The Effects of Student Loans on the Market for Higher Education

Rodrigo Azuero Melo [1] David Zarruk Valencia [2]

[1]University of Pennsylvania

[2]University of Pennsylvania

November 14, 2016

Latin American and Caribbean Economic Association Meeting

Table of Contents

1. Motivation

2. The Model

3. Calibration

4. Conclusions

5. Bibliography

Question

- What are the general equilibrium effects of student loan programs on the market for higher education in developing economies?
  - Literature has studied either supply or demand of the market
  - Supply and demand are linked through quality

Question

- What are the general equilibrium effects of student loan programs on the market for higher education in developing economies?
  - Literature has studied either supply or demand of the market
  - Supply and demand are linked through quality
- What are the effects on quality supplied by elite vs non-elite education institutions?
  - **Quality:** composite of expenditures/student and average ability

Question

- What are the general equilibrium effects of student loan programs on the market for higher education in developing economies?
  - Literature has studied either supply or demand of the market
  - Supply and demand are linked through quality
- What are the effects on quality supplied by elite vs non-elite education institutions?
  - **Quality:** composite of expenditures/student and average ability
- Optimal student loan policy

Colombia: ACCES Credits

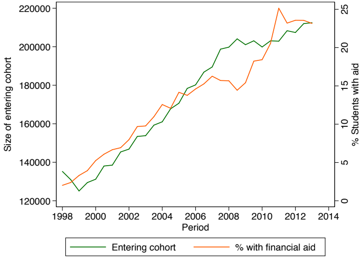

Figure: Enrollment and % of students with financial aid.

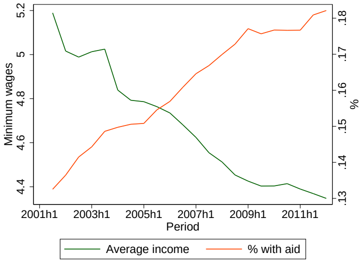

Figure: Average income and % of students with financial aid.

Colombia: Quality of Institutions

Difference between top 10 vs top 20-50 schools:

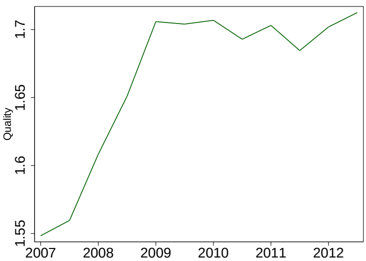

Figure: Average test scores

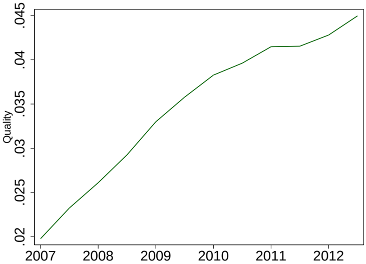

Figure: Professors per student

Our Environment

- Two tiers of institutions that differ in endowments:
  elite (top 10) vs non-elite (top 20-50) institutions
- Monopolistic competition
- Maximize quality offered subject to budget constraint
- Households maximize lifetime income, which depends on school quality

Our Hypothesis

Expansion of student loans

Our Hypothesis

Expansion of student loans

$$\Downarrow$$

Stronger demand response for elite schools

Our Hypothesis

Expansion of student loans

$\Downarrow$

Stronger demand response for elite schools

$\Downarrow$

Elite schools increase tuition and expenditures per student more

Our Hypothesis

Expansion of student loans

$\Downarrow$

Stronger demand response for elite schools

$\Downarrow$

Elite schools increase tuition and expenditures per student more

$\Downarrow$

(If expenditures and average student ability are complements)

Quality of elite schools increases more

What Do We Know?

From a partial equilibrium perspective:

- Keane and Wolpin (2001); Carneiro and Heckman (2002):

  In the U.S. borrowing constraints do not affect enrollment rates

  $\Rightarrow$ student loans have no effect on enrollment

- Attanasio and Kaufmann (2009); Kaufmann (2014); Melguizo et al. (2015):

  In developing economies, as Mexico and Colombia, borrowing constraints affect enrollment $\Rightarrow$ student loans increase enrollment

What Do We Know?

From a general equilibrium perspective:

- Epple et al. (2006); Chade et al. (2014): university sorting with fixed preferences
- William Bennett, former Secretary of Education:
  "If anything, increases in financial aid in recent years have enabled colleges [...] to raise their tuitions, confident that Federal loan subsidies would help cushion the increase"
- Gordon and Hedlund (2015):
  Student loan policies explain tuition increases

Table of Contents

1. Motivation

2. The Model

3. Calibration

4. Conclusions

5. Bibliography

Household's Problem

- Born with innate ability and wealth $(\theta, b) \sim F(\theta, b)$

Household's Problem

- Born with innate ability and wealth $(\theta, b) \sim F(\theta, b)$
- Live for 2 periods

Household's Problem

- Born with innate ability and wealth $(\theta, b) \sim F(\theta, b)$
- Live for 2 periods
- In period 1:
  - Consume save at an exogenous risk free rate r
  - Study at school $j \in \{l, h\}$ and pay tuition P^j or work at market wage θw
  - Those who study and have $\theta \geq \theta_{min}$ can access student loans up to P^j at a rate $R \geq r$
  - Those who study and have $b \leq b_{max}$ at rate $R(1 - s)$

Household's Problem

- Born with innate ability and wealth $(\theta, b) \sim F(\theta, b)$
- Live for 2 periods
- In period 1:
  - Consume save at an exogenous risk free rate r
  - Study at school $j \in \{l, h\}$ and pay tuition P^j or work at market wage θw
  - Those who study and have $\theta \geq \theta_{min}$ can access student loans up to P^j at a rate $R \geq r$
  - Those who study and have $b \leq b_{max}$ at rate $R(1 - s)$
- In period 2:
  - Earn wage $w\theta(1 + z^j)$

▸ Problem

Characterization of the Demand

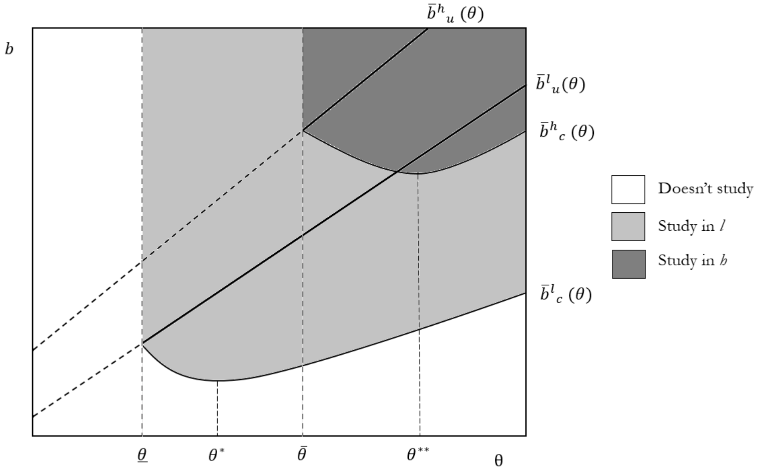

Figure: Representation of the education decisions on the state space.

Characterization of the Demand

- Unconstrained households with higher θ, ceteris paribus, choose higher education
- Constrained cut-offs are increasing in θ:
  - Individuals with higher θ will have higher lifetime income $\Rightarrow$ will consume more every period
  - To be unconstrained, they need higher b
- Among constrained individuals, there are two effects that determine the cut-off:
  - "Complementarity" effect: individuals with higher θ have incentives to choose better schools
  - "Constrainedness" effect: individuals with higher θ have higher wedges on Euler equation, so have incentives to not educate

Optimal Policy

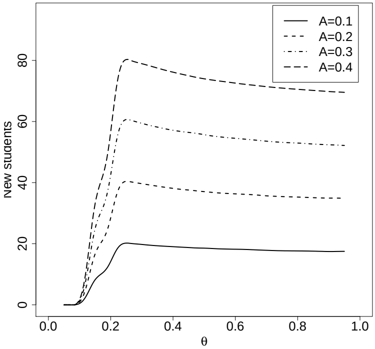

Figure: Number of students that change their study decision when borrowing constraints change from $\bar{A} = 0$ to $\bar{A}$, by ability θ.

Optimal Policy

- Two forces for constrained individuals:
  1. Studying at better schools $\Rightarrow$ higher future wages (+)
  2. Studying increases wedge on the Euler equation (-)

- Decreasing marginal utility makes motive 1. stronger for low-θ individuals

- $\Rightarrow$ From partial equilibrium perspective, optimal policy would lend to less able individuals

Universities' Problem

- Two universities
- Non-profit organizations
- Set tuition, ability cut-offs and investments per student to:
- Maximize composite of:
  - Quality offered
  - Income diversity of student body
- Subject to budget constraint
- Universities act simultaneously - Nash equilibrium

▸ Problem

Optimal Policy

- Increasing proportion of low-θ individuals reduces equilibrium quality of institutions
- From supply side, optimal policy would relax borrowing constraints to high-θ individuals
- $\Rightarrow$ from a general equilibrium perspective, optimal policy will be something in between

Equilibrium

An equilibrium are tuition prices, ability cut-offs, investments per student, government policies and allocations such that:

1. Households choose optimally their education, consumption and savings
2. Universities solve their problem optimally on a Nash game, given the households' behavior
3. Government has budget balance

Table of Contents

1. Motivation

2. The Model

3. Calibration

4. Conclusions

5. Bibliography

Target

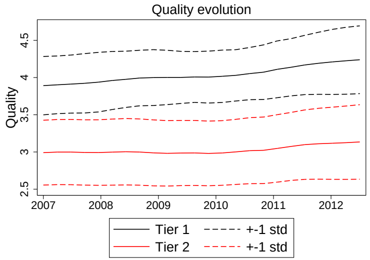

FIGURE: Estimated quality of tier 1 and tier 2 universities.

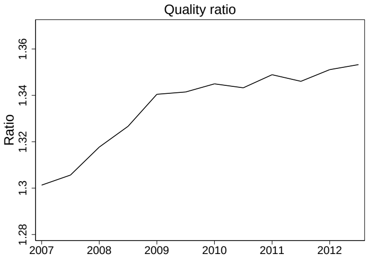

FIGURE: Quality ratio of tier 1 versus tier 2 universities.

Parameters

Parameter	Value	Source
Utility and discount		
β	0.97	Literature
σ	2	Literature
r	2%	Colombia
w	2	Normalization
Time parameters		
T	78	Colombia
S	5	Colombia
University parameters		
α_1	0.211	Estimation
α_2	0.358	Estimation
κ_l	1.4	Estimation
κ_h	1.2	Estimation
$E^h - C^h$	-12	Estimation
$E^l - C^l$	-7	Estimation

Table: Parameter values

Embedding Life-Cycle in 2-Period Model

- Assuming that individuals have perfect access to credit markets after they graduate from college:

$$\sum_{t=S}^{T} \beta^{t-S} u(c_t) = \Phi_S u(c_S), \qquad \sum_{t=0}^{S} \beta^{t} u(c_t) = \Phi_0 u(c_0)$$

Embedding Life-Cycle in 2-Period Model

- Assuming that individuals have perfect access to credit markets after they graduate from college:

$$\sum_{t=S}^{T} \beta^{t-S} u(c_t) = \Phi_S u(c_S), \qquad \sum_{t=0}^{S} \beta^{t} u(c_t) = \Phi_0 u(c_0)$$

$$\Phi_0 = \frac{1 - \left(\frac{\beta}{(1+r)^{\sigma-1}}\right)^{\frac{S}{\sigma}}}{1 - \left(\frac{\beta}{(1+r)^{\sigma-1}}\right)^{\frac{1}{\sigma}}}, \qquad \Phi_S = \frac{1 - \left(\frac{\beta}{(1+r)^{\sigma-1}}\right)^{\frac{T-S+1}{\sigma}}}{1 - \left(\frac{\beta}{(1+r)^{\sigma-1}}\right)^{\frac{1}{\sigma}}}$$

Embedding Life-Cycle in 2-Period Model

- Assuming that individuals have perfect access to credit markets after they graduate from college:

$$\sum_{t=S}^{T} \beta^{t-S} u(c_t) = \Phi_S u(c_S), \qquad \sum_{t=0}^{S} \beta^{t} u(c_t) = \Phi_0 u(c_0)$$

$$\Phi_0 = \frac{1 - \left(\frac{\beta}{(1+r)^{\sigma-1}}\right)^{\frac{S}{\sigma}}}{1 - \left(\frac{\beta}{(1+r)^{\sigma-1}}\right)^{\frac{1}{\sigma}}}, \qquad \Phi_S = \frac{1 - \left(\frac{\beta}{(1+r)^{\sigma-1}}\right)^{\frac{T-S+1}{\sigma}}}{1 - \left(\frac{\beta}{(1+r)^{\sigma-1}}\right)^{\frac{1}{\sigma}}}$$

- Life-cycle problem can be embedded in 2-period model by:

$$\tilde{\beta} = \frac{\beta^S \Phi_S}{\Phi_0}$$

Computation

- Given $P^j, \underline{\theta}^j, I^j$, compute the fixed point z^l, z^h in household's and firm's problem:
  - Start with a guess for z^l, z^h
  - Solve household's problem and aggregate students attending each school
  - Compute the quality supplied by schools using the aggregates
  - If z^l, z^h are close to the qualities supplied, stop. Otherwise, try new guess
- For each j, solve the university's problem given $P^i, \underline{\theta}^i, I^i, z^l, z^h$.
- If optimal $P^j, \underline{\theta}^j, I^j$ are close to initial guess, stop. Otherwise, try new guess

Preliminary Results

Reform: increase borrowing limit from $\bar{A} = 0$ to $\bar{A} > 0$:

Table: Equilibrum computations

		Pre-reform	Post-reform
Elite institutions	Students attending	0.29	0.47
	Average ability of student body	0.48	0.64
	Quality offered	1.01	1.19
Non-elite institutions	Students attending	0.35	0.34
	Average ability of student body	0.41	0.38
	Quality offered	0.53	0.42

Table of Contents

1. Motivation

2. The Model

3. Calibration

4. Conclusions

5. Bibliography

Conclusions

- We characterize the market for higher education when there are two tiers of schools
- Quality is an endogenous link between supply and demand
- We study general equilibrium effects of student loan policies on quality supplied by colleges
- Student loan policies have secondary pervasive effects that the literature has not studied: tuition prices and quality offered

Table of Contents

1. Motivation
2. The Model
3. Calibration
4. Conclusions
5. Bibliography

Bibliography

Attanasio, O. P. and Kaufmann, K. M. (2009). Educational choices, subjective expectations and credit constraints. *NBER Working Papers*.

Carneiro, P. and Heckman, J. J. (2002). The evidence on credit constraints in post-secondary schooling. *The Economic Journal*.

Chade, H., Lewis, G., and Smith, L. (2014). Student portfolios and the college admissions problem. *Review of Economic Studies*.

Epple, D., Romano, R., and Sieg, H. (2006). Admission, tuition and financial aid policies in the market for higher education. *Econometrica*.

Gordon, G. and Hedlund, A. (2015). Accounting for the rise in college tuition. *NBER Chapters*.

Kaufmann, K. M. (2014). Understanding the income gradient in college attendance in mexico: the role of heterogeneity in expected returns. *Quantitative Economics*.

Keane, M. P. and Wolpin, K. (2001). The effect of parental transfers and borrowing constraints on educational attainment. *International*

Household's Problem

$$
\begin{aligned}
V^j(\theta, b) = \max_{c,a} \quad & u(c) + \beta u(c'), \quad \text{s.t.} \\
& c + a + P^j = b \cdot (1 - \tau) \\
& c' = a(1+r) \cdot 1_{\{a \geq 0\}} + a(1+\tilde{R}) \cdot 1_{\{a<0\}} + w\theta(1 + z^j) \\
& \tilde{R} = \begin{cases} R(1-s) & \text{if } b \leq b_{max} \\ R & \text{if } b > b_{max} \end{cases} \\
& a \geq -1_{\{\theta \geq \theta_{min}\}} \cdot P^j, \quad c \geq 0, \quad c' \geq 0
\end{aligned}
$$

$$
\begin{aligned}
V^N(\theta, b) = \max_{c,a} \quad & u(c) + \beta u(c'), \quad \text{s.t.} \\
& c + a = b \cdot (1 - \tau) + w\theta \\
& c' = a(1+r) + w\theta \\
& a \geq 0, \quad c \geq 0, \quad c' \geq 0
\end{aligned}
$$

Household's Problem

$$V(\theta, b) = \begin{cases} \max\{V^h(\theta, b), V^l(\theta, b), V^N(\theta, b)\} \text{ if } \theta \geq \max\{\underline{\theta}^h, \underline{\theta}^l\} \\ \max\{V^j(\theta, b), V^N(\theta, b)\} \text{ if } \underline{\theta}^{-j} > \theta \geq \underline{\theta}^j \\ V^N(\theta, b)\} \text{ if } \theta < \min\{\underline{\theta}^h, \underline{\theta}^l\} \end{cases}$$

Go back

Universities' Problem

$$\max_{P^j, \underline{\theta}^j} \quad \left(z^j\right)^{\alpha} \left(\sigma_b^j\right)^{1-\alpha} \qquad \text{subject to:}$$

$$z^j = \tilde{\theta^j}^{\alpha_1} (I^j)^{\alpha_2}$$

$$\tilde{\theta^j} = \int_{\Theta \times B} \theta \cdot e^j(\theta, b) dF(\theta, b)$$

$$I^j \cdot N^j + V^j(N^j) + C^j = P^j \cdot N^j + E^j$$

$$N^j = \int_{\Theta \times B} s^j(\theta, b) dF(\theta, b)$$

- Investments per student: I^j
- Minimum ability cut-off: $\underline{\theta}^j$
- Tuition: P^j

Go back