2019

Analysis of Alternative Financial Aid Interventions

ERDC
Education Research & Data Center

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ABOUT THE ERDC

The research presented here uses data from the Education Research and Data Center, located in the Washington Office of Financial Management. ERDC works with partner agencies to conduct powerful analyses of learning that can help inform the decisionmaking of Washington legislators, parents, and education providers. ERDC's data system is a statewide longitudinal data system that includes de-identified data about people's preschool, educational and workforce experiences.

This study was completed as part of a larger program funded primarily by federal grant CFD #84.372A NCES 15-01 awarded by the Institute for Education Science in the US Department of Education to the state of Washington's Office of the Superintendent of Public Instruction and carried out by the Office of Financial Management's Education Research and Data Center. The total program cost is $7,300,000. Ninety-five percent point seven percent (95.7%) ($6,992,452) of the total cost of the program is financed with this Federal grant money, and 4.3% ($307,548) by the state of Washington.

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Executive Summary

This study is about student financial aid and college degree completion. It concerns a group of students who entered public postsecondary education in Washington State in the first year after their high school graduation. They all received need-based financial aid in the first year of attending college. The students were followed for six years. They differed in the amounts of financial aid they received relative to their financial need. This study is an attempt to quantify the impact on college completion that is associated with varying levels of financial aid. Study highlights include:

- Increasing student need-based financial aid is positively associated with increasing the probability of earning a college degree.
- The marginal impact of increasing a student's financial aid seems to be greater for a student who started at a community or technical college (CTC) compared to a student who started at a 4-year institution. The increase in the probability of earning a degree associated with another $500 per year in financial aid to a CTC student is greater than a like amount provided to a 4-year student.
    - Students starting at a 4-year institution are more likely to earn a degree than students beginning at a CTC.
    - Students starting at a 4-year institution have more of their need met by financial aid than students starting at a CTC.
    - Increasing financial aid by $500 per year has more of an impact to a CTC student than a 4-year student in regard to the amount of need being met by financial aid.
    - Increasing aid is associated with increasing the probability of earning a degree; more so for a CTC student than a 4-year student.

Introduction

Purpose

This study is an attempt to quantify the impact of need-based student financial aid, by type of aid, on college completion. Separate models are developed for gender and for where a student begins postsecondary education – a public four-year institution or a public community or technical college.

Study Cohorts

This analysis includes 2007-08 and 2008-09 Washington public high school graduates who subsequently entered Washington public postsecondary institutions and earned at least 15 college-level credits. The students attended only Washington public postsecondary institutions. Students who attended private or out-of-state institutions were not included.[1]

The students all entered postsecondary education in the first year after graduating from high school and received need-based financial aid in the first year. Thus every student in this study was considered "needy", at least in their first year of postsecondary education. Every student received some level of "treatment" with a key difference being the amount of aid or "treatment" that a student received.

Each student was followed for up to six years.

In an attempt to minimize the differences between the students, they are grouped into four relatively homogeneous cohorts by gender and the institutional sector in which they began postsecondary education:

- 4-Year Men: 3,696 men who first entered a public 4-year institution;
- 4-Year Women: 5,083 women who first entered a public 4-year institution;
- CTC Men: 3,504 men who first entered a public community or technical college; and
- CTC Women: 4,729 women who first entered a public community or technical college.[2]

Due to differences in average academic background, socioeconomic status, financial aid, work history and postsecondary outcomes, CTC students are analyzed separately from students who began at a 4-year institution. CTC students generally:

1 Information on student financial aid was not available for private or out-of-state students. Financial aid data on students attending Washington public postsecondary institutions were provided by the Washington Student Achievement Council.

2 Students who first entered a CTC and subsequently transferred to a 4-year institution are retained in the CTC cohorts.

- have lower high school GPAs,
- are less likely to have met the high school standardized math assessment standard,
- more likely to have been eligible for free or reduced price lunches while in high school,
- less likely to receive need-based financial aid (and students who do receive aid receive smaller amounts),
- less likely to borrow,
- more likely to work (and work longer hours) and
- less likely to persist and graduate.[3]

Women are separated from men in this analysis because female high school graduates are more likely than male high school graduates to pursue postsecondary education, are more likely to receive need-based financial aid, and are more likely to earn a degree.[4]

Need-based Financial Aid

$$\text{Financial Need} = \text{COA} - \text{EFC}$$

A student's financial need is equal to the cost of attendance (COA) at a postsecondary institution less the expected family contribution (EFC) towards the student's education. The COA comprises tuition and fees, books and supplies, room and board, transportation and personal expenses. Some, all or none of these expenses are expected to be paid by the family or student. The EFC, the amount expected to be paid by the family or student, is based on the family's and student's income and assets, family size and the number of family members attending college during the year. The EFC is calculated according to a formula established in federal law.[5] All students in this study had some amount of financial need, at least in their first year.

3 See "Persistence and Completion of Students Receiving Need-based Financial Aid," ERDC, 2017 and "Unmet Need among Financially Needy College Students in the State of Washington," ERDC, 2018.

4 Again, see "Persistence and Completion of Students Receiving Need-based Financial Aid," ERDC, 2017 and "Unmet Need among Financially Needy College Students in the State of Washington," ERDC, 2018.

5 Families are not required to provide the EFC. Families may contribute more or less than the amount determined by the formula. The formula is only used to determine the extent of eligibility for need-based aid.

Need-based Aid = Grants + Subsidized Loans + Work Study[6]

Table 1 presents a summary of financial aid programs for students who have and do not have financial need.

Table 1: Summary of Student Financial Aid

Need-Based Aid	Non-Need-Based Aid
Student has need, i.e., COA > EFC	Student may or may not have need
Grants: Includes grants, scholarships, tuition waivers; do not need to be repaid; are provided by governments, institutions or other entities	
Examples: Federal Pell Grant, State Need Grant, need-based institutional gift aid; Note: non-need-based grants provided to needy students are treated as need-based aid	Examples: merit aid, academic scholarships, athletic scholarships, non-need-based institutional gift aid
Loans: Need to be repaid; provided by the federal government, institutions and private financial institutions	
Subsidized loans are offered by the federal government only to needy students up to the amount of need; Note: unsubsidized loans to needy students are NOT treated as need-based aid	Unsubsidized loans do not require that a student have need and may be in excess of need; offered by the federal government, institutions and private entities
Work study: Provide part-time jobs to students, either on or off-campus, to help pay for college expenses	
Examples: Federal Work-Study Program, State Work-Study Program; Note: institutional employment to needy students is treated as need-based aid	Example: Institutional Employment

Need-based Aid as a percent of Need = (Need-based Aid / Financial Need) * 100

The variable of interest in predicting degree completion is need-based aid as a percent of need, a measure of the relative amount of need-based aid provided to a student. This compares the amount of need-based aid that a student receives over their postsecondary career to the student's total financial need. The amount of a student's financial need that is met by need-based financial aid cannot exceed 100 percent. Since all students in this study received some need-based aid in at least their first year the minimal amount of need-based aid as a percent of need is greater than zero.

Need-based aid as a percent of need provides an index of the affordability of college to an individual student. In essence it measures the price of college to the student taking into account the COA, the EFC and the amount of financial aid a student receives. Students who receive aid equal to their need will have an index of 100 percent and will find college the most affordable. Students who receive aid substantially less than their need will have an index approaching zero and for these students the price of college is relatively more expensive.

6 All financial aid data used in this study comes from the Unit Record Report as provided by the Washington Student Achievement Council (WSAC). Only financial aid that has gone through an institution's financial aid office and subsequently reported to the WSAC is used in this analysis. Information on private grants or loans not reported to an institution is not reported to WSAC.

Theory

The basic model contends that college completion is dependent on a number of factors including:

- The price of attending college including the net effect of student financial aid;
- Student characteristics including the student's abilities, determination and goals; and
- Institutional characteristics.[7]

Simple economic demand theory suggests that lowering the price of a good will increase its demand. More people will buy a product (college education) when its price (cost of attendance) is lower. The theoretical effect of financial aid on college persistence and completion is twofold: (a) it lowers the cost of attendance for financially needy students, and (b) it reduces the need for students to direct time away from academic activities to working in jobs. By lowering economic barriers for low-income students, financial aid should promote the year-to-year persistence and college graduation likelihood of these students.[8]

Selection Bias

Comparing degree completion between students who receive need-based financial aid to students who do not is problematic. Since we do not how students are selected into these two groups the comparison is likely to be biased. There are many reasons why students may or may not receive need-based financial aid – reasons that may be unobservable or for which there is no data. Omitting these factors from an analysis can lead to biased results by attributing to financial aid impacts that are in reality attributed to unobserved differences.

This study eliminates some of the selection bias issue by including only students who have received need-based financial aid. It also separates men from women and students who start at a public 4-year institution from those who start at a community or technical college. Additional control variables are also included to account for some of the differences in students and institutions.

The lack of a non-treated comparison group prevents making a statement about the causality of financial aid (does financial aid cause an increase in the probability of earning a college degree). However it is still possible to state that differing amounts of financial aid provided to needy students is associated with variation in college completion.

7 For a discussion of the theoretical underpinnings and conceptual framework for examining college outcomes see "Financial Aid and Student Dropout in Higher Education: A Heterogeneous Research Approach," Rong Chen in "Higher Education: Handbook of Theory and Research," J. C. Smart (ed.), pp. 209-239, Springer, New York, 2008 and "Understanding College Degree Completion of Students with Low Socioeconomic Status: The Influence of the Institutional Financial Context," Marvin A. Titus, Research in Higher Education, Vol. 47, No. 4, June 2006.

8 See "Who Benefits Most from Financial Aid? The Heterogeneous Effect of Need-Based Grants on Students' College Persistence," Sigal Alon, Social Science Quarterly, volume 92, Number 3, September 2011.

Disentangling Being Poor and Receiving Aid

An issue in researching the impact of financial aid on academic outcomes is the blending of (a) the effect of being eligible for need-based financial aid with (b) the influence of receiving need-based financial aid. Being eligible for need-based financial aid, or coming from a relatively poor background with fewer academic advantages, exerts a negative effect on college persistence and completion. The receipt of financial aid meanwhile should be positively related to college success. Thus, when modeling academic success care must be taken to separate the effects of eligibility for financial aid from the amount of financial aid received by the needy students.[9]

Students eligible for need-based financial aid are by definition relatively poor. As such they are less likely to enroll in and succeed in postsecondary education. It has been shown that at every level of academic ability, low-income students are less likely to finish college than their wealthier peers.[10] They disproportionately attended lower-quality high schools, have weaker academic skills, and are less likely to have parents who went to college.

This should not imply that the receipt of need-based aid lowers college enrollment and success. According to the theory the receipt of need-based financial aid should help students succeed in postsecondary education.

This study seeks to avoid this issue by only looking at students who are eligible for need-based financial aid. All the students in the study cohorts applied for and received need-based in at least their first year of postsecondary education. The study question revolves around the amount of aid received, not whether the student was eligible for aid.

Internal Influences

Another issue with studying the impact of financial aid on graduation is whether aid eligibility and the receipt of aid are independent of other factors that may also influence college completion. Confounding factors such as academic ability, race/ethnicity, the willingness to incur debt, or family, cultural and social values can affect both the amount aid a student receives and whether a student completes postsecondary education. The fact that the amount of need-based aid a student receives is also influenced by factors that also influence college completion makes it difficult to disentangle the true effects of aid on completion and makes it less likely to draw a causal inference.

This analysis does not make any concerted effort to avoid this problem. The focus is on financial aid while controlling for a number of other student and institutional differences. The models developed to explain college completion appear to be robust for

9 See "Model Mis-Specification in Assessing the Impact of Financial on Academic Outcomes," Sigal Alon, Research in Higher education, Vol. 46, No. 1, February 2005.

10 See "Spotlights: Postsecondary Attainment: Differences by Socioeconomic Status" in "The Condition of Education 2015 (NCES 2015-144)" U.S. Department of Education, National Center for Education Statistics, Washington, D.C.

the key predictor under investigation: need-based aid as a percent of need. Results from many configurations of the basic model using a variety of predictors converged on the results presented in Appendices 4 and 5. In all cases the financial aid variables positively influenced college completion and were statistically significant.

Degree Completion Models

Models are developed to predict the probability of a student graduating from a college or university based on the amount of need-based financial aid the student receives along with other factors found in existing literature to affect college completion. The goal is to be able make a statement about the change in probability of earning a college degree associated with a change in the amount of financial aid a student receives, holding all other factors constant.

For the men and women who began at a 4-year institution two outcomes are considered: earning a Bachelor's degree or not earning a Bachelor's degree. Using logistic regression, two completion models are developed for each. The first model predicts the probability of earning a Bachelor's degree using total need-based aid as a percent of need as an explanatory variable along with other individual and institutional predictors thought to influence college completion. The second model uses the components of need-based aid – grants, subsidized loans and work study – as separate predictors along with the other control variables.

For the men and women who begin at a CTC four possible outcomes are considered: earning a Bachelor's degree, earning an Associate degree, earning a long-term certificate, or not earning any of these awards. A multinomial logistic regression approach is taken in which the reference category is not earning an award.[11] Four completion models are developed for each cohort. For modeling purposes only the highest award earned by a student is considered. One set of models compare earning a Bachelor's degree to not earning any award. A second set of models compare earning an Associate degree to not earning any award. Due to the relatively low number of students whose highest award was a long-term certificate no modeling is presented regarding earning a long-term certificate. For each set of models two equations are developed: using total need-based aid as a percent of need as a predictor; and using the components of need-based aid as separate predictors. In each equation other factors thought to influence completion are included.

11 Multinomial logistic regression is used to predict the probabilities of different outcomes when there are more than two possible discrete outcomes. A multinomial logistic model can be estimated by running a set of binary logistic models. Each equation corresponds to a comparison between two of the potential outcomes.

Findings

Increasing student need-based financial is positively associated with increasing the probability of earning a college degree.

The impact of increasing a student's financial aid appears to be greater for a CTC student compared to a student who started at a 4-year institution. The marginal impact on college graduation associated with another $500 per year in financial aid to a CTC student is greater than a like amount provided to a 4-year student.

Need-based financial aid lowers the cost of attending college. Therefore it can be expected that needy students who receive relatively more aid compared to their need should have an increased likelihood of earning a degree. The results of this analysis do show that increasing student need-based financial aid is positively associated with increasing the probability of earning a college degree. Students who receive more financial aid as a share of need are more likely to receive a Bachelor's or Associate degree. This appears to be true for all the cohorts – men and women and students who begin postsecondary education at either a public 4-year institution or a CTC.

The impact of increasing a student's financial aid seems to be greater for a CTC student compared to a student who started at a 4-year institution. This is in line with past research.[12] While the cost-of-attendance at a CTC is less than at a 4-year institution, the students attending a CTC are on average poorer and receive less financial aid. CTC students on average have greater amounts of unmet need than 4-year students.[13] Also, the probability of a CTC student earning a Bachelor's or Associate degree is less than a 4-year student earning a Bachelor's degree. The marginal impact associated with another $500 per year in financial aid to a CTC student is greater than a like amount provided to a 4-year student. An increase of $500 per year in financial aid means more to a CTC student as it increases aid as a share of need by a greater amount. Increasing aid as a share of need by a greater amount also leads to an increased probability of earning a degree.

The results of the logistic regression analysis for completion are presented in Appendix 5, Tables A5.1 through A5.6. The equations from Appendix 5 are used to estimate the change in probability of graduation associated with a $500 annual change in the amount of need-based provided to a student.[14]

12 See "Unmet Need among Financially Needy College Students in the State of Washington," ERDC, 2018 and "Impact of Need-Based Financial Aid on College Completion," ERDC, 2019.

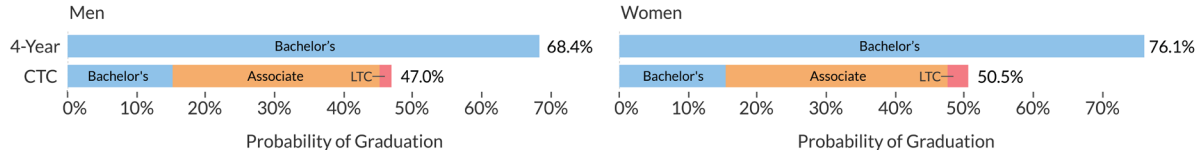
13 Unmet need is the gap between financial need (the COA less the EFC) and the amount of financial aid received. See "Unmet Need among Financially Needy College Students in the State of Washington, ERDC, 2018.

14 This is done by first (1) determining the impact of increasing aid by $500 on aid as a percent of need and then (2) calculating the change in the probability of degree completion related to the change in financial aid as a percent of need, centered on the average of need-based aid as a percent of need,

Students starting at a 4-year institution are more likely to earn a degree than students beginning at a CTC

Figure 1 (see also Table A1.1) shows the baseline probabilities of earning a Bachelor's or Associate degree. As found in earlier reports, women tend to graduate at higher rates than men and 4-year students tend to complete more than CTC students.[15] The probability of earning a Bachelor's degree by a woman high school graduate entering a public 4-year institution right after high school and receiving need-based in her first year is 76 percent. A man first entering a CTC has a 47 percent probability of earning a Bachelor's degree (15 percent), an Associate degree (30 percent) or a long-term certificate (2 percent). The point here is not to compare men to women or 4-year students to CTC students as their abilities, options and goals may be very different – but rather to present a starting point for evaluating the completion model results.

Figure 1. Probability of Degree Completion (See also Table A1.1)



Students starting at a 4-year institution have more of their need met by financial aid than students starting at a CTC

Students who began postsecondary education at a 4-year institution had a greater portion of their financial need met by financial aid than the students who began at a CTC. The 4-year students did have higher average annual levels of need than students who started at a CTC. As shown in Figure 2 (see also Table A1.2), average annual need for the 4-year students was about $16,000 and around $11,000 for the CTC students. The 4-year student also received higher levels of need-based aid - $11,000 per year compared to $6,000 for the CTC students. The resulting share of need met by aid as shown in Figure 3 (see also Table A1.2) was around 70 percent for the 4-year students and 55 percent for the CTC students.

holding all other variables constant. The relationship between the probability of earning a degree and the independent variables, such as financial aid, is not linear and varies at each level of probability and value of an independent variable.

15 See "Persistence and completion of Students Receiving Need-based Financial Aid," ERDC, 2017 or "Unmet Need among Financially Needy College Students in the state of Washington," ERDC, 2018.

Figure 2. Average Annual Need and Average Annual Need-based Aid (see also Table A1.2)

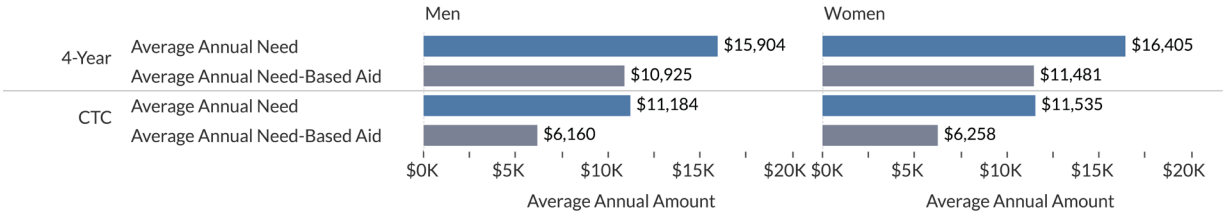
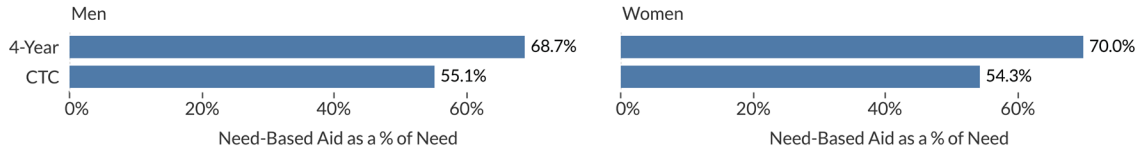


Figure 3. Need-based Aid as a Percent of Need (see also Table A1.2)



Grants are the predominate source of need-based financial aid

Need-based financial aid is comprised of three types of aid: grants, subsidized loans and work study. Figures 4 and 5 (see also Tables A1.3 and A1.4) present the participation in these programs. Figure 3 shows the average share of aid dollars for each type of aid making up the aid package. For the 4-year students nearly three-fourths of the aid dollars are in the form of grants and for the CTC students it is over 80 percent. Subsidized loans represent a quarter of the aid received by the 4-year students and about 15 percent for the CTC students. Work study provides 3 percent or less of the need-based financial aid dollars.

As shown in Figure 5 well over 90 percent of all students receiving need-based aid participate in grant programs. Eighty-five percent of the 4-year students take out subsidized loans while less than half that amount, 40 percent, of the CTC students do so. While work study makes up a very small share of aid dollars, participation in the program is more significant. One-quarter of the 4-year women participate in work study and at the low end, 13 percent of CTC men participate in work study.

Figure 4. Share of Aid Dollars by Program (see also Table A1.3)

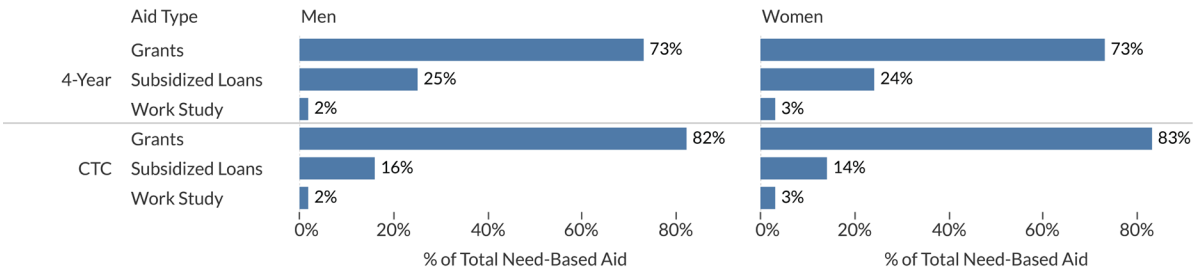
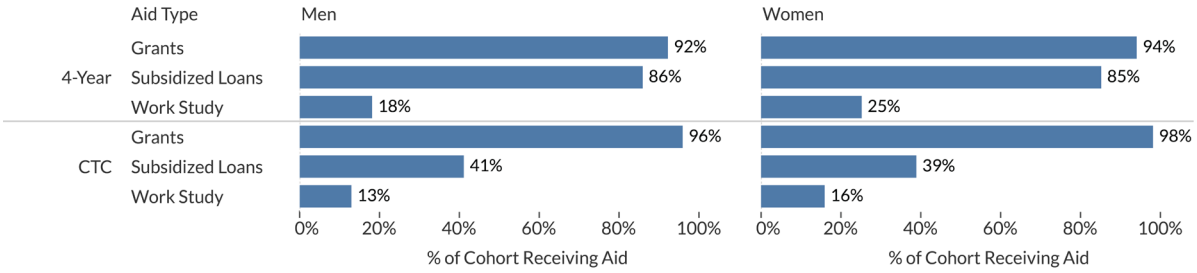


Figure 5. Student Participation in Aid Programs (see also Table A1.4)

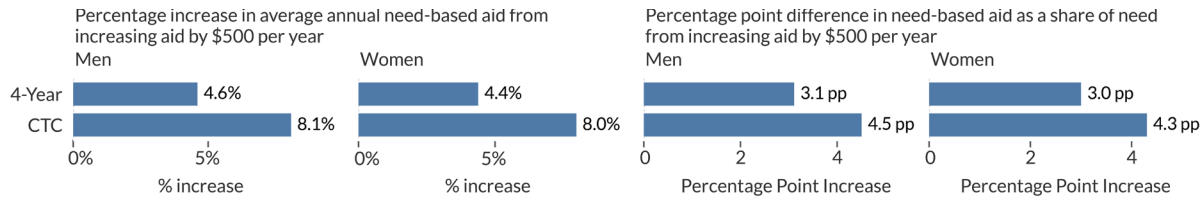


Increasing financial aid by $500 per year has a greater impact to CTC students than 4-year students on the amount of need being met by financial aid

Figure 6 (see also Table A1.5) shows the resulting impact at the average of increasing need-based financial aid by $500 per year on the amount of need that is met by financial aid. For example, for men beginning at a 4-year institution the amount of aid would increase by $500 from $10,900 to $11,400, an increase of 4.6 percent. The share of need being met by financial aid increases from 68.7 percent to 71.8 percent, an increase of 3.1 percentage points.

Five hundred dollars means more to CTC students than to students who began at 4-year institutions. CTC students on average receive lower amounts of financial aid (around $6,000 per year compared to $11,000). Increasing these lower amounts by $500 results in a greater percentage increase in aid, 8 percent, for the average CTC student than for the 4-year student. The resulting increase in the amount of need being met by aid is likewise greater for the CTC students (around 4.4 percentage points) than for the 4-year students (3 percentage points).

Figure 6. Adding $500 per Year to Financial Aid Means More to a CTC Student (see also Table A1.6)



Increasing aid is associated with increasing the probability of completion; more so for CTC students than 4-year students

From the equations found in Appendix 5 – Final Degree Completion Models it is possible to derive the change in probability of a student earning a degree associated with a change in the amount of financial aid provided to a student. The changes are not linear and the results shown in Figure 7 (see also Table A1.5) assume a $500 annual increase to the average aid

Figure 7. Increase in the Probability of Earning a Degree with a $500 per Year Increase in Financial Aid, at the Average (see also Table A1.7)

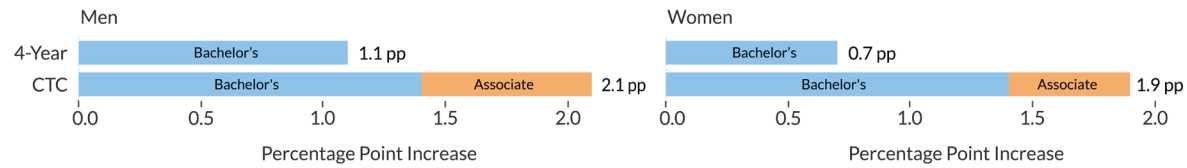
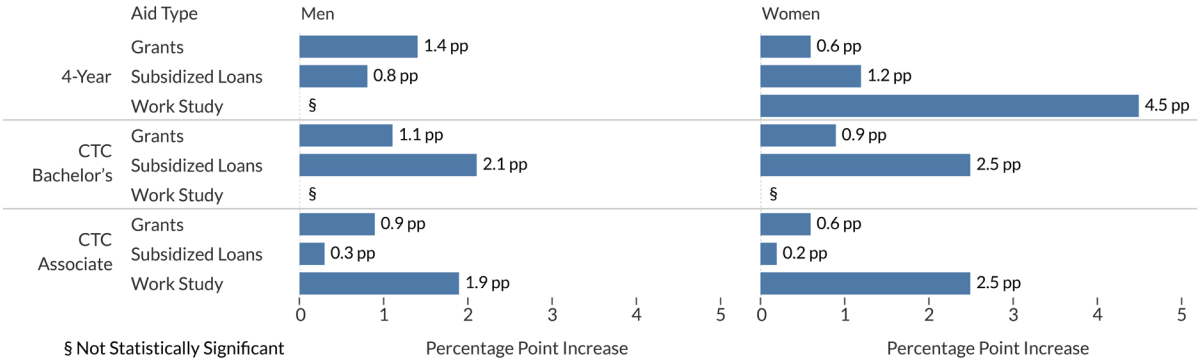


Figure 8: Change in the Probability of Earning a Degree Associated with Increasing Aid by $500 per Year by Type of Aid (see also Table A1.8)



recipient holding all other factors affecting completion constant. If the aid provided to a 4-year woman currently receiving $11,500 annually (from Figure 2) were to be increased by $500 per year (with all other factors held constant), the increased probability of earning a Bachelor's degree would increase by 0.7 percentage points, from 76.1 percent (from Figure 1) to 76.8 percent. For a woman who started at a CTC and currently receiving $6,300 in aid, an increase of $500 per year would boost the probability of earning a Bachelor's degree by 1.4 percentage points, from 15.4 percent to 17.2 percent and increase the probability of earning an Associate degree by 0.5 percentage points, from 32.2 percent to 32.7 percent.

The results shown in Figure 7 suggest that increasing financial aid to students who begins at a CTC has a greater impact on the probability of a student earning a Bachelor's or Associate degree than a similar increase to a student who begins at a 4-year institution.

Figure 8 (see also Table A1.6) looks at the change in probability of college completion associated with a $500 per year increase in financial aid by the type of aid. The same approach as described above was taken – a specific aid program was increased by $500 per year at the mean amount of that aid and all other factors, including other types of aid, were held constant.

For 4-year men, at the average, increasing grants by $500 per year is associated with a 1.4 percentage point increase in earning a Bachelor's degree while a similar increase in subsidized loans increases the probability of completion by 0.8 percentage points. For 4-year men work study was found not to have a statistically significant effect on college graduation.

Overall the results the mixed. Increasing grant aid has similar impacts as increasing overall aid (see Figure 7), but then grant aid makes up the vast majority financial aid (as shown in Figure 3) and nearly all needy students receive some aid in the form of grants (as shown in Figure 4).

Increasing subsidized loans to CTC students appears to have a greater impact on earning a Bachelor's degree than other types of aid. Subsidized loans are less effective than grants for CTC students earning an Associate degree. For the 4-year students subsidized loans appear less effective than grants for men and more effective for women.

Work study programs constitute the smallest piece of need-based financial aid and have the lowest number of participants. In some cases (4-year women and CTC students earning an Associate degree) it appears that work study is the most effective aid program while in other cases (4-year men and CTC students earning a Bachelor's degree) work study was found to be statistically insignificant. For 4-year women and CTC students earning an Associate degree adding $500 per year in work study increases the likelihood of earning a degree from 2 to 4.5 percentage points.

Appendices

Following are five appendices: (1) summary tables for figures, (2) variables used, (3) descriptive statistics, (4) comparative degree completion models, and (5) final degree completion models. In appendices 3-5 each section has four sets of tables: 4-year men, 4-year women, CTC men and CTC women.

Appendix Tables

	4-Year Men	4-Year Women	CTC Men	CTC Women
Appendix 1: Summary Tables for Figures				
Probability of Degree Completion	A1.1	A1.1	A1.1	A1.1
Average Need and Need-Based Aid	A1.2	A1.2	A1.2	A1.2
Source of aid by program (percent of total need-based aid)	A1.3	A1.3	A1.3	A1.3
Participation by program (percent of cohort receiving aid)	A1.4	A1.4	A1.4	A1.4
Impact at the mean of adding $500 per year in financial aid	A1.5	A1.5	A1.5	A1.5
Impact on completion of adding $500 per year in financial aid by type of aid	A1.6	A1.6	A1.6	A1.6
Appendix 3: Descriptive Statistics				
Descriptive Statistics	A3.1	A3.2	A3.3	A3.4
Appendix 4: Comparative Degree Completion Models				
Bachelor's Degree Completion	A4.1	A4.2	A4.3	A4.5
Associate Degree Completion			A4.4	A4.6
Appendix 5: Final Degree Completion Models				
Bachelor's Degree Completion	A5.1	A5.2	A5.3	A5.5
Associate Degree Completion			A5.4	A5.6

Appendix 1: Summary Tables for the Completion Models

The following tables support Figures 1 through 8. Table A1.1 presents the probability of degree completion by cohort. The only degree considered for students who began at a 4-year institution is whether or not they earned a Bachelor's degree. For CTC students the degrees considered are Bachelor's and Associate degrees or a Long-term Certificate.

Table A1.1: Probability of Degree Completion

	Men	Women
4-Year Students		
Bachelor's	68.4%	76.1%
CTC Students		
Bachelor's	15.2%	15.4%
Associate	29.9%	32.2%
Long-term Certificate	1.9%	2.9%
Total	47.0%	50.5%

Some 68 percent (men) to 76 percent (women) of the needy students who begin at a 4-year institution earn a Bachelor's degree within six years. At the CTCs about one-half of the needy students earn a degree or long-term certificate within six years.

Table A1.2 presents the baseline average annual financial need and average annual need-based aid for each of the cohorts. Need is the difference between the cost-of-attendance at a postsecondary institution and the expected family contribution towards those costs. Need-based aid is the amount of grants, subsidized loans and work study provided to the students with need.

Table A1.2: Average Need and Need-Based Aid

	Men	Women
4-Year Students		
Average Annual Need	$15,904	$16,405
Average Annual Need-Based Aid	$10,925	$11,481
Need-Based Aid as a Percent of Aid	68.7%	70.0%
CTC Students		
Average Annual Need	$11,184	$11,535
Average Annual Need-Based Aid	$6,160	$6,258
Need-Based Aid as a Percent of Aid	55.1%	54.3%

The 4-year students average about 70 percent of their need being met by financial aid while CTC students average in the mid-50 percent range of their need being met by financial aid.

Tables A1.3 and A1.4 are for informational purposes. They are not used in calculating the impact of increasing aid. Table A1.3 shows the share of financial aid dollars coming from each type of aid; Table A1.4 shows the share of students participating in an aid program.

Table A1.3: Source of aid by program (percent of total need-based aid)

	Men	Women
4-Year Students		
Grants	73%	73%
Subsidized Loans	25%	24%
Work Study	2%	3%
CTC Students		
Grants	82%	83%
Subsidized Loans	16%	14%
Work Study	2%	3%

Table A1.4: Participation by program (percent of cohort receiving aid)

	Men	Women
4-Year Students		
Grants	92%	94%
Subsidized Loans	86%	85%
Work Study	18%	25%
CTC Students		
Grants	96%	98%
Subsidized Loans	41%	39%
Work Study	13%	16%

Table A1.5 demonstrates the impact on the probability of earning a degree associated with adding $500 per year in financial aid to a student receiving need-based aid. The baseline average annual amount of aid being received by each group can be found in Table A1.2 which shows the average dollar amount of need-based aid received and the share of need being met by aid. Table A1.5 presents the impact of increasing need-based financial aid to the average student by $500 per year. Adding $500 at the mean to the aid amount received by a 4-year student increases their aid by 4.5 percent while for a CTC student it increases their aid by 8 percent.

Table A1.5: Impact at the mean of adding $500 per year in financial aid

	Men	Women
4-Year Women		
Percent Increase in Average Annual Need-based Aid	4.6%	4.4%
Change in Need-based Aid as a Percent of Need	3.1 pp	3.0 pp
Change in Probability of Earning a Bachelor's Degree	1.1 pp	0.7 pp
CTC Students		
Percent Increase in Average Annual Need-based Aid	8.1%	8.0%
Change in Need-based Aid as a Percent of Need	4.5 pp	4.3 pp
Change in Probability of Earning a Bachelor's Degree	1.4 pp	1.4 pp
Change in Probability of Earning an Associate Degree	0.7 pp	0.5 pp

Increasing aid amounts also increases the amount of aid received as a percent of need. For the average 4-year student $500 more per year increases need-based aid as a percent of need by 3.0 percentage points, from about 70 percent to 73 percent. For a CTC student an additional $500 per year increases the share of need being met by aid by about 4.4 percentage points. A financial aid increase of $500 per year has a larger impact on CTC students given that they start from a lower base – smaller average annual amounts of aid and a lesser amount of aid per their need.

Also shown is the change in probability of earning a degree from increasing financial aid by $500 per year. This is calculated using the completion models as presented in Appendix 5 – Final Degree Completion Models. The steps in calculating the change in probability of earning a degree by increasing financial aid by $500 per year were:

- Begin with the current probability of earning a degree (for 4-year women this 76.2 percent); convert this amount to odds (3.19); and then take the log of this amount, which is the "log-odds" (1.16).
- Next calculate the change in log-odds from increasing financial aid. Using the log-odds coefficients found in the models for the financial aid variables (for 4-year women, 0.024 for need-based aid as a percent of need and -0.012 for the interaction term of need-based aid times full-time status leaving a net coefficient of 0.014 using the average share of full-time students of 85 percent) multiply by the increased financial aid (3 percentage points). Add this amount (0.04) to the baseline log-odds amount.
- Take the exponential of the log-odds to arrive at a new odds (3.32). Convert the odds to probabilities (76.9%) and compare to the baseline probability (an increase of 0.7 percentage points).

The impact on college completion by increasing aid by $500 per year to the average student is greater for CTC students than for students beginning at a 4-year institution. For a 4-year woman a $500 increase average annual aid is 4.4 percent increase in aid and increases the amount of need met by aid by 3.0 percentage points and for the average student increases the probability of earning a Bachelor's degree by 0.7 percentage points. For a CTC woman an annual increase of $500 in aid is a 8.0 percent increase in aid resulting in a 4.3 percentage point increase in need being met by aid. A 4.3 percentage point increase in aid as a percent of need at the average increases the probability of earning a Bachelor's degree by 1.4 percentage points and increases the probability of earning an Associate degree by 0.5 percentage points (in combination lowering the probability of not earning any degree by 1.9 percentage points).

Table A1.6: Impact on completion of adding $500 per year in financial aid by type of aid

	Men	Women
4-Year Students		
Grants	1.4 pp	0.6 pp
Subsidized Loans	0.8 pp	1.2 pp
Work Study	†	4.5 pp
CTC Students – Bachelor's		
Grants	1.1 pp	0.9 pp
Subsidized Loans	2.1 pp	2.5 pp
Work Study	†	†
CTC Students – Associate		
Grants	0.9 pp	0.6 pp
Subsidized Loans	0.3 pp	0.2 pp
Work Study	1.9 pp	2.5 pp

† Not statistically significant

Doing the same type of analysis as was done in Table A1.5, Table A1.6 presents the change in probability of earning a degree by increasing aid, by type of aid, by $500 per year. Using the models found in Appendix 5 – Final Degree Completion Models that have separate independent variables for each type of aid, each model was simulated by increasing one of the aid variables by $500 while all the other variables were held constant.

Appendix 2: Variables for Completion Models

Dependent Variables (left side)

For the students who started at a 4-year institution, the dependent variable is whether the student earned a Bachelor's degree within six years or not (1/0) where

1 = earned a Bachelor's degree;

0 = did not earn a Bachelor's degree.

For students who started at a CTC, the dependent variables are (a) whether the student earned a Bachelor's degree within six years or no degree or certificate (1/4) and (b) whether the student earned an Associate degree within six years or no degree or certificate (2/4) where

1 = earned a Bachelor's degree

2 = highest degree earned was an Associate degree

3 = highest degree/certificate earned was a long-term certificate

4 = did not earn a degree or certificate.

Independent Financial Aid Variables of Interest (right side)

Need-based aid as a percent of need: Cumulative reported need-based aid divided by cumulative reported financial need (percent).

Grant aid as a percent of need: Cumulative reported grants received divided by cumulative reported financial need (percent).

Subsidized loans as a percent of need: Cumulative reported subsidized loans received divided by cumulative reported financial need (percent).

Work study as a percent of need: Cumulative reported work study wages received divided by cumulative reported financial need (percent).

Independent Control Variables (right side)

Full-time student: Student attempted an average of 36 or more college-level credits per year while attending postsecondary education.

High school GPA: Reported high school grade point average at graduation (times 10).

Expected Family Contribution: The reported expected family contribution in the student's first year of postsecondary education.

Ever Independent: Whether the student was ever independent for financial aid purposes while attending postsecondary education.

High school income: The average percentage of 10th grade students eligible for free or reduced price lunch during the 2005-06 to 2008-09 school years at the high school from

which the student graduated.

Instruction expenditures per FTE student (first institution): Expenditures on instruction per FTE student at the first postsecondary institution attended.

Technical institution (first institution): For the CTC cohorts, whether the first institution attended was a technical college.

King County (first institution): For the CTC cohorts, whether the first institution attended was located in King County.

Race/ethnicity: Whether the student was Asian, Hispanic/Latino of any race, African-American, or other non-white race (American Indian/Alaskan Native, Native Hawaiian/Other Pacific Islander, two or more races, and "race not provided") as opposed to White.

Interactions

An interaction term was added to the completion models: the financial aid variables and the full-time student control variable. Students attending full-time are eligible for more financial aid. They also have a higher COA and have more financial need for a given EFC. Students with more financial aid relative to need may be more likely to attend full-time. In some cases (4-year women and CTC women) the interactive term was statistically significant meaning there is a change in the effect on completion of a given amount of financial aid relative to need between full-time and part-time students. In other cases (4-year men and CTC men) the interaction term was statistically insignificant meaning that for men the effect on completion at a given amount of financial aid relative to need is not affected by whether he was going full-time or part-time.

Appendix 3: Descriptive Statistics

The following tables display descriptive statistics for the variables used in the degree completion models. There are four study cohorts of 2007-08 and 2008-09 Washington public high school graduates who subsequently entered Washington public postsecondary institutions and earned at least 15 college-level credits. The students attended only Washington public postsecondary institutions. The students all entered postsecondary education in the first year after graduating from high school and received need-based financial aid in the first year. The students are divided into four cohorts by gender and the institutional sector in which they began postsecondary education:

- **4-Year Men:** 3,696 men who first entered a public 4-year institution;
- **4-Year Women:** 5,083 women who first entered a public 4-year institution;
- **CTC Men:** 3,504 men who first entered a public community or technical college; and
- **CTC Women:** 4,729 women who first entered a public community or technical college.[16]

Table A3.1: Descriptive Statistics – 4-Year Men

Variable	Mean	Std. Dev.	Minimum	Maximum
Earned BA Degree	0.684	0.465	0	1.000
Average Annual Need ($000)	15.904	6.301	0.077	41.117
Average Annual Need-Based Aid ($000)	10.925	5.724	0.077	31.287
Average Annual Grants ($000)	7.86	5.668	0	31.287
Average Annual Subsidized Loans ($000)	2.873	1.733	0	7.941
Average Annual Work Study ($000)	0.192	0.567	0	5.759
Full-time Student	0.819	0.385	0	1.000
High School GPA (tenths)	33.593	4.056	16.000	40.000
Expected Family Contribution ($000)	5.627	5.565	0	53.985
Ever Independent	0.119	0.324	0	1.000
High School Income (%)	32.549	18.397	0	94.000
Average Instruction Expenditures ($000)	12.642	6.683	6.240	22.006
White	0.659	0.474	0	1.000
Asian	0.172	0.377	0	1.000
Hispanic/Latino	0.0914	0.288	0	1.000
African-American	0.0515	0.221	0	1.000
Other Non-White Races	0.0262	0.160	0	1.000

16 Students who first entered a CTC and subsequently transferred to a 4-year institution are retained in the CTC cohorts.

Table A3.2: Descriptive Statistics – 4-Year Women

Variable	Mean	Std. Dev.	Minimum	Maximum
Earned BA Degree	0.761	0.426	0	1.000
Average Annual Need ($000)	16.405	6.358	0.305	42.613
Average Annual Need-Based Aid ($000)	11.481	5.818	0.305	33.191
Average Annual Grants ($000)	8.327	5.749	0	32.091
Average Annual Subsidized Loans ($000)	2.828	1.759	0	8.779
Average Annual Work Study ($000)	0.326	0.767	0	7.773
Full-time Student	0.846	0.361	0	1.000
High School GPA (tenths)	34.681	3.721	16.500	40.000
Expected Family Contribution ($000)	5.385	5.431	0	30.720
Ever Independent	0.143	0.350	0	1.000
High School Income (%)	33.272	18.338	0	99.000
Average Instruction Expenditures ($000)	12.651	6.773	6.240	22.006
White	0.640	0.480	0	1.000
Asian	0.175	0.380	0	1.000
Hispanic/Latino	0.094	0.292	0	1.000
African-American	0.061	0.239	0	1.000
Other Non-White Races	0.029	0.168	0	1.000

Table A3.3: Descriptive Statistics – CTC Men

Variable	Mean	Std. Dev.	Minimum	Maximum
Earned BA Degree	0.152	0.359	0	1
Earned AA Degree	0.299	0.458	0	1
Earned Long-term Certificate	0.019	0.137	0	1
No Award	0.53	0.499	0	1
Average Annual Need ($000)	11.184	4.643	0.217	35.726
Average Annual Need-Based Aid ($000)	6.16	3.461	0.14	22.171
Average Annual Grants ($000)	5.125	3.007	0	18.75
Average Annual Subsidized Loans ($000)	0.891	1.292	0	5.944
Average Annual Work Study ($000)	0.144	0.528	0	6.802
Full-time Student	0.37	0.483	0	1
High School GPA (tenths)	27.36	5.733	0.8	40
Expected Family Contribution ($000)	1.836	2.666	0	28.699
Ever Independent	0.184	0.388	0	1
High School Income (%)	37.72	17.551	0	99
Average Instruction Expenditures ($000)	5.237	0.973	3.324	8.621
Technical Institution (first institution)	0.0592	0.236	0	1
King County (location first institution)	0.266	0.442	0	1
White	0.596	0.491	0	1
Asian	0.139	0.346	0	1

Table A3.3: Descriptive Statistics – CTC Men

Variable	Mean	Std. Dev.	Minimum	Maximum
Hispanic/Latino	0.148	0.355	0	1
African-American	0.076	0.265	0	1
Other Non-White Races	0.0412	0.199	0	1

Table A3.4: Descriptive Statistics – CTC Women

Variable	Mean	Std. Dev.	Minimum	Maximum
Earned BA Degree	0.154	0.361	0	1
Earned AA Degree	0.322	0.467	0	1
Earned Long-term Certificate	0.0287	0.167	0	1
No Award	0.496	0.5	0	1
Average Annual Need ($000)	11.535	4.52	0.111	34.979
Average Annual Need-Based Aid ($000)	6.258	3.42	0.07	23.981
Average Annual Grants ($000)	5.29	2.991	0	20.83
Average Annual Subsidized Loans ($000)	0.793	1.217	0	6.89
Average Annual Work Study ($000)	0.175	0.565	0	5.601
Full-time Student	0.303	0.46	0	1
High School GPA (tenths)	29.354	5.594	4.3	40
Expected Family Contribution ($000)	1.7	2.663	0	31.182
Ever Independent	0.28	0.449	0	1
High School Income (%)	38.99	18.003	0	94
Average Instruction Expenditures ($000)	5.253	0.983	3.324	8.621
Technical Institution (first institution)	0.0415	0.199	0	1
King County (location first institution)	0.226	0.418	0	1
White	0.627	0.484	0	1
Asian	0.102	0.303	0	1
Hispanic/Latino	0.159	0.366	0	1
African-American	0.0712	0.257	0	1
Other Non-White Races	0.0407	0.198	0	1

Appendix 4: Comparative Degree Completion Models

The following tables present the logistic regression results for estimating the probability of a student earning a Bachelor's or Associate degree. For students who began at a 4-year institution the dependent variable is whether the student earned a Bachelor's degree (or not). For students who began at a CTC the dependent variable is either (a) whether a student earned a Bachelor's degree or no award or (b) whether a student earned an Associate degree or no award.

For each cohort four comparative models of completion are presented: (1) using need-based aid as percent of need as the only predictor for completion; (2) using aid and whether the student attempted an average of 36 or more credits per year (full-time); (3) using aid, full-time status, and institutional characteristics as predictors; and (4) using aid, full-time status, institutional characteristics, and student characteristics as predictors. An interaction term is utilized by multiplying the aid as a percent of need variable times the full-time status of the student. This implies that the effect of financial aid depends to some extent on whether the student was attending full-time or less than full-time, and vice versa.

For each model the log odds coefficient is displayed along with its statistically significance test p-value. The log odds coefficient in itself is not intuitive, however, it is used in calculating the delta-p statistic (the change in probability of graduation associated with a one unit change in an independent variable centered on its mean, holding all other all other variables at their mean). The p-value indicates the statistical significance of a variable. A single * indicates a p-value of less than 0.05; two ** indicate a p-value of less than 0.01; and three *** indicate a p-value of less than 0.001. A p-value of less than 0.05 (5 percent) indicates that the chance of the variable being statistically insignificant is less than one in twenty. A p-value of less than 0.01 (1 percent) indicates that the chance of the variable being statistically insignificant is less than one in one hundred. A p-value of less than 0.001 (0.1 percent) indicates that the chance of the variable being statistically insignificant is less than one in one thousand.

Two measures of fit are presented for each regression result. One is the maximum-rescaled R-squared statistic which attempts to measure the predictive power of the model. Logistic regression has no equivalent statistic to the adjusted R-squared statistic used in ordinary least squares.[17] In logistic regression the "pseudo" R-squared statistics, of which the maximum-rescaled R-squared statistic is one, are valid and useful when evaluating multiple models predicting the same outcome on the same dataset. The four comparative models for each individual cohort may be directly compared with the higher maximum-rescaled R-squared value (on a scale of 0 to 1) indicating the model which better predicts

17 In ordinary least squares the adjusted R-squared statistic measures the proportion of the variation in the dependent variable that is explained by the independent variables. Models with higher values for adjusted R-squared explain a greater proportion of the variation in outcomes. A model with an adjusted R-squared of 0.75 explains 75 percent of the variation in outcomes; a model with an adjusted R-squared value of 0.50 explains 50 percent of the variation in outcomes.

the outcome. There is no general rule or fixed cut-off that distinguishes an acceptable model from one that is not acceptable.

The second is the Hosmer-Lemeshow goodness-of-fit statistic which deals with how well the overall model fits the data. This is a formal test of the null hypothesis that the fitted model is correct – with higher values (on a scale of 0 to 1) indicating a better fit. Generally a value below 0.05 indicates that the model is not acceptable.

Moving from the "aid only" model to the "full model" the coefficient associated with the dependent variable of interest, need-based aid as a percent of need, becomes smaller and the measure of fit statistics are improved. In all instances the need-based aid variable is statistically highly significant. The additional covariates brought into the model have explanatory value and help control for the unobserved differences among the students. The coefficient associated with need-based aid has become more precise.

Table A4.1: Bachelor's Degree vs. No Award – 4-Year Men

	Aid Only		Aid + Enrollment Status		Aid, Enrollment & Inst. Characteristics		Full Model	
	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value
Need-Based Aid (% of Need)	0.0236	***	0.0226	***	0.0216	***	0.0184	***
Full-Time (1/0)			2.6396	***	2.7356	***	2.35	***
Need-Based Aid * Full-Time			-0.0054		-0.00756		-0.00211	
High School GPA (tenths)							0.1443	***
Expected Family Contribution (Yr1) ($000)							0.0235	**
Ever Independent							-0.4482	***
High School Income (%)							-0.0195	***
Instruction Expenditures per FTE student ($000)					0.0633	***	0.023	**
Asian							0.1889	
Hispanic/Latino							0.3354	*
African-American							0.00932	
Other Non-White Races							-0.4225	
	N = 3,861		N = 3,861		N = 3,861		N = 3,678	
	Max-rescaled R-squared = 0.0577		Max-rescaled R-squared = 0.2586		Max-rescaled R-squared = 0.2884		Max-rescaled R-squared = 0.3698	
* p<.05, ** p<.01, ***p<.001	H&L Goodness-of-Fit Test = 0.0003		H&L Goodness-of-Fit Test = 0.0345		H&L Goodness-of-Fit Test = 0.6323		H&L Goodness-of-Fit Test = 0.5131	

Table A4.2: Bachelor's Degree vs. No Award – 4-Year Women

	Aid Only		Aid + Enrollment Status		Aid, Enrollment & Inst. Characteristics		Full Model	
	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value
Need-Based Aid (% of Need)	0.0274	***	0.0312	***	0.0291	***	0.0241	***
Full-Time (1/0)			3.6268	***	3.7094	***	3.2817	***
Need-Based Aid * Full-Time			-0.0169	***	-0.0177	***	-0.0124	**
High School GPA (tenths)							0.1801	***
Expected Family Contribution (Yr1) ($000)							0.0209	*
Ever Independent							-0.3582	**
High School Income (%)							-0.0182	***
Instruction Expenditures per FTE student ($000)					0.067	***	0.0366	***
Asian							-0.012	
Hispanic/Latino							0.2318	
African-American							-0.1411	
Other Non-White Races							-0.4076	
	N = 5,273		N = 5,273		N = 5,273		N = 5,046	
	Max-rescaled R-squared = 0.0664		Max-rescaled R-squared = 0.2918		Max-rescaled R-squared = 0.3201		Max-rescaled R-squared = 0.4076	
* p<.05, ** p<.01, ***p<.001	H&L Goodness-of-Fit Test = 0.0		H&L Goodness-of-Fit Test = 0.0226		H&L Goodness-of-Fit Test = 0.1351		H&L Goodness-of-Fit Test = 0.6784	

Table A4.3: Bachelor's Degree vs. No Award – CTC Men

	Aid Only		Aid + Enrollment Status		Aid, Enrollment & Inst. Characteristics		Full Model	
	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value
Need-Based Aid (% of Need)	0.0369	***	0.0299	***	0.031	***	0.0275	***
Full-Time (1/0)			3.4867	***	3.7141	***	3.0852	***
Need-Based Aid * Full-Time			-0.0123		-0.0141	*	-0.00815	
High School GPA (tenths)							0.1397	***
Expected Family Contribution (Yr1) ($000)							0.0592	*
Ever Independent							0.633	***
High School Income (%)							-0.0248	***
Instruction Expenditures per FTE student ($000)					0.037		0.00821	
Technical Institute					-2.7341	***	-2.493	***
King County					0.7047	***	0.6094	***
Asian							0.1041	
Hispanic/Latino							0.4537	
African-American							0.1231	
Other Non-White Races							-0.8097	
	N = 2,547		N = 2,547		N = 2,547		N = 2,374	
	Max-rescaled R-squared = 0.1253		Max-rescaled R-squared = 0.4218		Max-rescaled R-squared = 0.4632		Max-rescaled R-squared = 0.5422	
* p<.05, ** p<.01, ***p<.001	H&L Goodness-of-Fit Test = 0.0		H&L Goodness-of-Fit Test = 0.0167		H&L Goodness-of-Fit Test = 0.2457		H&L Goodness-of-Fit Test = 0.7947	

Table A4.4: Associate Degree vs. No Award – CTC Men

	Aid Only		Aid + Enrollment Status		Aid, Enrollment & Inst. Characteristics		Full Model	
	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value
Need-Based Aid (% of Need)	0.0188	***	0.0163	***	0.0163	***	0.0142	***
Full-Time (1/0)			1.6892	***	1.6836	***	1.474	***
Need-Based Aid * Full-Time			-0.0108	*	-0.0105	*	-0.00832	
High School GPA (tenths)							0.0792	***
Expected Family Contribution (Yr1) ($000)							0.0312	
Ever Independent							0.2658	*
High School Income (%)							-0.00896	***
Instruction Expenditures per FTE student ($000)					0.0453		0.0429	
Technical Institute					-0.091		0.0173	
Asian							0.0765	
Hispanic/Latino							0.3218	*
African-American							-0.4648	*
Other Non-White Races							-0.3567	
	N = 3,098		N = 3,098		N = 3,098		N = 2,872	
	Max-rescaled R-squared = 0.0418		Max-rescaled R-squared = 0.1083		Max-rescaled R-squared = 0.1090		Max-rescaled R-squared = 0.1709	
* p<.05, ** p<.01, ***p<.001	H&L Goodness-of-Fit Test = 0.0		H&L Goodness-of-Fit Test = 0.002		H&L Goodness-of-Fit Test = 0.001		H&L Goodness-of-Fit Test = 0.1300	

Table A4.5: Bachelor's Degree vs. No Award – CTC Women

	Aid Only		Aid + Enrollment Status		Aid, Enrollment & Inst. Characteristics		Full Model	
	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value
Need-Based Aid (% of Need)	0.0442	***	0.034	***	0.034	***	0.0336	***
Full-Time (1/0)			3.9285	***	4.224	***	4.2191	***
Need-Based Aid * Full-Time			-0.014	*	-0.017	**	-0.0198	**
High School GPA (tenths)							0.1525	***
Expected Family Contribution (Yr1) ($000)							0.0338	
Ever Independent							0.3568	*
High School Income (%)							-0.0143	***
Instruction Expenditures per FTE student ($000)					-0.0703		-0.1008	
Technical Institute					-3.6432	***	-3.5791	***
King County					0.3469	**	0.1047	
Asian							0.6143	**
Hispanic/Latino							0.6605	***
African-American							0.6851	**
Other Non-White Races							-0.4405	
	N = 3,255		N = 3,255		N = 3,039		N = 2,872	
	Max-rescaled R-squared = 0.1678		Max-rescaled R-squared = 0.5084		Max-rescaled R-squared = 0.5376		Max-rescaled R-squared = 0.5939	
* p<.05, ** p<.01, ***p<.001	H&L Goodness-of-Fit Test = 0.0		H&L Goodness-of-Fit Test = 0.0125		H&L Goodness-of-Fit Test = 0.0207		H&L Goodness-of-Fit Test = 0.1843	

Table A4.6: Associate Degree vs. No Award – CTC Women

	Aid Only		Aid + Enrollment Status		Aid, Enrollment & Inst. Characteristics		Full Model	
	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value	Log Odds Coefficient	p-value
Need-Based Aid (% of Need)	0.0201	***	0.0163	***	0.0161	***	0.0158	***
Full-Time (1/0)			1.621	***	1.7169	***	1.7041	***
Need-Based Aid * Full-Time			-0.0086		-0.00925	*	-0.0122	*
High School GPA (tenths)							0.12	***
Expected Family Contribution (Yr1) ($000)							0.0235	
Ever Independent							0.2483	**
High School Income (%)							-0.00853	***
Instruction Expenditures per FTE student ($000)					-0.0376		-0.0466	
Technical Institute					-0.6534	***	-0.502	*
Asian							0.1639	
Hispanic/Latino							0.3046	**
African-American							-0.1193	
Other Non-White Races							-0.0866	
	N = 4,098		N = 4,098		N = 3,798		N = 2,872	
	Max-rescaled R-squared = 0.0467		Max-rescaled R-squared = 0.1052		Max-rescaled R-squared = 0.1096		Max-rescaled R-squared = 0.2151	
* p<.05, ** p<.01, ***p<.001	H&L Goodness-of-Fit Test = 0.0		H&L Goodness-of-Fit Test = 0.0		H&L Goodness-of-Fit Test = 0.0059		H&L Goodness-of-Fit Test = 0.5317	

Appendix 5: Final Degree Completion Models

The following tables present the logistic regression results for estimating the probability of a student earning a Bachelor's or Associate degree. For students who began at a 4-year institution the dependent variable is whether the student earned a Bachelor's degree or not. For students who began at a CTC the dependent variable is either (a) whether a student earned a Bachelor's degree or no award or (b) whether a student earned an Associate degree or no award.

For each cohort two completion models are presented: (1) Equation 1 shows the results of the "full model" as developed in Appendix 4 with need-based aid as a percent of need being the independent variable of interest along with student and institutional characteristic covariates; and (2) Equation 2 which has the components of need-based aid, grants as a percent of need, subsidized loans as a percent of need, and work study as a percent of need, as separate independent variables of interest. Equation 2 also includes the student and institutional characteristic covariates.

As in Appendix 4 the log odds coefficient is displayed along with its statistical significance p-value. While the log odds coefficient is not intuitive it is used in calculating the change in probability of graduation associated with a one unit change in an independent variable, holding all other all other variables constant. Also displayed is the "standardized coefficient" or beta weight. This is a measure of how strongly each predictor variable influences the dependent variable. It allows for a comparison of the strength of the effect of each individual independent covariate to probability of a student earning a degree. In all cases the strongest influence on whether a student earns a degree is whether the student attends full-time (attempts an average of 36 or credits per year). The next most influential is the student's high school GPA. Need-based as aid as a percent of need ranks third in impact on college completion.

Again, two measures of fit are presented for each regression result. One is the max-rescaled R-squared statistic which measures the proportion of the variation in the dependent variable that is explained by the independent variables. The second is the Hosmer-Lemeshow goodness-of-fit statistic which deals with how well the overall model fits the data.

Table A5.1: Bachelor's Degree vs. No Award – 4-Year Men

	Equation 1				Equation 2			
Independent Variable	Log Odds Coefficient	Standardized Coefficient	p-value		Log Odds Coefficient	Standardized Coefficient	p-value	
Intercept	-6.729		<.0001	***	-6.696		<.0001	***
Need-Based Aid (% of Need)	0.018	0.193	0.0001	***				
Grants (% of Need)					0.021	0.294	<.0001	***
Subsidized Loans (% of Need)					0.012	0.134	0.0319	*
Work Study (% of Need)					0.069	0.118	0.0521	
Full-Time (1/0)	2.350	0.496	<.0001	***	2.306	0.486	<.0001	***
Need-Based Aid * Full-Time	-0.002	-0.036	0.7039					
Grants * Full-Time					-0.006	-0.094	0.3114	
Subsidized Loans * Full-Time					0.006	0.061	0.4005	
Work Study * Full-Time					-0.015	-0.025	0.6955	
High School GPA (tenths)	0.144	0.323	<.0001	***	0.143	0.319	<.0001	***
Expected Family Contribution (Yr1) ($000)	0.024	0.072	0.0050	**	0.025	0.078	0.0136	*
Ever Independent	-0.448	-0.080	0.0002	***	-0.458	-0.082	0.0002	***
High School Income (%)	-0.020	-0.193	<.0001	***	-0.020	-0.193	<.0001	***
Instruction Expenditures per FTE student ($000)	0.023	0.085	0.0037	**	0.026	0.094	0.0016	**
Asian	0.189	0.039	0.1596		0.186	0.039	0.1672	
Hispanic/Latino	0.335	0.052	0.0409	*	0.324	0.050	0.0485	*
African-American	0.009	0.001	0.9612		0.009	0.001	0.9622	
Other Non-White Races	-0.423	-0.037	0.0965		-0.424	-0.037	0.0943	
			N = 3,678				N = 3,678	
			Max-rescaled R-squared = 0.3698				Max-rescaled R-squared = 0.3731	
* p<.05, ** p<.01, ***p<.001			H&L Goodness-of-Fit Test = 0.5131				H&L Goodness-of-Fit Test = 0.7015	

Table A5.2: Bachelor's Degree vs. No Award – 4-Year Women

	Equation 1				Equation 2			
	Equation 1	Equation 2	p-value		Log Odds Coefficient	Standardized Coefficient	p-value	
Independent Variable	Log Odds Coefficient	Standardized Coefficient	p-value	Log	Standardized Coefficient	p-value	<.0001	***
Intercept	-8.370		<.0001	***	-8.470		<.0001	***
Need-Based Aid (% of Need)	0.024	0.244	<.0001	***				
Grants (% of Need)					0.023	0.316	<.0001	***
Subsidized Loans (% of Need)					0.022	0.235	<.0001	***
Work Study (% of Need)					0.087	0.207	0.0035	**
Full-Time (1/0)	3.282	0.649	<.0001	***	3.331	0.659	<.0001	***
Need-Based Aid * Full-Time	-0.012	-0.205	0.0197	*				
Grants * Full-Time					-0.015	-0.224	0.0089	**
Subsidized Loans * Full-Time					-0.011	-0.112	0.1062	
Work Study * Full-Time					-0.033	-0.076	0.3073	
High School GPA (tenths)	0.180	0.369	<.0001	***	0.181	0.372	<.0001	***
Expected Family Contribution (Yr1) ($000)	0.021	0.063	0.0112	*	0.022	0.065	0.0356	*
Ever Independent	-0.358	-0.069	0.0012	**	-0.371	-0.071	0.0009	***
High School Income (%)	-0.018	-0.181	<.0001	***	-0.018	-0.177	<.0001	***
Instruction Expenditures per FTE student ($000)	0.037	0.137	<.0001	***	0.041	0.152	<.0001	***
Asian	-0.012	-0.003	0.9275		-0.015	-0.003	0.9111	
Hispanic/Latino	0.232	0.037	0.1288		0.210	0.033	0.1700	
African-American	-0.141	-0.019	0.3962		-0.125	-0.017	0.4546	
Other Non-White Races	-0.408	-0.038	0.0633		-0.383	-0.036	0.0805	
			N = 5,046				N = 5,046	
			Max-rescaled R-squared = 0.4076				Max-rescaled R-squared = 0.4117	
* p<.05, ** p<.01, ***p<.001			H&L Goodness-of-Fit Test = 0.6784				H&L Goodness-of-Fit Test = 0.6772	

Table A5.3: Bachelor's Degree vs. No Award – CTC Men

	Equation 1				Equation 2			
	Equation 1	Equation 2	p-value		Log Odds Coefficient	Standardized Coefficient	p-value	
Independent Variable	Log Odds Coefficient	Standardized Coefficient	p-value	Log	Standardized Coefficient	p-value	<.0001	***
Intercept	-7.694		<.0001	***	-7.814		<.0001	***
Need-Based Aid (% of Need)	0.028	0.303	<.0001	***				
Grants (% of Need)					0.024	0.264	0.0001	***
Subsidized Loans (% of Need)					0.038	0.338	<.0001	***
Work Study (% of Need)					0.019	0.044	0.3865	
Full-Time (1/0)	3.085	0.799	<.0001	***	2.994	0.775	<.0001	***
Need-Based Aid * Full-Time	-0.008	-0.141	0.2794					
Grants * Full-Time					-0.009	-0.127	0.2788	
Subsidized Loans * Full-Time					0.006	0.035	0.5240	
Work Study * Full-Time					-0.018	-0.023	0.5594	
High School GPA (tenths)	0.140	0.449	<.0001	***	0.146	0.471	<.0001	***
Expected Family Contribution (Yr1) ($000)	0.059	0.086	0.0147	*	-0.008	-0.012	0.7728	
Ever Independent	0.633	0.133	0.0003	***	0.593	0.125	0.0007	***
High School Income (%)	-0.025	-0.240	<.0001	***	-0.024	-0.236	<.0001	***
Instruction Expenditures per FTE student ($000)	0.008	0.004	0.9075		0.025	0.014	0.7254	
Technical Institute	-2.493	-0.276	<.0001	***	-2.946	-0.326	<.0001	***
King County	0.609	0.149	0.0001	***	0.633	0.155	<.0001	***
Asian	0.104	0.020	0.5947		0.177	0.035	0.3718	
Hispanic/Latino	0.454	0.086	0.0516		0.551	0.104	0.0188	*
African-American	0.123	0.019	0.6421		0.115	0.018	0.6667	
Other Non-White Races	-0.810	-0.091	0.0504		-0.865	-0.098	0.0402	*
			N = 2,374				N = 2,374	
			Max-rescaled R-squared = 0.5422				Max-rescaled R-squared = 0.5528	
* p<.05, ** p<.01, ***p<.001			H&L Goodness-of-Fit Test = 0.7947				H&L Goodness-of-Fit Test = 0.8382	

Table A5.4: Associate Degree vs. No Award – CTC Men

	Equation 1				Equation 2			
	Equation 1	Equation 2	p-value		Log Odds Coefficient	Standardized Coefficient	p-value	
Independent Variable	Log Odds Coefficient	Standardized Coefficient	p-value	Log	Standardized Coefficient	p-value	<.0001	***
Intercept	-3.809		<.0001	***	-8.132		<.0001	***
Need-Based Aid (% of Need)	0.014	0.155	<.0001	***				
Grants (% of Need)					0.015	0.165	<.0001	***
Subsidized Loans (% of Need)					0.012	0.117	0.0004	***
Work Study (% of Need)					0.021	0.056	0.0397	*
Full-Time (1/0)	1.474	0.364	<.0001	***	1.519	0.376	<.0001	***
Need-Based Aid * Full-Time	-0.008	-0.134	0.0835					
Grants * Full-Time					-0.010	-0.131	0.0675	
Subsidized Loans * Full-Time					-0.006	-0.033	0.3619	
Work Study * Full-Time					-0.012	-0.019	0.5080	
High School GPA (tenths)	0.079	0.245	<.0001	***	1.970	0.260	<.0001	***
Expected Family Contribution (Yr1) ($000)	0.031	0.045	0.0527		0.034	0.049	0.0741	
Ever Independent	0.266	0.055	0.0175	*	0.273	0.057	0.0149	*
High School Income (%)	-0.009	-0.087	0.0006	***	-0.009	-0.088	0.0005	***
Instruction Expenditures per FTE student ($000)	0.043	0.023	0.3215		0.042	0.023	0.3282	
Technical Institute	0.017	0.002	0.9210		0.002	0.000	0.9929	
Asian	0.077	0.014	0.5453		0.075	0.014	0.5515	
Hispanic/Latino	0.322	0.064	0.0130	*	0.313	0.062	0.0160	*
African-American	-0.465	-0.068	0.0118	*	-0.478	-0.070	0.0097	**
Other Non-White Races	-0.357	-0.041	0.0978		-0.362	-0.042	0.0927	
			N = 2,872				N = 2,872	
			Max-rescaled R-squared = 0.1709				Max-rescaled R-squared = 0.1700	
* p<.05, ** p<.01, ***p<.001			H&L Goodness-of-Fit Test = 0.1300				H&L Goodness-of-Fit Test = 0.1176	

Table A5.5: Bachelor's Degree vs. No Award – CTC Women

	Equation 1				Equation 2			
Independent Variable	Log Odds Coefficient	Standardized Coefficient	p-value		Log Odds Coefficient	Standardized Coefficient	p-value	
Intercept	-8.236		<.0001	***	-8.362		<.0001	***
Need-Based Aid (% of Need)	0.034	0.366	<.0001	***				
Grants (% of Need)					0.027	0.286	<.0001	***
Subsidized Loans (% of Need)					0.046	0.373	<.0001	***
Work Study (% of Need)					0.034	0.087	0.0826	
Full-Time (1/0)	4.219	1.048	<.0001	***	3.951	0.982	<.0001	***
Need-Based Aid * Full-Time	-0.020	-0.331	0.0042	**				
Grants * Full-Time					-0.021	-0.282	0.0063	**
Subsidized Loans * Full-Time					0.013	0.063	0.2164	
Work Study * Full-Time					-0.022	-0.036	0.3725	
High School GPA (tenths)	0.153	0.472	<.0001	***	0.163	0.503	<.0001	***
Expected Family Contribution (Yr1) ($000)	0.034	0.049	0.1175		-0.053	-0.076	0.0450	*
Ever Independent	0.357	0.088	0.0137	*	0.340	0.084	0.0202	*
High School Income (%)	-0.014	-0.142	0.0002	***	-0.013	-0.132	0.0007	***
Instruction Expenditures per FTE student ($000)	-0.101	-0.055	0.1260		-0.083	-0.045	0.2171	
Technical Institute	-3.579	-0.359	<.0001	***	-4.288	-0.430	<.0001	***
King County	0.105	0.024	0.5022		0.141	0.033	0.3761	
Asian	0.614	0.102	0.0024	**	0.711	0.118	0.0005	***
Hispanic/Latino	0.661	0.132	0.0007	***	0.706	0.142	0.0004	***
African-American	0.685	0.104	0.0067	**	0.622	0.095	0.0162	*
Other Non-White Races	-0.441	-0.048	0.2230		-0.425	-0.046	0.2521	
			N = 3,039				N = 3,039	
			Max-rescaled R-squared = 0.5939				Max-rescaled R-squared = 0.6069	
* p<.05, ** p<.01, ***p<.001			H&L Goodness-of-Fit Test = 0.1843				H&L Goodness-of-Fit Test = 0.4081	

Table A5.6: Associate Degree vs. No Award – CTC Women

	Equation 1				Equation 2			
Independent Variable	Log Odds Coefficient	Standardized Coefficient	p-value		Log Odds Coefficient	Standardized Coefficient	p-value	
Intercept	-4.576		<.0001	***	-4.570		<.0001	***
Need-Based Aid (% of Need)	0.016	0.169	<.0001	***				
Grants (% of Need)					0.016	0.174	<.0001	***
Subsidized Loans (% of Need)					0.013	0.111	<.0001	***
Work Study (% of Need)					0.026	0.079	0.0015	**
Full-Time (1/0)	1.704	0.379	<.0001	***	1.765	0.393	<.0001	***
Need-Based Aid * Full-Time	-0.012	-0.178	0.0129	*				
Grants * Full-Time					-0.014	-0.181	0.0059	**
Subsidized Loans * Full-Time					-0.008	-0.034	0.2413	
Work Study * Full-Time					-0.009	-0.018	0.5530	
High School GPA (tenths)	0.120	0.371	<.0001	***	0.120	0.370	<.0001	***
Expected Family Contribution (Yr1) ($000)	0.024	0.034	0.0937		0.026	0.037	0.1149	
Ever Independent	0.248	0.062	0.0031	**	0.249	0.062	0.0031	**
High School Income (%)	-0.009	-0.084	0.0002	***	-0.009	-0.086	0.0001	***
Instruction Expenditures per FTE student ($000)	-0.047	-0.025	0.2244		-0.048	-0.026	0.2155	
Technical Institute	-0.502	-0.055	0.0107	*	-0.513	-0.056	0.0096	**
Asian	0.164	0.026	0.2014		0.173	0.027	0.1787	
Hispanic/Latino	0.305	0.062	0.0065	**	0.303	0.061	0.0068	**
African-American	-0.119	-0.017	0.4402		-0.113	-0.016	0.4674	
Other Non-White Races	-0.087	-0.010	0.6495		-0.085	-0.009	0.6554	
			N = 3,798				N = 3,798	
			Max-rescaled R-squared = 0.2151				Max-rescaled R-squared = 0.2165	
* p<.05, ** p<.01, ***p<.001			H&L Goodness-of-Fit Test = 0.5317				H&L Goodness-of-Fit Test = 0.8388	

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