Borrowing Trouble? Student Loans, the Cost of Borrowing, and Implications for the Effectiveness of Need-Based Grant Aid*

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June 2014

Abstract

We estimate the impact of need-based grant aid on City University of New York students' borrowing and educational attainment using regression discontinuity and regression kink designs. An additional dollar of Pell Grant aid reduces federal loans by $0.43 on average, and by over $1.80 among borrowers. Our findings are consistent with students facing a fixed cost of borrowing, which may result in the unintended consequence of additional grant aid decreasing some students' attainment. Empirically, we can reject all but modest impacts of Pell Grant aid on attainment. Eliminating the fixed cost would increase borrowing by over 250 percent.

*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 Brian Cadena, Pamela Giustinelli, Sara Goldrick-Rab, Bruce Kogut, Wojciech Kopczuk, Mike Lovenheim, Amalia Miller, Brendan O'Flaherty, Bernard Salanié, Petra Todd, Miguel Urquiola, and seminar participants at the University of Maryland-Baltimore County, George Washington University, University of Michigan, the Congressional Budget Office, University of Virginia, Washington DC economics of education working group, University of Maryland, Harvard University, Michigan State University, Stanford University, DePaul University, University of Illinois at Chicago, University of Illinois Institute of Government and Public Affairs, Federal Reserve Bank of New York, the 2013 ASSA and AEFP annual meetings, the 2013 IRP summer research workshop, and the 2014 NBER Spring Economics of Education meeting for helpful comments and suggestions. We thank Luke Godwin-Jones for assistance in streamlining code and Stephanie Rennane for her assistance in gathering information on community colleges' loan packaging practices.

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1 Introduction

In the United States, federal and state governments provide substantial subsidies to college students, with the intention of increasing low-income individuals' educational attainment. During the 2011-12 academic year, the U.S. Department of Education provided $34 billion in Pell Grant aid and $59 billion in federal direct loans to undergraduate students (U.S. Department of Education 2013).[1] Although many students are eligible for both Pell Grants and federal loans, little is known about how these programs interact, how grant aid affects students' borrowing decisions, and the extent to which borrowing responses alter the ability of grant aid to increase human capital.

In this paper, we use a combined regression discontinuity / regression kink design to identify the impact of need-based grant aid on college students' educational investment decisions, focusing on borrowing and educational attainment. We study City University of New York (CUNY) students who are eligible or nearly eligible for a Pell Grant. Pell Grant aid has large, negative, and statistically significant impacts on borrowing. We estimate that a dollar increase in Pell Grant aid induces first-year students to reduce borrowing by $0.43, on average. Furthermore, Pell Grant aid crowds out loan aid among borrowers at a rate greater than 100 percent – with an additional dollar of Pell Grant aid leading first-year students to reduce borrowing by approximately $1.80 – a result at odds with traditional models of human capital investment under credit constraints.[2]

Crowd-out in excess of 100 percent can result when preferences or budget sets are discontinuous, as in the case of a fixed cost of borrowing. College students do not pay a monetary fixed cost of borrowing, but may face cognitive, psychic, and hassle costs. We develop a simple two-period model of students' joint borrowing and schooling choices in the presence of a fixed cost. A marginal increase in grant aid only increases the educational attainment of students at a borrowing threshold, such as a credit constraint (e.g., Becker 1975; Cameron and Taber 2004; Lochner and Monge-Naranjo 2011). A fixed cost of borrowing leads to a discontinuity in students' budget sets, resulting in another threshold at the first dollar of debt. Our model predicts that grant aid will increase the attainment of students at this threshold, even though they do not face binding credit constraints. Conversely, a small increase in grant aid may *reduce* educational attainment of students whose optimal debt is shifted to a level at which the fixed cost binds. Thus, the predicted sign of the average impact of grant aid on educational attainment is ambiguous, and empirically we can reject all but modest impacts of Pell Grant aid on attainment for CUNY students near the Pell Grant eligibility threshold, such as an additional $1,000 of Pell Grant aid leading to more than one additional credit earned by first-year students.

[1] Total student loan disbursements calculated from Department of Education's Title IV Program Volume Reports.
[2] Unless otherwise noted, all dollar amounts are inflated to 2012 dollars using the CPI-U.

We provide evidence supporting the existence of a fixed cost of borrowing. In the presence of a fixed cost, students will not be willing to take on debt below a threshold amount. Crowd-out will be largest for students who would borrow just above their threshold and are induced to forgo student loans due to a small increase in grant aid drive. Consistent with these theoretical predictions, borrowing primarily responds to Pell Grant aid along the extensive margin with quantile treatment effects suggesting smaller impacts of Pell Grant aid on borrowing at higher quantiles. Using a maximum likelihood estimator with borrowing thresholds treated as random effects, we estimate that eliminating the fixed cost would increase the probability of borrowing and average student debt of first-year students by more than 250 percent.

Our primary identification strategy uses nonlinearities in the Pell Grant Program's formula to estimate the causal effect of grant aid on borrowing and attainment for students near the program's eligibility threshold. A naïve regression of these outcomes on grant aid will conflate 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 (Hahn et al. 2001; Card et al. 2012). While a student's Pell Grant aid depends on the federal government's measure of need, this relationship is discontinuous at the Pell Grant eligibility threshold, causing students with similar characteristics to receive significantly different amounts of aid (Turner 2013).

Our paper contributes to the large literature on the effectiveness of financial aid in promoting educational attainment and highlights the importance of considering interactions between programs. Existing estimates suggest that increases in grant aid have the same impact on college attendance as tuition decreases of a similar magnitude, as long as the grant application process is relatively simple. In general, a $1,000 increase in financial aid (or decrease in tuition) increases the probability of college attendance by approximately 4 percent (Deming and Dynarski 2010).[3] The Pell Grant Program aims to relax credit constraints, and students targeted by the Pell Grant Program are especially needy. Nationwide, the average Pell Grant award represented 17 percent of average annual income in 2012 (U.S. Department of Education 2013). Despite the program's generosity, Pell Grant aid has not been found to increase college enrollment for most low-income students (Kane 1995).[4]

[3]Fewer studies examine how grant aid affects attainment conditional on enrollment. Angrist et al. (2009) study a program where students attending a non-selective 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. Castleman and Long (2012) examine the impact of Florida's need-based grant program on public college enrollment and educational attainment, and find that first year eligibility for grant aid increases credits earned and degree completion. Finally, Goldrick-Rab et al. (2014) show that Pell Grant recipients randomly assigned to receive additional aid through the Wisconsin Scholars Grant experienced larger increases in persistence when the additional grant aid did not displace federal loan aid.

[4]Bettinger et al. (2012) provide evidence that the complexity of the federal student aid application process substantially reduces the impact of Pell Grant eligibility on college-going. However, Seftor and Turner (2002) estimate that the introduction of the Pell Grant program did increase enrollment of non-traditional, older students. Bettinger (2004) finds positive impacts of

We also investigate the factors contributing to the fixed cost of borrowing faced by CUNY students. Using a nationally representative sample of college students, we provide suggestive evidence that Pell Grant aid has larger impacts on CUNY students' borrowing than that of the average public school student. To the extent that students within and outside the CUNY system face similar psychic costs of borrowing and that offered loans do not vary with Pell Grant eligibility, these results suggest that additional factors contribute to the fixed cost of borrowing faced by CUNY students. Access to federal loan aid in the CUNY system differs from other schools along two key dimensions. First, the default loan offer in the CUNY system is $0, while most other schools offer eligible students nonzero loan awards. Second, CUNY students must opt into borrowing by filling out an additional application for loans. Although we cannot directly test the importance of these these two features of the CUNY borrowing process, we show that students that have access to online loan applications, and thus face lower administrative costs of applying for loan aid, behave no differently than students who must submit their application in person, suggesting that an important component of the fixed cost facing CUNY students is a cognitive cost of deviating from the default loan amount.[5]

The remainder of our paper proceeds as follows: in Section 2, we describe the CUNY system. Section 3 outlines a simple conceptual framework allowing for discontinuous borrowing costs, which generates new predictions for how borrowing and attainment will respond to grant aid. We describe our data and sample in Section 4. In Section 5, we discuss our primary empirical approach, while in Section 6, we present reduced form estimates of the impact of Pell Grant aid on student loan debt and educational attainment. In Section 7, we characterize the fixed cost CUNY students incur when borrowing and investigate factors contributing to this cost. Section 8 concludes.

2 The CUNY System and Need-Based Student Aid

The City University of New York (CUNY) is the largest urban public university system in the country, encompassing 17 two- and four-year colleges that serve over 250,000 undergraduate students in a given year. CUNY institutions have low tuition and operate in a state with generous need-based grant aid.[6] The

Pell Grant aid on persistence, but does not consider interactions between Pell Grant aid and borrowing.

[5]Our hypothesis that the fixed cost of borrowing depends on the presentation of student loan offers is consistent with the literature on the importance of default options and other psychological factors. Pallais (forthcoming) examines an increase in the number of free score reports ACT test-takers can send to colleges and estimates that reducing the price of the fourth ACT score report from $6 to $0 substantially increased the quality of college attended by low-income students. Field (2009) studies an experiment conducted by New York University's law school, where prospective students were randomly assigned to receive either debt forgiveness or a tuition waiver tied to taking a job in the public sector. Although both options had the same present discounted value, tuition waiver recipients were significantly more likely to enter into a public sector career. Outside of higher education, Mandrian and Shea (2001) and Choi et al. (2006) show that default options matter for decisions related to investment, saving, and 401(k) participation.

[6]Nominal tuition at CUNY four-year schools was $4,000 per year in the 2006-07 through 2008-09 academic years, $4,600 per year in 2009-10, and $5,130 per year in 2010-11. Two-year CUNY tuition was $2,800 in 2006-07 through 2008-09, $3,150 in 2009-10, and $3,600 in 2010-11. Over this period, nominal fees at four-year CUNY schools ranged from $252 to $477 per year, while two-year schools charged $268 to $355 per year .

majority of CUNY undergraduates also receive federal grant aid. Similar to other urban public institutions, CUNY schools have low retention and graduation rates. 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.[7]

A centralized application system determines eligibility for federal need-based financial aid. Current and prospective students must submit a Free Application for Federal Student Aid (FAFSA) to the U.S. Department of Education every academic year. 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. Eligibility for Pell Grant aid and subsidized federal student loans are determined by a student's EFC and cost of attendance (COA), which includes tuition, fees, and estimated living expenses.[8]

For most students, Pell Grant aid is solely determined by EFC.[9] Students with EFC below a set threshold are eligible to receive the minimum Pell Grant award.[10] Every $1 decrease in EFC leads to a $1 increase in (statutory) Pell Grant aid, up to the maximum Pell Grant award. Only students with a zero EFC receive the maximum award.

Low- and middle-income students in New York received $920 million of grant aid through the state's Tuition Assistance Program (TAP) in 2012.[11] New York State residents must 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.[12]

In addition to federal and state grant aid, CUNY students are eligible to borrow through the federal Direct Loan Program.[13] The terms of federal loan aid depend on a student's course load, tenure, and unmet

[7]Even after taking into account the fact that community college students may transfer to a four-year CUNY college before receiving an associate's degree, over 60 percent of CUNY associate's degree seeking students do not graduate. Ten years after college entry, only 24 percent of first-time freshmen from Fall 2003 earned an associate's degree, and an additional 7 percent earned a bachelor's degree.

[8]Allowable living expenses include the cost of books and supplies, room and board, transportation expenses, miscellaneous personal expenses, and dependent care, when applicable. Within institutions, students within the same broad category (e.g., full-time freshmen living off campus) are all classified as having the same COA, even if actual living expenses vary substantially across individuals within a given group.

[9]As long as a student's COA is greater than her Pell Grant, Pell Grant aid only depends on EFC. For most students, this constraint is not binding. The lowest COA faced by full-time, full-year CUNY students ranged from $7,271 in 2007-08 to $7,978 in 2010-11. In comparison, the maximum Pell Grant award was $4,310 in 2007-08 and increased every following year until reaching $5,500 in 2010-11.

[10]The minimum Pell Grant award was $400 during the 2006-07 and 2007-08 academic years, increased to $890 in 2008-09 and $976 during 2009-10, and fell to $555 in 2010-11.

[11]See the National Association of State Student Grant and Aid Programs State Data Quick Check.

[12]The maximum TAP award equals the lesser of $5,000 and tuition and fees.

[13]Prior to 2010, schools participated in one of two parallel federal lending programs: the William D. Ford Federal Direct Loan Program and the Federal Family Education Loan (FFEL) Program, through which the federal government guaranteed loans originated by private lenders. The 2010 Health Care and Education Reconciliation Act abolished the FFEL program. Since CUNY schools participated in Direct Loan Program prior to 2010, the legislation did not affect federal lending to CUNY

need. Specifically, a student's unmet need, equal to the total cost of attendance (tuition, fees, and a cost of living allowance) minus EFC and grants, determines her eligibility for subsidized federal loans. First-year students are eligible for subsidized loan aid equal to the lesser of remaining need and $3,500. Dependent first-year students can borrow an additional $2,000 in unsubsidized loans while independent students can borrow an additional $6,000.[14] All students are eligible for unsubsidized loans and even students that do not qualify for subsidized loan aid can still borrow up to the overall maximum in unsubsidized loans (currently, $5,500 for first-year dependent students and $9,500 for first-year independent students). Subsidized loans do not accrue interest until six months after a student leaves school; after this period, students face an interest rate of between 3.4 and 6.8 percent, depending on the year in which the loan was disbursed. The cohorts of students we examine could borrow unsubsidized federal loans at an interest rate of 6.8 percent.

The timing of the school and financial aid application processes lends credibility to the use of the Pell Grant formula as a quasi-experiment for estimating the impact of grant aid on borrowing and educational investment. Prospective students generally apply to CUNY schools in advance of completing a FAFSA. 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 planned 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 FAFSA until after their family has filed their tax return (at best, early February). 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 grant aid (federal, state, and institutional).[15] 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.

Schools must offer students their full federal grant aid entitlement, but they have discretion over federal loan packaging (Scott-Clayton 2013). In the CUNY system, the default loan offer is $0. While most other

students.

[14] Prior to fall 2007, first-year, dependent students could borrow a maximum of $2,625 in subsidized federal loans. Before fall 2008, dependent students were not eligible to borrow above the subsidized limit and independent students were allowed to borrow an additional $4,000 in unsubsidized loans. Students who are considered to be in their second year for federal loan eligibility purposes (i.e., those who have accumulated between 30 and 59 credits) with unmet need can borrow up to $4,500 in subsidized loans ($3,500 prior to fall 2007), while students in their third year and above (i.e., those who have accumulated at least 60 credits) who have unmet need can borrow up to $5,500. Regardless of credits accumulated, students in two-year degree programs are never considered to be third year students for federal borrowing purposes. The overall borrowing limits dependent students face are $6,500 in their second year and $7,500 as upper years ($3,500 and $5,500, respectively, before fall 2008), while independent students can borrow up to $10,500 in their second year and $12,500 in their third year and beyond ($7,500 and $10,500, respectively, before fall 2008). Students are limited in the total amount of federal debt they can incur during their undergraduate education: up to $31,000 for dependent students and up to $57,500 for independent students (only $23,000 can be subsidized in both cases).

[15] Appendix Figure A.1 displays a sample of a CUNY financial aid award letter. Grant and loan aid is first used to pay direct costs (tuition and fees), with the student receiving any remaining aid directly.

higher education institutions include recommended federal loan awards as part of a student's financial aid package, CUNY institutions require students to submit a separate application and specify both their desired amount of federal loan aid and whether they are willing to take on unsubsidized debt.[16] Approximately one-third of the students in our sample attend an institution that provides an online application for federal loans. The remainder of students must submit an application in person to their institution's financial aid office if they wish to borrow.

3 Conceptual Framework

In this section, we outline our model of students' human capital investment decisions, which we tailor to match the key features of federal student loan programs. An individual lives for two periods. In the first period, she chooses schooling s 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, and twice continuously differentiable). In the first period, the student receives exogenous grants g from the government and has resources equal to her expected family contribution EFC and exogenous income ω, where ω represents the error term in the federal government's estimation of family resources, and can be positive or negative. The student faces costs $C(s)$ associated with her first period educational investment, which encompass both direct costs $C_t(s)$ (e.g., such as tuition and fees) and opportunity costs $C_i(s)$ (e.g., foregone earnings). $C(s)$ is twice continuously differential, with $C_t'(s) \geq 0$, $C'(s) > 0$ and $C''(s) \geq 0$. In the second period, the student receives earnings $w(s)$ where $w' > 0$ and $w'' \leq 0$.[17]

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 market interest rate is $R_m < \frac{1}{\beta}$, but the government subsidizes some student loans by charging the rate $R_s < R_m$.[18] The student receives the subsidized interest rate on all loans up to a limiting amount $d_s^{max} = \min\left\{\bar{d}, C_t(s) - g - EFC\right\}$, where $\bar{d}$ is a constant. This formulation captures the structure of the federal subsidized Direct Loan Program, which can be used to cover "unmet need", represented by $C_t(s) - g - EFC$, up to a fixed limit $\bar{d}$. Additionally, the student can borrow up to the overall federal loan limit $\bar{\bar{d}} > d_s^{max}$, where loans in excess of d_s^{max} are subject

[16] Appendix Figure A.2 displays a sample of the additional loan application required by Hunter College.

[17] Our model yields similar predicts if we 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 letting ability vary across students (as in Lochner and Monge-Naranjo (2011)).

[18] In practice, if students were able to earn R_m on their savings, all students should either chose not to borrow, or borrow at or above the subsidized limit. This is because for subsidized loans, students can borrow at R_s and earn $R_m > R_s$ by saving. However, in the years we examine, market interest rates were quite low and students faced a 1 percent origination fee on all loans, resulting in R_s being approximately equal to the market rate. While the interest rate on unsubsidized debt was higher than the market rate in our setting, we only include two terms for gross interest rates, rather than a third term representing the market rate for savings - omitting this additional term does not affect our predictions.

to the market interest rate.

The student also pays a fixed borrowing cost γ if she chooses any $d > 0$, which represents discrete monetary, time, and psychic costs of incurring debt.[19] For notational convenience, we define indicator functions $\kappa_0 = \mathbf{1}\{d > 0\}$ (incurring positive debt), $\kappa_s = \mathbf{1}\{d > d_s^{max}\}$ (incurring positive unsubsidized debt), and $\xi = \mathbf{1}\left\{C_t(s) - g - EFC < \bar{\bar{d}}\right\} = \mathbf{1}\{d_s^{max} = C_t(s) - g - EFC\}$ (being bound by the endogenous subsidized borrowing limit).[20] Assigning the variable λ for the Lagrange multiplier on the maximum-loan constraint, the student solves:

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

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

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

$$u'(c_0) = \beta(R_s + \kappa_s(R_m - R_s))\, u'(c_1) + \lambda \tag{1}$$

$$C'(s)\, u'(c_0) = \beta(w'(s) - \xi\kappa_s(R_m - R_s)\, C_t'(s))\, u'(c_1) \tag{2}$$

$$d = \bar{\bar{d}} \tag{3}$$

Which subset of the first-order conditions applies depends on which case the student falls into. For example, if the maximum loan constraint is not binding ($\lambda = 0$), the student's remaining need is greater than the subsidized loan limit ($\xi = 0$), and optimal borrowing is nonzero ($d^* \neq 0$) then conditions (1) and (2) hold, implying that $C'(s^*) = (R_s + \kappa_s(R_m - R_s))^{-1} w'(s^*)$. In such cases, s^* equates the present discounted values of the marginal costs and benefits of schooling. Optimal schooling does not depend on income or consumption in either period, implying that schooling will not respond to a marginal increase in grant aid. This result is standard: students who not do not face borrowing constraints will not increase their schooling in response to a marginal increase in grant aid.

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. The chart

[19] Students pay an origination fee when taking out federal loan aid, but this fee is continuous in the amount borrowed (i.e., 1 percent) and thus, would not represent the fixed cost we model.

[20] We assume the regularity condition $w''(s) \leq -R_m C_t''(s)$ for all s to ensure global concavity of the problem. We deem this condition reasonable because direct costs are linear or concave in schooling, depending on a student's course load: tuition is linear in credits attempted for part-time students, while full-time students (attempting 12 to 18 credits) are charged a flat rate. Additionally, we show in Appendix B that a weaker condition would suffice.

below summarizes students' choices of debt and responses to grant aid in each potential case. Group A is made up of students with resources great enough that they choose to save (i.e., $d^* < 0$). 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 between these extreme cases, the optimal level of debt is weakly decreasing in resources.[21] As long as $\gamma > 0$, there will be some minimum level of debt that students are unwilling to take on, which we denote as $\underline{d}$.

Optimal Borrowing and Educational Investment Decisions by Level of Exogenous Resources

Group	A	B	B/C Switchers	C	D	E	F
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	$\frac{\Delta d^*}{\Delta g} = \frac{0-\underline{d}}{\Delta g} < 0$	$(-1, 0)$	$\xi\left(\frac{\partial s^*}{\partial g} C_t'(s^*) - 1\right)$	$(-1, 0)$	0
$\frac{\partial s^*}{\partial g}$	0	$(0, \infty)$	$\frac{\Delta s^*}{\Delta g} = \frac{s_0 - \underline{s}}{\Delta g} < 0$	0	$(0, \infty)$	0	$(0, \infty)$

Notes: Groups are listed in decreasing order of exogenous resources ω, where group A has the highest resources and group F has the lowest resources. Observed debt is bounded from below by 0 and $d^* < 0$ implies saving.

The above table displays categories of students according to their optimal debt level and schooling and borrowing responses to grants. Though we distinguish six distinct groups of students, the groups fall into two general types: those choosing corner solutions for debt – who we label "threshold borrowers" – 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. Grant aid does not increase the educational attainment of students in these three groups. Threshold borrowers, however, arrive at a corner solution for borrowing due to the presence of fixed costs (Group B), kinks in the interest rate schedule (Group D), or credit constraints (Group F).

Panel A of Figure 1 displays the borrowing and consumption choices of Groups B, C, and D members on along the budget constraint. Members of Group A (not shown) locate to the left of the discontinuity in the budget set caused by the fixed cost, while individuals in Group B arrive at a corner solution and neither borrow nor save. Likewise, Group D members borrow at the subsidized maximum, arriving at a corner solution caused by the interest rate kink, and Group F members (not shown) borrow at the federal maximum, represented by the far right discontinuity in the budget constraint. Students in Group C locate between the discontinuity and the interest rate kink, while those in Group E (not shown) locate between the interest rate kink and discontinuity caused by the federal borrowing limit.

The remainder of Figure 1 provides an illustration of the impact of Pell Grant aid on students' borrowing decisions. Students in Group B remain at their borrowing thresholds when grants increase slightly but complete more schooling in order to raise the ratio of future income to current income (Panel B). Members

[21] See Appendix B for proofs.

of Groups D and F, follow a similar response.[22] Responses within and between these groups are all continuous except for students switching between Groups B and C (Panel C). Students whose optimal debt is close to $\underline{d}$ may be induced to switch to $d^* = 0$ by small increases in grant aid, Δg. Those who would have taken small loans in the absence of the fixed cost will instead choose not to borrow, which in turn, leads to a reduction in educational attainment. This unintended consequence of grant aid leads to our first and third empirical predictions described below.

3.1 Empirical predictions

Our framework generates three key predictions concerning how overall borrowing and educational investment respond to changes in grant aid in the presence of a fixed cost:

1. *If the fixed cost of borrowing $\gamma > 0$ 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 to exceed 100 percent. If students have loans close to $\underline{d}$, a small increase in grants will cause a discrete drop in (observed) 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.

2. *Grants only increase threshold borrowers' educational attainment.* 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 (e.g., Figure 1, Panel D). An increase in grant aid has no impact on educational attainment; it only induces these students to borrow less. On the other hand, threshold borrowers (Groups B, D, and F) are limited in their ability to offset small changes in grant aid by altering their borrowing. Only these groups respond to grant aid by increasing schooling (e.g., Figure 1, Panel B). Finally, students induced to switch from Group C to Group B will respond to a marginal increase in grant aid by reducing schooling (e.g., Figure 1, Panel C).

3. *Grants decrease educational attainment of students whose optimal debt level drops from (weakly) above $\underline{d}$ to a positive amount below $\underline{d}$.* Students whose optimal borrowing after grant aid falls below $\underline{d}$ will no longer be willing to pay the fixed cost of borrowing. Foregoing loans reduces current consumption but raises future consumption, causing these students to invest less in education in order to shift

[22] Students remain at their respective borrowing thresholds by keeping debt constant, except in the case of students in Group D for whom unmet need is less than the exogenous limit on subsidized loans ($\xi = 1$). For these students, grants reduce unmet need and consequently the amount they can borrow at the subsidized rate. These students adjust loans so as to remain at the kink but otherwise behave like other threshold borrowers, increasing schooling as grant aid rises.

consumption to the present.

4 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 (borrowing and educational investment), and a sufficient number of observations to focus on the outcomes of students on either side of the discontinuities in the Pell Grant formula. We use administrative data from the CUNY system that contains the universe of students from multiple cohorts. This data provides extensive information on students' EFC, student grant and loan aid, and measures of educational attainment (GPA, and credits attempted and earned for semesters between entry and spring 2011).

Our primary sample includes eight cohorts of first-time, degree-seeking freshmen who entered a CUNY institution in the fall of the 2004-05 through 2010-11 academic years (hereafter 2005 through 2011 academic years). Unfortunately, we only observe students' FAFSA information (most importantly EFC) between 2007 and 2011. We observe students in their first three years of attendance and differentiate students by entry cohort and level, where level corresponds to years since college entry. We restrict our sample to only include US citizens or permanent residents.[23] Finally, we eliminate students with an EFC more than $4,000 from the threshold for Pell Grant eligibility. This window excludes students with an EFC equal to zero, who are eligible for the maximum Pell Grant award.[24]

Table 1 displays the characteristics of first-year students by Pell Grant eligibility. Pell Grant eligible students receive more TAP and other grant aid (including aid from smaller state and federal grant programs, as well as institutional aid) than ineligible students, while ineligible students take on greater debt. On average, both eligible and ineligible students borrow at low rates; only 12 percent of the sample takes on any debt in their first year, despite having substantial need and eligibility for subsidized loans. Less than 1 percent of our sample exhausts their total federal loan eligibility in their first year.[25] Pell-ineligible students are more likely to borrow, with 24 percent taking on some debt. Finally, Pell Grant eligible students 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

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

[24] For the 2007 through 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.

[25] In general, private lenders and some institutions also offer student loans. CUNY schools do not offer loans, and we find that no CUNY students borrow through private lenders, most likely due to the superior terms on federal loans.

designs to identify the causal impact of grant aid on student outcomes.

4.1 Are CUNY Pell Grant recipients representative of the national population?

In Appendix Table A.1, we the compare the demographic characteristics, cost of attendance, and financial aid for the 2008 cohort of first-year, degree-seeking, CUNY Pell Grant recipients to a nationally representative sample using data from the 2008 National Postsecondary Student Aid Study (NPSAS).[26] We compare CUNY students to both the full NPSAS sample and to public school NPSAS students.

CUNY Pell Grant recipients have greater need than the average Pell Grant recipient enrolled in a public institution, and slightly higher, but comparable need relative to Pell Grant recipients enrolled in public and private schools. CUNY students also receive more grant aid. After taking into account federal, state, and institutional grant aid, CUNY students have around $5,000 in unmet need compared to $5,700 for the full NPSAS sample and approximately $3,700 for public school NPSAS students.

CUNY Pell Grant recipients borrow at substantially lower rates than the average Pell Grant recipient, despite having similar levels of remaining need after accounting for grant aid and EFC. While on average, 36 percent of public school Pell Grant recipients borrow, only 4 percent of CUNY students incur any student loan debt in their first year.[27] CUNY students entirely avoid private loans, while 25 percent of college students nationwide and 12 percent of public school students take on private student loan debt.

On average, CUNY Pell Grant recipients are younger, more likely to be classified as dependent students, more likely to be nonwhite, and more likely to have parents who did not attend college (Panel B). CUNY students' SAT performance is comparable to that of the average Pell Grant recipient. Finally, CUNY Pell Grant recipients are more likely to be first- or second-generation immigrants, reflecting the fact that the majority of CUNY students attended New York City public schools. Burdman (2005) shows that first-generation college students are more likely to voice aversion to taking on student loan debt; thus, we examine whether our main estimates vary across a number of predetermined characteristics, including dependency, parental education, and immigrant status.

[26] The NPSAS is a a nationally representative, restricted-use, repeated cross-section of college students. A stratified random sample of Title IV-eligible institutions is first drawn, and from these institutions, degree-seeking students are selected. We use the publicly available NCES PowerStats application to generate aggregate statistics from this underlying sample.

[27] In general, CUNY students are less likely to borrow than other public college students. For instance, 35 percent of 2008 full-time degree seeking students attending four-year public schools received federal loan aid while only 5 percent of full-time, bachelor's degree seeking CUNY students borrowed (National Center for Education Statistics 2013). Similarly, 5 percent of 2008 full-time associate's degree seeking CUNY students took out federal loans while 19 percent of full-time, degree-seeking two-year students borrowed. Cadena and Keys (forthcoming) estimate that 83 percent of four-year students eligible for subsidized loans borrow through this program. In comparison, only 8 percent of full-time, bachelor's degree-seeking CUNY students that are eligible for subsidized loans borrow.

5 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 investment. 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. 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 2 displays the empirical distribution of Pell Grant aid among first year students.[28]

Let $Y = \tau Pell + g\,(EFC) + U$ represent the causal relationship between educational investment, 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. 2012). These assumptions encompass those required for identification using the RD design (Hahn et al. 2001). 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, and with locally constant treatment effects, then both the RK estimator, τ_{RK}, and the RD estimator, τ_{RD}, will identify the causal impact of Pell Grant aid:

$$\tau_{RK} = \frac{\lim\limits_{\varepsilon \uparrow 0}\left[\frac{\partial Y|EFC=efc_0+\varepsilon}{\partial efc}\right] - \lim\limits_{\varepsilon \downarrow 0}\left[\frac{\partial Y|EFC=efc_0+\varepsilon}{\partial efc}\right]}{\lim\limits_{\varepsilon \uparrow 0}\left[\frac{\partial Pell|EFC=efc_0+\varepsilon}{\partial efc}\right] - \lim\limits_{\varepsilon \downarrow 0}\left[\frac{\partial Pell|EFC=efc_0+\varepsilon}{\partial efc}\right]} = \tau \tag{4}$$

$$\tau_{RD} = \frac{\lim\limits_{\varepsilon \uparrow 0}\left[Y|EFC = efc_0+\varepsilon\right] - \lim\limits_{\varepsilon \downarrow 0}\left[Y|EFC = efc_0+\varepsilon\right]}{\lim\limits_{\varepsilon \uparrow 0}\left[Pell|EFC = efc_0+\varepsilon\right] - \lim\limits_{\varepsilon \downarrow 0}\left[Pell|EFC = efc_0+\varepsilon\right]} = \tau \tag{5}$$

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

[28] Appendix Figure A.3 displays the empirical distribution of Pell Grant aid for second and third year students.

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: $\widetilde{EFC}_{it} = EFC_{it} - efc_{0t}$.

Consider the following first stage and reduced form equations, where i indicates students, t indicates year, c indicates cohorts, and s indicates colleges, $f(\cdot)$ and $g(\cdot)$ are flexible functions of $\widetilde{EFC}$ 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 predetermined demographic characteristics:

$$Pell_{ist} = f\left(\widetilde{EFC}_{it}\right) + \beta_1 \mathbf{1}\left[\widetilde{EFC}_{it} < 0\right] + \beta_2 \widetilde{EFC}_{it} \times \mathbf{1}\left[\widetilde{EFC}_{it} < 0\right] + \boldsymbol{\eta}\mathbf{X_{it}} + \delta_s + \delta_c + \nu_{ist} \quad (6)$$

$$Y_{ist} = g\left(\widetilde{EFC}_{it}\right) + \pi_1 \mathbf{1}\left[\widetilde{EFC}_{it} < 0\right] + \pi_2 \widetilde{EFC}_{it} \times \mathbf{1}\left[\widetilde{EFC}_{it} < 0\right] + \boldsymbol{\phi}\mathbf{X_{it}} + \alpha_s + \alpha_c + \epsilon_{ist} \quad (7)$$

In this framework, $\hat{\tau}_{RK} = \frac{\hat{\pi}_2}{\hat{\beta}_2}$ and $\hat{\tau}_{RD} = \frac{\hat{\pi}_1}{\hat{\beta}_1}$. In practice, we use both the kink and the discontinuity for identification and provide separate estimates by years since college entry.[29]

Table 2 displays first stage estimates of the impact of the kink and discontinuity on Pell Grant aid by student level, and pooling across all students, where $f(\cdot)$ and $g(\cdot)$ are quadratic functions of $\widetilde{EFC}$, estimated separately on either side of the eligibility threshold. On average, first-year students that are barely-eligible for Pell Grants aid experience an approximately \$390 increase in Pell Grant aid, and for every dollar decrease in EFC, their Pell Grant increases by approximately \$0.76. Point estimates for the set of second and third year students are similar.

We are also interested in estimating whether Pell Grant aid has persistent impacts on educational investment. To do so, we regress the period $t+n$ outcome on Pell Grant aid received in period t, and estimate 2SLS models where the second stage takes the form:

$$Y_{ist} = \tau_n \widehat{Pell}_{it-n} + g_n\left(\widetilde{EFC}_{it-n}\right) + \boldsymbol{\varsigma}\mathbf{X_{it}} + \varphi_s + \varphi_c + \varepsilon_{istn} \quad (8)$$

Here, τ_n represents the impact of an additional dollar of Pell Grant aid in period $t-n$ on the period t outcome, *vis-à-vis* all other intermediate outcomes affected by Pell Grant aid (including future grants awards). Both the kink and discontinuity in period $t-n$ serve as excluded instruments for $Pell_{it-n}$.[30] As shown in Panel B of Table 2, an additional dollar of Pell Grant aid in a student's first year leads to an approximately \$1.14 increase in cumulative Pell Grant aid two years after entry, and a \$1.19 increase three years after entry.

[29] Dong (2013) shows that with locally constant treatment effects, the combined RD/RK estimator $\frac{\hat{\pi}_1 + w\hat{\pi}_2}{\hat{\beta}_1 + w\hat{\beta}_2} = \tau$, where weights w are based on the relative strength of the first stage relationship.

[30] This is a version of the ITT estimator proposed by Cellini et al. (2010).

5.1 Evaluating the RD and RK identifying assumptions

We evaluate the RD/RK identifying assumptions by examining both the density of first-year CUNY students on either side of the Pell Grant eligibility threshold and the probability of attendance conditional on submitting an application. We also test for discontinuities in the level and slope of the distribution of observable characteristics, including gender, race, family adjusted gross income (AGI), average math and verbal SAT scores (when available), parental education, and dependency status.

As shown in Panel A of Figure 3, the level and slope of the density function are continuous through the threshold.[31] Examining the number of first-year students around the eligibility threshold provides suggestive evidence that Pell Grant aid does not influence students' enrollment decisions. We also examine the density of applications and changes in the probability of attendance, conditional on applying, at the Pell Grant threshold. We match applicant data to FAFSA and enrollment information for the fall 2007 through fall 2010 applicant cohorts. We observe each applicant's ranking of up to eight CUNY institutions and whether she ultimately matriculated to a given institution.

Panel B of Figure 3 displays the density of applications and the probability of enrollment conditional on submitting an application by $\widetilde{EFC}$. Although we find a slight decrease in the number of applications to the left of the threshold, the probability of enrollment conditional on application is continuous through the threshold. We formally estimate the change in the probability of enrollment, conditional on application, and can reject effects as small as an additional $1,000 of Pell Grant aid leading to a 2.5 percent increase in the probability of enrollment in a given CUNY school and a 4 percent increase in the probability of enrollment in any CUNY school (Appendix Table A.2).[32] These effect sizes are substantially smaller than the estimated impact of other types of grant aid on enrollment (e.g., Deming and Dynarski (2010)).

We find no graphical evidence of a discontinuous change in the level or slope of the distribution of observable characteristics (Figure 4). Appendix Table A.3 contains corresponding point estimates from regressions of these characteristics on the kink and discontinuity, degree program and school by year fixed effects, and a polynomial in $\widetilde{EFC}$, allowed to vary on either side of the Pell Grant eligibility threshold. We choose the degree of polynomial that minimizes the Akaike Information Criterion (AIC). We estimate a statistically significant, negative relationship between AGI and Pell Grant eligibility for first and third-year students, although when we include higher order polynomials in $\widetilde{EFC}$, our estimates are no longer significant. Outside of AGI, only four of the 36 point estimates are significant at the 10 percent level or

[31] Appendix Figure A.4 displays the density of second and third year students.

[32] Specifically, we estimate that $1,000 increase in federal grant aid at the Pell Grant eligibility threshold leads to a 0.003 percentage point increase in the probability of enrolling in a given CUNY school (Panel C, Column 1) and a 0.014 percentage point increase in the probability of enrolling in any CUNY school (Panel C, Column 2). The upper bounds of the 95 percent confidence intervals include 0.008 and 0.026, respectively. Scaling these upper bounds changes by the overall probability of enrollment (0.32 in a given CUNY school and 0.64 in any CUNY school) gives us the corresponding upper bounds on the percent change in the probability of enrollment.

below. We control for these characteristics in our main specification, while also showing that our estimates are robust to excluding all controls except for $\widetilde{EFC}$.

6 The Impact of Pell Grant Aid on Borrowing and Attainment

Our model suggests that Pell Grant aid will reduce unconstrained students' borrowing. Predicted effects on educational attainment vary, with "threshold borrowers" increasing schooling, unconstrained students not altering their schooling, and students who stop borrowing in response to additional Pell dollars experiencing a reduction in attainment. In this section, we first present graphical evidence of the reduced form impacts of Pell Grant eligibility and generosity on borrowing and then present estimates from our parametric specification.

6.1 Pell Grant aid reduces borrowing

Figure 5 displays mean student loan aid by distance from the Pell Grant eligibility threshold for first year students.[33] Average loan aid falls discontinuously at the Pell Grant eligibility threshold, and the relationship between borrowing and EFC changes discontinuously, indicating that (on average) students reduce borrowing upon receiving additional grant aid.[34] These impacts are driven by a reduction in the probability of any borrowing at the threshold, as well as a reduction in the size of loans conditional on taking on any debt (Figure 6).

To quantify the contemporaneous impact of Pell Grant aid on borrowing, we estimate equation (7), generating separate estimates by years since college entry (Table 3). Panel A presents reduced form impacts of Pell Grant eligibility and generosity on student loan aid. Panel B displays 2SLS estimates of the impact of Pell Grant aid on debt using both the kink and discontinuity as instruments for Pell Grant aid. An additional dollar of Pell Grant aid induces first-year students to reduce borrowing by approximately \$0.43. Second- and third-year students respond to an additional dollar of Pell Grant aid by forgoing \$0.34 and \$0.72, respectively.[35]

Panel C displays estimates of the impact of an additional dollar of Pell Grant aid in a student's first year on cumulative student loan debt two and three years after entry, regardless of whether a student persists or leaves college. Pell Grant aid has persistent effects on borrowing and we estimate that an additional \$1,000 of Pell Grant aid in a student's first year reduces cumulative debt by close to \$600 three years after entry, a

[33] Appendix Figure A.5 displays corresponding results for second and third year students.

[34] This reduction primarily comes from a fall in subsidized loans (Appendix Figure A.6), likely due to the fact that few borrowers take on unsubsidized debt.

[35] Appendix Table A.4 displays estimated impacts on subsidized borrowing and unsubsidized borrowing.

57 percent decrease from the sample mean.

Consistent with our model, grant aid crowd-out of loans exceeds 100 percent among borrowers. We define the "latent probability of borrowing" as the borrowing rate among Pell Grant-ineligible students near the eligibility threshold. Under the assumption that these students' behavior represents a valid counterfactual for the choices of students barely eligible for Pell Grant aid in the absence of Pell Grant receipt, we can scale our estimates of the impact of Pell Grant aid on borrowing by this probability to estimate average crowd-out among borrowers and would-be borrowers. For instance, fewer than 24 percent of Pell-ineligible first-year students borrow, yet \$1 increase in Pell Grant aid reduces average loan aid by \$0.43, suggesting crowd-out exceeding to \$1.80 among borrowers and would-be borrowers. To quantify these effects, we jointly estimating the overall impact of Pell Grant aid on borrowing and latent probability of borrowing (using only the sample of Pell ineligible students). We then scale our 2SLS estimates by the latent probability of borrowing and generate standard errors using a block bootstrap that allows for clustering at the institution by year level (Table 3, Panel D). Among borrowers and would-be borrowers, an additional dollar of Pell Grant aid crowds out between \$1.40 and \$2.43 in student loan aid. Among first and third year students, we can reject the hypothesis that crowd-out for borrowers falls below 100 percent at the 99 percent level.

6.2 Robustness of the estimated impact of Pell Grant aid on borrowing

Before concluding that CUNY students' borrowing decisions are influenced by a fixed cost of taking on debt, we wish to rule out the possibility that our estimates are driven by our choice of bandwidth or polynomial in $\widetilde{EFC}$. We estimate 2SLS models in which we focus on first-year students with EFCs within \$4,000, \$3,000, \$2,000, and \$1,000 of the Pell Grant eligibility threshold, and within each window around the eligibility threshold, we allow for up to a fourth degree polynomial in the running variable. For each window, the optimal degree of polynomial in $\widetilde{EFC}$ is chosen to minimize the AIC. Finally, we employ the goodness-of-fit test suggested by Lee and Lemieux (2010), by testing the joint significance of \$200 $\widetilde{EFC}$ bin dummies added to our main specification (brackets contain p-values from this test). This exercise also directly tests for discontinuities in borrowing away from the Pell Grant eligibility threshold.

Appendix Table A.6 displays impacts on first-year students' borrowing (impacts on second- and third-year students' borrowing and cumulative debt are available upon request). Our estimates are robust to smaller windows and higher order polynomials. The point estimates increase in magnitude when we include higher degree polynomials in $\widetilde{EFC}$ or limit our sample to students closer to the Pell Grant eligibility threshold. For instance, when we limit our sample to students with EFCs within \$1,000 of the threshold and allow for a cubic in $\widetilde{EFC}$, we estimate that every dollar of Pell Grant aid leads to a \$0.77 reduction in loans,

which represents an approximately $3.20 decrease for borrowers. In fact, when scaled by the percentage of Pell Grant ineligible students who borrow, all but two of the 16 point estimates suggest that crowd-out of borrowing in response to Pell Grant increases significantly exceeds 100 percent (results available upon request).

We also estimate the impact of Pell Grant aid on first-year students' borrowing via local linear regression (Appendix Table A.7), using the the Imbens and Kalyanaraman (2012) optimal bandwidth (Panel A), the Fan and Gijbels (1996) rule-of-thumb bandwidth (Panel B), and the bandwidth chosen by the Ludwig and Miller (2005) cross-validation procedure (Panel C).[36] In all cases, we use a rectangular kernel and cluster standard errors at the institution by year level. We report first-stage, reduced form, and 2SLS estimates (using either the kink, the discontinuity, or both as instruments) as well as estimated crowd-out for borrowers and would-be borrowers. In the case of 2SLS specifications, we use the bandwidth chosen for the outcome (rather than the endogenous regressor). In each case, our estimates are less precise but consistent with those obtained from our parametric specifications.

Appendix Table A.8 presents separate IV-RD and IV-RK estimates of the impact of Pell Grant aid on borrowing. Point estimates using only the discontinuity as an instrument for Pell Grant are larger in magnitude than estimates obtained from instrumenting with only the kink, but IV-RK estimates still predict crowd-out for borrowers and would-be borrowers that exceeds 100 percent. Finally, Appendix Table A.9 presents results from additional robustness tests. First, we take into account the increase in total grant aid that results from a $1 increase in Pell Grant aid (Panel A).[37] We want to rule out the fact that our estimates are driven by both an increase in Pell Grant aid and grant aid from other sources. To do so, we estimate equation (7), replacing the endogenous regressor with the sum of Pell Grant aid and other grant aid; results are consistent with those generated by our main specification. In Panel B, we address the concern that increases in Pell Grant aid may mechanically decrease borrowing by reducing some students' eligibility for subsidized loans.[38] We show that our main results are robust to limiting our sample to students whose subsidized loan eligibility is not affected by Pell Grant aid, although standard errors grow due to the reduction in sample size. Finally, in Panel C, we show that estimates from models that exclude all covariates

[36] We use the `rdrobust` Stata command to estimate the bandwidth chosen by the Ludwig-Miller cross-validation procedure (Calonico et al. 2014).

[37] Appendix Table A.5 presents estimated impacts of Pell Grant aid on other sources of grant aid. We find no evidence of a relationship between Pell Grant aid and grant aid from the New York State Tuition Assistance Program (TAP). A student's TAP grant is determined by her New York State Taxable Income, which does not have a one-to-one correspondence with EFC; thus, this exercise serves as a placebo test since we should not expect to find a relationship between two sources of aid that are independently determined. Pell Grant aid is positively correlated with other grant aid (including institutional, federal, and non-TAP New York State aid) for first- and second-year students, although this relationship is only statistically significant among first-year students, who receive an additional $0.08 in other grant aid for every dollar of Pell Grant aid.

[38] For instance, increases in Pell Grant aid will directly affect subsidized loan eligibility for students with less than $3,500 in unmet need. Specifically, suppose a student has $2,000 in unmet need, and therefore, is eligible to borrow up to $2,000 in subsidized loans. The discrete increase in Pell Grant aid that occurs at the eligibility threshold, from $0 to the minimum Pell award, will reduce her eligibility for subsidized loans to $2,000-$minPell$. However, her overall eligibility for student loan aid remains unchanged.

besides a quadratic $\widetilde{EFC}$ are consistent with our main results.

6.3 Impacts on educational attainment

When the cost of borrowing is continuous in loan aid, grants increase the attainment of credit-constrained students but do not alter the schooling decisions of students at interior solutions for borrowing. Our model shows that, in the presence of a fixed cost of incurring debt, grant aid has ambiguous impacts on average educational attainment. Grants induce a subset of students to stop borrowing to avoid this fixed cost, leading to a decrease in educational attainment, while threshold borrowers experience an increase in educational attainment.

Table 4 displays 2SLS estimates of the impact of an additional $1,000 in Pell Grant aid on contemporaneous and longer-run educational outcomes, including persistence (measured by the probability remaining enrolled in the following semester), effort (measured by academic and remedial credits attempted), attainment (measured by academic credits earned), and performance (measured by GPA).[39] Overall, additional Pell Grant aid has small or nonexistent impacts on attainment and performance. We find small, marginally significant impacts on credits attempted by first-year students, with an additional $1,000 of Pell Grant aid inducing students to take an additional 0.7 credits (an approximately 3 percent increase from the mean for Pell Grant ineligible students). This effect does not translate into an increase in academic credits earned.

Ultimately, we are interested in whether Pell Grant aid has longer-run impacts on attainment. The fourth column of Table 4 displays estimates of first-year Pell Grant aid on enrollment, cumulative credits attempted, and cumulative credits earned three years after entry. An additional $1,000 of Pell Grant aid in a student's first year leads to an insignificant 0.4 increase in cumulative credits. Furthermore, we can rule out impacts on cumulative credits that are larger than a 2.6 credit (6 percent) gain three years after entry, suggesting that, on average, Pell Grant aid does little to increase the educational attainment of CUNY students.

Our finding that the average impact of Pell Grant aid on educational attainment is not significantly different from zero is also consistent with heterogeneous treatment effects. Our model predicts that only students arriving at a corner solution for borrowing ("threshold borrowers") will respond to increases in Pell Grant aid by increasing schooling, while those at interior solutions will not respond. Finally, students who cease borrowing due to a binding fixed cost will experience a reduction in educational attainment. We check for heterogeneous treatment effects by estimating effects on the quantiles of cumulative credits earned three years after entry but find no statistically significant point estimates at any quantile (available upon request).

[39] Appendix Figure A.7 displays graphical evidence of the reduced form, contemporaneous relationship between Pell Grant eligibility and generosity and educational attainment for first-year students.

6.4 Heterogeneity

Finally, we test whether the impact of Pell Grant aid on borrowing and attainment varies across students with different demographic characteristics. CUNY students are more likely to be first or second generation immigrants, more likely to be considered dependent students, and are less likely to have a college educated parent. We also test for heterogeneity by students' initial degree program. In Table 5, we present estimates of the impact of Pell Grant aid on borrowing (Panel A) and credits earned (Panel B) by first-year students from fully-interacted models. We test the equality of overall impacts on borrowing and impacts for borrowers and would-be borrowers and display the respective p-values below point estimates. Although we find some evidence of lower crowd-out in some groups (e.g., independent students, BA degree seeking students), point estimates are not statistically distinguishable across any of these dimensions.

We do find some evidence of heterogeneous impacts of Pell Grant aid on attainment. A $1,000 increase in Pell Grant aid leads to a 5 credit increase among independent students and we can reject the equality of estimates for dependent and independent students at the 1 percent level. Additionally, Pell Grant aid leads to a marginally significant increase in credits earned for students with a college educated parent, with an additional $1,000 of Pell Grant aid resulting in an additional credit earned.

7 Characterizing the Fixed Cost of Borrowing

A fixed cost of borrowing can rationalize our finding that an additional dollar of grant aid induces some students to reduce student loans by more than a dollar. In the canonical model, a student equates current and future marginal utility of consumption and therefore saves only a portion of the marginal grant dollar for the future by reducing debt. When borrowing entails a fixed cost, however, the receipt of an additional dollar of grant aid may cause a student to switch from borrowing hundreds or thousands of dollars to borrowing nothing. This is because there is a range $(0, \underline{d})$ in which the amount of debt that would solve the first-order condition (1) would produce only a small utility gain over zero borrowing and hence would not be worth paying the fixed cost. As a result, few students should borrow in small amounts and we expect crowd-out would be greatest among students who would, in the absence of Pell Grant aid, take-up small positive loans. We provide evidence of both of these predictions, then outline a strategy for quantifying the impact of the fixed cost on borrowing rates and debt.

As shown in Figure 7, which displays the distribution of loans among first-year borrowers with a subsidized loan limit of $3,500, students are unlikely to take up small amounts of debt. The density of loans is generally upward sloping between zero and $2,000, as would be the case if students exhibit heterogeneous

fixed borrowing costs. These simple histograms, however, do not rule out the possibility that the distribution of desired loan amounts simply does not often take on small positive values.

Estimates of the quantile treatment effects of grant aid on loans reinforce the fixed cost interpretation by showing that the impact of Pell Grant eligibility on borrowing is larger for quantiles corresponding to small positive amounts of debt. Figure 8 provides inverse CDFs of loan amounts for first-year (Panel A) and all students (Panel B) with EFCs within $1,000 of the Pell Grant eligibility threshold. The vertical distance between the curves provides a reduced-form estimate of the quantile treatment effects of Pell Grant eligibility. In the pooled sample, Pell Grant eligibility does not affect borrowing below the 75th quantile because three-quarters of students borrow nothing irrespective of their eligibility for Pell Grant aid. Differences in borrowing between eligible and ineligible students are also small at the highest quantiles, but at intermediate quantiles, a Pell Grant of less than $1,000 reduces borrowing by close to $2,000. The patterns for quantiles in which ineligible students borrow but eligible students do not borrow suggests heterogeneous values of $\underline{d}$ that may reach into the thousands of dollars. These patterns are suggestive, but cannot provide an unbiased estimate of $\underline{d}$ if Pell Grants induce students to switch quantiles (i.e., if the assumption of rank-invariance is violated).

7.1 Model and implementation

To estimate the threshold loan amounts below which students are unwilling to borrow, we employ a maximum likelihood approach. The econometric model is similar in spirit to a Tobit model, but we treat the censoring threshold as a random effect that varies across students.

Student i has latent, desired loans $d_i^* = \mathbf{X_i}\beta + e_i$ and borrowing threshold $\underline{d}_i$, where $\underline{d}_i$ is exponentially distributed with density $f(\underline{d}_i, \theta_d) = \xi e^{-\xi \underline{d}_i}$ and e_i is normally distributed with cumulative distribution $G(e_i, \theta_e) = N(0, \sigma^2)$ and density $g(e_i, \theta_e)$. We focus on subsidized loans, which are capped by loan limit d_i^{max}, because these loans make up the majority of CUNY students' borrowing and are utilized before unsubsidized loans.

The likelihood of the observed data conditional on parameter values must be specified for each student over each possible value of $\underline{d}_i$. Not borrowing (i.e., $d_i = 0$) is a possibility for any value of $\underline{d}_i$, so that the probability of not borrowing conditional on $\underline{d}_i$ must be integrated over the entire distribution of $\underline{d}_i$. Similarly, a student will ultimately choose $d_i = d_i^{max}$ when $d_i^{max} < \underline{d}_i \leq d_i^*$, and so all values of $\underline{d}_i$ are possible when $d_i = d_i^{max}$ is observed. However, if $0 < d_i < d_i^{max}$, then $\underline{d}_i \leq d_i$, and the observed loan amount provides the upper limit of integration. Because the other terms in the likelihood function for the individuals will not depend on $\underline{d}_i$, they can be factored out and the integral written as $F(d_i, \theta_d)$.

We make two adjustments to allow for the possibility that students round up to their subsidized loan limits

to account for the observed bunching at loan limits. First, we over-censor loans from above at $d_i^{max} - 1500$ to avoid obtaining identification from the region just below d_i^{max} from which students are most likely to round up, replacing $d_i \in [d_i^{max} - 1500, d_i^{max}]$ with $\tilde{d}_i^{max} := d_i^{max} - 1500$. Second, we allow for a share ρ of students who, conditional on $d_i^* \geq \underline{d}_i$, round up and choose $d_i = d_i^{max}$ rather than $d_i = d_i^* < d_i^{max}$.

The log likelihood function is:

$$\log L\left(\theta | d_i, \mathbf{X_i}\right) =$$

$$\sum_{d_i=0} \log\left(\int_0^{\infty} G\left(\underline{d}_i - \mathbf{X_i}\beta, \theta_e\right) f\left(\underline{d}_i, \theta_d\right) d\underline{d}_i\right) + \sum_{0<d_i<\tilde{d}_i^{max}} \log\left(\left(1-\rho\right) g\left(d_i - \mathbf{X_i}\beta, \theta_e\right) F\left(d_i, \theta_d\right)\right)$$

$$+ \sum_{d_i=\tilde{d}_i^{max}} \log\left[\rho \int_0^{\tilde{d}_i^{max}} \left(1 - G\left(\underline{d}_i - \mathbf{X_i}\beta, \theta_e\right)\right) f\left(\underline{d}_i, \theta_d\right) d\underline{d}_i + \int_{\tilde{d}_i^{max}}^{\infty} \left(1 - G\left(\tilde{d}_i^{max} - \mathbf{X_i}\beta, \theta_e\right)\right) f\left(\underline{d}_i, \theta_d\right) d\underline{d}_i\right]$$

We implement the estimation by numerically maximizing the log likelihood. We restrict attention to students whose unmet need is greater than their exogenous loan limit. We include a subset of covariates from our reduced-form models in $\mathbf{X_i}$, and use the kink and discontinuity instruments to identify shifts in the distribution of d^*. To do so, we first estimate equation (6) by ordinary least squares to obtain predicted values $\widehat{Pell}_i$, and we then include $\widehat{Pell}_i$ as one of the covariates $\mathbf{X_i}$, while excluding the instruments. We calculate standard errors corrected for the fact that $\widehat{Pell}_i$ is a generated regressor, following Murhpy and Topel (1985). This two-step procedure provides an estimate of $\frac{\partial d^*}{\partial Pell}$, the amount by which grant aid affects desired debt, which our model predicts will fall within $[-1, 0]$. [40]

7.2 Estimation results

Estimates indicate that CUNY students at all levels have large thresholds below which they will not borrow (Table 6). We estimate that average desired debt, d^*, falls below \$500. Desired debt responds to grant aid as predicted, with $\frac{\partial d^*}{\partial Pell} \in [-0.96, -0.80]$. However, few students actually borrow in small amounts due to high borrowing thresholds ($\underline{d}_i$). The median value of $\underline{d}_i$ is approximately \$3,500 among first-year students, \$3,000 among second-year students, and \$2,300 among third-year students.[41]

With the estimated model, we can describe a counterfactual world with no borrowing cost (Table 7). We estimate that eliminating the fixed cost would increase the share of first-year students who borrow would quadruple, rising from 14.6 percent to nearly 60 percent (Table 7). Because many of the newly-observed

[40] The log likelihood is maximized numerically using the optim command in R. Alternative models that allowed $\underline{d}_i$ to vary as a quadratic function of EFC and in which students know d_i^{max} before applying were both rejected using the Akaike Information Criterion. The covariates of $\mathbf{X_i}$ used in both steps are a quadratic in $\widehat{EFC}$ and indicators for dependency status, race, gender, and degree program.

[41] Estimated robust standard errors do not differ from classical standard errors (corrected for two-step estimation) by more than 8.5 percent of the value of the corresponding parameter, suggesting that model misspecification is limited.

loans would come from the lower part of the distribution where the fixed cost is most prohibitive, the size of loans conditional on borrowing would decrease slightly, while unconditional mean borrowing would increase by 274 percent. The pattern is similar for students in their second or third year (Appendix Table A.11). Consistent with decreasing borrowing thresholds, more second- and third-year students borrow, and the projected increase in borrowing when the fixed cost is removed is smaller but still large.

Panel A of Figure 9 displays actual, predicted, and counterfactual borrowing rates of first-year students as a function of $\widetilde{EFC}$. In the presence of the fixed cost, the model predicts borrowing rates (red plus markets) that match empirical borrowing rates (blue circles) fairly well at all levels of EFC. In particular, the probability of borrowing falls discretely when a student becomes eligible for a Pell grant and decreases as Pell Grant aid rises. Predicted borrowing rates when fixed costs are removed (green X markers) are dramatically higher. Predicted borrowing still decreases with Pell Grant aid, but borrowing rates are higher at all levels of EFC. The model projects that close to 90 percent of Pell-Grant-ineligible students would incur federal loans if borrowing did not entail a fixed cost. In Panel B, we plot the corresponding results for the amount borrowed by first-year students. The pattern is quite similar, with predicted values of the model with fixed costs matching the data fairly closely, and substantial increases in average loan aid when the fixed cost is removed. Among Pell-ineligible students, borrowing would more than triple in the absence of a fixed cost.[42]

7.3 Factors contributing to the fixed borrowing cost

Our estimates indicate that fixed costs are large and substantially alter students' borrowing decisions. The finding that a majority of CUNY students behave as if facing a fixed cost sufficient to prevent them from borrowing less than several thousand dollars is in line with estimated costs of deviating from defaults in other financial settings.[43] Whether complete elimination of the fixed cost represents a realistic counterfactual depends on the nature of the fixed cost, to which we now turn.

Thus far, we have remained agnostic about what factors lead CUNY students to behave as though they face a fixed cost of borrowing. This behavior may be influenced by some combination of psychic costs caused by debt aversion, hassle and administrative costs caused by paperwork and other requirements, or cognitive costs caused by deviating from the default offer of $0. Under the assumption that CUNY students face similar psychic costs of borrowing as other public school students, we can investigate the importance of debt aversion by examining the impact of Pell Grant aid on borrowing in a nationally representative sample. We

[42] Appendix Figure A.8 shows the strong fit of the model to the distribution of loan amounts and the fact that removing the fixed cost increases the number of small loans. Appendix Figure A.9 shows the estimated distribution of borrowing thresholds.

[43] For instance, Bernheim et al. (2011) estimate that the median cost of deviating from the default 401(k) contribution rate exceeds 5.5 percent of income (approximately $2,200 for a worker earning $40,000).

use data on public school students from the 2008 National Postsecondary Student Aid Study (NPSAS). As shown in Appendix Figure A.10, we find no evidence of a discontinuity or kink in total federal loan aid or the probability of borrowing at the Pell Grant eligibility threshold among first-year NPSAS students. Due to small sample sizes in the NPSAS, we cannot reject the possibility that NPSAS and CUNY students have similar borrowing responses to a marginal increase in Pell Grant aid, although estimated crowd-out in the nationally representative sample is always smaller than estimates using the CUNY sample (available upon request).

If we reweight the NPSAS sample to match the characteristics of CUNY students, then the two groups should have similar distributions of desired loans and differ in their observed borrowing due to differences in the fixed cost of borrowing. We use propensity score reweighting to determine the role that observable characteristics play in the differences in borrowing between CUNY and other public school students, and estimate a borrowing rate of 32 percent in the reweighted sample of first-year NPSAS public school students.[44] To match the NPSAS first-year borrowing rate, we must decrease the median value of $\underline{d}_i$ to \$1,069, less than a third of the estimated \$3,482 median threshold faced by first-year CUNY students. Thus, while students across the country still appear to face some common fixed cost of borrowing, such as a psychic cost, the students of CUNY face costs that are far greater.

Although all CUNY institutions offer a default federal loan package of \$0, schools differ in the process through which students can request nonzero loan aid. All CUNY schools require a short supplemental application, but a subset of schools allow students to submit this application online, while the remainder require students to submit the application in person. If hassle and time costs are important factors contributing to the fixed borrowing cost we observe, we would expect that crowd-out would be lower among students who could submit an application online. Under the assumption that schools that offer an online loan application do not differ from those that do not in ways that also influence borrowing decisions, we can test for heterogeneity in the impact of Pell Grant aid on borrowing along this dimension. We estimate our main specification, fully interacting an indicator for having an online loan application with Pell Grant aid (Table 8). We find no evidence that the impact of Pell Grant aid on borrowing varies by the availability of an online loan application. Although estimated crowd-out is larger for students who have access to an online application, crowd-out for borrowers and would-be borrowers is similar between these two groups. Since all CUNY schools provide a default loan offer of zero, we cannot investigate the extent to which default offers influence behavior directly. However, given that we find no evidence that borrowing patterns vary by implied time and hassle costs, we conclude that default loan offers have potentially important impacts on students'

[44]The model we use to estimate the propensity score incorporates all observable and predetermined characteristics that are available in both the CUNY and NPSAS data, fully interacted with dependency status.

borrowing and educational investment decisions.

8 Conclusion

In this paper, we take advantage of the nonlinearities in the Pell Grant Program's formula to estimate the impact of need-based grant aid on educational attainment and borrowing. Our main results - that Pell Grant aid reduces borrowing and has small to zero impact on educational outcomes - is consistent with traditional models of educational investment under credit constraints. We observe very few CUNY students exhausting their federal loan eligibility, suggesting most students do not face borrowing constraints.

However, among students who borrow, an additional $1 of Pell Grant aid leads to borrowers reducing loans by more than $1, which is inconsistent with traditional models of credit constraints where the marginal cost of borrowing is continuous in debt. To explain this irregularity, we extend the traditional credit constraints framework to allow for a fixed cost of borrowing. We estimate that this cost induces a substantial portion of CUNY students to forgo borrowing in a given year. Our model predicts that grant aid may actually reduce the educational attainment of a subset of these students, offsetting the expected improvements among students constrained by loan limits and perhaps explaining our finding of no aggregate effect of Pell Grant aid on educational outcomes.

Our findings are likely relevant for a substantial portion of two-year colleges. Among large community colleges, CUNY's practice of $0 loan offers is not uncommon.[45] We gathered information on loan packaging practices from 75 of the 100 largest community colleges (excluding CUNY schools).[46] Of these schools, 52 percent packaged both subsidized and unsubsidized loans, 8 percent only packaged subsidized loans, and 40 percent were similar to CUNY institutions in not packaging loans.

In 2013, outstanding student loan debt exceeded $960 billion (Federal Reserve Bank of New York 2013). The choice of the default loan offered to low income students may have important implications for students' borrowing decisions. While Dunlop (2013) estimates that access to federal loan aid increases educational attainment of low-income community college students, in general there is limited evidence concerning the impact of federal loan aid on student outcomes.[47] Furthermore, while estimated returns to higher education suggest that borrowing to finance college is optimal (Avery and Turner 2012), student loan debt may impose costs that alter students' behavior when they enter the labor force or while students are still making educa-

[45] We are not aware of any four-year institutions outside of the CUNY system make $0 loan offers.

[46] Four institutions do not participate in federal student loan programs and we were unable to obtain information on loan packaging practices of the remaining 21 institutions. Data on enrollment and federal student loan program participation was drawn from Cochrane and Szabo-Kubitz (2013) and http://projectonstudentdebt.org/files/pub//CC_participation_status_2010-11.pdf.

[47] Avery and Hoxby (2004) provide evidence that high-ability students respond similarly to offered loans and offered grants when deciding between colleges.

tional investments (e.g., Field 2009;Rothstein and Rouse 2011). Imposing a fixed borrowing cost may reduce welfare by reducing educational attainment or increasing other debt, but it may enhance welfare if student debt distorts future decisions. We leave welfare analysis and estimation of these interesting parameters to future work.

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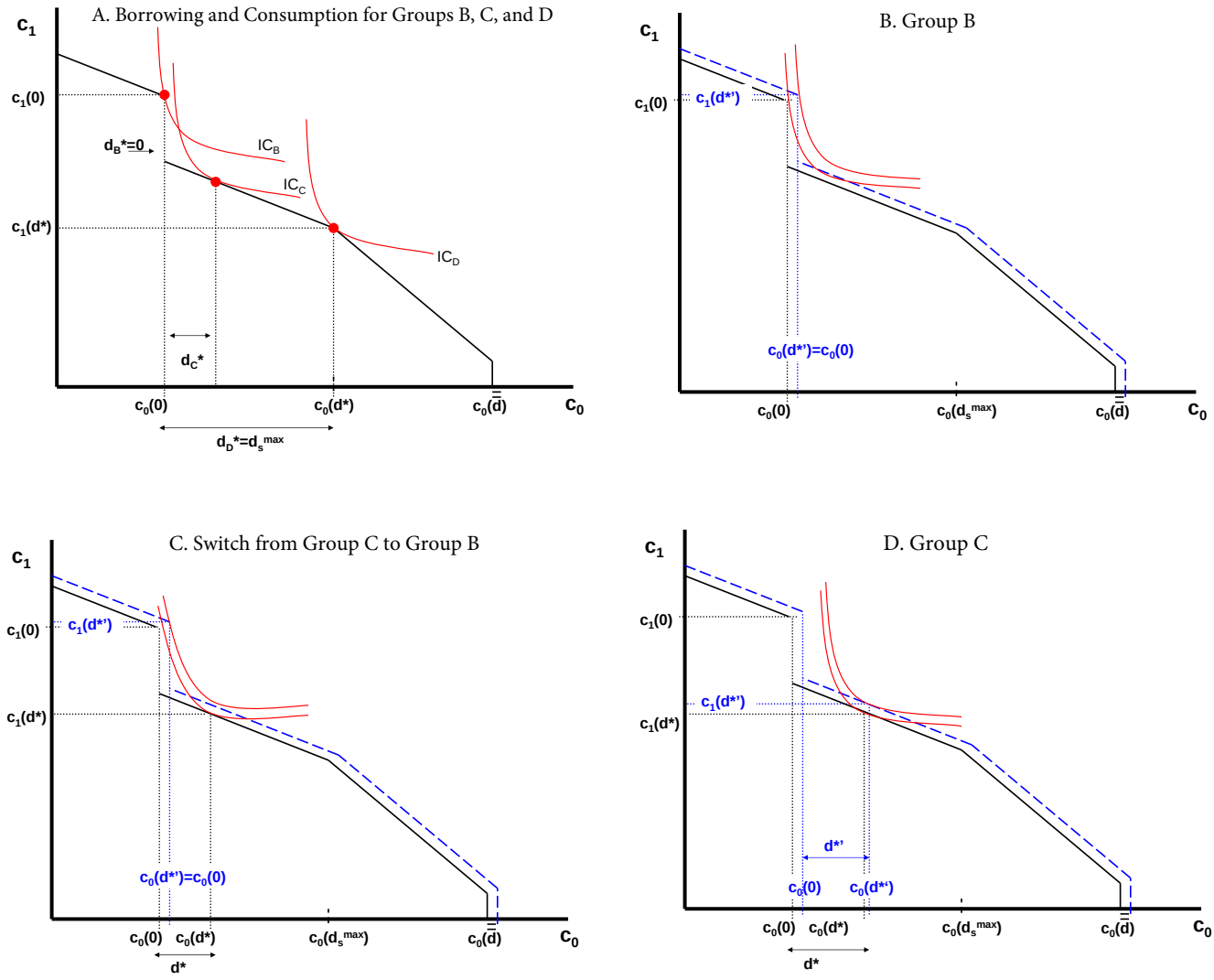
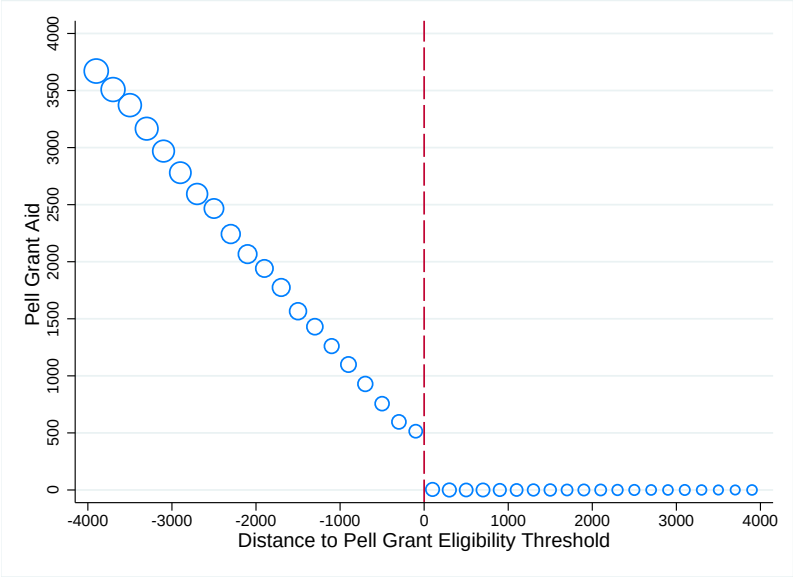
Figures and Tables

Figure 1: The Impact of Pell Grant Aid on Debt by Level of Exogenous Resources



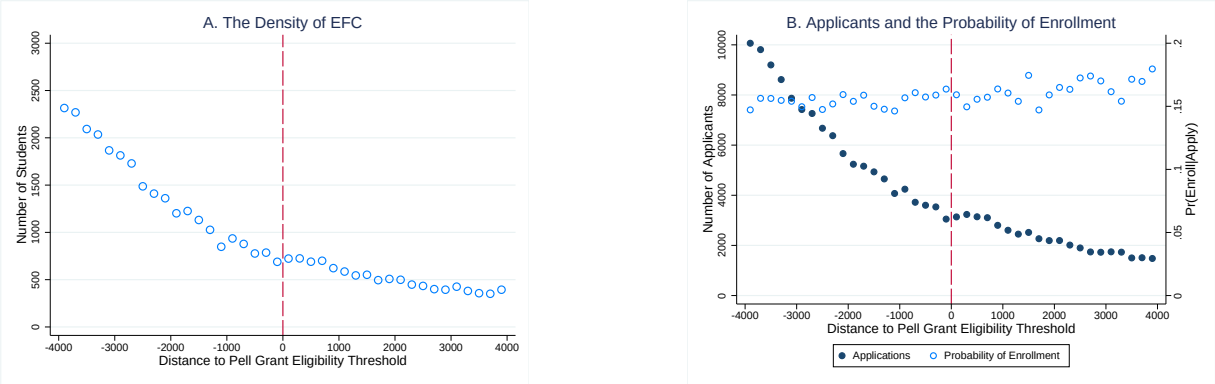
Notes: The black line represents the student's budget constraint in the absence of grant aid (e.g., Panel A), the dashed line represents the student's budget constraint upon the receipt of grant aid, c_0 is consumption in the first period, while c_1 is consumption in the second period. See Section 3 for descriptions of groups. Panel B – $\frac{\partial d}{\partial g} = 0$ and $\frac{\partial s}{\partial g} > 0$. Panel C – $\frac{\triangle d}{\triangle g} < -1$ and $\frac{\triangle s}{\triangle g} < 0$. Panel D – $\frac{\partial d}{\partial g} \in (-1, 0)$ and $\frac{\partial s}{\partial g} = 0$.

Figure 2: The Empirical Distribution of Pell Grant Aid by Distance to Eligibility Threshold



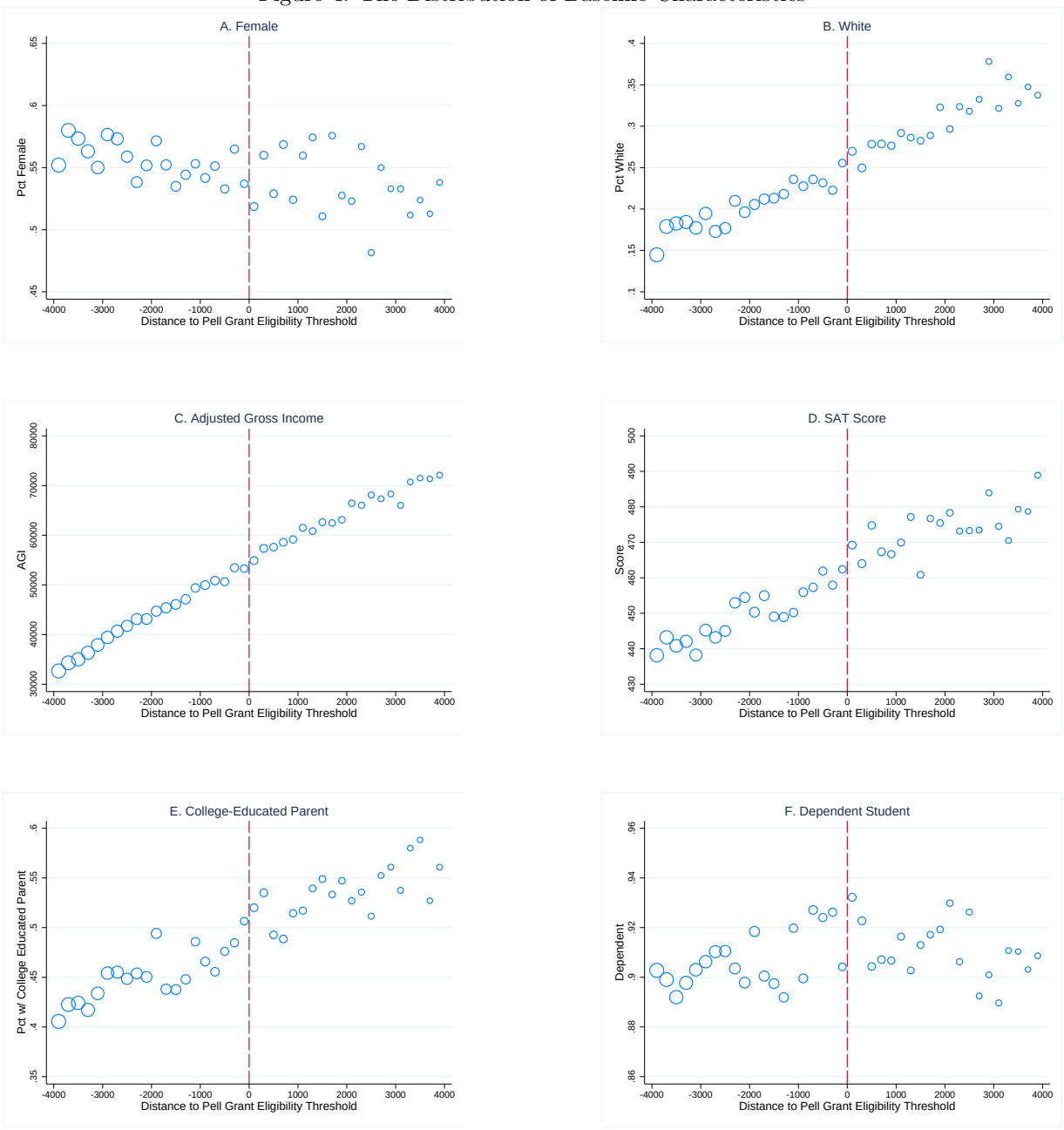
Notes: First-year CUNY undergraduate degree-seeking students; 2007 through 2011 cohorts. $200 EFC bins. Each circle represents the average Pell Grant aid received by students in the bin. Larger circles represent a larger underlying sample size. All dollar amounts adjusted to represent constant 2012$.

Figure 3: The Density of EFC and Probability of Enrollment at the Pell Grant Eligibility Threshold



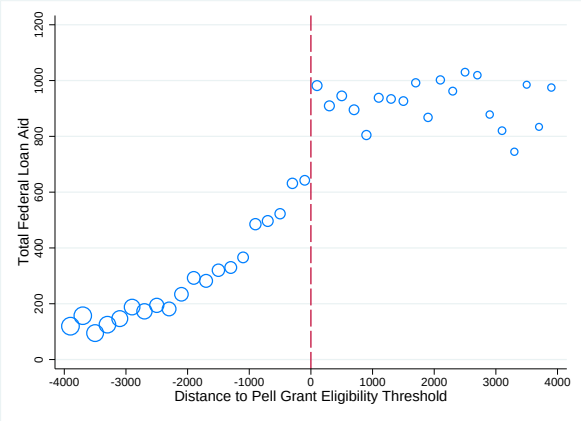
Notes: First-year CUNY undergraduate degree-seeking students; 2007 through 2011 cohorts (Panel A) or 2008 to 2011 cohorts (Panel B). $200 EFC bins. In Panel A, each circle represents the total number of students in the bin. In Panel B, solid circles represent the total number of applicants in the bin while hollow circles represent the probability of enrollment conditional on submitting an application for individuals in the bin. All dollar amounts adjusted to represent constant 2012$.

Figure 4: The Distribution of Baseline Characteristics



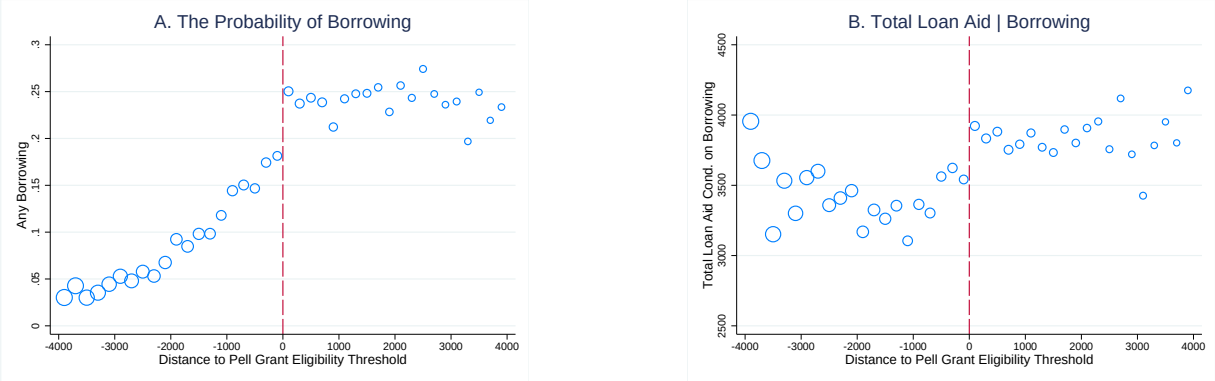
Notes: First-year CUNY undergraduate degree-seeking students; 2007 through 2011 cohorts. $200 EFC bins. Each circle represents the average characteristic of students in the bin. Larger circles represent a larger underlying sample size. All dollar amounts adjusted to represent constant 2012$.

Figure 5: The Reduced Form Impact of Pell Grant Eligibility and Generosity on Total Borrowing



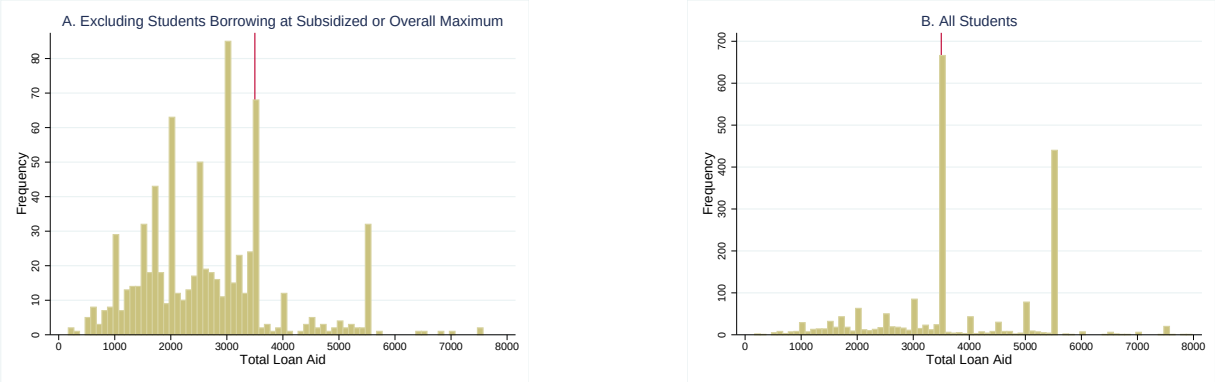
Notes: First-year CUNY undergraduate degree-seeking students; 2007 through 2011 cohorts. $200 EFC bins. Each circle represents average loan aid (subsidized + unsubsidized Federal Direct Loans) received by students in the bin. Larger circles represent a larger underlying sample size. All dollar amounts adjusted to represent constant 2012$.

Figure 6: Impacts on the Probability of Borrowing and Loan Aid for Borrowers



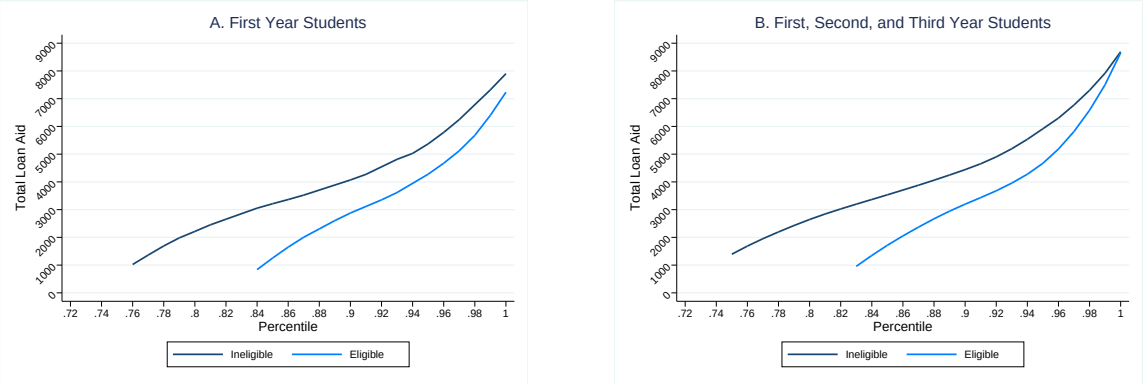
Notes: First-year CUNY undergraduate degree-seeking students; 2007 through 2011 cohorts. $200 EFC bins. Each circle represents average probability of borrowing (A) or subsidized Federal Direct Loan aid received by borrowers (B) in the bin. Larger circles represent a larger underlying sample size. All dollar amounts adjusted to represent constant 2012$.

Figure 7: The Distribution of Loans: Borrowers Subject to Exogenous Subsidized Borrowing Limit



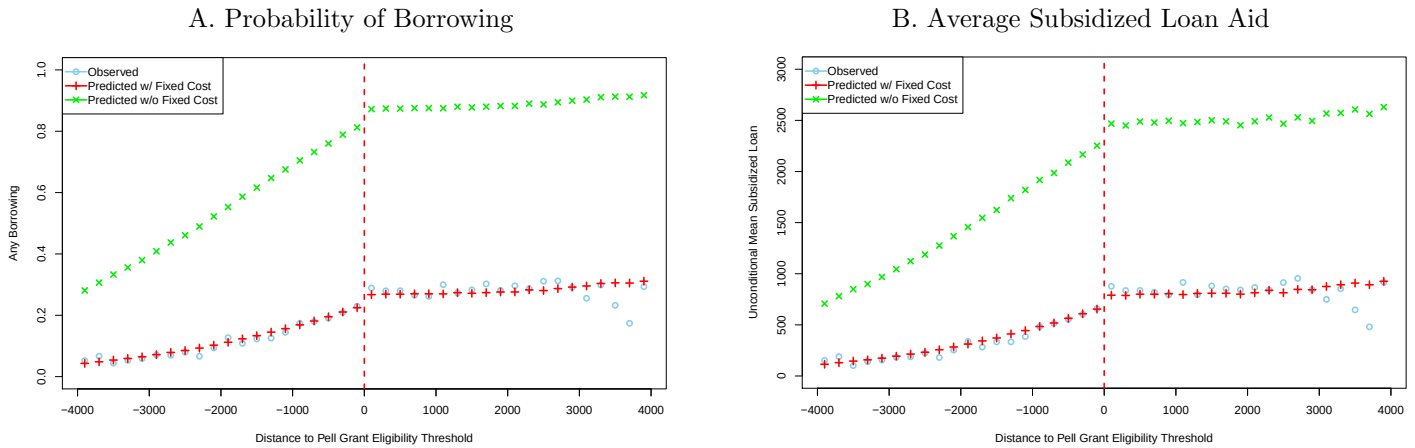
Notes: First-year CUNY undergraduate degree-seeking students; 2007 through 2011 cohorts. $100 bins. Dollar amounts in nominal terms.

Figure 8: Quantiles of Student Loans by Pell Grant Eligibility



Notes: Panel A: first-year CUNY undergraduate degree seeking students; 2007 through 2011 cohorts. Panel B: first-, second-, and third-year CUNY undergraduate degree-seeking students; 2005 through 2010 cohorts. Students in percentiles that are not listed take on $0 debt. Limited to students with an EFC less than $1000 to the Pell Grant eligibility threshold. All dollar amounts adjusted to represent constant 2012$.

Figure 9: Actual and Counterfactual Borrowing



Notes: First-year CUNY undergraduate degree seeking students; 2007 through 2011 cohorts. $200 EFC bins. Limited to students who are subject to the exogenous subsidized loan limit. Circles indicate averages (probability of borrowing in Panel A, amount borrowed in Panel B) among students in the bin. Red plus markers represent predicted borrowing outcomes from the maximum likelihood model. Green X markers are predictions for a counterfactual situation with no fixed cost of borrowing. All dollar amounts adjusted to represent constant 2012$.

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

	Ineligible	Eligible	Full Sample
A. Cost of Attendance and Financial Aid			
Expected family contribution (EFC)	$6,451	$2,254	$3,381
Total need (= Cost of attendance - EFC)	$6,772	$10,406	$9,430
Total grant aid	$1,012	$4,313	$3,411
Pell Grant aid	$0	$2,394	$1,751
TAP Grant aid	$753	$1,573	$1,352
Percent need met with grants	0.20	0.46	0.39
Any borrowing?	0.24	0.07	0.12
Borrowing at subsidized limit	0.18	0.04	0.08
Subject to endogenous limit	0.34	0.32	0.32
Subsidized borrowing limit	$2,464	$2,556	$2,531
Total loan aid	$923	$244	$427
Share subsidized	0.73	0.80	0.76
B. Student Demographic Characteristics			
Female	0.54	0.56	0.55
Dependent student	0.91	0.90	0.91
Black	0.30	0.34	0.33
Hispanic	0.27	0.33	0.32
White	0.30	0.19	0.22
SAT percentile	38.8	32.4	34.2
Foreign-born	0.15	0.19	0.18
Foreign-born parent(s)	0.41	0.47	0.45
Parents' highest education			
Less than high school	0.04	0.06	0.06
High school	0.37	0.40	0.40
College	0.53	0.45	0.47
Parents' resources			
Adjusted gross income	$64,405	$42,522	$48,434
Savings	$6,314	$3,494	$4,252
Student's resources			
Adjusted gross income	$4,422	$3,044	$3,414
Savings	$459	$280	$328
Initial degree program = BA	0.44	0.35	0.37
Number of Students	10,231	27,869	38,100

*Note*s: First-year CUNY undergraduate degree seeking students; 2007 through 2011 cohorts. COA represents the total cost of attendance, which is equal to tuition and fees, books and supplies, and living expenses. A student's total need is equal to the total cost of attendance minus her EFC. AGI = adjusted gross income. Race and parental education categories may not sum to one due to missing values. Students with EFC greater than $4,000 from Pell Grant eligibility threshold are excluded. All dollar amounts adjusted to represent constant 2012$.

Table 2: The Impact of Pell Grant Eligibility on Pell Grant Aid

	Year 1	Year 2	Year 3
A. OLS Estimates: Impacts on Contemporaneous Pell Grant Aid			
Pell Grant eligible	388.69	370.83	325.37
	(27.60)**	(25.94)**	(31.40)**
× Distance from threshold	-0.761	-0.718	-0.798
	(0.020)**	(0.023)**	(0.033)**
Observations	38,100	27,789	18,955
B. 2SLS Estimates: Impacts on Cumulative Pell Grant Aid			
First year Pell Grant aid	--	1.140	1.189
	--	(0.067)**	(0.128)**
Test coeff = 1: *p* -value	--	0.036	0.140
Mean	$1,750	$3,144	$4,310
Observations	38,100	38,100	32,271

*Note*s: Panel A: First-, second-, and third-year CUNY undergraduate degree-seeking students; 2005 through 2011 cohorts. Panel B: CUNY undergraduate degree-seeking students; 2007 through 2011 cohorts. Each column within a panel represents a separate regression. Clustered standard errors (institution by year) in parentheses; ** p<0.01, * p<0.05, + p<0.1. All regressions include controls for age, family AGI, 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), level of attendance (for federal loan eligibility purposes), degree program (AA versus BA), school by year fixed effects, and a quadratic in student expected family contribution ($\widetilde{EFC}_{it} = EFC_{it} - efc_{0t}$, where efc_{0t} is the threshold for Pell Grant eligibility in year t), allowed to vary on either side of the eligibility threshold. Panel B displays 2SLS estimates of the impact of an additional dollar of Pell Grant aid in a student's first year on cumulative Pell Grant aid two and three years after entry; excluded instruments are $\mathbf{1}[\widetilde{EFC}_{it} < 0]$ and $\widetilde{EFC}_{it} \times \mathbf{1}[\widetilde{EFC}_{it} < 0]$. Students with EFC greater than $4,000 from Pell Grant eligibility threshold are excluded. All dollar amounts adjusted to represent constant 2012$.

Table 3: The Impact of Pell Grant Aid on Borrowing

	Year 1	Year 2	Year 3
A. OLS Estimates: Impacts on Contemporaneous Borrowing			
Pell Grant Eligible	-224.45	-220.30	-336.53
	(53.76)**	(66.98)**	(88.70)**
× Distance from Threshold	0.295	0.192	0.535
	(0.075)**	(0.080)*	(0.119)**
Observations	38,100	27,789	18,955
B. 2SLS Estimates: Impacts on Contemporaneous Borrowing			
Pell Grant Aid	-0.428	-0.341	-0.723
	(0.092)**	(0.108)**	(0.139)**
Observations	38,100	27,789	18,955
C. 2SLS Estimates: Impacts on Cumulative Borrowing			
First year Pell Grant Aid	--	-0.592	-0.574
	--	(0.156)**	(0.226)*
Mean	$427	$766	$1,004
Observations	38,100	38,100	32,271
D. Crowd-out | Borrower			
Pell Grant Aid	-1.821	-1.400	-2.430
	(0.281)**	(0.353)**	(0.312)**
H_0: crowd-out > -1, *p* -value	0.002	0.129	<0.001
Observations	38,100	27,789	18,955

*Note*s: Panels A, B, and D: First-, second-, and third-year CUNY undergraduate degree-seeking students; 2005 through 2011 cohorts. Panel C: CUNY undergraduate degree-seeking students; 2007 through 2011 cohorts. Each column within a panel represents a separate regression. Clustered standard errors (institution by year) in parentheses in Panels A through C; bootstrapped standard errors (clustered at institution by year) in Panel D; ** p<0.01, * p<0.05, + p<0.1. See Table 2 for description of control variables and instruments. Panel B displays 2SLS estimates of the impact of an additional dollar of Pell Grant aid on contemporaneous borrowing, Panel C displays 2SLS estimates of the impact of an additional dollar of Pell Grant aid in a student's first year on cumulative borrowing two and three years after entry, and Panel D displays 2SLS estimates of the impact of an additional dollar of Pell Grant aid on contemporaneous borrowing scaled by the latent probability of borrowing. F-stat from test of significance of excluded instruments: 656 (Year 1), 491 (Year 2), 313 (Year 3). Students with EFC greater than $4,000 from Pell Grant eligibility threshold are excluded. All dollar amounts adjusted to represent constant 2012$.

Table 4: The Impact of Pell Grant Aid on Persistence and Educational Attainment

	Year 1	Year 2	Year 3	Year 3 Cumulative
A. Persistence				
Pell Grant Aid ($1k)	0.012	0.020	0.004	-0.002
	(0.020)	(0.018)	(0.024)	(0.023)
	[-0.03, 0.05]	[-0.02, 0.06]	[-0.04, 0.05]	[-0.05, 0.04]
Mean | Pell Grant ineligible	0.79	0.71	0.7	0.67
Observations	38,100	27,792	18,954	32,271
B. Credits attempted (academic + remedial)				
Pell Grant Aid ($1k)	0.490	0.118	0.797	0.539
	(0.266)+	(0.427)	(0.481)+	(1.190)
	[-0.03, 1.01]	[-0.72, 0.96]	[-0.15, 1.74]	[-1.79, 2.87]
Mean | Pell Grant ineligible	25.5	24.7	24.2	59.8
Observations	38,100	27,792	18,954	32,271
C. Credits earned (academic only)				
Pell Grant Aid ($1k)	0.212	0.594	0.287	0.223
	(0.410)	(0.506)	(0.484)	(1.233)
	[-0.59, 1.02]	[-0.4, 1.59]	[-0.66, 1.24]	[-2.19, 2.64]
Mean | Pell Grant ineligible	17.6	19.6	20	44.7
Observations	38,100	27,792	18,954	32,271
D. Cumulative grade point average				
Pell Grant Aid ($1k)	-0.025	-0.019	0.026	--
	(0.035)	(0.043)	(0.045)	--
	[-0.09, 0.04]	[-0.1, 0.06]	[-0.06, 0.11]	--
Mean | Pell Grant ineligible	2.65	2.71	2.81	--
Observations	34,203	26,083	18,147	--

Notes: See Table 3 notes. Persistence indicates the probability of re-enrolling the following year.

Table 5: Heterogeneity in the Impact of Pell Grant Aid on Borrowing

	1. Immigrant		2. Dependent Student		3. College Educated Parent		4. BA Degree Program	
	N	Y	N	Y	N	Y	N	Y
A. Dependent Var = Total Loans								
Pell Grant Aid	-0.613	-0.255	-0.424	-0.433	-0.457	-0.458	-0.616	-0.185
	(0.141)**	(0.115)**	(0.436)	(0.087)**	(0.118)**	(0.150)**	(0.125)**	(0.122)
Test of eq: *p*- value	0.053		0.984		0.998		0.013	
Crowd-out | borrower	-2.229	-1.294	-1.606	-1.858	-1.970	-1.877	-2.307	-0.959
	(0.348)**	(0.487)**	(1.531)	(0.253)**	(0.366)**	(0.414)**	(0.324)**	(0.550)+
H_0: crowd-out > -1, *p* -value	<0.001	0.273	0.346	<0.001	0.004	0.017	<0.001	0.470
Test of eq: *p*- value	0.628		0.957		0.962		0.507	
Observations	38,100		38,100		35,011		38,100	
B. Dependent Var = Credits Earned								
Pell Grant Aid ($1k)	0.044	0.442	3.288	-0.018	-0.069	0.720	0.178	0.507
	(0.541)	(0.553)	(1.294)*	(0.431)	(0.717)	(0.540)	(0.562)	(0.523)
Test of eq: *p*- value	0.584		0.018		0.418		0.650	
Observations	38,100		38,100		35,011		38,100	

Notes: First-year CUNY undergraduate degree-seeking students; 2007 through 2011 cohorts. Each column within a panel represents a separate regression; 2SLS estimates of the impact of an additional dollar of Pell Grant aid on contemporaneous borrowing (Panel A) or credits earned during academic year (Panel B). See Table 3 notes.

Table 6: Characterizing the Fixed Cost of Borrowing:
MLE Parameter Estimates

	Year 1	Year 2	Year 3
Desired debt d^*:			
Mean	420	-18	316
	(13)	(20)	(29)
Standard deviation	1431	2128	1975
	(0.26)	(0.44)	(1.27)
$\frac{\partial d^*}{\partial Pell}$	-0.80	-0.96	-0.82
	(0.02)	(0.02)	(0.14)
Median borrowing threshold $\underline{d}$:	3482	3014	2295
	(0.003)	(0.002)	(0.039)
Share rounding up to loan limit:	0.71	0.66	0.66
	(0.01)	(0.02)	(0.43)
Observations	20,607	14,166	6,747

Notes: First-, second-, and third-year CUNY undergraduate degree-seeking students; 2005 through 2011 cohorts subject to the exogenous subsidized loan limit. See Section 7 for description of parameters and estimation. Robust standard errors in parentheses. Students with EFC greater than $4,000 from Pell Grant eligibility threshold are excluded. All dollar amounts adjusted to represent constant 2012$.

Table 7: Observed and Counterfactual Borrowing: First-Year Students

	Empirical Moments	Counterfactual: No Fixed Cost of Borrowing	Percentage Change
Share Borrowing	0.146	0.592	305%
Mean Loan | Borrowing	$1,667	$1,540	-8%
Unconditional Mean Loan	$243	$912	274%

*Note*s: First-year CUNY undergraduate degree-seeking students; 2007 through 2011 cohorts subject to the exogenous subsidized loan limit. See Table 6 notes.

Table 8: Heterogeneity in the Impact of Pell Grant Aid on Borrowing by Availability of Online Loan Application

	Prior Borrowing		Prior Borrowing | AA Degree		Prior Borrowing | BA Degree	
	N	Y	N	Y	N	Y
Pell Grant Aid	-0.265	-0.969	-0.321	-0.205	-0.233	-1.305
	(0.066)**	(0.226)**	(0.086)**	(0.382)	(0.086)**	(0.238)**
Test of eq: *p*- value	0.003		0.783		<0.001	
Crowd-out | borrower	-1.992	-1.119	-2.488	-0.245	-1.713	-1.471
	(0.342)**	(0.233)**	(0.449)**	(0.493)	(0.450)**	(0.242)**
Test of eq: *p*- value	0.447		0.278		0.859	
H_0: crowd-out > -1, *p* -value	0.002	0.305	<0.001	0.063	0.113	0.026
Observations	46,744		20,768		25,976	

*Note*s: See Table 5 notes.