The Heterogeneous Impacts of Financial Aid on Educational Outcomes: Utilization and Diversion of Pell Grants*

Benjamin M. Marx† and Lesley J. Turner‡

March 1, 2013

Abstract

Governments provide substantial subsidies to low-income college students through need-based grant aid with the aim of increasing educational attainment. In this paper, we take advantage of the nonlinearities in the Pell Grant Program's formula to identify the impact of need-based grant aid on college students' educational outcomes, focusing on several cohorts of City University of New York (CUNY) students. Overall, we find only weak evidence that Pell Grant aid increases attainment. However, we find robust evidence that Pell Grant aid reduces borrowing, with an extra dollar of Pell Grant aid inducing borrowers to reduce their federal student loans by more than a dollar. A simple model suggests these two findings are closely linked: grants crowd-out borrowing rather than increasing educational investment unless students are constrained by the kinks or discontinuities in the cost of borrowing that are introduced by exogenous borrowing limits, fixed costs, or interest rate schedules. We show that students who are more likely to face these constraints respond to Pell Grant aid by increasing semester-to-semester persistence, cumulative credits earned, and grade point average.

*__Preliminary and incomplete; please do not cite or distribute without authors' permission__. We are grateful to the Office of Policy Research at the City University of New York for providing the data used in this study. We also thank Colin Chellman, Simon McDonnell, and Andrew Wallace for sharing their invaluable knowledge of the CUNY administrative data with us, and Wojciech Kopczuk and ASSA annual meeting participants for helpful comments and suggestions. Correspondence should be sent to turner@econ.umd.edu.

†Department of Economics, Columbia University, 420 West 118th Street, New York, NY 10027.

‡Department of Economics, University of Maryland, 3115E Tydings Hall College Park, MD 20742.

1 Introduction

In the United States, federal and state governments provide substantial subsidies to low-income college students through need-based grant aid. During the 2010-2011 academic year alone, 9.5 million students received $35 billion dollars through the federal Pell Grant Program. Low- and middle-income students in New York received an additional $850 million through the state's Tuition Assistance Program (TAP). Need-based grant aid aims to increase the educational attainment of low income individuals but, there is little evidence that the federal Pell Grant Program, in its current form, increases the probability that low-income individuals enroll in college (Deming and Dynarski, 2010). Even so, need-based grant aid may still increase low-income individuals' educational attainment if it improves the educational outcomes of those already enrolled.

In this paper, we take advantage of the nonlinearities in the formula for the Pell Grant Program to identify the impact of need-based grant aid on college students' effort, attainment, and borrowing. We study City University of New York (CUNY) students who are eligible or nearly eligible for Pell Grant aid. Overall, we find little evidence that Pell Grant aid increases educational attainment. The largest effect of Pell Grant aid is a negative impact on student loans, with $1 of grant aid to loan recipients crowding out more than $1 of borrowing. For borrowing-constrained students, however, the Pell Grant has large impacts on effort, persistence and attainment.

A naive regression of outcomes on grant aid conflates the effect of aid with the effect of unobserved factors that are correlated with aid, such as motivation or family support. To overcome this concern, we use regression discontinuity (RD) and regression kink (RK) designs to identify the causal impact of need-based aid on educational attainment (Angrist and Lavy 1999; Hahn et al. 2001; Card et al. 2009; Turner 2012). While a student's Pell Grant aid depends on the federal government's measure of her need, the relationship is discontinuous and kinked at the Pell Grant eligibility threshold, causing students with similar characteristics to receive different amounts of aid.

Our paper contributes to the large literature on the effectiveness of student financial aid programs in promoting educational attainment. In general, increases in grant aid have the same impact as decreases in tuition on college attendance, as long as the application process is relatively simple and easy to understand (Deming and Dynarski, 2010). Existing estimates suggest that a $1000 decrease in tuition (or increase in financial aid) increases the probability of college attendance by approximately 4 percent. Studies suggest, however, that aid in the form of Pell Grants has no effect on the enrollment of most low-income students (e.g., Kane 1995). Bettinger et al. (forthcoming) provide evidence that the complexity of the federal student

aid application process substantially reduces the impact of Pell Grant eligibility on college-going.[1]

Our paper is most similar to Castleman and Long (2012), which examines the impact of Florida's need-based grant program on college enrollment and educational attainment, Bettinger (2004), which estimates the impact of Pell Grant aid on enrolled students' persistence, and Goldrick-Rab et al. (2012), which presents experiment evidence of the impact of additional grant aid on Pell Grant recipients' educational attainment. The first two studies find a positive impact of grant aid on persistence; Castleman and Long (2012) show that first year eligibility for grant aid increases degree completion as well. Unfortunately, these studies do not observe other sources of financial aid, making it difficult to test whether students decrease their borrowing, as we find in this paper, or colleges decrease institutional aid, as in Turner (2012), in response to increased grant aid. Conversely, Goldrick-Rab et al. (2012) find that scholarship recipients use the grants to reduce their loans and show little improvement in educational attainment.

Our paper helps to reconcile the conflicting findings on grant aid effectiveness. With a simple model of a student's joint borrowing and schooling decisions, we show how the effects of grant aid are likely to vary according to the student's financial circumstances. Consistent with a long literature on credit constraints in education (e.g., Becker 1975; Cameron and Taber 2004; Lochner and Monge-Naranjo 2011), a marginal increase in grant aid only increases constrained students' educational attainment. We extend the traditional credit constraints framework to allow for a fixed cost of borrowing (e.g., a discontinuity in the price of borrowing), showing that students at these thresholds behave much like those who fully exhaust their loan eligibility. Intuitively, if the cost and benefit of schooling are separable from the amount of borrowing, schooling will only respond to financial aid in order to smooth consumption when doing so by adjusting borrowing is impossible or prohibitively expensive. Consistent with the predictions of the model, we show that the weak overall effects of Pell Grant aid mask strongly positive impacts among students who are likely to be constrained by a borrowing cost threshold. Estimated impacts of programs like the Pell Grant are therefore likely to vary considerably with the degree to which different student populations are able to smoothly adjust their borrowing.

The remainder of our paper proceeds as follows: in Section 2, we describe the CUNY system and our data and sample. In Section 3, we discuss our empirical approach, present graphical evidence of the impact of Pell Grant aid on borrowing and attainment, and discuss regression results. In Section 4, we outline a simple conceptual framework allowing for discontinuous borrowing costs, which generates testable predictions for

[1] In general, previous research suggests that grant aid affects the behavior of students beyond the enrollment decision when it is paired with other requirements and/or supports. For instance, Angrist et al. (2009) study a program where students attending a nonselective Canadian public university were randomly assigned to earn aid based on maintaining a minimum GPA and course load. Male students were not affected, but the program had a small impact on the GPAs of female students that were also assigned to receive additional services, such as peer advising and study groups. Scott-Clayton (2011) finds that a conditional merit-aid program in West Virginia, where recipients were required to meet minimum GPA and credit requirements to receive aid, increased educational attainment and graduation rates.

heterogeneous impacts that are born out in the data. Section 5 discusses future work and concludes.

2 Need-Based Aid and CUNY Students

The City University of New York (CUNY) provides an excellent setting to investigate the impact of need-based grant aid on student outcomes. CUNY is the largest urban public university system in the country, comprising 24 two- and four-year institutions that serve roughly half a million students each year. A substantial portion of CUNY students receive federal grant aid. For instance, 81 percent of the 2009-2010 cohort of first-time freshmen students received a Pell Grant. Additionally, CUNY institutions have low tuition and operate in a state with generous financial aid.[2] Despite these resources, retention and graduation rates for CUNY students are low, as is the case with other urban public institutions. Among first-time freshmen who enrolled in fall 2006, only 15 percent of students pursuing an associate's degree graduated in four years and only 41 percent of students in a bachelor's degree program graduated within six years.

Federal and New York state financial aid are determined using centralized application systems. To receive federal aid, students must complete a Free Application for Federal Student Aid (FAFSA). FAFSA inputs include a detailed set of financial and demographic information, such as income, untaxed benefits, assets, family size and structure, and number of siblings in college. The federal government calculates a student's "Expected Family Contribution" (EFC) using a complicated, non-linear function of these inputs. Full-time, full-year students with EFC at or just below the eligibility threshold receive a Pell grant. For every $1 by which a student's EFC is below the eligibility threshold, the Pell Grant is increased by $1, up to the maximum Pell Grant award.[3] New York State residents must also complete a supplemental application for the TAP program, as TAP aid depends on New York State taxable income, which cannot be calculated from FAFSA inputs alone. TAP provides grants to students much higher in the income distribution than the Pell Grant Program - up to $80,000 in New York State taxable income for dependent students. The maximum TAP award is the lesser of $5000 and tuition and fees.

The terms of student loans depend on a student's course load, tenure, and need. A student's remaining need, equal to the total cost of attendance (tuition, fees, and a cost of living allowance) minus her EFC and grants, determines her eligibility for additional loan aid. Students with remaining need after all state, federal, and institutional grants are subtracted from her total need are eligible for subsidized federal loans. Specifically, students can borrow up to the lesser of remaining need or $3,500 in subsidized federal Direct

[2] Tuition at CUNY four-year schools was $4000 per year in 2008 and 2009 and $4600 per year in 2010. Two-year schools charged full-time students $2800 in tuition in 2008 and 2009 and $3150 in 2010. Over this period, four-year CUNY schools' fees ranged from $291 to $477 per year, while two-year schools' charged $268 to $355 per year in fees. At its most generous, the New York State Tuition Assistance Program (TAP) covers tuition at any CUNY school. In general, the maximum TAP award is the less of $5000 and tuition. Only New York State residents are eligible for TAP funding.

[3] The maximum Pell Grant award was $4310 in 2007-08, $4732 in 2008-09, and $5350 in 2009-10.

Loans in their first year. Dependent students can borrow an additional $2,000 in unsubsidized loans while independent students can borrow an additional $6,000 in their first year.[4] Students without remaining need can still borrow up to the overall maximum in unsubsidized loans ($5,500 for first-year dependent students and $9,500 for first-year independent students). By law, the interest rate for unsubsidized direct loans cannot exceed 8.25 percent. The cohorts of students we examine could borrow unsubsidized federal loans at an interest rate of 6.8 percent. Despite low tuition and generous state grant aid, most CUNY students remain eligible to borrow the maximum allowed subsidized federal loans.

The timing of the school and financial aid application processes lends credibility to the use of the Pell Grant formulas a quasi-experiment for estimating effects of grant aid. CUNY schools admit prospective students on a rolling basis, but students must submit an application by February 1st to be guaranteed consideration. Prospective students list up to six two- or four-year colleges within the system they would like to attend, in order of preference, as well as their attendance intensity (i.e., full-time or part-time). Because the FAFSA requires information on prior-year taxable income, prospective students generally wait to complete the application until after their family has filed their tax return (at best, early February).[5] Students are notified of their EFC by the Department of Education shortly after submitting a FAFSA but do not learn of their financial aid eligibility until after they have been admitted to a college. Upon admission, the college provides the student with a financial aid package which specifies grants (federal, state, and institutional) and eligibility for federal student loans (both subsidized and unsubsidized). During the months leading up to the fall semester, the student decides whether to accept the admissions offer and how much (if any) federal loan debt to incur. Grant and loan aid is first used to pay direct costs (tuition and fees), with the student receiving any remaining aid directly.

2.1 Data and sample

In order to take advantage of the nonlinearities in the Pell Grant Program's schedule, we need data that contains information on the underlying assignment variable (EFC), our outcomes of interest (e.g., credits received, graduation rates), and a sufficient number of observations to focus on the outcomes of students on either side of a kink or discontinuity in the funding formula. We use administrative data from the CUNY system that contains the universe of students in multiple cohort-semesters. This data provides extensive

[4]Second year students with unmet need can borrow up to $4,500 in subsidized loans, while students in their third or higher year who have unmet need can borrow up to $5,500. The overall borrowing limits dependent students face are $6,500 in their second year and $7,500 as upper years, while independent students can borrow up to $10,500 in their second year and $12,500 in their third year and beyond. Additionally, students are limited in the total amount of federal debt they can incur during their undergraduate education. Dependent students can borrow up to $31,000 overall ($23,000 subsidized) and independent students can borrow up to $57,500 ($23,000 subsidized). See studentaid.ed.gov/types/loans for additional details.

[5]Individuals are allowed to estimate their prior year taxable income if they wish to submit the FAFSA before their family's tax return is submitted, and update the FAFSA information at a later date, but few choose to do so.

information on sources and amounts of student aid, credits attempted and earned by semester between entry and 2012, choice of major, and degree receipt.

Our sample includes five cohorts of first-time, degree-seeking freshmen entering a CUNY institutions in the fall of the 2005-06, 2006-07, 2007-08, 2008-09, and 2009-10 academic years (hereafter 2006 through 2010 academic years). Unfortunately, we only observe students' FAFSA information, (most importantly EFC) in 2008, 2009, 2010. Thus, we potentially observe three years of financial aid outcomes for the 2008 cohort, two years for the 2007 and 2009 cohorts, and one year for the 2006 and 2010 cohorts. We differentiate students by entry cohort and level, where level corresponds to the first, second, or third year of college. We restrict our sample to only include US citizens or permanent residents and eliminate students with low need - those with an EFC more than $5,000 above the threshold for Pell Grant eligibility.[6]

Table 1 displays the characteristics of students in our sample by Pell Grant eligibility.[7] We also single out students that are eligible to receive the maximum Pell Grant award - those with an EFC of $0 - from the full set of Pell Grant eligible students.[8] We run a series of robustness tests that exclude students with a zero EFC to ensure that our results are not driven by these individuals. Although our estimates become less precise due to the sample size reduction, all of our results are robust to focusing on students within $4,000 of the Pell Grant eligibility threshold (which eliminates students with zero EFC).[9] Pell-Grant-eligible students receive more grant aid than ineligible students, while ineligible students receive more loan aid. On average, borrowing is low for both Pell-eligible and -ineligible students - only 5 percent of the sample takes on any debt in their first year, despite, on average, having substantial eligibility for subsidized loans and substantial need. Borrowing appears to be increasing as grant aid falls, with 23 percent of Pell ineligible students taking on some debt.

Finally, Pell Grant eligible students also have different demographic characteristics than ineligible students - they are more likely to be nonwhite, have lower SAT scores, and are less likely to have a college educated parent. These differences in observable characteristics between Pell Grant recipient students and ineligible students motivate our use of RD and RK designs to identify the causal impact of grant aid on student outcomes.

[6] Non-citizens that are not permanent residents are ineligible for most federal and state grant aid and make up less than 1 percent of students in these cohorts.

[7] A small number of students we classify as ineligible for Pell Grant aid receive Pell Grants. This is likely due to measurement error in our measure of EFC. For instance, financial aid officers can adjust EFC after FAFSA application if students' financial situations change (e.g., parents lose jobs, etc.). However, this measurement error does not appear to be systematically related to distance from the Pell Grant eligibility threshold.

[8] For the 2008 and 2009 academic years, dependent students and independent students with children would automatically receive a $0 EFC if their family income fell below $20,000 and their parents either received means tested benefits during the year or were eligible to file a simplified tax return (indicating low assets). In 2010, the income limit was raised to $30,000. See studentaid.ed.gov/types/loanshttp://www.ifap.ed.gov/eannouncements/attachments/0708EFCFormulaGuide.pdf and http://www.ifap.ed.gov/efcformulaguide/attachments/111408EFCFormulaGuide0910.pdf for further details.

[9] Available upon request.

3 Empirical Framework

We use the variation induced by the kink and discontinuity in the Pell Grant Program's formula to identify the impact of Pell Grant aid on educational attainment. The kink occurs where the slope of the statutory $Pell\,(EFC)$ schedule changes from 0 to -1, while the discontinuity is driven by the increase in Pell Grant aid from \$0 to the minimum Pell Grant award at the eligibility threshold (Turner, 2012). Since the eligibility threshold occurs at different EFC values in different years, we standardize our measure of EFC to represent distance from the year-specific threshold. Figure 1 displays the empirical distribution of Pell Grant aid for all students.[10]

Let $Y = \tau Pell + g\,(EFC) + U$ represent the causal relationship between educational attainment, Y, and Pell Grant aid, $Pell = Pell\,(EFC)$, where U is a random vector of unobservable, predetermined characteristics. The required identifying assumptions for the RK design are: (1) the direct marginal impact of EFC on Y is continuous (e.g., around the eligibility threshold, there are no discontinuities in the direct relationship between EFC and Y) and (2) the conditional density of EFC (with respect to U) is continuously differentiable at the threshold for Pell Grant eligibility (Card et al. (2009)). These assumptions encompass those required for identification using the RD design. As long as the relationship between unobservable factors and EFC evolves continuously across the Pell Grant eligibility threshold, the RK design approximates random assignment in the neighborhood of the kink. Additionally, as in the case of the RD design, the second assumption generates testable predictions concerning how the density of EFC and the distribution of observable characteristics should behave in the neighborhood of the eligibility threshold.

If these conditions hold, then both the RK estimator, τ_{RK}, and the RD estimator, τ_{RD}, will identify the causal impact of Pell Grant aid:

$$\tau_{RK} = \frac{\lim\limits_{\varepsilon \uparrow 0}\left[\frac{\partial EFC|EFC=efc_0+\varepsilon}{\partial efc}\right] - \lim\limits_{\varepsilon \downarrow 0}\left[\frac{\partial EFC|EFC=efc_0+\varepsilon}{\partial efc}\right]}{\lim\limits_{\varepsilon \uparrow 0}\left[\frac{\partial Pell|EFC=efc_0+\varepsilon}{\partial efc}\right] - \lim\limits_{\varepsilon \downarrow 0}\left[\frac{\partial Pell|EFC=efc_0+\varepsilon}{\partial efc}\right]} = \tau \tag{1}$$

$$\tau_{RD} = \frac{\lim\limits_{\varepsilon \uparrow 0}\left[EFC|EFC = efc_0 + \varepsilon\right] - \lim\limits_{\varepsilon \downarrow 0}\left[EFC|EFC = efc_0 + \varepsilon\right]}{\lim\limits_{\varepsilon \uparrow 0}\left[Pell|EFC = efc_0 + \varepsilon\right] - \lim\limits_{\varepsilon \downarrow 0}\left[Pell|EFC = efc_0 + \varepsilon\right]} = \tau \tag{2}$$

Where efc_0 represents the Pell Grant eligibility threshold. Since not all students complete a full year of college, EFC will imperfectly predict students' Pell Grant aid. Therefore, in practice, our estimation

[10] Figures in Appendix A disaggregate Pell Grant aid and other outcomes by level of attendance.

strategy involves fuzzy RD/RK. Specifically, we use an instrumental variables approach to estimate τ_{RK} and τ_{RD}. Since the eligibility threshold changes as the size of the maximum Pell award increases, we first create a standardized measure of the distance a student's EFC falls from the Pell Grant eligibility threshold: $\tilde{EFC}_{it} = EFC_{it} - efc_{0t}$.

Consider the following first stage and reduced form equations, where i indicates students, c indicates cohorts, l indicates level of attendance (first year, second year, etc.), and s indicates colleges, $f(\cdot)$ and $g(\cdot)$ are flexible functions of $\tilde{EFC}$ that we allow to vary depending on the side of the eligibility threshold on which a student falls, and$\mathbf{X}$ is a vector of demographic characteristics:

$$Pell_{ils} = f\left(\tilde{EFC}_{il}\right) + \beta_1 \mathbf{1}\left[\tilde{EFC}_{il} < 0\right] + \beta_2 \mathbf{1}\left[\tilde{EFC}_{il} < 0\right] \times \tilde{EFC}_{il} + \boldsymbol{\gamma}\mathbf{X_{il}} + \delta_s + \delta_c + \nu_{ils} \quad (3)$$

$$Y_{ils} = g\left(\tilde{EFC}_{il}\right) + \pi_1 \mathbf{1}\left[\tilde{EFC}_{il} < 0\right] + \pi_2 \mathbf{1}\left[\tilde{EFC}_{il} < 0\right] \times \tilde{EFC}_{il} + \boldsymbol{\lambda}\mathbf{X_{il}} + \alpha_s + \alpha_c + \epsilon_{ils} \quad (4)$$

In this framework, $\hat{\tau}_{RK} = \frac{\hat{\pi}_2}{\hat{\beta}_2}$ and $\hat{\tau}_{RD} = \frac{\hat{\pi}_1}{\hat{\beta}_1}$. Additionally, both the kink and the discontinuity can be used for identification.

Table 2 displays first stage estimates of the impact of the kink and discontinuity on Pell Grant aid by student level, where $f(\cdot)$ and $g(\cdot)$ are quadratic functions of $\tilde{EFC}$, estimated separately on either side of the eligibility threshold. On average, barely-eligible Pell Grant recipients experience about a $600 increase in Pell Grant aid compared to barely ineligible students, and for every dollar decrease in EFC, their Pell Grant increases by approximately $1.

3.1 Evaluating the RD and RK Identifying Assumptions

We evaluate the RD/RK identifying assumptions by examining the density of students on either side of the Pell Grant eligibility threshold (Figure 2) and the distribution of observable characteristics, including gender, race, math and verbal SAT scores (when available), parental education, and dependency status (Figure 3). We find no evidence of a discontinuous change in the level or slope of the density or in observable characteristics, the sole exception being the probability of being classified as a dependent student. Examining the density of students on either side of the eligibility threshold for first year students also provides a test of whether Pell Grant aid increases the probability of enrollment, which would produce additional mass to the left of the threshold. Consistent with earlier studies, we find no evidence that Pell Grant aid increases the probability of college enrollment (Appendix Figure 14).[11]

[11] Unfortunately, we currently do not observe the universe of applicants to CUNY schools. Once we have this data, we will be able to construct a more definitive test of the impact of Pell Grant aid on enrollment (conditional on applying for college).

3.2 Pell Grant Aid Reduces Borrowing

We first present graphical evidence of reduced form impacts of Pell Grant eligibility and generosity on other sources of financial aid. First, we would like to rule out the possibility that CUNY schools crowd-out Pell Grant aid by reducing institutional grants for eligible students. Second, we are interested in how additional grant aid affects students' borrowing decisions. Finally, by testing for discontinuities in TAP aid, which in theory should not respond to the parameters of the Pell Grant Program, we can rule out some sources of endogeneity, such as students selectively manipulating measures of their need to gain more grant aid.

Figure 4 displays the distribution of total student loan aid, pooling first, second, and third year students. We present disaggregated results in Appendix A and estimate impacts separately by year when we turn to our parametric specification. Average loan aid falls discontinuously at the Pell Grant eligibility threshold, and the relationship between loan aid and EFC discontinuously changes, suggesting that students unambiguously reduce borrowing upon receiving additional grant aid. These impacts are driven by a reduction in subsidized borrowing (Figure 5), which in turn is caused by both a reduction in the probability of any borrowing at the threshold and on the size of loans conditional on taking on any debt (Figure 6).

To quantify these impacts, we estimate equation (4) separately for each level of student, examining the impact of Pell Grant eligibility and potential generosity on other sources of financial aid, including subsidized and unsubsidized loans, TAP grant aid, institutional grant aid, and total financial aid (Table 3). Table 3 also presents 2SLS estimates of the impact of an increase in Pell Grant aid on other sources of aid using both the kink and discontinuity as instruments. First-year students respond to an additional dollar of Pell Grant aid by reducing their borrowing by approximately \$0.24 (Column 1). Specifically, students respond by reducing their borrowing of subsidized federal loans. Second- and third-year students also respond by reducing loan aid, although the point estimates become noisy as the sample size falls. Conversely, at all levels of attendance, Pell Grant aid has no impact on unsubsidized borrowing. As shown in Column 2, an additional dollar of Pell Grant aid has a small, insignificant, and precisely-estimated impact on unsubsidized loan aid.

Pell Grant aid has no impact on TAP aid (Column 3). This is reasonable, given that TAP awards are determined by New York State taxable income, which does not have a one-to-one correspondence with EFC. We find little evidence that CUNY institutions crowd out or crowd in Pell Grant aid in students' first or second year by manipulating institutional grant aid, as in Turner (2012). For third-year students, we see some evidence of crowd-out, although our standard errors are large due to the reduced sample size. The lack of response on the part of CUNY institutions for first- and second-year students is likely due to the limited resources of the CUNY system - very few students receive institutional aid, making it more costly for

institutions to practice price discrimination than in many other cases. If upper year students have less-elastic demand, it makes sense for institutions to target these students when responding to Pell Grant aid. On net, a $1 increase in Pell Grant aid leads to an approximately $0.75 increase in total aid for first-year students, $0.85 increase for second year students, and $0.41 increase for third year students.

3.3 Pell Grant Aid Has Limited Impacts on Achievement

We next turn to estimating the impact of Pell Grant aid on educational outcomes. Specifically, we observe persistence between semesters, effort (measured by credits attempted), attainment (measured by credits earned), and performance (measured by GPA) for students' first six semesters. As in the previous section, we first present graphical evidence of the reduced form impacts of Pell Grant eligibility on educational attainment, pooling students at all levels of attendance.

The strongest graphical evidence is for persistence, as shown in Figure 7. Although there is little evidence of a discontinuous change in the probability of persisting between consecutive semesters, there is a definite change in the relationship between EFC and persistence, suggesting Pell Grant aid may have a positive impact on semesters of college attendance. Impacts on other outcomes are less clear. Figure 8 displays our measure of effort - the number of credits attempted in a given semester. Although there may be suggestive evidence of a discontinuous change in the level of effort for barely-eligible students, the relationship between EFC and credits attempted is relatively continuous through the threshold. Evidence of impacts on credits completed and GPA are even less conclusive, suggesting that overall, additional Pell Grant aid did little to improve attainment (as measured by credits received) or performance (Figures 9and 10).

Table 4 presents 2SLS estimates of the impact of an additional $1000 in Pell Grant aid on these outcomes, broken out by semester of attendance. First-year students appear to benefit the most from Pell Grant aid in their second semester. We estimate that an additional $1000 increases the probability of persisting from the first to the second semester by 3.4 percentage points (3.9 percent), increases credits attempted by first-year students in their second semester of college by 0.5 (5 percent), and increases total credits earned in students' second semester of college by 0.4 (3.2 percent). Additionally, receiving an additional $1000 of Pell Grant aid in a student's first year has a marginally significant impact on the probability she re-enrolls for an additional year. However, outside of the second semester of college, we find little evidence that Pell Grant aid affects educational attainment.

3.4 Most Students Maximize Subsidized Loans and Limit Unsubsidized Borrowing

Before turning to a conceptual framework for interpreting the results, it is worth characterizing the distribution of loan sizes. The distribution is suggestive of the nature of borrowing costs and has important implications for the expected impacts of grant aid.

Figure 12 displays a histogram of loan size relative to the limit for unsubsidized loans. By far the most popular choice of loan amount is that which maximizes allowed subsidized loans. Greater total loan amounts necessarily include some portion of unsubsidized loans and are much less common. The small spike just over $2000 above the subsidized loan limit corresponds to the total loan limit for dependent students. There are more students at this upper limit than at all other levels of unsubsidized lending combined, indicating that when students incur any unsubsidized loans they often take the maximum amount available.

Figure 12 shows that students are also unlikely to take subsidized loans in small amounts. These figures display the distribution of loan sizes among students subject to the exogenous subsidized loan limits for first-, second-, and third-year students, as displayed by the vertical lines. Loans at the precise values of the limit have been excluded for visibility of less common loan amounts. Here again one can see that students typically choose to borrow up to their subsidized loan limit, which could be due to fixed borrowing costs or "anchoring" at the salient loan limit. Among the relatively uncommon loans below the subsidized loan limit, the density is generally upward sloping between zero and about $2000, as would be the case if students exhibit heterogeneous fixed borrowing costs. We therefore choose to allow for a fixed cost of borrowing, as would be incurred if students are debt-averse due to known self-control issues, as has been suggested in the literature (Cadena and Keys, forthcoming).

4 Conceptual Framework

We tailor our model to match the actual structure of the federal student aid programs. A more parsimonious model, as in Lochner and Monge-Naranjo (2011), provides similar conclusions. The institutional detail incorporated here is intended to distinguish groups of students in different circumstances and highlight the expected responses of each group to the provision of grant aid.

An individual lives for two periods. In the first period, she chooses schooling s (as measured by years of full-time college or credits taken) and debt d to maximize lifetime utility, $U = u(c_0) + \beta u(c_1)$, where subscripts indicate the period, $\beta \in (0, 1)$ is the time discount factor, and $u(\cdot)$ follows standard assumptions for instantaneous utility (strictly increasing, strictly concave, twice continuously differentiable). In the

first period, the student faces costs $C(s)$ associated with her educational investment. School costs $C(s)$ encompass both direct costs $C_d(s)$, such as tuition and fees, and opportunity costs $C_i(s)$, including foregone earnings. $C(s)$ is twice continuously differential, with $C_d'(s)$, $C'(s) > 0$ and $C''(s) \geq 0$. [12] In the second period, the student receives the wage $w(s)$ where $w' > 0$ and $w'' \leq 0$. The student receives grants g from the government and has Expected Family Contribution EFC and exogenous income ω in the first period.

Borrowing is subject to multiple interest rates and potential constraints. The student can borrow an amount d, which can be less than zero if the student prefers to save. The gross rate of interest in the market is R_m, but the government subsidizes some student loans by charging the rate $R_s < R_m$. The student receives the subsidized interest rate on all loans up to a limiting amount $d_s^{max} = \min\left\{\bar{d}, C_d(s) - g - EFC\right\}$, where $\bar{d}$ is a constant. This formulation captures the structure of Federal Direct Subsidized Loans, which can be used to cover "unmet need" up to a fixed limit. The student also pays a fixed borrowing cost γ if she chooses any $d > 0$, which represents both the small monetary cost of borrowing (e.g., loan origination fees) and any psychic cost of taking on debt. Inclusion of this term allows for an empirical test for the existence of fixed costs associated with taking on student loan debt; under the null hypothesis, $\gamma = 0$. For notational convenience, we define indicator functions $\kappa_0 = \mathbf{1}\{d > 0\}$, $\kappa_s = \mathbf{1}\{d > d_s^{max}\}$, and $\xi = \mathbf{1}\left\{C_d(s) - g - EFC > \bar{d}\right\} = \mathbf{1}\left\{d_s^{max} = \bar{d}\right\}$ to distinguish between cases.

The student faces budget constraints $c_0 \leq \omega + EFC + g + d - C(s) - \gamma \cdot \kappa_0$ in the first period and $c_1 \leq w(s) - R_s d - \kappa_s (R_m - R_s)\left(d - \bar{d} - \xi\left(C_d(s) - g - EFC - \bar{d}\right)\right)$ in the second period.[13] Assigning the variable λ for the Lagrange multiplier on the maximum-loan constraint, the student solves:

$$\max_{s,d} \{u(\omega + EFC + g + d - C(s) - \gamma \cdot \kappa_0) +$$

$$\beta u\left(w(s) - R_s d - \kappa_s (R_m - R_s)\left(d - \bar{d} - \xi\left(C_d(s) - g - EFC - \bar{d}\right)\right)\right) + \lambda\left(\bar{\bar{d}} - d\right)\Big\}$$

Optimal schooling s^* and debt d^* will satisfy some combination of the first order conditions:

$$u'(c_0) = \beta\left(R_s + \kappa_s (R_m - R_s)\right) u'(c_1) + \lambda \tag{5}$$

$$C'(s)\, u'(c_0) = \beta\left(w'(s) - \xi\kappa_s (R_m - R_s)\, C_d'(s)\right) u'(c_1) \tag{6}$$

$$d = \bar{\bar{d}} \tag{7}$$

[12] We could also allow for heterogeneous costs of schooling effort by letting s enter directly into the period utility functions (as in Cameron and Taber (2004)) or by allowing ability to vary across students (as in Lochner and Monge-Naranjo (2011)).

[13] In this framework, ω represents the error term in the federal government's estimation of family resources, and can be positive or negative.

Which subset of the first-order conditions applies depends on which case the student falls into. For example, if $\lambda = 0$, $\xi = 0$, and $d^* \neq 0$ then conditions 5 and 6 hold, implying $C'(s^*) = (R_s + \kappa_s (R_m - R_s))^{-1} w'(s^*)$. In such cases, schooling is chosen to equate the present values of the marginal cost and benefit of schooling. Optimal schooling does not depend on income or consumption in either period, implying that grants will have no effect on schooling in such cases.

The chart below summarizes students' choices of debt and responses to grant aid in each potential case. For a given level of EFC, students can be ordered in terms of additional resources ω. A partition of this spectrum defines the different cases a student may fall into, which we label groups A through F. Group A is made up of students with resources great enough that they choose to save. Group F describes students who have so few resources that they would prefer to borrow more than the maximum allowable government loan $\bar{\bar{d}}$ but cannot. For groups in between, the optimal level of debt is weakly decreasing in resources.

Though we distinguish six distinct groups of students, the groups fall into two general types: those choosing corner solutions for debt, and those choosing interior solutions for debt. Groups A, C, and E choose interior levels of debt, and the amount they borrow therefore responds to the amount of grant aid they receive. These groups satisfy the condition implying invariance of schooling to grants. Groups B, D, and F, however, arrive at corner solutions for borrowing. Because these students cannot alter their debt holdings to shift additional grant income into the second period, they instead respond to grants by completing more schooling in order to raise the ratio of future income to current income.[14]

Optimal Schooling and Debt Decisions by Decreasing Level of Exogenous Resources

Group	A (highest resources)	B	C	D	E	F (lowest resources)
d^*	$(-\infty, 0)$	0	$(\underline{d}, d_s^{max})$	d_s^{max}	$\left(d_s^{max}, \bar{\bar{d}}\right)$	$\bar{\bar{d}}$
$\frac{\partial d^*}{\partial g}$	$(-1, 0)$	0	$(-1, 0)$	$\xi\left(\frac{\partial s^*}{\partial g} C_d'(s) - 1\right)$	$(-1, 0)$	0
$\frac{\partial s^*}{\partial g}$	0	$(0, \infty)$	0	$(0, \infty)$	0	$(0, \infty)$

Note: Groups are listed in decreasing order of exogenous resources ω, i.e. lower resources are associated with weakly greater debt.

4.1 Empirical Predictions

1. *A student's probability of taking out any loan falls as grant aid increases.* Grants weakly reduce the optimal amount of debt. The number of loans will be reduced to the extent that students in group C (or above) are induced to shift to group B (or A).

2. *The effect of grants on average loan size, conditional on any loan, is theoretically ambiguous. Average*

[14] Those students choosing zero loans due to the fixed cost (group B), a subsidized loan at the exogenous limit $\bar{d}$ (group D when $\xi = 0$), or maximum available loans $\bar{\bar{d}}$ (group F) will not adjust debt at all. In cases where unmet need is less than the exogenous limit on subsidized loans ($\xi = 1$), students in group D will adjust loans so as to remain at the kink as grants directly and indirectly affect their unmet need, but the kink in the marginal cost of borrowing at this limit will still induce them to increase schooling rather than reduce borrowing if their grant aid rises.

loan size is more likely to fall when grants rise if groups C and D are large relative to the share of students with d near $\underline{d}$. Students with levels of debt close to $\underline{d}$, the minimum positive amount they would be willing to incur, will no longer borrow. This effect will raise the average size among loans still incurred. On the other hand, all other students in groups C and D will reduce the size of their loans. If most borrowing students are at or near the limit for subsidized loans, as is true in the CUNY data, then the latter effect will dominate and the overall average loan size will fall.

3. *The amount of loan crowd-out is increasing in the share of borrowers.* Not surprisingly, loans can only be crowded out to the extent they are being taken up at all. In particular, this results suggests regression kink analysis will give a smaller percentage-point estimate of loan crowd-out than the regression discontinuity estimate because there are more borrowers among those barely ineligible for Pell grants than among those who are barely eligible.

4. *If the fixed cost $\gamma > 0$ then $\underline{d} > 0$ and an increase in grant aid may lead to a greater than \$1 for \$1 reduction in loans for borrowers.* This result allows for crowd-out greater than 100 percent. If students have loan debt d near $\underline{d}$ then a small increase in grants will cause a discrete drop in borrowing to zero. With no fixed borrowing cost the amount of crowd-out is strictly bounded above by 100 percent because $\frac{\partial d^*}{\partial g}$ is bounded from below by -1 for all groups and there would be no groups between which there would be a discontinuity in optimal borrowing.

5. *Unsubsidized loans decrease with grants if the Group E is non-empty.* Students in Group E will reduce their debt, starting with unsubsidized loans, when they receive a grant. This prediction is unambiguous, but if Group E is small relative to Group F then the percentage change in unsubsidized borrowing will be small.

6. *Grants only improve the educational outcomes of students facing some form of borrowing constraint.* Students facing a straightforward borrowing choice (groups A, C, and E) choose the level of schooling that equates current marginal cost with discounted future marginal benefit and then use debt to smooth income between periods. An increase in grant aid has no impact on educational attainment; it only induces these students to borrow less. On the other hand, "constrained" students - those at the thresholds in the formula for the cost of debt (groups B, D, and F) – are restricted in their ability to offset small changes in grant aid by altering their borrowing. Only these groups respond by increasing schooling.

4.2 The Impact of Pell Grant Aid on the "Likely Constrained"

To test the sixth prediction - that only "constrained" students' educational attainment is increasing in Pell Grant aid, we use a blunt measure - students *ex ante* planned housing for the coming academic year. Specifically, when filling out a FAFSA, but before they learn of their aid package or choose how much debt to take on, students must specify their planned housing arrangement during the school year. Most CUNY students specify that they expect to live with their parents (70 percent) or "off campus" (25 percent). The remainder do not specify their planned housing or plan to live "on campus" (although only a handful of CUNY schools have dorms). However, among Pell Grant eligible students borrowing at the subsidized limit, 56 percent plan on living off campus. Thus, we consider students that state that they plan to live off campus as having a higher probability of being constrained, while remaining agnostic as to whether this is due to true constraints, fixed costs of borrowing, or the kink in the interest rate at the subsidized limit. We focus on students in their first four semesters; due to attrition and the smaller number of students planning on living off campus, estimated impacts for third year students are not informative.

As discussed in the previous section, our model predicts that for constrained students, educational attainment is increasing in Pell Grant aid, while debt is weakly decreasing. Table 5 displays impacts of Pell Grant aid on borrowing, separating students according to their planned housing via a fully interacted model. Although the estimated impact of Pell Grant aid on loans for likely constrained students is insignificant and slightly smaller than for less constrained students, due to large standard errors, they are statistically indistinguishable. Estimates are can't rule out zero or larger impacts

However, when we turn to impacts on educational outcomes in Table 6, we find clear differences between the two groups of students. Pell Grant aid has a large positive impact on persistence, effort, attainment, and GPA for as much as four semesters after entry. An additional $1000 of Pell Grant aid leads to a 9 percentage point increase in the probability of persisting between semesters one and two, an 8 percentage point increase in the probability of enrolling for a second year, and a 6 percent increase in the probability of completing two four semesters of college. In each of their first four semesters, an additional $1000 of Pell Grant aid induces likely constrained students to complete 0.5 to 1.5 additional credits, while impacts on credits earned by less constrained students are small and insignificant. Finally, Pell Grant aid leads to higher grades for constrained students.

5 Conclusion

References

Angrist, Joshua D. and Victor Lavy, "Using Maimonides' Rule to Estimate the Effect of Class Size on Scholastic Achievement," *Quarterly Journal of Economics*, 1999, *114*, 533–575.

Angrist, Joshua, Daniel Lang, and Philip Oreopoulos, "Incentives and Services for College Achievement: Evidence from a Randomized Trial," *American Economic Journal: Applied Economics*, 2009, *1(1)*, 136–63.

Becker, Gary S., *Human Capital*, Columbia University Press: New York, NY, 1975.

Bettinger, Eric, "How Financial Aid Affects Persistence," in Caroline M. Hoxby, ed., *College Choices: The Economics of Where to Go, When to Go, and How to Pay For It*, University of Chicago Press, 2004, chapter 5, pp. 207–237.

_ , **Bridget Terry Long, Philip Oreopolous, and Lisa Sanbonmastu**, "The Role of Simplification and Information in College Decisions: Results from the HI&R Block FAFSA Experiment," *Quarterly Journal of Economics*, forthcoming.

Cadena, Brian C. and Benjamin J. Keys, "Can Self-Control Explain Avoiding Free Money? Evidence from Interest-Free Student Loans," *Review of Economics and Statistics*, forthcoming.

Cameron, Stephen V. and Christopher Taber, "Estimaton of Educational Borrowing Constraints Using Returns to Schooling," *Journal of Political Economy*, 2004, *112* (1), 132–182.

Card, David, David S. Lee, and Zhuan Pei, "Quasi-Experimental Identification and Estimation in the Regression Kink Design," 2009. Princeton University Industrial Relations Section Working Paper 553.

Castleman, Benjamin L. and Bridget Terry Long, "Looking Beyond Enrollment: The Causal Effect of Need-based Grants on College Access, Persistence, and Graduation," 2012. working paper.

Deming, David and Susan Dynarski, *Targeting Investments in Children: Fighting Poverty When Resources are Limited*, The University of Chicago Press,

Goldrick-Rab, Sara, Douglas N. Harris, Robert Kelchen, and James Benson, "Need-Based Financial Aid and College Persistence: Experimental Evidence from Wisconsin," 2012. Working paper.

Hahn, Jinyong, Petra Todd, and Wilbert Van der Klauuw, "Identification and Estimation of Treatment Effects with a Regression-Discontinuity Design," *Econometrica*, 2001, *1*, 201–209.

Kane, Thomas J., "Rising Public College Tuition and College Entry: How Well Do Public Subsidies Promote Access to College?," *NBER working paper 5164*, 1995.

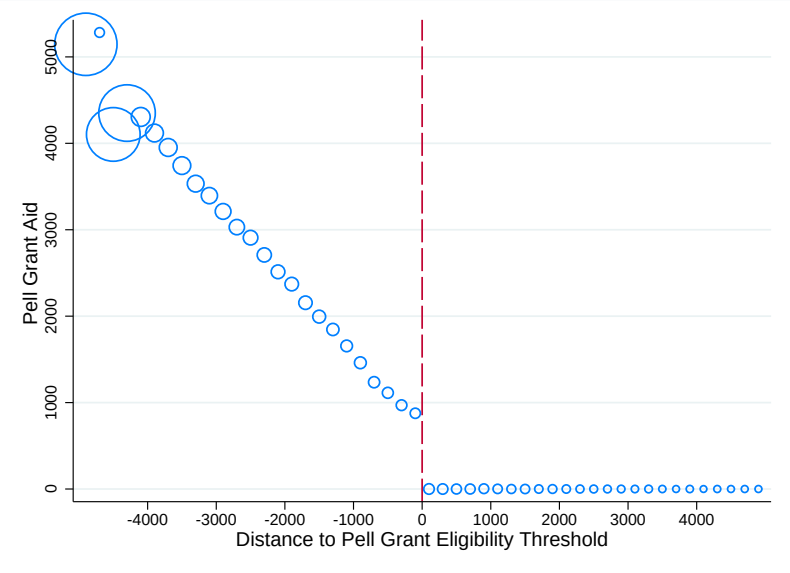
Lochner, Lance J. and Alexander Monge-Naranjo, "The Nature of Credit Constraints and Human Capital," *American Economic Review*, 2011, *101* (6), 2487–2529.

Scott-Clayton, Judith, "On Money and Motivation: A Quasi-Experimental Analysis of Financial Incentives for College Achievement," *Journal of Human Resources*, 2011, *46(3)*, 614–46.

Turner, Lesley J., "The Incidence of Need-Based Student Aid: Evidence from the Pell Grant Program," April 2012. Working paper.

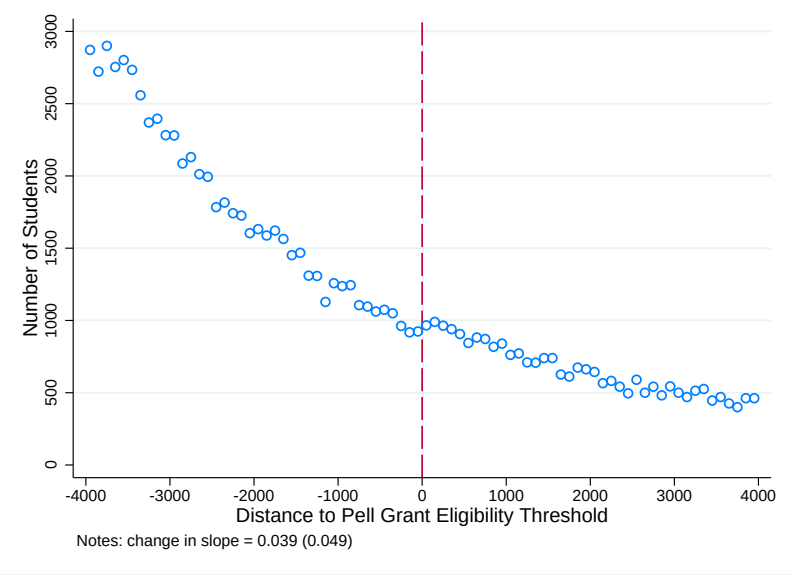
Figures and Tables

Figure 1: The Empirical Distribution of Pell Grant Aid by Distance to Eligibility Threshold



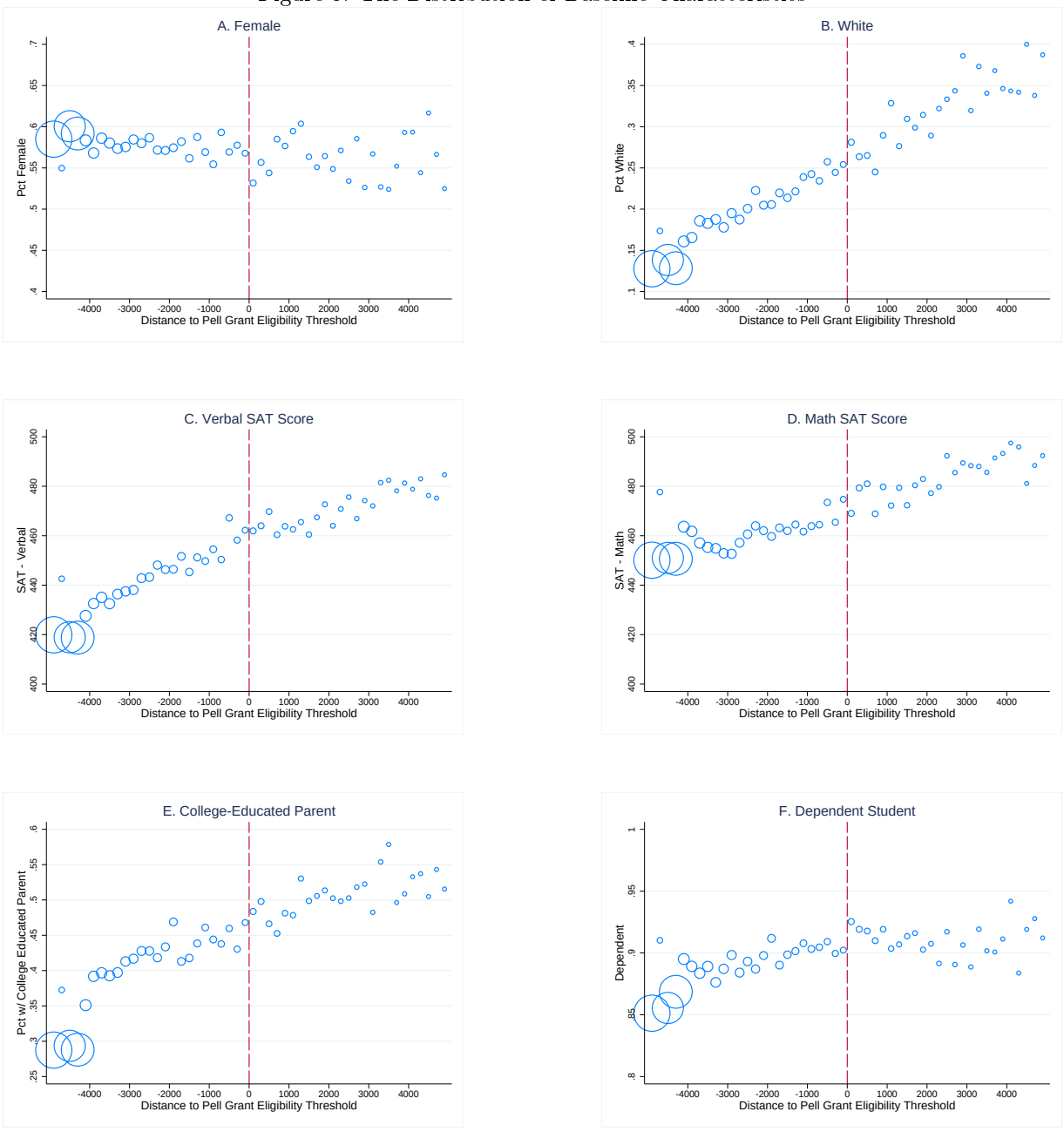
Notes: $200 EFC bins. Each circle represents the average Pell Grant aid received by students in the bin. Larger circles represent a larger underlying sample size. Sample includes students in their first, second, and third years.

Figure 2: The Density of EFC at the Pell Grant Eligibility Threshold



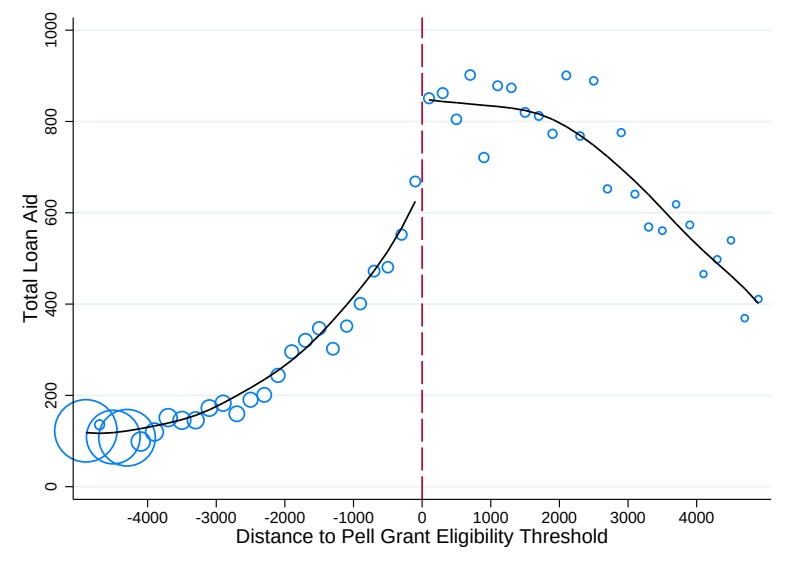
Notes: $100 EFC bins. Each circle represents the average number of students in the bin. Sample includes students in their first, second, and third years. All dollar amounts adjusted to represent constant 2012$.

Figure 3: The Distribution of Baseline Characteristics



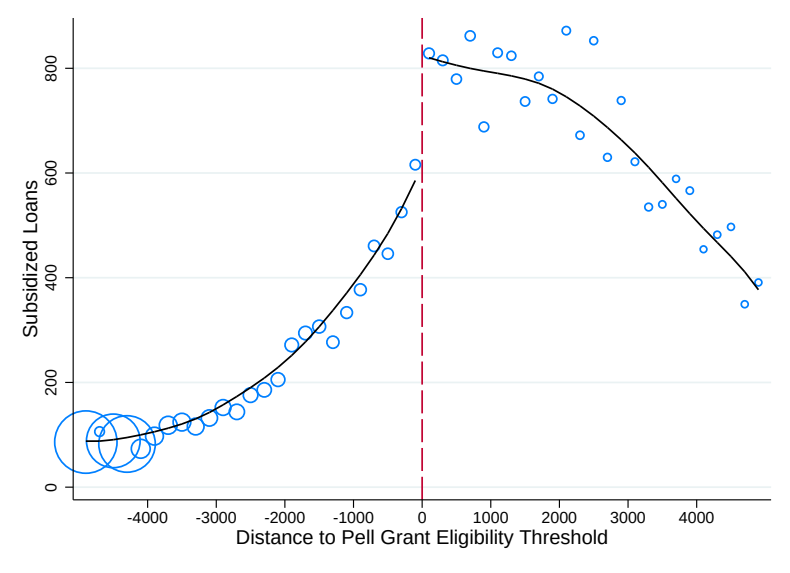
Notes: $200 EFC bins. Each circle represents the average characteristic of students in the bin. Larger circles represent a larger underlying sample size. All dollar amounts adjusted to represent constant 2012$.

Figure 4: The Reduced Form Impact of Pell Grant Eligibility and Generosity on Total Borrowing



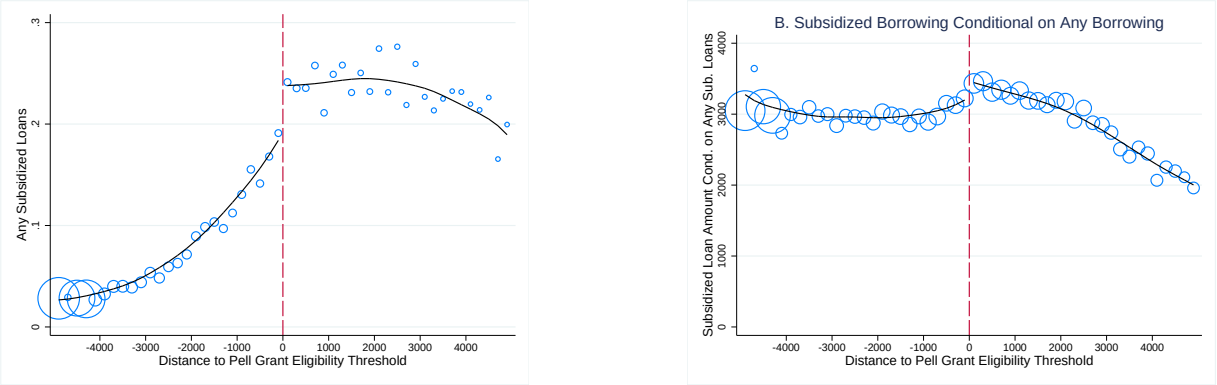
Notes: $200 EFC bins. Each circle represents average loan aid (subsidized + unsubsidized Federal Direct Loans) received by students in the bin. Larger circles represent a larger underlying sample size. All dollar amounts adjusted to represent constant 2012$.

Figure 5: Impacts on Overall Borrowing Driven by a Reduction in Subsidized Borrowing



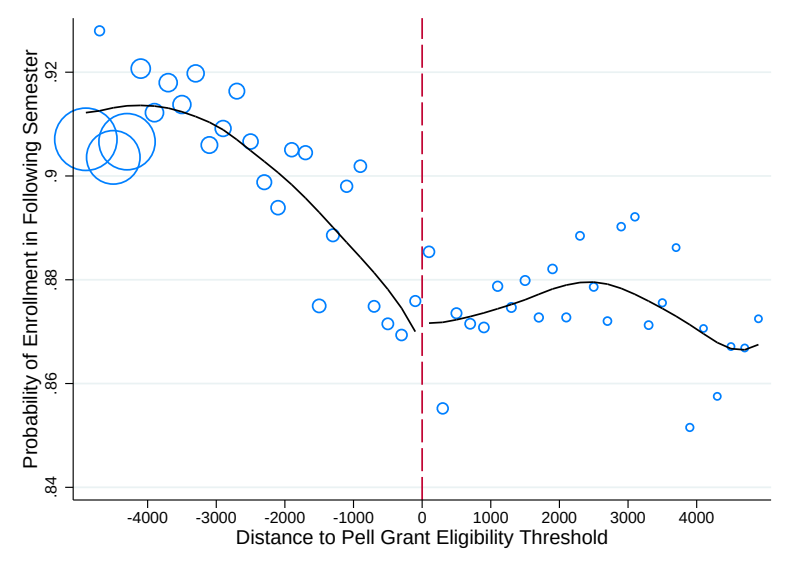
Notes: $200 EFC bins. Each circle represents average subsidized Federal Direct Loan aid received by students in the bin. Larger circles represent a larger underlying sample size. All dollar amounts adjusted to represent constant 2012$.

Figure 6: Both the Probability of Subsidized Borrowing and the Size of Subsidized Loans Conditional on Any Borrowing Responds to Pell Grant Eligibility and Generosity



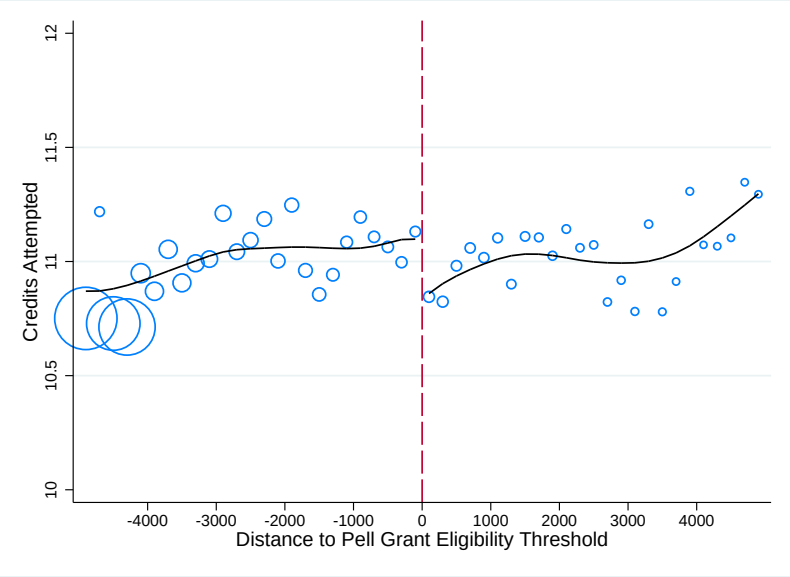
Notes: $200 EFC bins. Each circle represents average probability of borrowing (A) or subsidized Federal Direct Loan aid received by borrowers (B) in the bin. Larger circles represent a larger underlying sample size. All dollar amounts adjusted to represent constant 2012$.

Figure 7: Reduced Form Impacts of Pell Grant Aid on Persistence



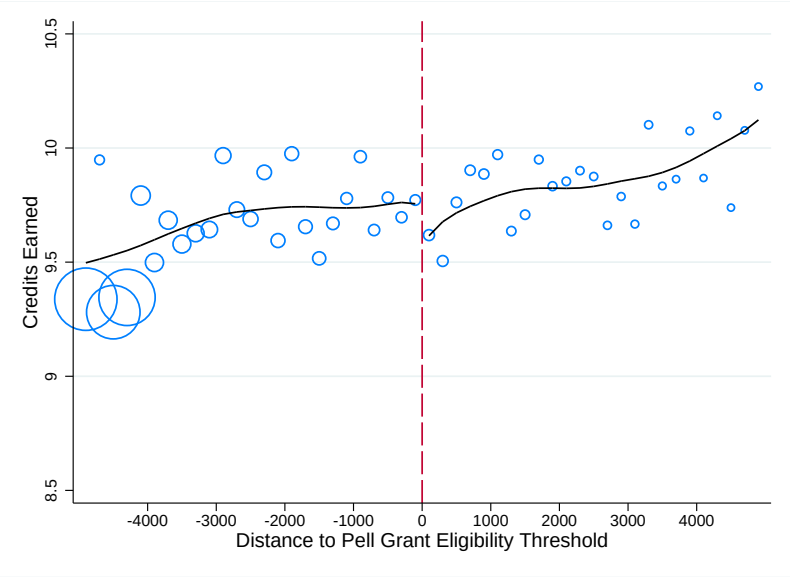
Note: $200 EFC bins. Each circle represents the average probability of enrolling in the following semester (conditional on current enrollment) for first, second, and third year students. Recentered residuals from a regression on school, cohort, and semester fixed effects. Larger circles represent a larger underlying sample size.

Figure 8: Reduced Form Impacts of Pell Grant Aid on Effort



Note: $200 EFC bins. Each circle represents the average credits attempted (conditional on current enrollment) for first, second, and third year students. Recentered residuals from a regression on school, cohort, and semester fixed effects. Larger circles represent a larger underlying sample size.

Figure 9: Reduced Form Impacts of Pell Grant Aid on Credits Earned



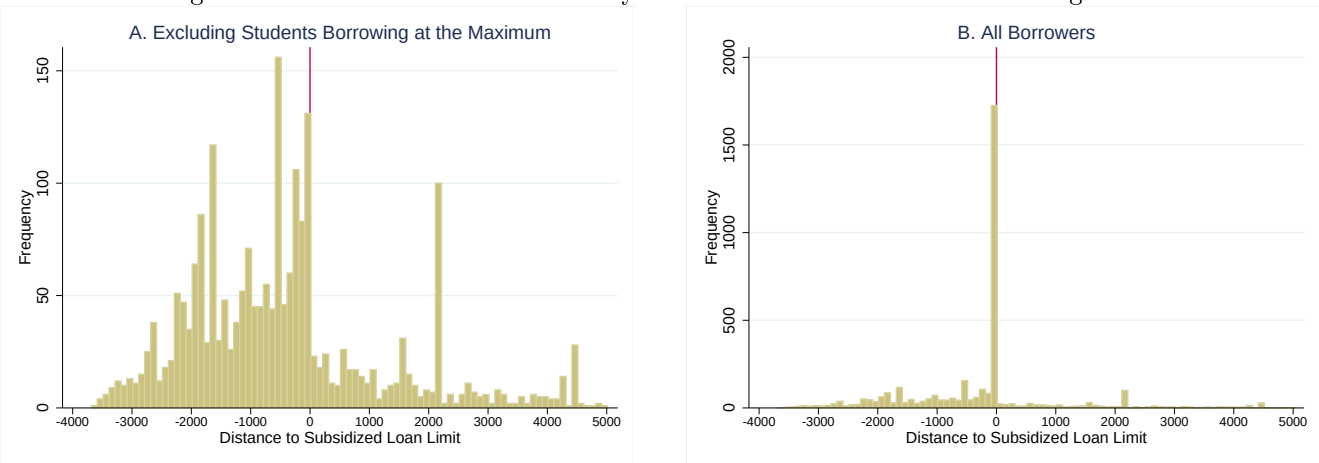
Note: $200 EFC bins. Each circle represents the average credits earned in the semester (conditional on current enrollment) for first, second, and third year students. Recentered residuals from a regression on school, cohort, and semester fixed effects. Larger circles represent a larger underlying sample size.

Figure 10: Reduced Form Impacts of Pell Grant Aid on GPA



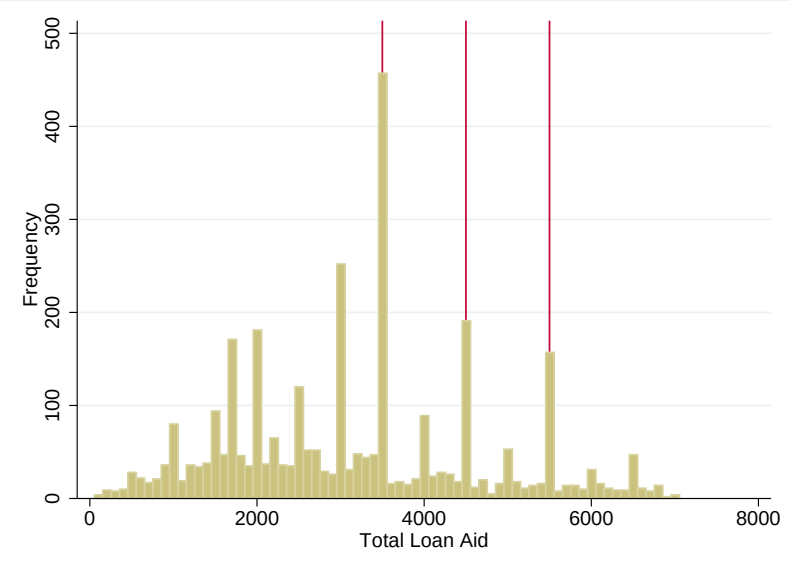
Note: $200 EFC bins. Each circle represents the average semester GPA (conditional on enrollment) for first, second, and third year students. Recentered residuals from a regression on school, cohort, and semester fixed effects. Larger circles represent a larger underlying sample size.

Figure 11: The Distribution of Loans by Distance to the Subsidized Borrowing Limit



Notes: $100 bins. All dollar amounts adjusted to represent constant 2012$.

Figure 12: The Distribution of Loans for Borrowers Subject to the Exogenous Subsidized Borrowing Limit



Notes: $100 bins. Dollar amounts in nominal terms. Students borrowing at the maximum allowed subsidized loans are excluded.

Table 1: Characteristics of Schools and Students by Pell Grant Eligibility

	Ineligible	Eligible	EFC = 0	Full Sample
Number of Students	7,421	22,322	42,372	72,115
A. Cost of Attendance and Financial Aid				
Total need	$6,541	$10,865	$12,213	$11,212
Planned housing - off campus	0.25	0.24	0.26	0.25
Planned housing - with parents	0.69	0.72	0.69	0.70
Expected family contribution	$6,717	$1,766	$0	$1,238
Parent AGI	$65,095	$39,025	$20,682	$32,531
Parent savings	$6,320	$3,062	$1,443	$2,446
Student AGI	$4,489	$2,864	$1,836	$2,427
Student savings	$459	$297	$130	$215
Grant Aid				
Pell Grant aid	$0	$3,239	$4,646	$3,732
TAP aid	$790	$1,802	$2,466	$2,088
Institutional aid	$438	$273	$190	$242
Any borrowing?	0.23	0.06	0.02	0.05
Subsidized loans	$650	$167	$63	$155
Unsubsidized loans	$32	$26	$25	$26
Subsidized borrowing limit	$2,811	$2,864	$2,226	$2,484
% subject to endogenous limit	0.48	0.49	0.60	0.55
% borrowing at limit	0.14	0.03	0.02	0.03
% Need met with Grants	0.17	0.50	0.62	0.53
B. Student Demographic Characteristics				
Female	0.54	0.56	0.58	0.57
Dependent student	0.91	0.91	0.86	0.88
API	0.13	0.15	0.19	0.17
Black	0.31	0.32	0.27	0.29
Hispanic	0.27	0.34	0.41	0.38
White	0.30	0.18	0.12	0.16
SAT verbal score	468	438	416	429
Percentile	0.39	0.32	0.26	0.29
SAT math score	477	455	445	452
Percentile	0.39	0.33	0.31	0.32
Parents' highest education				
Less than high school	0.04	0.07	0.13	0.10
High school	0.37	0.41	0.42	0.41
College	0.51	0.40	0.28	0.34
Initial Degree Program				
AA	0.58	0.67	0.70	0.67
BA	0.42	0.33	0.30	0.33

Note: All dollar amounts in 2012$.

Table 2: Estimates of the Impact of Pell Grant Eligibility and Generosity on Pell Grant Aid

	Year 1	Year 2	Year 3
Change in level	648.0	634.6	597.9
	(63.0)**	(79.3)**	(67.9)**
Change in slope	-1.181	-1.064	-1.010
	(0.040)**	(0.035)**	(0.060)**
Observations	72,501	43,014	27,972

Note: Each column within a panel represents a separate regression. Standard errors clustered at institution level in parentheses; ** p<0.01, * p<0.05, + p<0.1; all dollar amounts adjusted to represent constant 2012$. All regressions include controls for age, family AGI, college fixed effects, and indicators for race (white versus nonwhite), dependency status (dependent versus independent), parents' highest level of education (college, high school, or less than high school), cohort of entry, semester, and a cubic in student expected family contribution ($EFC - k_t$, where k_t is the threshold for Pell Grant eligibility in year t) IV estimates use $\mathbf{1}[EFC < k_t]$ and $(EFC - k_t) \times \mathbf{1}[EFC < k_t]$ as instruments for Pell Grant Aid. Students with EFC greater than $5,000 from Pell Grant eligibility threshold are excluded.

Table 3: RK and RD Estimates of the Impact of Pell Grants on Other Sources of Financial Aid

	(1) Sub. Loans	(2) Unsub. Loans	(3) TAP	(4) Inst. Grant Aid	(5) Total Aid
Year 1: OLS					
Change in level	-259.9	9.1	89.8	-8.7	320.7
	(51.9)**	(11.2)	(46.1)+	(44.9)	(97.6)**
Change in slope	0.204	-0.024	-0.061	0.086	-1.114
	(0.050)**	(0.021)	(0.058)	(0.042)+	(0.104)**
Observations	72,501	72,501	72,501	72,501	72,501
Year 1: 2SLS					
Pell Grant Aid	-0.236	0.019	-0.001	-0.061	0.752
	(0.049)**	(0.013)	(0.043)	(0.038)	(0.066)**
Observations	72,501	72,501	72,501	72,501	72,501
Year 2: OLS					
Change in level	-235.0	-30.2	54.3	14.6	212.0
	(48.0)**	(23.7)	(53.9)	(46.0)	(161.7)
Change in slope	0.063	0.016	-0.060	0.128	-1.157
	(0.071)	(0.022)	(0.050)	(0.069)+	(0.120)**
Observations	43,014	43,014	43,014	43,014	43,014
Year 2: 2SLS					
Pell Grant Aid	-0.134	-0.024	0.011	-0.085	0.854
	(0.065)*	(0.022)	(0.043)	(0.059)	(0.106)**
Observations	43,104	43,104	43,104	43,104	43,104
Year 3: OLS					
Change in level	-316.4	3.5	55.4	-108.3	47.9
	(74.5)**	(18.9)	(44.8)	(69.6)	(138.9)
Change in slope	0.431	0.006	-0.120	0.179	-0.592
	(0.089)**	(0.011)	(0.111)	(0.046)**	(0.204)*
Observations	27,972	27,972	27,972	27,972	27,972
Year 3: 2SLS					
Pell Grant Aid	-0.462	-0.004	0.072	-0.177	0.407
	(0.091)**	(0.012)	(0.084)	(0.054)**	(0.150)**
Observations	27,972	27,972	27,972	27,972	27,972

Notes: Each column within a panel represents a separate regression. Standard errors clustered at institution level in parentheses; ** p<0.01, * p<0.05, + p<0.1; all dollar amounts adjusted to represent constant 2012$. All regressions include controls for age, family AGI, college fixed effects, and indicators for race (white versus nonwhite), dependency status (dependent versus independent), parents' highest level of education (college, high school, or less than high school), cohort of entry, and a quadratic in student expected family contribution ($EFC - k_t$, where k_t is the threshold for Pell Grant eligibility in year t), allowed to vary on either side of the eligibility threshold. 2SLS estimates use $\mathbf{1}[EFC < k_t]$ and $(EFC - k_t) \times \mathbf{1}[EFC < k_t]$ as instruments for Pell Grant Aid. Students with EFC greater than $5,000 from Pell Grant eligibility threshold are excluded. F-stat from test of significance of excluded instruments: 526 (Year 1), 695 (Year 2), 174 (Year 3).

Table 4: 2SLS Estimates of the Impact of Pell Grant Aid on Persistence and Educational Attainment

	1. Persistence	2. Credits Attempted	3. Credits Earned	4. GPA
Impact of $1K Pell Grant Aid				
A. First semester	0.034	0.132	0.116	0.027
	(0.012)**	(0.090)	(0.097)	(0.033)
Observations	72,501	72,501	72,501	67,497
B. Second Semester	0.026	0.509	0.388	-0.025
	(0.015)+	(0.199)*	(0.195)*	(0.026)
Observations	72,501	72,501	72,501	60,516
C. Third Semester	-0.002	0.191	0.209	-0.020
	(0.008)	(0.139)	(0.173)	(0.057)
Observations	43,085	43,085	43,091	41,612
D. Fourth Semester	0.004	-0.013	0.069	0.067
	(0.013)	(0.175)	(0.200)	(0.034)*
Observations	43,091	43,091	43,091	36,342
E. Fifth Semester	0.004	0.271	0.295	0.054
	(0.015)	(0.189)	(0.204)	(0.034)
Observations	28,013	28,013	28,021	27,249
G. Sixth Semester	0.017	0.313	0.326	0.0001
	(0.019)	(0.295)	(0.304)	(0.049)
Observations	28,021	28,021	28,021	23,742

Note: Each cell within a panel represents estimates from a separate regression. Standard errors clustered at institution level in parentheses; ** p<0.01, * p<0.05, + p<0.1; all dollar amounts adjusted to represent constant 2012$. All regressions include controls for age, family AGI, college fixed effects, and indicators for race (white versus nonwhite), dependency status (dependent versus independent), parents' highest level of education (college, high school, or less than high school), cohort of entry, semester, and a cubic in student expected family contribution ($EFC - k_t$, where k_t is the threshold for Pell Grant eligibility in year t) IV estimates use $\mathbf{1}[EFC < k_t]$ and $(EFC - k_t) \times \mathbf{1}[EFC < k_t]$ as instruments for Pell Grant Aid. Students with EFC greater than $5,000 from Pell Grant eligibility threshold are excluded.

Table 5: 2SLS Estimates of the Impact of Pell Grant Aid on Borrowing by Planned Housing

	1. Total Loans		2. Subsidized Loans		3. Unsubsidized Loans	
	A. Off Campus	B. With Parents	A. Off Campus	B. With Parents	A. Off Campus	B. With Parents
Impact of $1K Pell Grant Aid						
A. First Year	-0.172	-0.296	-0.187	-0.297	0.015	0.001
	(0.123)	(0.055)**	(0.114)	(0.054)**	(0.023)	(0.005)
Observations	18,444	50,702	18,444	50,702	18,444	50,702
B. Second Year	-0.207	-0.175	-0.067	-0.174	-0.140	-0.002
	(0.160)	(0.079)*	(0.115)	(0.074)*	(0.095)	(0.011)
Observations	9,818	32,435	9,818	32,435	9,818	32,435

Notes: Each cell within a panel represents estimates from a separate regression. Standard errors clustered at institution level in parentheses; ** p<0.01, * p<0.05, + p<0.1; all dollar amounts adjusted to represent constant 2012$. All regressions include controls for age, family AGI, college fixed effects, and indicators for race (white versus nonwhite), dependency status (dependent versus independent), parents' highest level of education (college, high school, or less than high school), cohort of entry, and a quadratic in student expected family contribution ($EFC - k_t$, where k_t is the threshold for Pell Grant eligibility in year t), allowed to vary on either side of the eligibility threshold. 2SLS estimates use $\mathbf{1}[EFC < k_t]$ and $(EFC - k_t) \times \mathbf{1}[EFC < k_t]$ as instruments for Pell Grant Aid. Students with EFC greater than $5,000 from Pell Grant eligibility threshold are excluded.

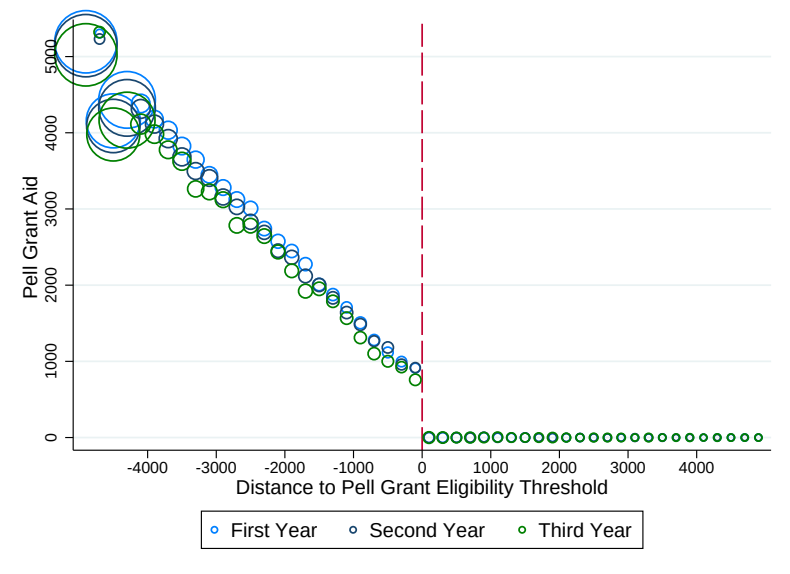
Table 6: 2SLS Estimates of the Impact of Pell Grant Aid on Achievement and Persistence by Planned Housing

	1. Persistence		2. Credits Attempted		3. Credits Earned		4. GPA	
	A. Off Campus	B. With Parents	A. Off Campus	B. With Parents	A. Off Campus	B. With Parents	A. Off Campus	B. With Parents
Impact of $1K Pell Grant Aid								
A. First semester	0.092	0.022	0.384	0.054	0.585	0.023	0.142	0.022
	(0.021)**	(0.013)+	(0.222)+	(0.086)	(0.204)**	(0.116)	(0.049)**	(0.041)
Observations	18,444	50,702	18,444	50,702	18,444	50,702	16,651	47,672
B. Second Semester	0.083	0.021	1.401	0.297	1.477	0.122	0.172	-0.068
	(0.024)**	(0.017)	(0.320)**	(0.219)	(0.359)**	(0.225)	(0.068)*	(0.035)+
Observations	18,444	50,702	18,444	50,702	18,444	50,702	14,391	43,242
C. Third Semester	0.056	-0.017	0.255	0.214	0.428	0.200	-0.015	-0.015
	(0.022)**	(0.010)	(0.385)	(0.142)	(0.429)	(0.151)	(0.099)	(0.061)
Observations	9,847	32,475	9,847	32,475	9,847	32,475	9,345	31,524
D. Fourth Semester	0.062	-0.013	0.763	-0.161	1.018	-0.095	0.108	0.062
	(0.044)	(0.015)	(0.427)+	(0.199)	(0.455)*	(0.223)	(0.105)	(0.033)+
Observations	9,849	32,479	9,849	32,479	9,849	32,479	7,863	27,804

Notes: Each cell within a panel represents estimates from a separate regression. Standard errors clustered at institution level in parentheses; ** p<0.01, * p<0.05, + p<0.1; all dollar amounts adjusted to represent constant 2012$. All regressions include controls for age, family AGI, college fixed effects, and indicators for race (white versus nonwhite), dependency status (dependent versus independent), parents' highest level of education (college, high school, or less than high school), cohort of entry, and a quadratic in student expected family contribution ($EFC - k_t$, where k_t is the threshold for Pell Grant eligibility in year t), allowed to vary on either side of the eligibility threshold. 2SLS estimates use $\mathbf{1}[EFC < k_t]$ and $(EFC - k_t) \times \mathbf{1}[EFC < k_t]$ as instruments for Pell Grant Aid. Students with EFC greater than $5,000 from Pell Grant eligibility threshold are excluded.

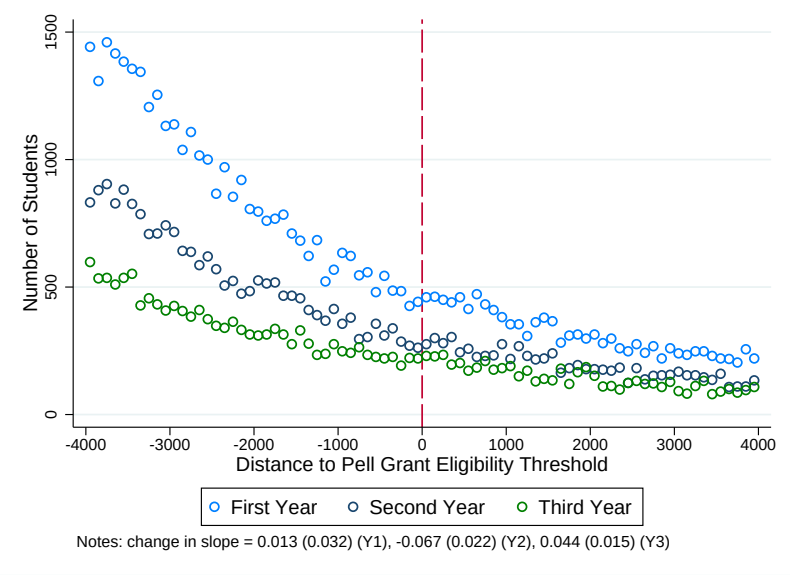
Appendix A: Additional Figures and Tables

Figure 13: The Empirical Distribution of Pell Grant Aid by Distance to Eligibility Threshold and Level



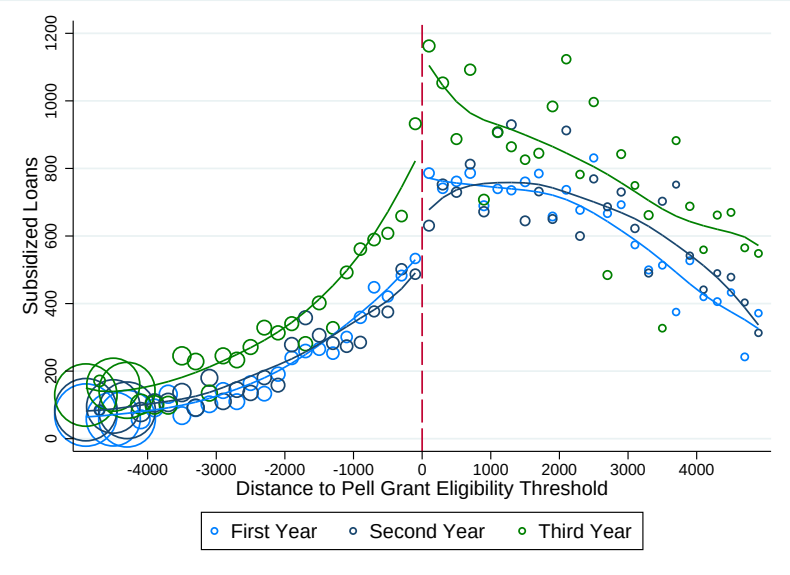
Notes: $200 EFC bins. Each circle represents the average Pell Grant aid received by students in the bin. Larger circles represent a larger underlying sample size. Sample includes students in their first, second, and third years.

Figure 14: The Density of EFC at the Pell Grant Eligibility Threshold by Level



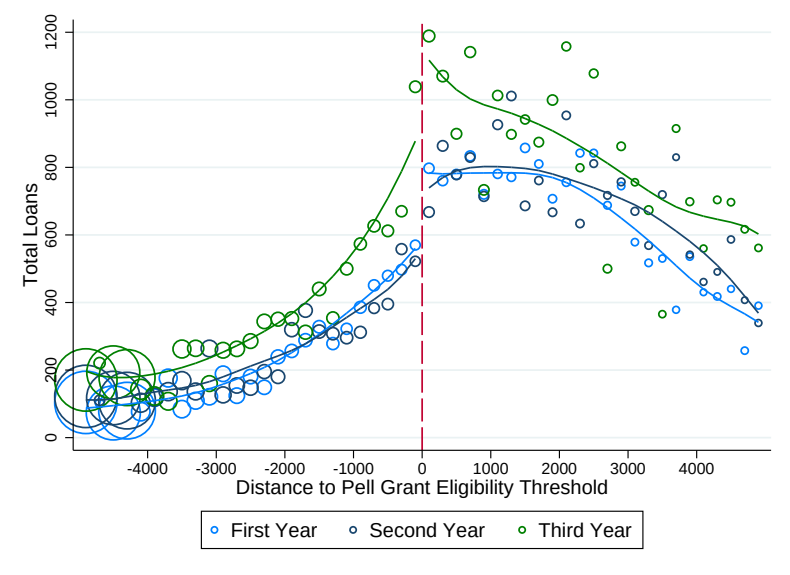
Notes: $100 EFC bins. Each circle represents the average number of students in the bin. Sample includes students in their first, second, and third years.

Figure 16: Impacts on Subsidized Borrowing by Level



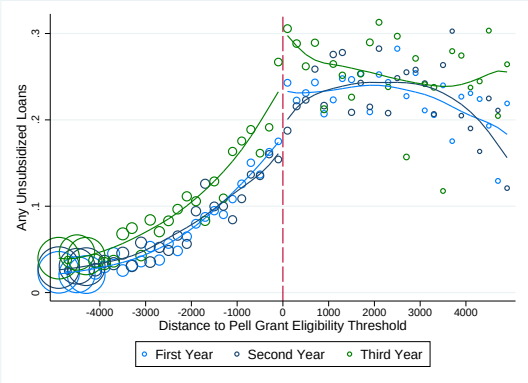
Notes: $200 EFC bins. Each circle represents average subsidized Federal Direct Loan aid received by students in the bin. Larger circles represent a larger underlying sample size. All dollar amounts adjusted to represent constant 2012$.

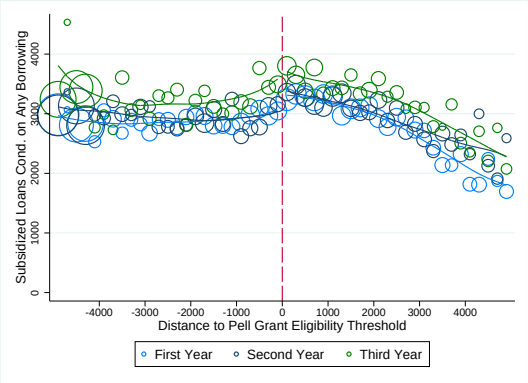
Figure 15: The Reduced Form Impact of Pell Grant Eligibility and Generosity on Total Borrowing by Level



Notes: $200 EFC bins. Each circle represents average loan aid (subsidized + unsubsidized Federal Direct Loans) received by students in the bin. Larger circles represent a larger underlying sample size. All dollar amounts adjusted to represent constant 2012$.

Figure 17: Impacts on the Probability of Subsidized Borrowing and the Size of Subsidized Loans Conditional on Any Borrowing by Level





Notes: $200 EFC bins. Each circle represents average probability of borrowing (A) or subsidized Federal Direct Loan aid received by borrowers (B) in the bin. Larger circles represent a larger underlying sample size. All dollar amounts adjusted to represent constant 2012$.

Appendix B: Proofs

To be added in next draft.