Redesigning Federal Student Aid in Higher Education

Luis Armona, Shengmao Cao
Stanford University
December 31, 2021

AEA CSMGEP Dissertation Session 2022
Motivation

• Direct-to-student aid comprises 20% of public higher education spending, through a combination of grants and loans [OECD, 2016].

• Scope for misuse of aid:
  • Low return on investment if school is low quality.
  • Under imperfect competition, private colleges may capture aid via markups.
Motivation

- Direct-to-student aid comprises 20% of public higher education spending, through a combination of grants and loans [OECD, 2016].
- Scope for misuse of aid:
  - Low return on investment if school is low quality.
  - Under imperfect competition, private colleges may capture aid via markups.
- Prior literature highlights deficiencies of U.S. aid design:
  - Largest beneficiaries (for-profit colleges) are low quality schools.
  - Aid design allows for colleges to receive more aid by increasing prices.
Motivation

• Direct-to-student aid comprises 20% of public higher education spending, through a combination of grants and loans [OECD, 2016].

• Scope for misuse of aid:
  • Low return on investment if school is low quality.
  • Under imperfect competition, private colleges may capture aid via markups.

• Prior literature highlights deficiencies of U.S. aid design:
  • Largest beneficiaries (for-profit colleges) are low quality schools.
  • Aid design allows for colleges to receive more aid by increasing prices.

• This paper: Evaluate alternative aid policies via a structural model of U.S higher education to improve student welfare.
Market Background

- Setting: Sub-baccalaureate (non-selective) colleges (35% of college enrollment).
Market Background

- Setting: Sub-baccalaureate (non-selective) colleges (35% of college enrollment).
- Government intervention in the U.S. sub-baccalaureate education market:
  - Means-tested student aid programs, funded by federal government. Low-income students have access to pell grants, all students have access to subsidized federal loans. Aid increases with cost of school.
  - Community Colleges (CCs), funded by state and local governments, offer education at subsidized tuition levels.
Market Background

- Setting: Sub-baccalaureate (non-selective) colleges (35% of college enrollment).
- Government intervention in the U.S. sub-baccalaureate education market:
  - Means-tested student aid programs, funded by federal government. Low-income students have access to pell grants, all students have access to subsidized federal loans. Aid increases with cost of school.
  - Community Colleges (CCs), funded by state and local governments, offer education at subsidized tuition levels.
- Private providers of education are overwhelmingly for-profit institutions (FPIs)
  - FPIs are typically smaller and specialize in vocational training programs.
  - Attract students via advertising: comprises 43.4% of total spending on student services.
  - Receive 74% of revenue from federal student aid programs.
Datasets

- **Sample**: All non-selective, sub-baccalaureate colleges in top 101 DMAs (metro areas) from 2008-2016.

- **School Characteristics/Enrollment**: IPEDS Survey. Participation mandated for all aid-eligible postsecondary schools in U.S.

- **Advertising Data**: Ad$ponder dataset (DMA-level).

- **Consumer Demographics**: ACS Census Data.

- **Student Outcomes**: College Scorecard. Cohort-level earnings from IRS for federal aid recipients.
Summary Statistics: Higher Education Prices + Advertising

Tuition + Fees (2017 $)

Community Colleges For-Profit Colleges IQR

Annual Ad Spending in Local Market (2017 $)

Community Colleges For-Profit Colleges IQR
Summary Statistics: Value Added, By School Type

- Estimate quality as value-added in post-college earnings at each school chain.
- Assume selection on observables.
- Identify level of value-added by constructing measure of counterfactual wages if cohort only completed high school.

Other Value-Added Measures

[Graph showing density and school value added in earnings for Community Colleges and For-Profit Colleges]
Model: Demand Side

- Market Definition: All working age (18-50) individuals with high-school education.
- Choice set: all sub-baccalaureate, non-selective schools in home county.
Model: Demand Side

- Market Definition: All working age (18-50) individuals with high-school education.
- Choice set: all sub-baccalaureate, non-selective schools in home county.

Individual $i$ chooses school $j$ (or outside option) that maximizes utility

$$u_{i,j,t} = -\alpha_i p_{i,j,t}(\beta_i) + \lambda_i \log(a_{f(j),t} + 1) + \tilde{\gamma}_i \vec{X}_{j,t} + \delta_j + \xi_{j,t} + \epsilon_{i,j,t}$$

- Utility depends on the following school characteristics:
  - Prices: $p_{i,j,t}$, the net price a student pays.
  - Observables: FPI TV advertising $a_{f,t}$, student services, degree types, quality.
  - Unobservable Characteristics: $\delta_j, \xi_{j,t}, \epsilon_{i,j,t}$.

- Preferences depend on:
  - Age, Race, Gender, Low-Income Status,
  - Random unobserved heterogeneity $\sim N(0, \sigma^2_k)$ for each characteristic $k$. 
Model: Demand Side

- Market Definition: All working age (18-50) individuals with high-school education.
- Choice set: all sub-baccalaureate, non-selective schools in home county.

Individual $i$ chooses school $j$ (or outside option) that maximizes utility

$$u_{i,j,t} = -\alpha_i p_{i,j,t}(\beta_i) + \lambda_i \log(a_{f(j)},t + 1) + \gamma_i X_j,t + \delta_j + \xi_j,t + \epsilon_{i,j,t}$$

- Student net price $p_{i,j,t}$: NPV of all payments to attend college. depend on student characteristics, cost of attendance, government aid, and how students discount loans:

$$p_{i,j,t}(\beta_i) = OOP_{i,j,t} + \beta_i L_{i,j,t}$$

  - $OOP_{i,j,t}$: out-of-pocket cost, after receiving Pell grants. Capped at $EFC_i$.
  - $L_{i,j,t}$: loan amount+interest needed to pay cost of attendance.
  - $\beta_i$: Net discount factor $\in [0,1]$ on 10-year loans.
Model: Supply Side

- For-Profit colleges choose tuition $p_{j,t}$ and advertising $a_{f,t}$ to maximize static chain-level profits, given constant marginal costs and linear fixed advertising costs.
Model: Supply Side

- For-Profit colleges choose tuition $p_{j,t}$ and advertising $a_{f,t}$ to maximize static chain-level profits, given constant marginal costs and linear fixed advertising costs.
- Community Colleges choose tuition $p_{j,t}$ to satisfy a budget constraint, given constant marginal costs and observed budget from state to subsidize students.
Model: Estimation Strategy

- Estimate model using GMM, with micromoments on student demographic sorting and survey data on discount rates.
- Construct 3 instruments to identify preferences for endogenous supply variables.
Model: Estimation Strategy

- Estimate model using GMM, with micromoments on student demographic sorting and survey data on discount rates.
- Construct 3 instruments to identify preferences for endogenous supply variables.

- **FPI Prices**: Simulated pell grant generosity. [Details]
- **CC Prices**: 4-year public college tuition. [Details]
- **FPI Advertising**: Political advertising [Details]
Model: Estimation Strategy

- Estimate model using GMM, with micromoments on student demographic sorting and survey data on discount rates.
- Construct 3 instruments to identify preferences for endogenous supply variables.
  
  - **FPI Prices**: Simulated pell grant generosity.
  

  - **CC Prices**: 4-year public college tuition.

  - **FPI Advertising**: Political advertising
Model: Estimation Strategy

- Estimate model using GMM, with micromoments on student demographic sorting and survey data on discount rates.
- Construct 3 instruments to identify preferences for endogenous supply variables.
  
  - **FPI Prices**: Simulated pell grant generosity. Details
  
  - **CC Prices**: 4-year public college tuition. Details

Using dependence of CCs on state aid, use prices of state-owned schools in another market (geographically distant 4-year colleges) as a measure of state policy changes towards education funding.

- **FPI Advertising**: Political advertising Details
Model: Estimation Strategy

- Estimate model using GMM, with micromoments on student demographic sorting and survey data on discount rates.
- Construct 3 instruments to identify preferences for endogenous supply variables.

- **FPI Prices**: Simulated pell grant generosity. Details
- **CC Prices**: 4-year public college tuition. Details
- **FPI Advertising**: Political advertising Details

Estimate the effect of cost shock on monthly FPI advertising. Use schools’ advertising propensities in different parts of year to generate within-market variation in political ad shock exposure.
Overview: Model Results

- Students are less price elastic to tuition (-1.2) than net price (-3.2).
- Low-income students less tuition/net price elastic due to low passthrough from tuition to net price and lower net prices, respectively.
- Low average valuation of quality ($1000 increase in annual earnings = $33), high valuation of FPI advertising (10% increase = $80)
- High markups / state subsidies explain difference between CC and FPI prices.
Counterfactual Policies

- Counterfactual policies considered:
  - Aid Bans
  - Vouchers
Counterfactual Policies

- Counterfactual policies considered:

  - **Aid Bans**:
    1. **For-Profit Ban**: Ban for-profit education sector from federal aid
    2. **Gainful Employment Ban**: Ban low quality schools from federal aid ($\psi_j < 0$, 23% of schools)

Forms of both have been proposed by national policymakers. Hold government spending constant by increasing pell grant generosity.

- **Vouchers**
Counterfactual Policies

- Counterfactual policies considered:
  
  - **Aid Bans**
  
  - **Vouchers**: Eliminate current aid system, and give low income students a cash transfer to attend a school.
    
    1. **Fixed voucher**: Equal size transfer regardless of school.
    
    2. **Optimal Quality Voucher**: Solution to social planner problem of maximizing total value added. Give more voucher aid to schools with higher quality. Conditional on quality, give more aid to schools whose enrollment is more elastic to aid.
Counterfactual Policies

• Counterfactual policies considered:
  
  • Aid Bans
  
  • Vouchers

• Evaluate alternative policies based on two metrics, capturing student taste for schooling environment and the quality of education delivered:
  
  • Revealed Choice Consumer Surplus: expected utility in dollars
  
  • Expected Value-added: expected quality for individual $i$ in market $t$. 
Counterfactual Outcomes

Percent Change in Expected Value Added vs. Percent Change in Consumer Surplus

- Current Equilibrium
- FPI Ban
- GE Ban
- Fixed Voucher
- Optimal Voucher

No Advertising CS  Low-Income Consumer Outcomes  Enrollment Response to Optimal Voucher  Supply Response to Optimal Voucher
• Existing policy proposals do little to improve student outcomes.
• Vouchers increase consumer surplus and quality of education. Effect is largest for targeted students.
• Policymakers can maximize education quality by incentivizing high-quality FPIs to attract students.


Counterfactual Outcomes (Exclude Advertising in CS)

The graph shows the percent change in expected value added on the y-axis and the percent change in consumer surplus (no ads) on the x-axis. The different scenarios are represented by various markers:

- Current Equilibrium
- FPI Ban
- GE Ban
- Fixed Voucher
- Optimal Voucher

The plot indicates the outcomes of excluding advertising in the context of consumer surplus and expected value added.
Low-Income Counterfactual Outcomes

Percent Change in Expected Value Added

Percent Change in Consumer Surplus

Current Equilibrium  FPI Ban  GE Ban  Fixed Voucher  Optimal Voucher
Federal Pell Grant Policy over time

<table>
<thead>
<tr>
<th>Year</th>
<th>Max Pell Grant</th>
<th>Max EFC Pell Eligibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>$2006</td>
<td>$4000</td>
</tr>
<tr>
<td>2008</td>
<td>$2008</td>
<td>$4500</td>
</tr>
<tr>
<td>2010</td>
<td>$5000</td>
<td>$5000</td>
</tr>
<tr>
<td>2012</td>
<td>$5500</td>
<td>$5500</td>
</tr>
<tr>
<td>2014</td>
<td>$6000</td>
<td>$6000</td>
</tr>
<tr>
<td>2016</td>
<td>$6500</td>
<td>$6500</td>
</tr>
</tbody>
</table>

Year vs. 2017 USD

- **Max Pell Grant**
- **Max EFC Pell Eligibility**

Go back
## Student Loan Policy over time

<table>
<thead>
<tr>
<th>Year</th>
<th>Subsidized Federal Loans</th>
<th>Unsubsidized Federal Loans</th>
<th>Private Market Loans</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>8.0%</td>
<td>6.0%</td>
<td>8.0%</td>
</tr>
<tr>
<td>2010</td>
<td>6.0%</td>
<td>4.0%</td>
<td>6.0%</td>
</tr>
<tr>
<td>2012</td>
<td>4.0%</td>
<td>2.0%</td>
<td>4.0%</td>
</tr>
<tr>
<td>2014</td>
<td>2.0%</td>
<td>0.0%</td>
<td>2.0%</td>
</tr>
<tr>
<td>2016</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Subsidized Loan Limit</th>
<th>Unsubsidized Loan Limit (Dependents)</th>
<th>Unsubsidized Loan Limit (Independents)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>46,000</td>
<td>60,000</td>
<td>80,000</td>
</tr>
<tr>
<td>2010</td>
<td>46,000</td>
<td>60,000</td>
<td>80,000</td>
</tr>
<tr>
<td>2012</td>
<td>46,000</td>
<td>60,000</td>
<td>80,000</td>
</tr>
<tr>
<td>2014</td>
<td>46,000</td>
<td>60,000</td>
<td>80,000</td>
</tr>
<tr>
<td>2016</td>
<td>46,000</td>
<td>60,000</td>
<td>80,000</td>
</tr>
</tbody>
</table>

The graphs show the APR (%) and Loan Limit (2017 USD) over time, with different loan types (Subsidized Federal Loans, Unsubsidized Federal Loans, and Private Market Loans) and loan limits for Dependents and Independents.
Price Identification - Pell Grants

- FPI tuitions tracks federal aid generosity ($\widetilde{\pi}_t$). Consistent with the Bennett hypothesis studied in education research [Cellini and Goldin, 2014, Turner, 2014, ?].

Note: Prices weighted by enrollment, adjusted to 2017 USD
FPI Prices: Simulated Pell Grant Generosity Instrument

• use a *shift-share* design with simulated instrument capturing Pell Grant generosity.

• Idea: $E[\bar{\pi}_{i,t} \mid t]$ captures generosity in market $t$, but endogenous to current labor market conditions.

• Instead: Simulate generosity from policy in year corresponding to market $t$, given pre-period (2006) demographics in county $c$:

\[
Z_{j,t}^{\pi} = E[\bar{\pi}_{i,t} \mid i \sim F(EFC_c,2006), \text{Pell Grant Policy in } t] = \int_i \max(\bar{\pi}_t - EFC_i, 0) \partial F(EFC_c,2006)
\]

• Intuition: national increases in pell grant aid induce higher FPI prices. FPIs located in historically poorer areas more likely to respond.
For-Profit College Tuition Instrument Binscatter

\[ \beta = 2.277 \text{ (F-Stat=241.93)} \]

Number of Bins = 22
Community College Prices: Hausman Instrument

- CCs receive on average 1/3 of annual revenue from state governments.
- Construct a “cost shock” instrument for CCs: price changes at schools owned by state in another market. (4 year schools $\geq$ 100 miles away).
• CCs receive on average 1/3 of annual revenue from state governments.

• Construct a “cost shock” instrument for CCs: price changes at schools owned by state in another market. (4 year schools $\geq$ 100 miles away).

• “Other market” in two senses:
  • Geographically distant (79th percentile for 4-year students, 95th percentile for CC students)
  • Cater to different students (only 23% of CC students apply to public 4-year)

• Intuition: Both schools depend on state for funding, subject to different demand shocks.
Community College Tuition Instrument Binscatter

Average Public 4-year Tuition >100 Miles Away

\[ \beta = 0.287 \ (F-\text{Stat}=228.31) \]

Number of Bins = 34
Estimate nonlinear effect $f$ of political ads on FPI ads using monthly data:

$$\log(a_{f,d,m,t} + 1) = \alpha_{f,d} + \delta_t + \beta X_{f,t,d} + f(P_{d,m,t})$$
Monthly AdShares

- High-frequency variation in monthly advertising can have heterogeneous effects on annual enrollment at schools.
• High-frequency variation in monthly advertising can have heterogeneous effects on annual enrollment at schools.
• Major driver of when firms advertise: enrollment periods.
• High-frequency variation in monthly advertising can have heterogeneous effects on annual enrollment at schools.

• Major driver of when firms advertise: enrollment periods.

• Construct “exposure” measure to political ads in month \( m \) based on propensity to purchase ads in non-election years:

\[
\tilde{S}_{f,d,m} = \frac{1}{T_{f,d,NE}} \sum_{t:t \in NE} \frac{\sum_{k=1}^{12} a_{f,d,k,t}}{\sum_{k=1}^{12} a_{f,d,k,t}}
\]

• Propensity shares create within-market heterogeneity in effect of political advertising.
Ad Scheduling By Calendar System

Fraction Of Annual TV Ads in Month

Month Of Year

Semester (5.8%)
Quarter (23.5%)
Other academic year (10.8%)
Differs by program (16.9%)
Continuous (42.5%)
For-Profit College Advertising Instrument Binscatter

\[
\log(1 + \text{FPI Spot TV Ads}) - 0.08 - 0.06 - 0.04 - 0.02 - 0.00 = 3.949 \quad (F\text{-Stat}=13.02)
\]

Number of Bins=25
Determinants of Value-added: Selected Coefficients

Effect on Value-Added (2017 $)

Offer Consumer Services Program
Offer Engineering Program
Offer Health Sciences Program
Offer Business Program
Offer Associate's Degree
For-Profit College

-6,000  -4,000  -2,000  0  2,000
Alternative Value-Added Measures

VA in Pr(Employed)

VA in Earnings | Employment
For-Profit College Bans

- National policymakers have proposed barring federal aid for FPI firms, or low-performing schools.
- Consider an equilibrium where FPIs/low-quality schools receive no federal aid.
• National policymakers have proposed barring federal aid for FPI firms, or low-performing schools.
• Consider an equilibrium where FPIs/low-quality schools receive no federal aid.
• Return government savings in the form of increasing the generosity $g$ of the Pell grant program

$$\pi_{t,p} = g\pi_t \times \pi_t$$
National policymakers have proposed barring federal aid for FPI firms, or low-performing schools.

Consider an equilibrium where FPIs/low-quality schools receive no federal aid.

Return government savings in the form of increasing the generosity $g$ of the pell grant program

$$\pi_{t,p} = gP \times \pi_t$$

Benchmark for evaluating existing policy proposals to improve welfare/quality in the sector.
Voucher Policies

• 99% of federal aid in-sample is spent on low-income (pell-eligible) students. Focus on voucher policies servicing these individuals.

\[ \tau_{i,j,t} = \begin{cases} 
\tau_{j,t} & \text{if } EFC_i \leq EFC_t \\
0 & \text{if } EFC_i > EFC_t 
\end{cases} \]

• **Voucher Design 1**: \( \tau_{j,t} = g \). Deliver equal amount of aid to students regardless of cost, eliminating increased aid to higher priced schools.

• **Voucher Design 2**: \( \tau_{j,t} = g \times \psi_j \times \frac{\varepsilon_j}{\varepsilon_j+1} \). Give students more aid for attending higher quality institutions that are elastic to voucher subsidy.
Social planner chooses policy $\mathcal{P}$ to maximize quality provision to low-income students $L$ of the sector. Restrict $\mathcal{P}$ to be a set of school-specific vouchers $\{\tau_{j,t}\}$ for each school:

$$\begin{align*}
\max_{\mathcal{P} = \{\tau_{j,t}\}} & \sum_m M_{t,L} \sum_{j \in J_t} s_{j,t,L}(\vec{\tau}) \times \psi_j \\
\text{s.t.} & \sum_m M_{m,L} \sum_{j \in J_m} s_{j,t,L}(\vec{\tau}) \times \tau_{j,t} \leq G
\end{align*}$$

(1)
• Simplified solution to social planner problem:

\[ \tau_{j,t}^* = \frac{1}{\lambda} \times \frac{\varepsilon_{j,j,t}^T}{(1 + \varepsilon_{j,j,t}^T)} \times \psi_j \]  

(2)
Optimal Voucher

• Simplified solution to social planner problem:

\[
\tau_{j,t}^* = \frac{1}{\lambda} \times \frac{\varepsilon_{j,j,t}^T}{(1 + \varepsilon_{j,j,t}^T)} \times \psi_j
\]

• Schools receive more aid if voucher elasticity \( \varepsilon_{j,j,t}^T \) (change in enrollment from more voucher aid) is higher. Depends on price sensitivity of demand side and price/advertising response from supply side.
Proposition 1
Suppose the social planner optimizes Equation 1. The optimal voucher in market $m$ is:

$$\tilde{\tau}_m^* = \left( I + E_m \right)^{-1} E_m \times \frac{1}{\lambda} \times \bar{\psi}_m$$

where $E_m$ is a $J_m \times J_m$ matrix with elements:

$$E_{m,k,j} = \varepsilon_{k,j,t} \times \frac{S_{k,L}}{S_{j,L}}$$
Distribution of Voucher Distortion Term

Distribution of Voucher Distortion

Distortion Term $\frac{\epsilon}{\epsilon+1}$

Density

Community Colleges
Non-Advertising For-Profits
Advertising For-Profits
Binscatter of Enrollment Change Under Optimal Voucher

Change in Log(Enrollment) vs. Value-Added

- CCs (Bins=16)
- FPIs (Bins=22)
Binscatter of Supply Response Under Optimal Voucher