-based aid in the 1990s. This study looks at Tennessee that implemented its merit aid more recently. In addition, the effect of merit-based aid can be varied depending on the program design. As Tennessee has less rigorous academic requirements and provides low-income students with a bonus award, it would be interesting to explore the impact of the state's scholarships on college completion. Lastly, my study examines the impact of merit-based aid by looking at students who were at the margins of receiving (or not receiving) merit-based aid due to their academic performance.

Data, sample, and methods

In this study, I use administrative data in Tennessee, focusing on students who started at one of the public 4-year colleges in the state in the 2004 fall semester. I can track students as long as they remained in one of the state's public 4-year colleges. The data provides information on demographics, parental educational levels, Pell Grant eligibility, financial aid, enrollment status, high school grades, and standardized test scores.

My sample is limited to first-time freshman students who graduated from high school in 2003 or later and first enrolled in a public 4-year college in Tennessee in 2004 fall. Non-traditional students such as adult students are excluded from the analysis not only because they are very different from traditional students (Bean & Metzner, 1985), but also because the scholarship eligibility was limited to students who entered college within 16 months of their high school graduation. I also limit the sample to Tennessee state residents those who registered for at least six credits for their first semester. These two conditions (state residency and at least part-time status) are basic eligibility criteria for TELS. Therefore, whether students in my sample were eligible for TELS totally depends on their test scores and high school grades. Fourteen thousand three hundred ninety-one first-time freshmen students (12,669 recipients and 1,722 non-recipients) were included in the analysis.

In Table 2, I provide the descriptive statistics for the sample, which are broken down by their TELS status. Overall, racial minority students, Pell Grant recipients, and first-generation students are overrepresented among those who did not receive TELS. Their test scores and high school grades are much lower than those who received TELS. Each of these covariates (except the proportion of female students) is statistically significant between recipients and non-recipients. Given these differences, it is hard to attribute the average graduation rate gap solely to their TELS status.

	Not received	Received	Total	<i>t</i> -value ^a
Female	0.551 (0.498)	0.551 (0.497)	0.551 (0.497)	-0.015
Racial Minority	0.433 (0.496)	0.183 (0.387)	0.213 (0.409)	24.238****
Pell-Eligible	0.591 (0.492)	0.294 (0.456)	0.320 (0.467)	21.586***
College-Educated Parent(s)	0.439 (0.496)	0.689 (0.463)	0.659 (0.474)	-20.86***
High School GPA	2.809 (0.488)	3.329 (0.499)	3.270 (0.525)	-26.799***
ACT score	18.83 (3.686)	22.95 (3.746)	22.47 (3.965)	-42.264***
Graduation rates (within six years)	0.253 (0.435)	0.546 (0.498)	0.511 (0.500)	-23.248***
Sample size	1,722 (11.97%)	12,669 (84.85%)	14,391 (100%)	14,391

Table 2. Descriptive Statistics for the Sample

Note. When I calculated the average high school GPA, I dropped GED students. In the data set, their high school GPAs actually mean their GED scores.

^a*T*-value in the last column shows obtained t-values after conducting independent t-test between recipients and non-recipients on each of the covariates. Stars next to t-values are associated *p*-values ($\stackrel{*}{:} < .05, \stackrel{**}{:} < .01$).

I use a regression discontinuity model that minimizes both observable and unobservable differences between recipients and non-recipients. The regression discontinuity model is used when a treatment is given on the basis of a pre-determined arbitrary standard, such as the TELS eligibility criteria (Schneider, Carnoy, Kilpatrick, Schmidt, & Shavelson, 2007). To be eligible for TELS, students with a family income of \$36,000 or above had to score at least a 19 on the ACT exam or receive a 3.0 high school GPA. If students did not meet the GPA standard, they should have scored at least a 19 in order to receive TELS. This cut-off score of 19 is arbitrary, though. If there had not been the scholarships, there is no reason that students who just passed the cut-off score are more likely to graduate than students who slightly missed it. The former students would do slightly better than the latter students because standardized test scores reflect academic capability to some extent; however, there should not be a sharp gap in graduation rates between the two groups without the scholarships. The continuity in a dependent variable is a major assumption of the regression discontinuity method (Imbens & Lemieux, 2008).

Since we cannot observe what would have happened in the absence of the scholarship, the continuity assumption cannot be directly tested. Instead, researchers are recommended to see whether student characteristics except for the treatment are comparable across a cut-off score (Imbens & Lemieux, 2008; van der Klaauw, 2008). In Figures 1 and 2, I create several plots that examine whether student covariates are comparable across an ACT and GPA threshold, respectively. Because the TELS was awarded to students who met at least one of the academic requirements, I re-grouped my sample into two different groups. Students in Figure 1 are those who failed to meet the GPA requirement, so their TELS eligibility was solely determined by their ACT scores. In

contrast, students in Figure 2 failed to meet the ACT requirement, so their GPA determined whether they received TELS or not. As these figures look at students near the cut-off scores, the number of students included in these figures is much smaller than the total sample size. In figure 1, a total of 1,627 students (1,224 recipients and 403 non-recipients) were included, and a total of 277 students (197 recipients and 80 non-recipients) were used in figure 2. The point zero on the x-axis indicates the cut-off scores, and y-axis shows the proportion of students at each x value. If students on both sides are quite comparable, the plot should not suddenly jump or drop at the threshold. However, if there is a sudden change across the cut-off score, it suggests that recipients are different from non-recipients at least for that covariate.



Figure 1. Discontinuity in Covariates (ACT)



Figure 2. Discontinuity in Covariates (GPA)

When the award decision was made based on ACT scores, as in Figure 1, there are fewer racial minority students and low-income students among recipients than non-recipients. In addition, the proportion of students who have college-educated parents is higher among recipients than non-recipients. When I ran a *t*-test on each of the covariates, the share of low-income students, underrepresented racial minority students, and students with college-educated parents is significantly different between recipients and non-recipients (results available upon request). This suggests that recipients came from more advantaged backgrounds than non-recipients when the assignment variable was an ACT score. When the award decision was made based on high school GPAs, as in Figure 2, the sample is more balanced. The only significantly higher among recipients than non-recipients (*t*-test results available upon request). Although the sample is more balanced in Figure 2, it is partly due to the narrow bandwidth used and fewer students included in the analysis.

In addition, students are assumed not to be able to manipulate their assignment variable in a regression discontinuity method (McCrary, 2008). If students were especially determined and motivated to receive the scholarship, they may have worked very hard to meet the criteria and consequentially received them. If so, students who barely met the eligibility requirements would not be comparable to those who failed to meet them by a slight margin. Simply comparing these two students could overestimate the effects of the scholarships. In order to check potential manipulation, I ran a McCrary test on both assignment variables (ACT scores and high school grades) (McCrary, 2008).

Figure 3. McCrary Test Results on ACT Scores (among Students Who Failed to Meet the GPA Cut-Off)



Figure 4. McCrary Test Results on High School GPA (among Students Who Failed to Meet the ACT Cut-Off Scores)



Unfortunately, Figures 3 and 4 show that the number of students increases right after the cut-off scores, and the jump across the cut-off score is statistically significant in both cases. These results suggest possible student manipulation. Although passing the McCrary test is "neither necessary nor sufficient" (McCrary, 2008, p. 701) for causal interpretation, I cannot entirely rule out the possibility that my estimates could be confounded by pre-existing differences between scholarship recipients and non-recipients. The issue of student manipulation is difficult to avoid when the assignment criteria are known to the public, and the treatment is beneficial for recipients, such as merit-based aid (McCrary, 2008). The TELS bill was passed only a few months before students in this study started their college education in January 2004, but it was still possible for some students to take the ACT exam many times until they passed the cut-off score. The regression discontinuity estimates in this study would largely reduce selection bias, but not entirely get rid of it.

In this study, I ran the fuzzy regression discontinuity model using the *xtivreg* command in STATA software. When receiving treatment is not entirely determined by assignment variables, a fuzzy discontinuity model is used (Imbens & Lemieux, 2008). For example, 6% of students in my sample met all requirements, but they did not receive the scholarships. One possibility for this type of noncompliance is due to the fact that some students receive grants from other sources (e.g., the federal government or institutions) that exceed their cost of attendance. If this happened, their state grants could be reduced even to zero. In contrast, 0.1% of students in the sample received TELS although they failed to meet both requirements. As the number is very small, I speculate that this kind of non-compliance would be largely due to data coding error.

The fuzzy model assumes that the academic criteria (ACT score and high school grades) predict whether students received either HOPE base or ASPIRE scholarships, but do not perfectly determine it. The fuzzy model can be estimated using a 2-stage least squares model that is mathematically equivalent to an instrumental variable model (Imbens & Lemieux, 2008). In the first stage, as specified in equation (1), I predict D_i , which is the probability of receiving one of the scholarships. The probability is predicted by whether students met one of the academic criteria (*Above*_i). I include a set of covariates (X_i) including a student's demographic, parental educational level, Pell Grant eligibility, and academic achievement (Adelman, 2006). The model also takes into account students' higher education institutions because graduation rates can be varied across different institutions. Although adding covariates does not change point estimates, it improves precision of the estimates (Imbens & Lemieux, 2008).

Equation (2) represents the second-stage model. In the second stage, I use the predicted probabilities of being awarded one of the scholarships (\hat{D}_i) and estimate if receiving the scholarships has any effect on graduation (Y_i) . If it has a positive influence on graduation, a_1 will be positive and statistically significant. If it does not have an impact, a_1 will not be statistically different from zero. Again, I include my running variables and a set of covariates (X_i) .

$$D_i = B_o + B_1(Above_i) + X_i\delta + \varepsilon_i$$
⁽¹⁾

$$Y_{i} = a_{o} + a_{1}(D_{i}) + X_{i}\gamma + u_{i}$$
⁽²⁾

Because TELS eligibility is determined by two assignment variables, I use the fuzzy frontier regression discontinuity model suggested by Reardon and Robinson (2012). I use only two subsets of data. In the first set of data, I limit my sample to those who failed to meet the GPA requirement. In this sample, aid eligibility is solely determined by whether students met the ACT requirement. Estimates from this analysis show the effect of receiving TELS over not receiving TELS among those who failed to meet the ACT requirement, and their aid eligibility is solely determined by whether the ACT requirement, and their aid eligibility is solely determined by whether the GPA requirement. Estimates from this analysis show the failed to meet the GPA requirement. Estimates from this analysis show the effect of receiving TELS over not receiving TELS among those who failed to meet the GPA requirement. Estimates from this analysis show the effect of receiving TELS over not receiving TELS among those who failed to meet the GPA requirement. Estimates from this analysis show the effect of receiving TELS over not receiving TELS among those who failed to meet the GPA requirement. Estimates from this analysis show the effect of receiving TELS over not receiving TELS among those who failed to meet the ACT requirement.

Population of my interest is limited to those who received the TELS award by slightly meeting only one of the academic criteria. In other words, results from this research cannot be applied to students who received the TELS award by meeting both academic criteria. I use the fuzzy frontier model not only because it is relatively straightforward, but also because the aid effect can be heterogeneous based on which requirement students meet (Reardon & Robinson, 2012). Bettinger et al. (2016) also estimate the effect of receiving a Cal Grant separately for students who only met the GPA criterion and for students who only met the income criterion. They find that the effect of receiving a Cal Grant different between these two subpopulations.

Regression discontinuity estimates can be sensitive to the bandwidth selection. A narrow bandwidth minimizes bias by limiting a sample to students who are very comparable one another, while a wide bandwidth makes estimates more precise by increasing a sample size. Following Jacob, Zhu, Somers, and Bloom (2012), I use the cross-validation procedure to find an optimal bandwidth. In addition, I also run the model using 50% and 200% of the optimal bandwidths in order to see if my estimates significantly change depending on bandwidths.

This study has several limitations. Most importantly, estimates from this study should not be interpreted as causal because scholarship recipients are not comparable to non-recipients, as seen in the McCrary test results. To the degree that they are different in ways that cannot be observed in this study, the regression discontinuity model significantly reduces, but does not entirely address selection bias. Second, this study's results may not be applied to those at the very bottom or top of the ACT score (or high school GPA) distribution. Because the regression discontinuity model only includes a narrow range of students who barely met or slightly missed the academic eligibility criteria, results from this study may not be applied to highest- or lowest-performing students. In addition, the key independent variable has measurement errors, as discussed above. Although it is fairly accurate for most students, some students who are identified as non-recipients lost their scholarship after their first year. I treat them as scholarship recipients because they cannot lose a scholarship unless they received it in the first place. If there were measurement errors in the identification of scholarship recipients, estimates of this study would be biased downward.

Fourth, when an outcome variable is binary, as in this study, using a 2-stage least squares model can be problematic (Chesher & Rosen, 2013). Because 2-stage least squares models are designed for continuous outcome variables, fitted values for an outcome variable from 2-stage least squares models sometime lie outside the unit interval (which

ranges from 0 to 1). Lastly, data in this study only include students enrolled in one of the public institutions within the state. That is, if students who received the aid transferred to a private or an out-of-state institution and graduated there, they are coded as dropping out (and not graduating) in the data. If this were the case, my estimates may have been biased downward.

Results

I first compared the average graduation rates between recipients and non-recipients within a set of bandwidths (results available upon request). In this case, graduation rates of recipients are always higher than that of non-recipients. However, once I include all covariates in the full discontinuity models as in Table 3, most estimates become statistically not significant, except in the 200% bandwidth which is significant at the 10% level. That is, receiving the TELS award does not significantly affect the probability of graduating within six years. These results suggest that the higher graduation rates of TELS recipients are largely attributable to observable differences between recipients and non-recipients. Of covariates, female students, those not eligible for Pell Grants (an indicator of middle-income students), students with a college-educated parent, and those with higher high school grades are more likely to graduate.

Bandwidth	Optimal	50%	200%
	(2 ACT)	(1 ACT)	(4 ACT)
Received TELS	0.039	0.043	0.045+
	(0.028)	(0.036)	(0.024)
Female	0.034	0.045+	0.053 ^{**}
	(0.019)	(0.023)	(0.016)
Racial Minority	-0.005	-0.014	-0.023
	(0.024)	(0.028)	(0.020)
Pell Grants Eligible	-0.081 ^{***}	-0.080 ^{**}	-0.077 ^{***}
	(0.021)	(0.025)	(0.017)
Parental Education	0.061^{**}	0.039	0.050 ^{**}
	(0.020)	(0.024)	(0.017)
High School GPA	0.615+	0.853 [*]	0.760 ^{**}
	(0.335)	(0.419)	(0.236)
Squared High School GPA	-0.090	-0.140	-0.117 ^{**}
	(0.065)	(0.081)	(0.045)
Sample Size	2,199	1,498	3,132

Table 3. Regression Discontinuity Estimates (ACT Scores, Graduation)

Note. p-value: +: < .10. *: < .05. **: < .01. **: < .001; institutional dummies were included in all models.

In Table 4, I look at graduation at the fourth, fifth, and sixth years after initial enrollment. Because the scholarships can be renewed up to five years, it may have incentivized students to earn their degree within five years. According to Table 4, scholarship recipients were significantly more likely to graduate than non-recipients were, only in their fourth year. However, receiving the scholarships does not significantly predict graduation in the fifth or sixth year.

Bandwidth	Optimal	50%	200%
Fourth-year graduation	0.040^{*}	0.051 ^{**}	0.043 ^{**}
	(0.016)	(0.019)	(0.014)
Fifth-year graduation	-0.018	-0.019	-0.011
	(0.022)	(0.029)	(0.019)
Sixth-year graduation	0.017	0.011	0.013
	(0.016)	(0.020)	(0.013)

Table 4. Regression Discontinuity Estimates (ACT Scores, Graduation in a Given Year)

Note. p-value: +: < .10. *: < .05. **: < .01. ***: < .001.

Tables 5 and 6 present discontinuity estimates when an assignment variable is high school GPAs. Consistent with the previous results, receiving TELS does not have an impact on degree attainment anytime within six years. According to Table 5, the estimates on the TELS variable are all positive, but they are not significant at the 5% level. In Table 6, I examine the effect of the scholarships on graduation in the fourth year, fifth year, and sixth years separately, but none of the estimates are statistically significant.

It is noteworthy that the results are varied by the assignment variables used. The scholarship has a positive effect on the fourth-year graduation when the ACT score is an assignment variable, but it does not have effects when the GPA is an assignment variable. This is partially because the optimal bandwidth is narrower for the second model (with a GPA as an assignment variable). Due to the narrow bandwidth, the sample used in the second model is smaller, which increases standard errors. In addition, as described in Figures 1 and 2, students on either side of the cut-off scores are more comparable when the assignment variable is GPA. That is, the significant difference in the fourth year graduation observed in Table 4 may be due to the difference between recipients and non-recipients when the assignment variable is the ACT score.

Bandwidth	Optimal	50%	200%
	(0.07 GPA)	(0.03 GPA)	(0.14 GPA)
Received TELS	0.086	0.191	0.058
	(0.129)	(0.285)	(0.082)
Female	0.062	0.019	0.086+
	(0.064)	(0.095)	(0.048)
Racial Minority	-0.159 [*]	-0.104	-0.155 ^{**}
	(0.081)	(0.117)	(0.059)
Pell Grants Eligible	-0.074	-0.205+	-0.074
	(0.066)	(0.108)	(0.050)
Parental Education	-0.019	0.027	0.001
	(0.062)	(0.093)	(0.046)
ACT Scores	0.316	-0.035	0.406
	(0.485)	(0.646)	(0.361)
ACT squared	-0.010	0.000	-0.012
	(0.015)	(0.020)	(0.011)
Sample Size	257	130	432

Table 5. Regression Discontinuity Estimates (High School GPA, Graduation)

Note. p-value: +: < .10. *: < .05. **: < .01. ***: < .001; institutional dummies were included in all models.

Bandwidth	Optimal	50%	200%
Fourth-year Graduation	0.004	0.089	-0.025
	(0.069)	(0.154)	(0.046)
Fifth-year Graduation	-0.050	-0.147	-0.019
	(0.101)	(0.234)	(0.064)
Sixth-year Graduation	0.131	0.249	0.101+
	(0.086)	(0.217)	(0.053)

Table 6. Regression Discontinuity Estimates (High School GPA, Graduation in a Given Year)

Note. p-value: +: < .10. *: < .05. **: < .01. ***: < .001.

In order to check this possibility, I increased the bandwidth of GPAs (0.2 point as a new optimal bandwidth instead of 0.07 point) and ran the fuzzy models again (results available upon request). Results are largely consistent except that receiving TELS has a significant and positive effect in the 200% bandwidth (0.4 GPA point) only. Although this result may suggest a positive effect of TELS, it would be more plausible to attribute the significant result to a substantial difference between recipients (e.g., students with a 3.4 GPA) and non-recipients (e.g., students with a 2.6 GPA) in this large bandwidth. Another possible explanation for the different results depending on the assignment variable used is due to the heterogeneous subpopulations from the fuzzy frontier model (Reardon & Robinson 2012). It may be possible that students with a high school GPA below 3.0 were more responsive to the TELS award as these students were less likely to get other types of financial aid (e.g., institutional aid) than students with a 3.0 GPA or above.

Discussion and conclusion

This study examined the effect of receiving TELS on degree attainment. Based on the results from the study, I draw several conclusions as following. First, receiving TELS has a positive effect on degree attainment in the fourth year, but not in the fifth or sixth year. There are two possible explanations for this result, although these two explanations are somewhat contrary to each other. One way to explain it is that receiving the scholarships has a positive net impact on degree attainment, but many students fail to renew their scholarship eligibility. Hence, students do not fully benefit from the aid. Consistent with human capital theory, TELS reduces the direct costs of college education and mitigates the financial burden of students. This may give students more time and energy to engage in academic and social activities on campus, which then leads to persistence and degree attainment. It is also possible that the renewal requirement, of TELS maintaining a 3.0 college GPA, gives recipients an incentive to work hard in class. That is, merit-based aid, including TELS, can have both financial and academic incentives that encourage students to persist until graduation (Scott-Clayton, 2011).

The effect of TELS could be underestimated in this study for the following reasons. Approximately 52% of scholarship recipients lost their scholarships in their second year because they failed to meet the renewal requirement (THEC, 2011). Supposing that receiving the scholarships has a positive impact on degree attainment, if all scholarship recipients in the study had renewed their scholarship eligibility, then they might have graduated at higher rates (Henry et al., 2004). In addition, as I use the frontier regression discontinuity model, this study does not include students who met both academic criteria and received TELS. If I included these students in my analysis as well, estimates could have been larger than the current estimates as graduation rates for this group are higher than graduation rates for TELS recipients who met only one criterion (THEC, 2011).

Another way to explain this result is that there might be confounding variables that influence both receiving the scholarships and graduation. Although this study demonstrates a positive effect of the scholarships on graduation, it is not yet conclusive if TELS is the sole factor. The McCrary test and balanced test results suggest that recipients are different from non-recipients. The difference between these two groups might have affected the graduation outcomes. For instance, recipients might be more motivated or academically well-prepared in the first place than non-recipients, and this may have contributed to their higher graduation probabilities in the fourth year. The regression discontinuity estimates in this study substantially reduce the difference between the two groups by limiting the sample to students near the cut-off scores and including several covariates, but the difference is not entirely removed.

For now, there is not much evidence to determine which explanation fits the results better. Instead, both explanations are not necessarily mutually exclusive. It may be the case that recipients were more motivated than non-recipients in the first place, and then providing recipients with the scholarships helped them graduate even faster compared to non-recipients.

Secondly, there are a lot more students who barely met the eligibility criteria than those who slightly missed them. In other words, some students might have worked hard to meet the criteria by taking the ACT exam many times or pushing for better grades. It comes as no surprise considering that students can control their ACT scores or high school grades to some extent because they already knew the cut-off scores, and receiving the scholarships is beneficial to them (McCrary, 2008). Although students in this study had only a few months before starting their college education, some students still appeared to work their way through meeting the criteria to receive the scholarships. As van der Klaauw (2008) mentions, there may be some other reasons that students need to meet the criteria. Students might have to earn a 3.0 high school GPA not only for receiving TELS but also for being eligible for other scholarships (e.g., other state or local scholarships). Regardless of the reason, it is still plausible that students who barely met the criteria are more persistent and motivated than students who failed to do so.

There are several strategies to handle potential manipulation. Acknowledging that students could take the SAT exam many times, Zhang, Hu, and Pu (2013) use scores from the first attempt of each student. In Cohodes and Goodman's (2013) study, the manipulation issue is addressed because the scholarship eligibility in Massachusetts is determined in relative terms compared to other students. Hence, it is impossible for students to predict a cut-off score and manipulate it beforehand. Due to the data availability, I leave the manipulation issue as a limitation of the study.

Lastly, considering possible student manipulation, TELS seems to give high school students an incentive to receive a higher grade or a test score so that they can secure their aid. This is consistent with the literature which reports that the mean test scores of high school students have significantly increased after a state implemented merit-based aid (Henry & Rubenstein, 2002; Pallais, 2009). The improved test scores are encouraging, especially if the test scores indicated improved student ability. However, it is also possible that students merely took advantage of the system by taking the test many times, and the increased test scores did not translate into better outcomes in college. In this case, the students' money, time, and effort devoted to increase their test scores would not be socially efficient.

In conclusion, there are some recommendations for future research. First, future research using regression discontinuity models needs to address the potential manipulation issue. Future research that adequately solves this issue will provide more accurate evidence about the relationship between merit aid and graduation. Another research topic to consider is the impact of merit-based aid on a student's college pathway to a degree. Recently, researchers have recognized that merit-based aid could affect which college students go to, and explored the way their college choices influence their graduation (Cohodes & Goodman, 2013; Castleman, 2013). In addition, future research can also examine whether receiving merit-based aid affects student enrollment intensity, transfer, and year-to-year persistence, all of which are related to their degree attainment.

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