Funding Instruments and Effort Choices in Higher Education

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Introduction

- Funding Higher Education has become an increasingly controversial topic.
  - In the US, the Biden administration has recently proposed to
    - Expand merit-base scholarships.
    - Create a debt-forgiveness plan.
    - Broaden community college.
  - In Chile, massive protests due to high levels of student debt led Bachelet to promise free college by 2020.
  - Countries that have adopted free college have increased enrollment but have had a limited graduation impact (Ferreyra et al., 2022).

→ **How do students react to different funding instruments?**

↪ **What are the effects on enrollment and educational outcomes?**

↪ **Does the type of instrument affect effort in Higher Education?**

How do students react to different funding instruments?

- **What is the impact of free college?** We analyze the impact of free college for the first five income deciles in Chile in 2016 (*Gratuidad*).
  - Difference-in-Differences: Enrollment and persistence (years enrolled) increases.
  - Ambiguous results on dropout and graduation rates.
    ↪ Composition effect driven by the increase in enrollment.
    ↪ Behavioral response to change in incentives (from performance-based scholarship to full, unconditional funding).
- **How to separate the effect on educational outcomes from the increase in enrollment? How do students adjust effort decisions?**
  - We build a structural model of enrollment and graduation with endogenous effort as in De Groote (2023) to account for changes in effort under different funding schemes.
    - Allows us to **separate extensive from intensive margins**.
    - Identifies marginal cost of effort and allows for **effort responses in counterfactuals**.

Literature & Contribution

- Impact of financial aid on higher education
  - Large literature of effects on enrollment: Angrist et al. (2015) and Denning (2017) found a positive effect for the US, Solis (2017) for Chile.
  - Mixed results and less evidence on educational outcomes (Dynarski (2003), Cohodes and Goodman (2014), Denning (2019) for the US, Fack (2015) for France).
    $\hookrightarrow$ **impact of free college on both enrollment and higher education outcomes.**
- Structural modeling of Educational policies
  - Effort as an exogenous stochastic process: college admission probabilities (Arcidiacono, 2005), length of studies (Beffy et al., 2012), course credits (Joensen and Mattana, 2021) .
  - Effort endogenous: Ferreyra et al. (2022) for Colombia, effort in high school and subjective beliefs (Tincani et al., 2023), De Groote (2023) on school track choices.
    $\hookrightarrow$ (WIP) **endogenizing (unobserved) effort under different funding schemes.**

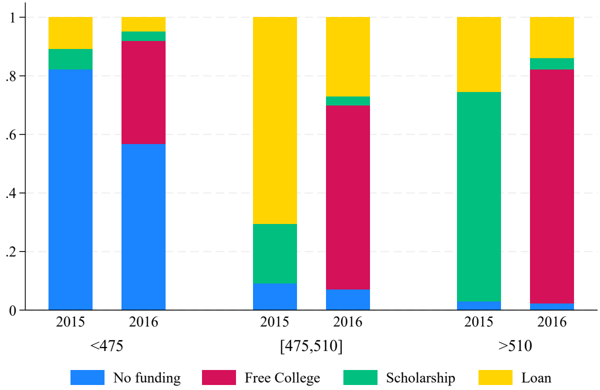
Institutional Background: Chile

- 156 institutions $\rightarrow$ 60 Universities.
- Around half in the Centralized Admission System.
- College Entrance Exam: PSU
  - Scores from 150 to 850, average is 500.
  - 2 parts are mandatory (Language and Math) and two are optional (Social and Natural Sciences).
- Avg. annual tuition is roughly 10 minimum wages.

Context and Policy: Gratuidad (2016)

- Main funding options
  - Until 2015: Merit-income based scholarships (around 510 PSU and belong to lowest 7-8 income deciles) and subsidized loans ($>$ 475 PSU).
  - From 2016: *Gratuidad* $\rightarrow$ **free college for the five lowest income deciles**; subsidized loans and scholarships maintained.
    - **No performance requirement** (unlike the merit scholarships).
    - Finances nominal length of degree, allowing degree switches.
    - Only eligible institutions (half of all universities in 2016, mostly public).
    - Extended to Short-Cycle Programs (SCP) in 2017.
- Affected relatively low-income students very differently.
  - High-ability $\rightarrow$ switched from merit scholarship ($>$ 510 PSU) covering 80% of tuition to *Gratuidad* (performance requirement removed).
  - Mean-ability $\rightarrow$ switched from subsidized loan ($>$ 475 PSU) to *Gratuidad*.
  - Low-ability $\rightarrow$ switched from no (public) funding to *Gratuidad*.

Changes in funding instruments



Funding instruments by PSU score (2015 vs 2016) for eligible students.

Decile

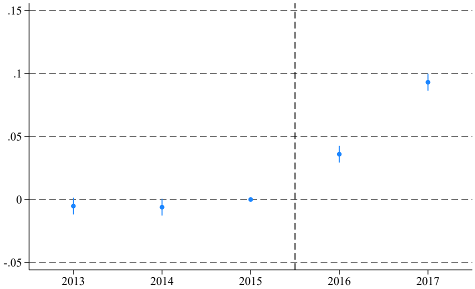
Data and Sample

- Administrative Chilean records
  1. DEMRE: Universe of students that took the national exam entry (score, demographics, enrollment).
  2. MINEDUC: College students, scholarship applications and assignment.
  3. CNED: Tuitions, vacancies, cutoffs.
- Sample: first-time test takers.
  - Cohorts 2013 to 2017 (degrees last 5 years in Chile).
  - Around 180,000 annually.

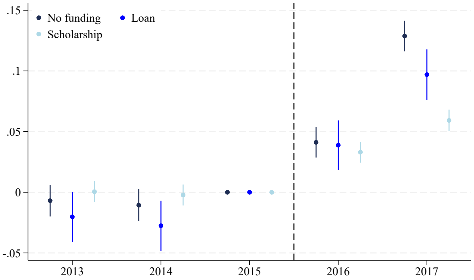
Desc

DiD: Enrollment

$$Y_{it} = \sum_t \beta_t \times \mathbb{1}\{dec_i < 6\} + \gamma\, \mathbb{1}\{dec_i < 6\} + \delta_{\mathbf{t}} + \mathbf{X}_{\mathbf{i}}'\alpha_{\mathbf{x}} + \epsilon_{\mathbf{it}}$$



Notes. OLS coefficient estimates (and their 95% confidence intervals) are reported. Mean of dep. variable: 0.62.



Notes. OLS coefficient estimates (and their 95% confidence intervals) are reported.
Mean of dep. variables: 0.47, 0.61 and 0.79, respectively.

a) Effect on enrollment

b) Effect on enrollment by funding eligibility

More

DiD: Educational outcomes

	< 510 PSU			≥ 510 PSU		
	Dropout	Graduated	Persistence	Dropout	Graduated	Persistence
2016 $\times$ Dec < 6	0.004	-0.010	0.040*	0.008**	-0.007	-0.012
	(0.006)	(0.007)	(0.023)	(0.004)	(0.006)	(0.016)
2017 $\times$ Dec < 6	-0.013**	-0.023***	0.101***	-0.017***	-0.007	0.033**
	(0.006)	(0.008)	(0.022)	(0.004)	(0.006)	(0.014)
Observations	128,171			162,535		
Mean of Dep. Variable	0.183	0.348	3.893	0.104	0.338	5.113

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Controls include degree type, PSU, gender, mother education, school type, and cohort FE.

Composition

Model

1. In periods 1 to 4, the student observes available funding instruments and decides degree $d_{it} = j$ and how much effort $e_{it} \in [0, +\infty)$ to exert.
   If she does not attain a minimum performance $\bar{g}$, she risks dropping out or fees to increase in the next period (losing scholarship).
2. From period 5, the student has a positive probability to graduate, which depends on effort.
3. In final period $t = 8$, the student drops out if she did not yet graduate and enters the labor market.

Flow utility is specified as

$$u_j(x_{it}) + \varepsilon_{ijt} = -FC_j(x_{it}, OP(x_{it}, g_{it-1})) - c_j(x_{it})e_{it} + \varepsilon_{ijt}$$

with $\varepsilon_{ijt} \sim EV1$, $c_j(x_{it}) > 0$ and out-of-pocket fees are given by

$$OP(x_{it}, g_{it-1}) = \begin{cases} (1-\lambda(x_{it}, g_{it-1}))P & \text{if the student has a scholarship,} \\ (1-\lambda(x_{it}))P & \text{otherwise .} \end{cases}$$

where λ is the fraction of the fees subsidized by the Government.
Starting 2016 $\rightarrow OP(x_{it}, g_{it-1}) = OP(x_{it}) = 0$ for students eligible to free college.
Students benefit from i) OP fees to decrease, ii) no performance requirement anymore.
The state space includes

$$x_{it} = (d_{it-1}, g_{it}, \Omega_i)$$

Performance measure

- Simultaneous decision: whether to stay enrolled $d_{it} = \{d_{it-1}, 0\}$ and effort choice e_{it}.
- Effort has an impact on performance outcomes. By increasing effort, the student can increase her probability to meet the scholarship requirements and/or avoid dropout.
- The performance measure g_{it+1} is the result of effort e_{it} and a logistically distributed shock η_{it+1}

$$g_{it+1} = \kappa \text{ if } \bar{g}^{\kappa} < \ln e_{it} + \eta_{it+1} \leq \bar{g}^{\kappa+1}$$

Effort can be interpreted as the probability to avoid the lowest outcome (dropout on the next period).

$$e_{it} = \frac{1 - \Pr(g_{it+1} = 0 | x_{it}, d_{it})}{\Pr(g_{it+1} = 0 | x_{it}, d_{it})}$$

Define the conditional value function $v_j(x_{it}, e_{it})$

$$v_j(x_{it}, e_{it}) + \varepsilon_{ijt} = u_j(x_{it}, e_{it}) + \beta \sum_{\bar{g} \in \mathcal{G}} \phi^{\bar{g}}(e_{it}) \bar{V}(x_{it+1}(\bar{g})) + \varepsilon_{ijt}$$

where $\phi^{\bar{g}}(e_{it})$ can be thought of the probability to obtain $\bar{g}$. In the last period,

$$\bar{V}(x_{it+1}(\bar{g})) = \gamma + \ln \sum_{j \in \mathcal{J}} \exp(\Psi_j(x_{t+1}(\bar{g}), wage, loan)) \text{ if } t+1 = 8$$

and could be solved recursively until period 1. $\Psi_j(x_{it+1}(\bar{g}), wage, loan)$ is the continuation value from choosing j in the last period.

Solution

De Groote (2023) shows that from the FOC,

$$\frac{\partial v_j(x_{it}, e_{it})}{\partial e_{it}} = \underbrace{\frac{\partial u_j(x_{it}, e_{it})}{\partial e_{it}}}_{=-c(x_{it})} + \beta \sum_{\bar{g} \in \mathcal{G}} \frac{\partial \phi^{\bar{g}}(e_{it})}{\partial e_{it}} \bar{V}(x_{it+1}(\bar{g})) = 0 \text{ if } e_{it} = e^*_{it}(x_{it})$$

$$c(x_{it}) = \beta \sum_{\bar{g}} \frac{\partial \phi^{\bar{g}}_{ijt}(e_{it})}{\partial e_{it}} \bar{V}(x_{it+1}(\bar{g})) \text{ if } e_{it} = e^*_{it}$$

Student chooses j with higher $v_j + \varepsilon_{ijt}$ after solving for optimal effort in each program.

Recovering treatment effects

Observed outcomes can be decomposed as the weighted average of marginal (who enroll *because* of free HE) and infra-marginal students (who would have enrolled anyway): $\bar{Y}_t = N^{-1} \sum_{i=IM} \frac{Y_{it}}{n_{IM}} + \sum_{i=MG} \frac{Y_{it}}{n_{MG}}$. The model allows to

- identify marginal and infra-marginal students: $d_{it}(FC(x_{it}, g_{it-1})) \neq d_{it}(FC'(x_{it}))$.
- compute effects on the intensive margin net of composition effects: $\sum_{i=IM} n_{IM}^{-1}(Y_{it}(FC, c) - Y_{it}(FC', c))$.
- recover optimal effort responses under different funding schemes.

Estimation

Given the Type-1 extreme value assumption, CCPs are of logit type. Following Hotz and Miller (1993),

$$p_{j't} = \frac{1}{\sum_{j \in \mathcal{J}} \exp(v_j(x_t) - v_{j'}(x_t))} \quad p_{jt} = \frac{\exp(v_j(x_t) - v_{j'}(x_t))}{\sum_{j \in \mathcal{J}} \exp(v_j(x_t) - v_{j'}(x_t))}$$

It is therefore convenient to use $j' = 0$ as an arbitrary choice and write

$$v_j(x_{it}, e_{it}) + \varepsilon_{ijt} = u_j(x_{it}, e_{it}) + \beta \sum_{\bar{g} \in \mathcal{G}} \phi^{\bar{g}}(e_{it})(v_0(x_{t+1}, e_j^*(x_{it})) - \ln(p_0)) + \beta\gamma + \varepsilon_{ijt}$$

1. Recover p_0 and $e_j^*(x_{it})$ from the data.
2. The FOC equals marginal cost to marginal benefits, that can be estimated from the data using CCPs. We can substitute the expression in v_j and estimate $FC_j(x_{it}, OP(x_{it}, g_{it-1}))$ by MLE.
3. Finally we use the estimates and the FOC to compute $c(x_{it})$.

Identification

Conclusion & next steps

- Take-away
  - Free college lowered entry barriers and increased enrollment.
  - Mixed results for intensive margin outcomes $\rightarrow$ difficult to isolate the composition effect.
  - We built on De Groote (2023) to separate impact of the extensive vs. intensive margins.
- Next steps
  - Access tax data to include first labor market outcomes $\rightarrow$ allows to control for unobserved types (Arcidiacono and Miller, 2011).
  - Access either credits completed and/or grades to have a better measure of performance.
  - Counterfactual simulations of alternative funding schemes.

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Summary statistics

	2012	2013	2014	2015	2016	2017
Enrollment						
N Students	165762	169257	169415	176027	180128	180302
Enrolled in platform	.260	.273	.280	.275	.280	.276
Enrolled out of platform	.338	.351	.346	.341	.330	.329
Not enrolled	.400	.374	.372	.382	.388	.394
Demograhics						
Family Income	3.5	3.7	3.9	4	4.1	4.5
Private School	.111	.111	.111	.109	.106	.105
Private Health	.268	.267	.268	.263	.262	.235
Father With College	.168	.169	.170	.171	.169	.184
Mother With College	.132	.132	.134	.135	.136	.139
Mother Employed	.414	.436	.460	.460	.461	.461
Funding						
Gratuidad	0	0	0	0	.236	.399
Subsidised loan	.281	.277	.273	.274	.223	.161
Other funding	.432	.515	.535	.614	.407	.254
No (public) funding	.407	.360	.346	.300	.273	.264

Notes: This table shows descriptive statistics on every student who enrolled and took the college entrance exam. Family income is categorized in 1-10 brackets.

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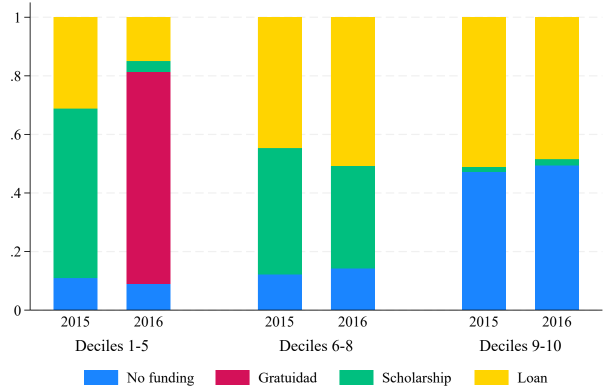
Changes in funding



Funding instruments by income decile (2015 vs 2016)

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Balance test

	2015			2016		
	Dec 6	Dec 5	p	Dec 6	Dec 5	p
Female	.51	.51	.56	.51	.52	.32
PSU	517.63	513.96	.01	508.2	508.11	.96
Employed	.03	.03	.35	.04	.04	.57
Health insurance	.17	.15	.01	.15	.15	.22
School type						
Public school	.34	.36	.02	.37	.37	.48
Voucher school	.63	.62	.24	.61	.61	.72
Private school	.04	.03	0	.03	.02	0
Mother education						
Less than secondary	.23	.29	0	.28	.3	.01
Secondary	.57	.56	.23	.56	.56	.87
Tertiary	.09	.08	.03	.08	.08	.34
University	.11	.07	0	.08	.07	0
Observations	6531	9140		5534	9581	

Sample are students who took the national exam and apply to university or SCP the year immediately after the exam

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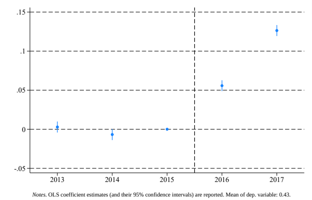
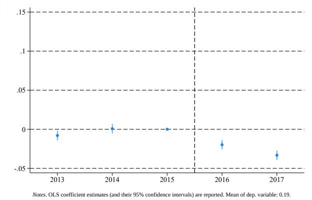
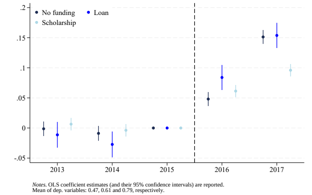


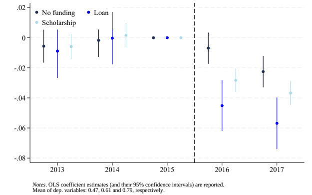
a) Eligible institutions



b) Non-eligible institutions



c) Eligible institutions by funding eligibility



d) Non-eligible institutions by funding eligibility

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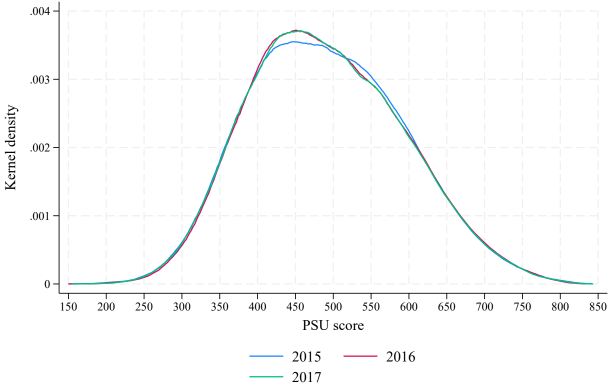
Enrollment by PSU



PSU score density

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Identification

- We fix β and normalize the utility of the outside option.
- e_{it} is recovered from conditional outcome probabilities.
- Marginal costs are identified by solving for optimal effort. Fixed costs then rationalize choices for different programs.

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2 period

Flow utility in $t = 1$ is specified as

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$$c(x_{it}) = \beta \sum_g \frac{\partial \phi^g_{ijt}(e_{it})}{\partial e_{it}} \bar{V}(x_{it+1}(g)) \text{ if } e_{it} = e^*_{it}$$

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