Student Loan Nudges: Experimental Evidence on Borrowing and Educational Attainment

Online Appendix

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Appendix A: Additional Tables and Figures

Figure A.1: Screen Shots From CCA Financial Aid Web Pages

A. Web page containing award and other information

My Award Package By Aid Year 2015-2016 Processing Year

General Information | Award Overview | Resources/Additional Information
Print

Your award may be adjusted due to your Satisfactory Academic Progress (SAP) status, receipt of additional external or ████ scholarships, grants, or loans, or changes in your enrollment level.

Need Calculation

Cost of Attendance	$13,504.00
Estimated Family Contribution	$1,700.00
Initial Need	$11,804.00
Outside Resource	$.00
Need	$11,804.00

Expected Enrollment

Status
Full Time

Cost of Attendance

Books and Supplies	$1,700.00
Institutional Fees	$140.00
Personal Expenses	$1,140.00
Room and Board	$6,000.00
Out of County Tuition & Fees	$3,364.00
Transportation	$1,160.00
Total:	$13,504.00

Cumulative Loan Information as of 23-APR-2015

Loan Type	Amount
Subsidized	$5,643.00
Unsubsidized	$8,934.00

Financial Aid Award by Term for the 2015-2016 Processing Year

See panels B and C

B. Award information presented to treatment group members

Financial Aid Award by Term for the 2015-2016 Processing Year

	Fall 2015		Spring 2016		
Fund	Status	Amount	Status	Amount	Total
Federal Pell Grant	Accepted	$2,063.00	Accepted	$2,062.00	$4,125.00
Direct Subsidized Loan	Offered	$1,750.00	Offered	$1,750.00	$3,500.00
Totals		$3,813.00		$3,812.00	$7,625.00

If you have questions regarding the above information, please contact the Financial Aid office.

C. Award information presented to control group members

Financial Aid Award by Term for the 2015-2016 Processing Year

	Fall 2015		Spring 2016		
Fund	Status	Amount	Status	Amount	Total
Federal Pell Grant	Accepted	$2,063.00	Accepted	$2,062.00	$4,125.00
Direct Subsidized Loan	Offered	$.00	Offered	$.00	$.00
Totals		$2,063.00		$2,062.00	$4,125.00

If you have questions regarding the above information, please contact the Financial Aid office.

Figure A.2: Information Provide to Treatment and Control Group Members via Email

A. Summary of email sent to treatment group
- The financial aid office has completed your 2015-16 financial aid award, which can be viewed by logging into [financial aid site].
- Awards are based on information in FAFSA and any other resources.
- CCA reserves the right to adjust financial aid awards award if your situation changes (e.g., due to Satisfactory Academic Progress status, receipt of additional financial aid, loan default, changes in enrollment intensity).
- "Important Notice" of aid limits:
  - Pell Grant for equivalent of 6 years of full-time enrollment
  - Subsidized loans within 150% of published length of time to degree
  - Aggregate loan limits for a bachelor's degree
  - You can log onto the National Student Loan Database to view eligibility and loan totals
- "Please note" requirement to complete loan request form to obtain loans, instructions on how to access this form.
- Contact info for financial aid office, links to financial aid site, important dates page, and policies page.

B. Summary of email sent to control group
- The financial aid office has completed your financial aid award.
- Awards based on information in FAFSA and any other resources, including (linked) National Student Loan Database System (NSLDS). Explanation that NSLDS is a database of information on federal loans and grants.
- You have not been offered a student loan at this time. If you plan to enrolling at least half time (6+ credits) and have not reached aggregate loan limit, you may request loans by completing the [linked loan request form].
- Contact the financial aid office with additional questions. Encouragement to "borrow wisely" because loan eligibility can be exhausted.
- Link to financial aid site. Invitation to call or email with questions (with link to email address).
- Instructions for navigating financial aid site and obtaining award letter.

*Note*s: This figure summarizes the information provided to members of the experimental sample following students' receipt of financial aid award letters.

Figure A.3: Online Loan Request Form

Subsidized Loan Only Request

Subsidized Loan: The interest is waived on subsidized loans while you are enrolled in school at least half-time.
Unsubsidized Loan: The interest is accumulated on unsubsidized loans after funds are applied to your student account. However, payments on interest can be postponed while you are enrolled in school at least half-time and during grace periods.
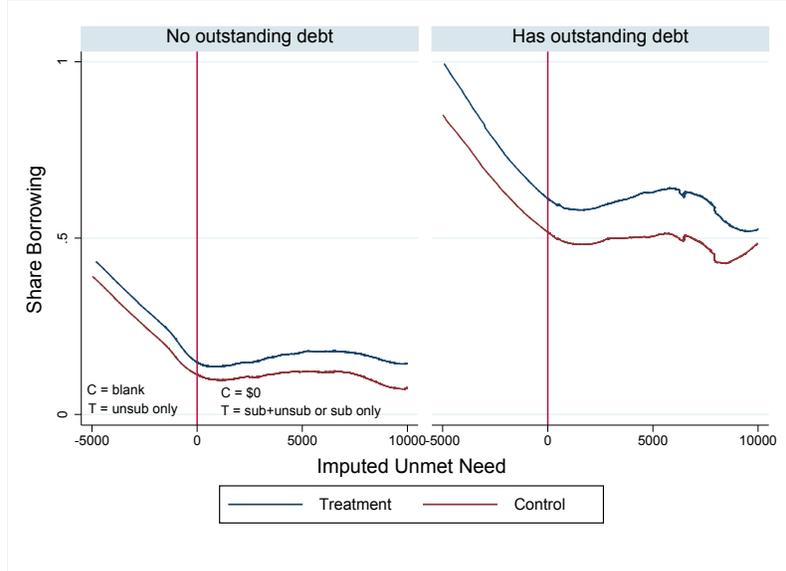
*Check here if you would like your loan processed as subsidized only, otherwise it will be processed as both subsidized and unsubsidized based on the amount you requested and your eligibility. **By answering yes to this question yout loan will be processed for either $3,500 or $4,500 dependent on your grade level.**: ○ Yes ○ No
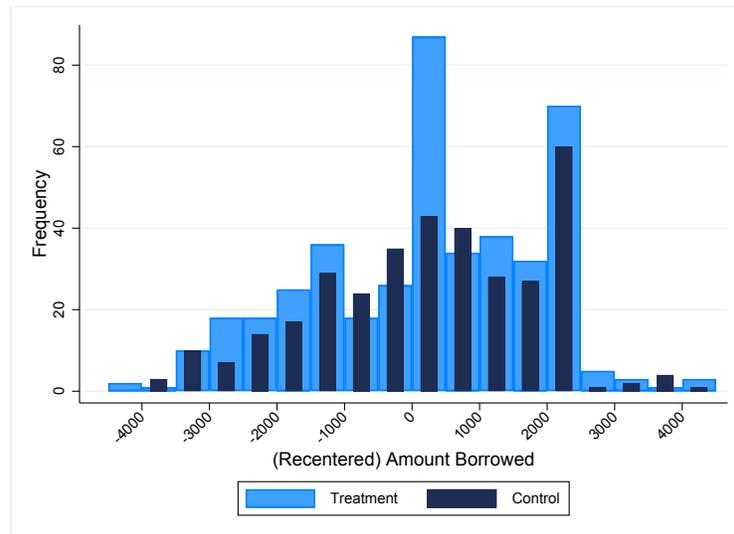
Loan Information

Enter the amount you wish to borrow via a Federal Direct Loan. The maximum amount you may be eligible for is 10,500. If you wish to borrow $4,500 then enter 4500 in the box.: [   ]

If you would like to get more information about eligibility, click here.

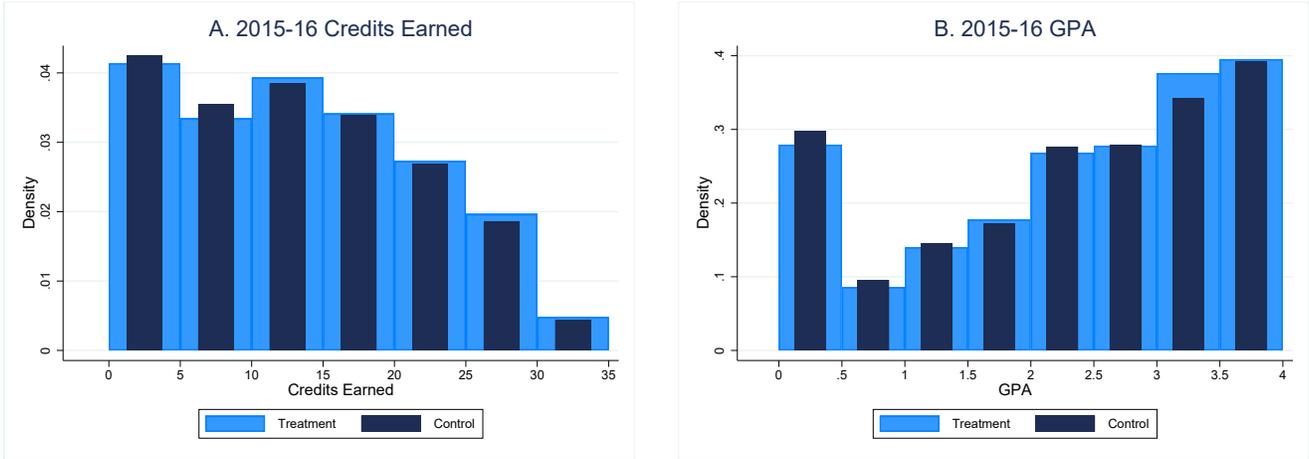Figure A.4: Explicit $0 Does Not Reduce Take-up Among Past Borrowers

Notes: Enrolled CCA students randomly assigned before October 15, 2015. Each line represents a local linear regression of the probability of borrowing on (imputed) unmet need (= gross need less EFC, grant aid, and work-study) by treatment assignment.

Figure A.5: Distribution of (Recentered) Amount Borrowed, Students with no Unmet Need

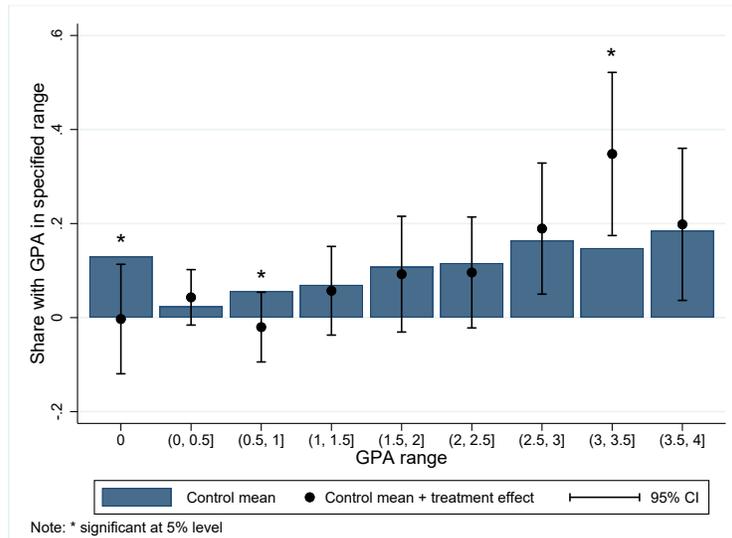*Notes*: CCA borrowers randomly assigned before February 2, 2016 who were ineligible for subsidized loans based on imputed unmet need. Amount borrowed recentered around the amount a student would have received had they been assigned to the treatment group ($3500 for freshmen and $4500 for sophomores). Light blue bars represent treatment group borrowers and dark blue bars represent control group borrowers.

Figure A.6: Distributions of Credits Earned and GPA: 2015-16 Academic Year

*Note*s: CCA borrowers randomly assigned before October 15, 2015. Light blue bars represent treatment group borrowers and dark blue bars represent control group borrowers.

Figure A.7: IV Estimates of the Impact of Borrowing on the Probability of Earning a GPA within Discrete Intervals: 2015-16 Academic Year

*Note*s: CCA borrowers randomly assigned before October 15, 2015. Dark bars represent the control group mean probability of receiving a GPA within the specified interval over the 2015-16 academic year, the estimated effect of borrowing on the receiving a GPA within the specified interval, and the corresponding 95 percent confidence interval. Treatment effects are estimated via 2SLS where assignment to treatment group serves as an instrument for the probability of borrowing.

Table A.1: Month of Random Assignment

Month packaged	Treatment Group	Control Group
May 2015	3,388	3,389
June 2015	1,145	1,151
July 2015	1,618	1,613
August 2015	1,497	1,498
September 2015	599	608
October 2015	264	257
November 2015	284	272
December 2015	397	393
January 2016	374	372
February 2016	299	306

*Note*s: CCA students who were randomly assigned before February 2, 2016.

Table A.2: Heterogeneity in the Impact of Loan Offers on Fall 2015 Enrollment

	(1) Enrolled	(2) Control group mean
A. Full sample		
1[Offered loan]	-0.006	
	(0.006)	0.722
	[-0.018, 0.006]	
B. Heterogeneity by subgroup		
No outstanding debt	-0.015	0.729
	(0.010)	
Has outstanding debt	-0.003	0.713
	(0.014)	
	[0.482]	
Pell eligible	-0.011	0.723
	(0.010)	
Pell ineligible	-0.003	0.716
	(0.016)	
	[0.694]	
New student	-0.021	0.684
	(0.018)	
Returning student	-0.004	0.736
	(0.010)	
	[0.428]	
<30 credits earned	-0.020	0.705
	(0.010)*	
30 or more credits earned	0.009	0.751
	(0.012)	
	[0.061]	
Dependent student	-0.008	0.763
	(0.013)	
Independent student	-0.011	0.693
	(0.012)	
	[0.874]	
All subgroups		
Test of equality (*p*-value)	0.416	
Test of joint significance (*p*-value)	0.482	

Notes: CCA students who were randomly assigned before the Fall 2015 semester drop/add deadline (N = 16,389). IV estimates of the impact of being offered a nonzero loan on Fall 2015 enrollment, estimated separately for each specified subgroup in Panel B. Assignment to treatment serves as an instrument for receipt of a nonzero loan offer. Upper and lower bounds from the 95 percent confidence interval displayed in brackets in Panel A. In Panel B, brackets contain *p*-values from a test of the equality of prior two subgroup estimates. Robust standard errors, clustered by strata, in parentheses; ** p<0.01, * p<0.05, + p<0.1. All regressions include controls for strata, randomization month, EFC, and baseline cumulative credits and cumulative GPA.

Table A.3: Descriptive Statistics, Attainment Sample

Characteristic	Control mean	Treatment effect
<30 credits earned	0.61	-0.008
	(0.49)	(0.009)
New	0.26	-0.004
	(0.44)	(0.008)
Independent	0.56	-0.001
	(0.50)	(0.009)
Outstanding loan debt	4171	-22
	(6435)	(118)
Expected family contribution (EFC)	3026	208
	(7769)	(165)
Pell Grant aid	3358	12
	(2181)	(40)
Work study aid	77	1
	(651)	(12)
All other grant aid	192	2
	(558)	(10)
Total other resources	50	-3
	(323)	(6)
Cumulative credits[1]	34.6	0.31
	(24.2)	(0.52)
Cumulative GPA[2]	2.76	-0.01
	(0.86)	(0.02)
Test of joint significance (p-value)		
excluding cumulative credits, GPA		0.990
including cumulative credits, GPA		0.991
Number of observations	5,920	5,854

*Note*s: Enrolled CCA students who were randomly assigned before October 16, 2015. GPA only measured for students with prior attendance at CCA. All other grant aid includes non-Pell federal grants, state grants, and institutional grants. Total other resources includes private and employer provided aid.

Table A.4: Student Cost-Benefit Calculations

Cost/Benefit to Student	CCA Treatment Effect per $4000 Borrowed	Source of Income Effect Estimates	Raw Estimates of Income Effects	Implied Effect on Real Annual Income	Assumptions
Credit completion benefit	3.7 credits	Jepsen et al. (2014)	$14 for women, $5.60 for men (quarterly, $2008)	$222 for women, $95 for men	Earnings effects begin five years after loan receipt, grow at a nominal rate of 3 percent over a 30-year career
4-year transfer benefit	11 percentage pts	Zimmerman (2014)	$1593 per enrollee ($2005)	$197.40	
Repayment cost				-500.31	4.29% interest rate, paid for first 10 years

*Note*s: The table summarizes the costs and benefits of borrowing described in Section 7.

Appendix B: Community College B Experiment

In this appendix, we describe the setting and design of the experiment that took place at Community College B (CCB). We then present preliminary estimates of the impact of loan offers on borrowing and attainment (fall semester enrollment and credits attempted).

B.1 CCB Experiment Design

In the year prior to the intervention (2014-15), CCB students were not offered loan aid. CCB only provides financial aid packages to students after they have registered for courses and sends students hard-copies of their financial aid package via mail. In addition to federal requirements (i.e., entrance counseling and completion of a master promissory note), CCB students who wish to borrow must complete several additional steps. These include filling out a budget, determining their expected future salary upon graduation and calculating estimated loan payments, and attending a one-on-one meeting with a college counselor.[1]

For the intervention, CCB's financial aid office offered students assigned to the treatment group their maximum subsidized loan and no unsubsidized loans. CCB students without subsidized loan eligibility were not included in the experimental sample. Offers continued to be made via paper award letters that were mailed to students (Figure B.1). Students in the control group did not receive an additional communications from CCB on their loan eligibility, although the school's financial aid website contained general information on federal loan programs.

CCB underperformed in terms of expected sample size. Based on past enrollment of degree-seeking students, we projected a sample size of roughly 8,000 students. However, the surprisingly small number of CCB students who completed a FAFSA and were eligible for subsidized loans reduced the number of students

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[1]The budgeting worksheet requires students to estimate their fall and spring semester education-related expenses, financial resources, and unmet need.

eligible to be included in random assignment to 2,221 and we only observe borrowing outcomes for 2,102 of these students. As shown in Table B.1, predetermined characteristics are balanced between CCB treatment and control groups.

B.2 Results

Table B.2 shows that only 74 percent of treatment group members received a nonzero loan offer. The estimated effect of a nonzero loan offer on the likelihood of borrowing is small and statistically insignificant. The corresponding 95 percent confidence interval - $[-0.015, 0.035]$ - excludes the estimated effect of the nudge within CCA. However, given the much lower borrowing rate in the CCB control group sample (6.6 percent versus 23 percent within CCA), when converted to percentage terms, we cannot rule out the possibility that effects on borrowing are the same within CCA and CCB. We find evidence of patterns of heterogeneous treatment effects in the impact of nonzero offers on borrowing that are similar to those produced in CCA (Table B.3), but we are underpowered to distinguish between effects across groups.

Given that we do not find any first-stage effects of loan offers on borrowing, we are only able to estimate reduced form impacts of loan offers on attainment. As shown in Table B.4, estimated impacts on fall semester enrollment, credits attempted, and the likelihood of part-time or full-time enrollment are negative, insignificant, and sufficiently imprecise that we cannot rule out impacts of a similar magnitude to those found in CCA.

B.3 Figures and Tables

Figure B.1: CCB Financial Aid Award Letters

A. Award information presented to treatment group members

The estimated awards below are based on full-time enrollment in aid-eligible classes. Any increase or decrease in your enrollment, for any reason, may result in a change to your award amounts. The actual amount of aid that you will receive for the fall term will be based on your enrollment in aid-eligible classes on our fall census date, September 25, 2015.

Grants and Scholarships: *Grants and scholarships are gifts that do not have to be paid back. Many scholarship opportunities are available through the ▮▮▮▮▮▮▮. Learn more and apply at ▮▮▮▮▮▮▮▮▮▮▮*

	Fall	Spring	Summer	Total
Federal Pell Grant	2888.00	2887.00	0.00	5775.00

Federal Work Study (FWS): ▮▮▮▮▮▮▮▮▮▮▮ *participates in the Federal Work-Study (FWS) program, which offers jobs to ▮▮▮ students as part of their financial aid package. If you are interested in FWS, contact the Financial Aid Office to see if you are eligible. More information about FWS and other available student employment opportunities can be found at ▮▮▮▮▮▮▮*

Federal Direct Loans (DL): Loans are a form of aid that must be paid back, with interest. ▮▮▮ encourages you to explore all other aid options before borrowing to pay for your education. If necessary, Federal Direct Loans are available to help meet your needs. Base loan amounts are $3500/year for freshmen and $4500/year for sophomores, although you can borrow less. Complete details on loan limits and eligibility requirements can be found at ▮▮▮▮▮▮▮

The following loan award is available to you. If you would like to accept this loan, visit ▮▮▮▮▮▮▮ for loan acceptance procedures.

A subsidized DL means that interest will not accrue on your loan until you enter repayment. Students may lose subsidized eligibility and benefits in some circumstances. Further information on student loans is available at: www.studenloans.gov.

	Fall	Spring	Summer	Total
DL Federal Sub Loan Fall/Spr	1750.00	1750.00	0.00	3500.00

B. Award information presented to control group members

The estimated awards below are based on full-time enrollment in aid-eligible classes. Any increase or decrease in your enrollment, for any reason, may result in a change to your award amounts. The actual amount of aid that you will receive for the fall term will be based on your enrollment in aid-eligible classes on our fall census date, September 25, 2015.

Grants and Scholarships: *Grants and scholarships are gifts that do not have to be paid back. Many scholarship opportunities are available through the ▮▮▮▮▮▮▮. Learn more and apply at ▮▮▮▮▮▮▮▮▮*

	Fall	Spring	Summer	Total
Federal Pell Grant	2888.00	2887.00	0.00	5775.00

Federal Work Study (FWS): ▮▮▮▮▮▮▮▮▮▮▮ *participates in the Federal Work-Study (FWS) program, which offers jobs to ▮▮▮ students as part of their financial aid package. If you are interested in FWS, contact the Financial Aid Office to see if you are eligible. More information about FWS and other available student employment opportunities can be found at ▮▮▮▮▮▮▮*

Table B.1: Descriptive Statistics

Characteristic	Control mean (sd)	Treatment effect (se)
<30 credits earned	0.63	0.002
	(0.10)	(0.003)
New	0.22	-0.004
	(0.07)	(0.003)
Independent	0.43	0.005
	(0.10)	(0.003)
Outstanding loan debt	1904	97
	(74)	(147)
Expected family contribution (EFC)	2390	34
	(18)	(35)
Pell Grant aid	4397	-5
	(6)	(12)
All other grant aid	906	-9
	(25)	(49)
Test of joint significance (p-value)		0.543
Number of observations	1,047	1,055

*Note*s: CCB students randomly assigned before November 6, 2015. All other grant aid includes non-Pell federal grants, state grants, and institutional grants.

Table B.2: The Impact of Nonzero Loan Offers on Borrowing

	(1) Offered loan	(2) Any borrowing	(3) Amount borrowed
A. OLS estimates			
Assigned to treatment group	0.741		
	(0.019)**		
B. IV estimates			
Offered loan		0.010	-41
		(0.013)	(70)
Observations	2,102	2,102	2,102
Mean control	0	0.066	$348

*Note*s: CCB students randomly assigned before November 6, 2015. OLS estimates of the impact of assignment to treatment on being offered a loan (Panel A) and IV estimates of the impact of being offered a loan on borrowing outcomes (Panel B), where assignment to the treatment group serves as an instrument for being offered a loan. Robust standard errors, clustered by strata, in parentheses; ** $p<0.01$, * $p<0.05$, + $p<0.1$. All regressions also include controls for strata fixed effects.

Table B.3: Heterogeneity in the Impact of Loan Offers on Borrowing

	(1) Any borrowing	(2) Amount borrowed
A. Outstanding debt		
Offered loan		
ˣ No student loan debt	-0.001	-31
	(0.012)	(61)
ˣ Outstanding student loan debt	0.054	-78
	(0.049)	(244)
Test of equality (p-value)	0.265	0.853
B. Pell Grant eligibility		
Offered loan		
ˣ Pell eligible	0.009	-49
	(0.014)	(71)
ˣ Pell ineligible	0.010	-14
	(0.033)	(178)
Test of equality (p-value)	0.978	0.854
C. Past enrollment		
Offered loan		
ˣ New student	0.009	18
	(0.032)	(159)
ˣ Returning student	0.010	-57
	(0.014)	(77)
Test of equality (p-value)	0.989	0.672
D. Class standing		
Offered loan		
ˣ <30 credits earned	-0.004	-67
	(0.016)	(70)
ˣ 30 or more credits earned	0.033	3
	(0.026)	(149)
Test of equality (p-value)	0.221	0.674
E. Dependency status		
Offered loan		
ˣ Dependent student	-0.011	-37
	(0.014)	(63)
ˣ Independent student	0.041	-46
	(0.028)	(149)
Test of equality (p-value)	0.094	0.957
Observations	2,102	2,102

Notes: CCB students randomly assigned before November 6, 2015. IV estimates of the impact of being offered a nonzero loan on the borrowing outcome specified in column. Each panel contains estimates from a separate regression. Assignment to treatment, interacted with the specified characteristics, serves as an instrument for the interaction between the receiving a nonzero loan offer and the specified characteristic. Robust standard errors, clustered by strata, in parentheses; ** p<0.01, * p<0.05, + p<0.1. Regressions also include controls for strata fixed effects.

Table B.4: The Impact of Nonzero Loan Offers on Fall 2015 Attainment

	(1) Enrolled	(2) Credits attempted	(3) ≥ 6 credits attempted	(4) ≥ 12 credits attempted
A. OLS estimates				
Assigned to treatment group	-0.019	-0.266	-0.010	-0.024
	(0.016)	(0.175)	(0.019)	(0.020)
B. IV estimates				
Offered loan	-0.025	-0.359	-0.013	-0.032
	(0.021)	(0.229)	(0.024)	(0.026)
Observations	2,102	2,102	2,102	2,102
Control mean	0.77	7.3	0.65	0.30

*Note*s: CCB students randomly assigned before November 6, 2015. Panel A contains OLS estimates of the impact of assignment to the treatment group on the specified outcome. Panel B contains IV estimates of the impact of being offered a nonzero loan on the specified outcome; assignment to the treatment group serves as an instrument for receipt of a nonzero loan offer. Robust standard errors, clustered by strata, in parentheses; ** p<0.01, * p<0.05, + p<0.1. Regressions also include controls for strata fixed effects.

Appendix C: Models

Model with default bias, information cost, and focal point

Consider a utility function $U(\ell|T)$, where ℓ is the chosen loan amount and T is an indicator for treatment with an offer of P. When $T = 0$, \$0 is offered. Utility takes the form

$$U(\ell|T) = -(\ell - \ell^*)^\alpha - Tc_a \mathbf{1}[\ell \neq P]\mathbf{1}[\ell \neq 0] - (c_d + (1-T)(c_i + c_a))\mathbf{1}[\ell \neq 0],$$

where $\ell^* \in \mathbb{R}$ is the latent desired loan amount, $\ell \geq 0$ is the amount borrowed, $c_a \geq 0$ is the cost of attending to options other than the offered amount, $c_d > 0$ is the cost of deviating from the default of zero, $c_i > 0$ is the information cost of discovering availability of federal loans, and $\alpha \in \{2, 4, 6, ...\}$.[2] Such preferences could represent the reduced form of a model in which latent borrowing demand is determined by the chosen amount of educational investment. Optimal loan amounts will take following form (without specifying a choice at points of indifference):

$$\ell = \begin{cases} 0 & T = 0, \ c_d + c_i + c_a > (\ell^*)^\alpha \\ \ell^* & T = 0, \ c_d + c_i + c_a < (\ell^*)^\alpha \\ 0 & T = 1, \ (\ell^*)^\alpha < (\ell^* - P)^\alpha + c_d \cap c_a + c_d > (\ell^*)^\alpha \\ P & T = 1, \ (\ell^*)^\alpha > (\ell^* - P)^\alpha + c_d \cap c_a > (\ell^* - P)^\alpha \\ \ell^* & T = 1, \ c_a < (\ell^* - P)^\alpha \cap c_a + c_d < (\ell^*)^\alpha \end{cases}$$

Treatment with a loan offer of P can increase the number of borrowers in two ways. First, if c_a is sufficiently large, inattentive students with $\ell^* \leq 0$ may be induced to borrow by taking up the offered amount. Second, students with $\ell^* > 0$ may not borrow when not treated, either by inattentively following the \$0 offer or because information costs are too large. Two empirical predictions offer tests for the presence of information costs and inattention, respectively.

Property 1: If $\Pr\left(\ell \in \left(0, \frac{P}{2}\right)|T = 0\right) < \Pr\left(\ell \in \left(0, \frac{P}{2}\right)|T = 1\right)$ *then there are students with* $\ell^* \in \left(0, \frac{P}{2}\right)$ *with* $c_i > 0$.

Proof: Regardless of treatment, $\ell \in \left(0, \frac{P}{2}\right)$ only if $\ell = \ell^* \in \left(0, \frac{P}{2}\right)$. If $T = 1$, students with $\ell^* \in \left(0, \frac{P}{2}\right)$ will not choose $\ell = P$ because $U(P|T = 1) = -(P - \ell^*)^\alpha - c_d < -(0 - \ell^*)^\alpha = U(0|T = 1)$. For such students, we can focus on the choice between $\ell = 0$ and $\ell = \ell^*$. $U(0|T = 0) = -(\ell^*)^\alpha = U(0|T = 1)$ is

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[2]The negative quadratic form is frequently used to model single-peaked preferences (e.g., **?**). This parsimonious model is consistent with a more general model in which the attention cost varies with the packaged amount and utility only depends on ℓ^* if the student pays the attention cost.

the utility obtained from $\ell = 0$ does not depend on treatment status, but $U(\ell^*|T = 0) = -c_d - c_a - c_i$ and $U(\ell^*|T = 1) = -c_d - c_a$. Treatment raises the utility obtained from choosing $\ell = \ell^*$ and increases the probability that it is chosen only if some of these students have $c_i > 0$.□

Property 2: Assume $c_a = 0$. For some $\delta > 0$ and all students with $\ell^* \in (P - \delta, P + \delta)$, if $\ell^* \neq P$ then $\ell \neq P$.

Proof: From the solution to the student's maximization problem, $\ell = P$ when $(\ell^*)^\alpha + c_a > (\ell^* - P)^\alpha + c_d \cap c_a > (\ell^* - P)^\alpha$. If $c_a = 0$, then $0 > (\ell^* - P)^\alpha$. The right-hand side of this expression is uniquely minimized to zero when $\ell^* = P$, and so for no other value of ℓ^* can it be that $\ell = P$.□

Property 3: For students with $c_i = 0$ and $\ell^* > 0 \cap \ell^* \neq P$, if $\ell = \ell^*$ when $T = 1$ then $\ell = \ell^*$ when $T = 0$.

Proof: From the solution to the student's maximization problem, for a student to choose $\ell = \ell^*$ when treated, $c_d + c_a < (\ell^*)^\alpha$. Because $c_i = 0$, $c_d + c_i + c_a < (\ell^*)^\alpha$, which implies that the student chooses $\ell = \ell^*$ when not treated.□

Property 4: Assume $c_i + c_a > 0$. For all students, if $\ell > 0$ when $T = 0$ then $\ell > 0$ when $T = 1$.

Proof: From the solution to the student's maximization problem, for a treated student to not borrow when treated, it is necessary that $c_d \geq (\ell^*)^\alpha$. If $c_i + c_a > 0$ then $c_d \geq (\ell^*)^\alpha \Rightarrow c_d + c_i + c_a > (\ell^*)^\alpha$, which implies that the student does not borrow when untreated.□

Anchoring model

We first consider a model with anchoring, which offers predictions that differ considerably from the other possible explanations discussed in Section 5. Let the utility function have the form

$$U(\ell|T) = -(\ell - \ell^*)^\alpha - Tc(\ell - P)^\alpha - (1 - T)c(\ell - 0)^\alpha,$$

where $\ell^* \in \mathbb{R}$ is the latent desired loan amount, $\ell \geq 0$ is the amount borrowed, $c > 0$ is a parameter affecting the cost of deviating from the offered amount, and $\alpha \in \{2, 4, 6, ...\}$. Anchoring c could arise if the offered amount is interpreted as a recommendation or generates an endowment effect at the reference point established by the offer. We consider two testable properties of this model.

Property 1: When T=1, only if $\ell^* = P$ does $\ell = P$.

Proof: $\frac{d}{d\ell}\big|_P U(\ell|T = 1) = -\alpha(\ell - \ell^*)^{\alpha-1} - \alpha T(\ell - P)^{\alpha-1} = -\alpha(P - \ell^*)^{\alpha-1}$. If $\ell = P$ and $\ell^* > P$ then the derivative is positive, and increasing ℓ would increase utility. If $\ell = P$ and $\ell^* < P$ then the derivative is negative, and decreasing ℓ would increase utility. Thus $\ell = P$ is only optimal if $\ell^* = P$.□

As Figure 4 shows, many students in the treatment group borrow exactly $\ell = P$, and this is not due to a shift in the distribution of loan amounts, suggesting that anchoring cannot be the only reason that the

loan offer affects borrowing. Among treated students, the number borrowing exactly $\ell = P$ is similar to or greater than the number borrowing any amount in a \$500 bin above or below P. This increased mass at exactly $\ell = P$ could arise because for some students P corresponds to the maximum subsidized loan, but this is also true for the control group, for which we do not see a spike at exactly $\ell = P$. Panel B of Figure 4 shows that a nonzero offer of P significantly increases the probability of borrowing exactly $\ell = P$ by a magnitude substantially larger than estimated impacts on the probability of borrowing other amounts.

Property 2: Suppose $\alpha = 2$ and $\epsilon \in \mathbb{R}^+$. If the density of ℓ^* is increasing (decreasing) over $[P, (1 + c)(P + \epsilon)]$ then the probability $\Pr(\ell \in (P, P + \epsilon))$ will be greater (lesser) when T=1 than when T=0.

Proof: For $\alpha = 2$, the first-order condition and be rearranged to show that the utility function is maximized by $\ell = \frac{\ell^* + TcP}{1+c}$. The relevant probabilities are therefore $\Pr(\ell \in (P, P + \epsilon) | T = 0) = \Pr\left(\frac{\ell^*}{1+c} \in (P, P + \epsilon)\right)$ $= \Pr(\ell^* \in ((1 + c)P, (1 + c)(P + \epsilon)))$ and $\Pr(\ell \in (P, P + \epsilon) | T = 1) = \Pr\left(\frac{\ell^* + cP}{1+c} \in (P, P + \epsilon)\right) = \Pr(\ell^* \in (P, P + (1 + c)\epsilon))$. Both the upper and lower bounds for the range of possible values of ℓ^* are decreased by cP when T=1 relative to when T=0. If the density of ℓ^* is increasing (decreasing) over the entire range then the higher values implied by T=1 occur with greater (lesser) probability.$\square$

Empirical evidence on Property 2 indicates that anchoring is limited. Though we cannot directly observe the density of ℓ^*, when the offer is \$$P$, the distribution of ℓ near \$$P$ is not greatly distorted from that of ℓ^* (as noted in Property 1). Hence we can get a sense of the slope of the latent distribution around \$$P$ from the observed distribution among students treated with an offer of \$$P$. Panel A of Figure 6 shows that the loan amount density of treated students is increasing in the range up to \$2000 above \$$P$, at least among freshmen. By property 2, this would imply that in the bin just above \$$P$ we should observe more control-group students than treatment-group students. We observe the opposite, suggesting that anchoring is limited.

Property 3: Suppose $\alpha = 2$. There exists $\epsilon \in \mathbb{R}^+$ such that if the density of ℓ^* is increasing (decreasing) over $(0, P)$ then the probability $\Pr\left(\ell \in \left(\frac{P}{2} - \epsilon, \frac{P}{2} + \epsilon\right)\right)$ will be greater (lesser) when T=0 than when T=1.

Proof: For $\alpha = 2$, the utility function is maximized by $\ell = \frac{\ell^* + TcP}{1+c}$. The relevant probabilities are therefore $\Pr\left(\ell \in \left(\frac{P}{2} - \epsilon, \frac{P}{2} + \epsilon\right) | T = 0\right) = \Pr\left(\frac{\ell^*}{1+c} \in \left(\frac{P}{2} - \epsilon, \frac{P}{2} + \epsilon\right)\right) = \Pr(\ell^* \in ((1 + c)\frac{P}{2} - (1 + c)\epsilon, (1 + c)\frac{P}{2} + (1 + c)\epsilon))$ and $\Pr\left(\ell \in \left(\frac{P}{2} - \epsilon, \frac{P}{2} + \epsilon\right) | T = 1\right) = \Pr\left(\frac{\ell^* + cP}{1+c} \in \left(\frac{P}{2} - \epsilon, \frac{P}{2} + \epsilon\right)\right) = \Pr(\ell^* \in ((1 - c)\frac{P}{2} - (1 + c)\epsilon, (1 - c)\frac{P}{2} + (1 + c)\epsilon))$. Both the upper and lower bounds for the range of possible values of ℓ^* are decreased by cP when T=0 relative to when T=1. If the density of ℓ^* is increasing (decreasing) over the entire range then the higher values implied by T=1 occur with greater (lesser) probability. The entire range is $((1 - c)\frac{P}{2} - (1 + c)\epsilon, (1 + c)\frac{P}{2} + (1 + c)\epsilon)$, and for this to be contained in $(0, P)$, it must be that $\frac{P}{2} + \epsilon \leq \frac{P}{1+c} \Leftrightarrow \epsilon \leq \frac{P}{2}$. Choose ϵ small enough that this holds.$\square$

Figures 4 and 6 show that the density is generally increasing over amounts less than P. Property 3

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therefore implies that the control group should exhibit more mass around $\frac{P}{2}$ than does the treatment group. We observe the opposite. In both figures we see that the treatment group has at least as many students as the control group who borrow at each level below P. This pattern provides another piece of evidence against the anchoring model.

The distributions of loan amounts among treatment and control groups does not support an anchoring explanation. Failure of Property 1 implies that anchoring cannot fully explain the borrowing effects, and failure of Properties 2 and 3 suggests that anchoring is limited. While there may be a small amount of anchoring that is obscured by offsetting factors, for the purpose of distinguishing between remaining possible mechanisms, we assume there is no anchoring.