# The Limited Impact of FREE College Policies

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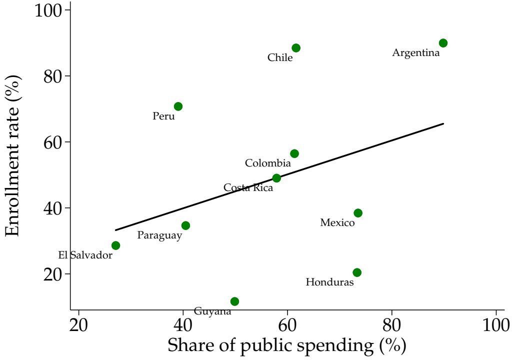
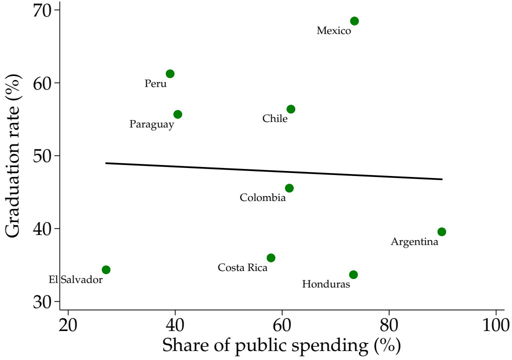
## What would be the impact of FREE college on enrollment and graduation rates, especially for low-income students?

The World Bank asked us this question in the context of emerging economies in Latin America.

# Impact of FREE College: Cross-Section Latin American Countries




a. Enrollment

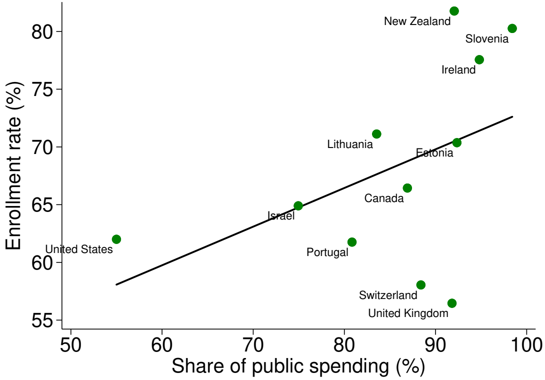



b. Graduation

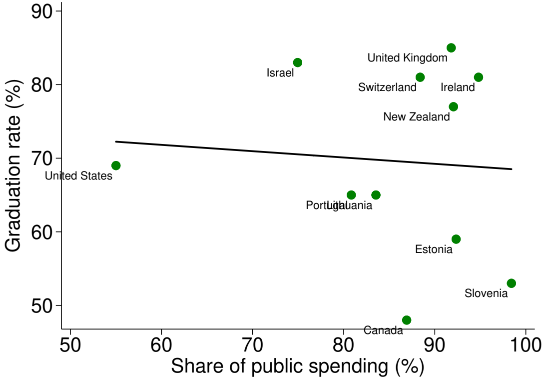
Rank countries by share of higher education funding via subsidies

- High enrollment rates (panel a), but flat graduation rates (panel b).

# Similar Pattern OECD Countries




a. Enrollment




b. Graduation

Much higher level of enrollment and graduation but same pattern.

# Why College?

- Young adults start making independent decisions.
- The college completion appears to be the break-even point in terms of labor market returns.
  - **College premiums** across countries range 1.5-3.
  - **Lifetime returns:** Accounts for most of the variation in lifetime earning and wealth (Huggett, Ventura, and Yaron 2011).
- There are some important limiting factors in the process of acquiring higher education.

# What do we do

- We estimate a dynamic choice model of college decisions.
- Can FREE college raise enrollment and graduation?
  - Raises enrollment $\Rightarrow$ evidence of resource constraint.
    1. Tuition cost,
    2. Opportunity cost (foregone income),
  - Small effect graduation rate.
    1. Attract weak students (negative selection).
    2. Lower incentives to student effort.
    3. Raise dropout rate.
- FREE college + performance incentives $\Rightarrow \downarrow$ enrollment and $\uparrow$ completion.
  - Attract better students (positive selection).
  - Increase incentives to student effort.
  - Decrease dropout rate.

# Outline

- Evidence: Colombia
- Model
- Estimation
- Counterfactuals: Free tuition
  - Universal
  - Need, ability, Need-Ability
  - Performance-based
- Cost-benefit
- Education outcomes and the college premium

# Evidence

# Why Colombia?

Interesting case study for multiple reasons:

1. **Size:** Colombia 3rd largest economy in Latin America.
2. **Returns:** Mincerian returns to college are extremely high (180 % relative to HS).
3. **Data:** Colombia's unique administrative data enables us to follow the full academic trajectory of high school graduates who enroll in college.

Relative to other countries

1. **Loans:** Student loan program covers a relatively small proportion of students.
2. **Work-in-college:** Working while in college is not a major source of higher education funding.

# Data: SPADIES foe Education and Household Survey Wages

- Almost even share of public and private enrollment (large public subsidies)
- Universe of higher ed students (SPADIES)
  - High school grads from 2005 (n=360,000)
  - For each student:
    - Score in mandatory high-school exit exam (ability measure)
    - Family income bracket at the end of high school
    - Full college trajectory (2-5 year degrees)
    - Focus on long-duration programs
    - Attention to initial enrollment right after HS graduation
    - Ignore the limited cases of enrollment after 25 years of age
  - We **do not** observe time studying or effort!!!
- Household survey: Labor market outcomes by educational attainment.

# Enrollment and Dropout Rates by Income and Ability

| Income bracket | Ability Quintile 1 | 2 | 3 | 4 | 5 | Total |
|---|---|---|---|---|---|---|
| 5+ MW | | | | | | 73 |
| 3-5 MW | | | | | | 62 |
| 2-3 MW | | | | | | 43 |
| 1-2 MW | | | | | | 28 |
| <1 MW | | | | | | 18 |
| Total | 13 | 19 | 26 | 39 | 64 | 32 |

**9-23** **23-37** **37-51** **51-65** **65-86**

a. Enrollment Rate

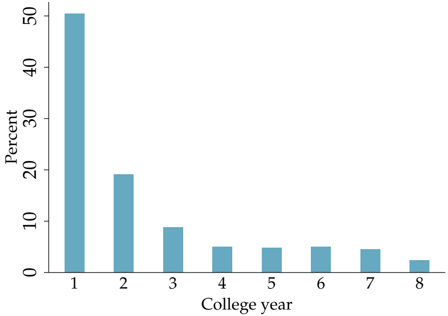
| Income bracket | Ability Quintile 1 | 2 | 3 | 4 | 5 | Total |
|---|---|---|---|---|---|---|
| 5+ MW | | | | | | 45 |
| 3-5 MW | | | | | | 51 |
| 2-3 MW | | | | | | 55 |
| 1-2 MW | | | | | | 58 |
| <1 MW | | | | | | 59 |
| | 71 | 67 | 62 | 57 | 46 | 54 |

**39-45** **45-51** **51-60** **60-65** **65+**

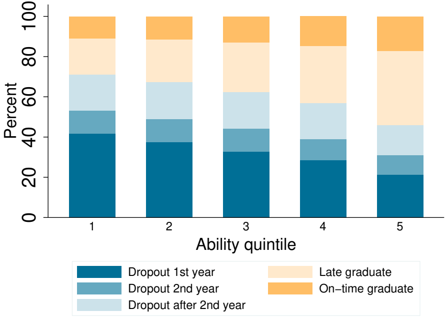
b. Dropout Rate

- Enrollment rates are low for low ability-income students.
- 70% of the dropouts are concentrated in the 2 initial years

# College Outcomes: Dropout and Graduation Timing




a. Dropout Timing

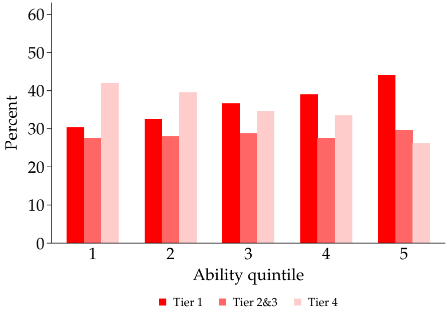



b. College Outcomes by Ability

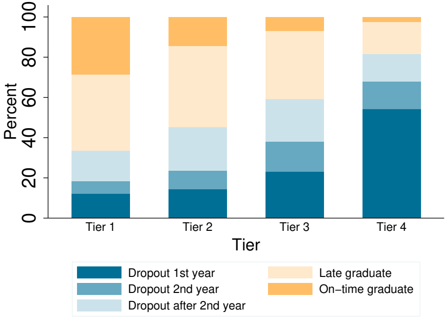
- Large attrition in year 1. The initial 2 years account for 70% of the drop outs.
- Small differences in on-time graduates across groups, but larger on late graduates.
- This is very hard to reconcile if ability is the only input to complete college credits.

# First-Year Outcomes and Predictability

Tier 1 $>$ 95% classes completed; tier 2: 85-95%; tier 3: 65-85%; and tier 4: 0-65%




a. 1st-year Performance Tiers by Ability




b. College Outcomes by 1st-year Performance Tier

Outcomes in year 1 provide great predictors of graduation and timing of graduation.

# Model

# Model Features

- **Students**: Population of HS graduates differ in ability $\theta \in \Theta$ and parental resources $y \in Y$ with a joint distribution $\Phi(y, \theta)$.
- **Education (Cognitive skills)**:
  - Technology: A risky, lumpy, multi-period college investment.
  - Decisions: Endogenous enrollment and academic progression.
- **Labor Market Outcomes (Experience skills):**
  - Hire skilled and unskilled workers (maps education outcomes to returns to labor)
  - All individuals accumulate experience in the workplace.
  - Cognitive skills are only valuable to complete education.

# Technology: College Credits and Academic Risks

- College max duration 8 years, but eligible to graduate 5 years, $\overline{x}^r = 0.2\underline{h}$.
- College technology (CRS)

$$\frac{x_t}{\overline{x}^r} = H(z_t, \theta, e_t) = z_t(\theta^{\alpha} e_t^{1-\alpha}).$$

  with output constraints $x_t \in [0, \overline{x}^r]$.
- Risk academic progression, $z_t$, determines completed credits, $x_t$.

$$h_{t+1} = x_t + h_t, \quad t = 1, ..., 8,$$

- Risk dropping out depends on endogenous variables

$$\Pr(d_t = 1 \mid z_t) = \tilde{p}^d(t, h_{t+1}, \theta, y),$$

- Preferences

$$U(c, e, \theta) = \frac{(c - \overline{c})^{1-\sigma}}{1-\sigma} - \mu \frac{e^{\gamma}}{(1+\theta)^k},$$

# Timeline

- Student starts the academic year with $(t, h, \theta, y)$
- Enroll in a fixed number of credits, $\overline{x}^r$.
- Choose of effort, $e_t$, under uncertainty about progression $z_t(\theta, h, ...)$
- Idiosyncratic progression shock revealed $z_t \Rightarrow \mathrm{h}_{t+1}$
- Next academic year: Dropout draw $\tilde{p}^d(t, h_{t+1}, \theta, y)$

# College Years: 1-4

Academic progression prior to graduation $\sum_{t=1}^{4}\overline{x}_t^r < \underline{h}$.

$$V^c(t, h_t, \theta, y) = \max_{e_t, x_t}\{U(c_t, e_t, \theta) + \beta E_{z_t}\widetilde{V}^\ell(t, h_{t+1}, \theta, y)\},$$

$$\begin{aligned} s.t. \qquad c_t &= y_t - T(t, h_t, \theta, y), \\ h_{t+1} &= h_t + x_t(z_t), \\ \frac{x_t}{\overline{x}^r} &= H(z_t, \theta, e_t), \\ c_t &> 0, \end{aligned}$$

where

$$\begin{aligned} \widetilde{V}^\ell(t, h_{t+1}, \theta, y) = \tilde{p}^d(t, h_{t+1}, \theta, y)V^d(t+1, h_{t+1}) + \\ (1 - \tilde{p}^d(t, h_{t+1}, \theta, y))V^c(t+1, h_{t+1}, \theta, y). \end{aligned}$$

# College Years: 5-7

Graduation becomes an option at the end of 5th year $\underline{h} = \sum_{t=1}^{5} \overline{x}_t^r$.

$$V^c(t, h_t, \theta, y) = \max_{e_t, x_t} \{ U(c_t, e_t, \theta) + \beta E_{z_t} \tilde{V}^c(t, h_{t+1}, \theta, y) \},$$

$$\begin{aligned} s.t. \qquad c_t &= y_t - T(t, h_t, \theta, y), \\ h_{t+1} &= h_t + x_t(z_t), \\ \frac{x_t}{\overline{x}^r} &= H(z_t, \theta, e_t), \\ c_t &> 0, \end{aligned}$$

where the continuation value includes the payoff from graduating.

$$\tilde{V}^c(t, h_{t+1}, \theta, y) = \max_{I_c, I_g} \left\{ \begin{array}{c} V^g(t+1, h_{t+1} \geq \underline{h}, \theta, y), \\ \widetilde{V}^\ell(t+1, h_{t+1} < \underline{h}, \theta, y) \end{array} \right\}.$$

# Terminal College Year

Final year students are allowed to remain in college.

$$V^c(t, h_t, \theta, y) = \max_{e_t, x_t} \{U(c_t, e_t, \theta) + \beta E_{z_t} \tilde{V}^f(t, h_{t+1}, \theta, y)\},$$

subject to the same constraints. The continuation value in the final college year is

$$\tilde{V}^f(t, h_{t+1}, \theta, y) = \max_{I_d, I_g} \left\{ V^d(9, h_{t+1} < \underline{h})), V^g(9, h_{t+1} \geq \underline{h}) \right\}.$$

College termination cut-off:

- Graduate if $h_{t+1} \geq \underline{h}$.
- Dropout college when $h_{t+1} < \underline{h}$.

# Workers Problem

Students join the labor force at different ages, $\tau$.

$$V_s^w(\tau, a) = \max_{c,a'}\{u(c) + \beta V_s^w(\tau + 1, a')\}$$

$$\begin{aligned} s.t. \qquad c + a' &= w(s, \tau) + (1 + r)a, \\ c, a' &\geq 0. \end{aligned}$$

Workers compensation $w(s, \tau)$ varies:

- Education status $s = \{h, g, d_h\}$
- Experience

Ignore decisions after retirement/social security, taxes, etc...

# College Enrollment Decision (I)

The enrollment decision solves a discrete choice problem

$$\underbrace{V^{c}(1,0,\theta,y)+\xi_i+\sigma_\epsilon \epsilon^{college}}_{\text{Value of going to college}} \geq \underbrace{V^{hs}(1,0,\theta,y)+\sigma_\epsilon \epsilon^{work}}_{\text{Value of working as a high school graduate}}$$

The payoff has 3 components

- Observable decision $k = \{college, work\}$ in the data $V^k(1,0,\theta,y,0)$.
- Type-specific component $\xi = \tilde{\xi}(\theta, y)$ representing individual **unobserved heterogeneity**.
- Idiosyncratic choice-specific shock, $\epsilon^k$, observed by the individual but not in the data.

$\epsilon^k$ is *iid* and distributed according to a *Type-I Extreme Value*.

$\sigma_\epsilon$ is a positive scalar that affects the effective variance of the shock

# College Enrollment Decision (II)

The probability that an individual goes to college for a given observed state variable is given by

$$P^c(1, 0, \theta, y) = \frac{\exp\{(V^c(1, 0, \theta, y) + \xi_i)/\sigma_\epsilon\}}{\exp\{(V^c(1, 0, \theta, y) + \xi_i)/\sigma_\epsilon\} + \exp\{V^{hs}(1, 0, \theta, y)/\sigma_\epsilon\}},$$

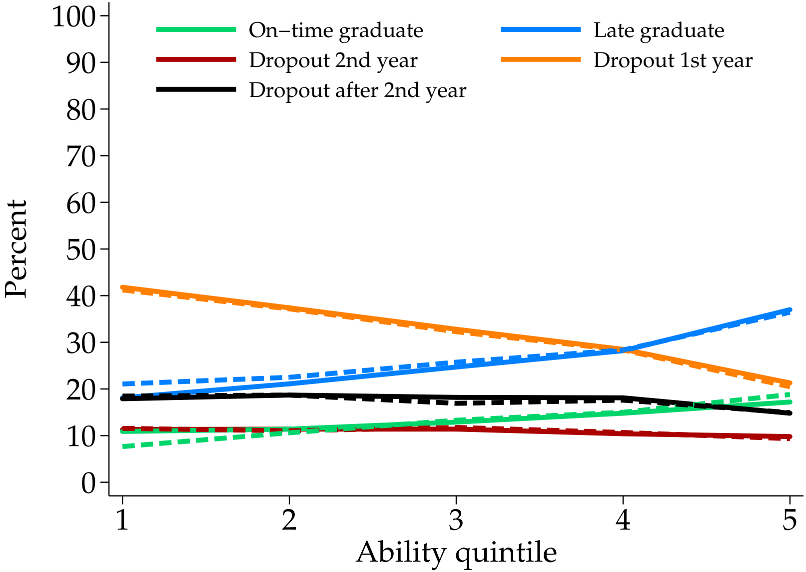
and the probability of working as a high school graduate is the complete, $P^{hs}(1, 0, \theta, y) = 1 - P^c(1, 0, \theta, y)$.

# Estimation: Simulated Method of Moments

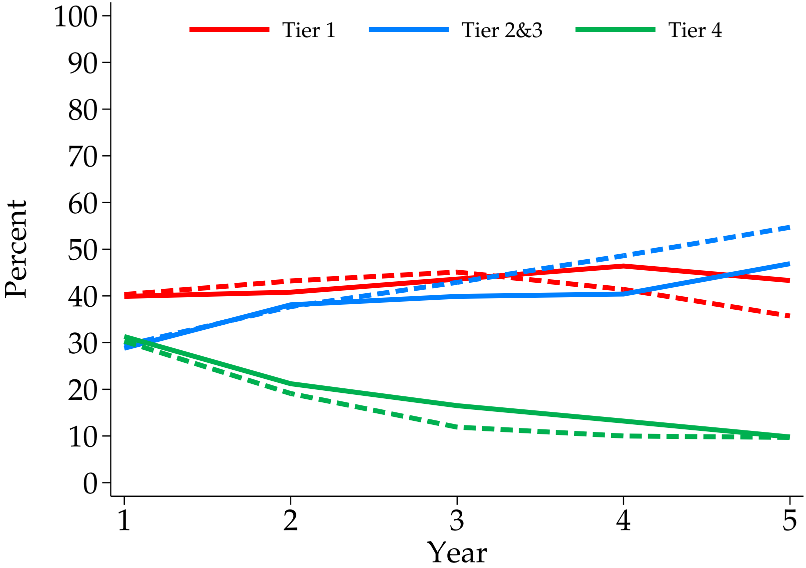
Moments to match

- Enrollment rates by (income, ability)
- Dropout rates by year, and (income, ability)
- Graduation timing
- Academic outcomes (on-time grad, late grad, dropout)
- Academic performance by year for each outcome
- Year-to-year transition between performance tiers
- Persistence in performance tiers
- Dropout by performance tier, by year
- Targets, by ability and year

# Goodness of Fit: College Outcomes



# Tiers of Cumulative Classes Completed, by Year



# SIDE NOTE EDUCATION TECHNOLOGY: Ability vs. Effort

| | **Regressions achievement $\log(\mathbf{x}_t)$** | | | |
|---|---|---|---|---|
| | **Actual data** | | **Model Data** | |
| | (1) | (2) | (3) | (4) |
| LogAbility | 0.166*** | 0.156*** | 0.090*** | 0.085*** |
| | (0.015) | (0.005) | (0.005) | (0.000) |
| logEffort | | | 0.854*** | 0.915*** |
| | | | (0.004) | (0.000) |
| logShock | | | | 1.000*** |
| | | | | (0.000) |
| Constant | 2.060*** | 2.748*** | 2.197*** | 2.996*** |
| | (0.012) | (0.004) | (0.004) | (0.000) |
| $R^2$ | 0.213 | 0.204 | 0.518 | 1.000 |
| N | 123,101 | 127,044 | 127,044 | 127,044 |

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

# Can Policies Affect Effort?

- Effective policies need to change achievement, via changing the number of credits

$$E(h_{t+1}) = E(x_t + h_t) = E(x_t) + h_t.$$

where

$$E(x_t) = \overline{x}^r E(z_t)(\theta^\alpha e_t^{1-\alpha})$$

The required effort to complete expected target $\overline{x}_t$

$$e_t = \left( \frac{\overline{x}_t}{\overline{x}^r} \frac{1}{E(z_t)\theta^\alpha} \right)^{\frac{1}{1-\alpha}}.$$

- The discreteness of $\overline{x}_t$ plays a role.

# Counterfactuals: Free College

# FREE College Counterfactuals

We compare the baseline to different FREE college counterfactuals

- **Universal**
- **Performance-based**
- **Additional cases**: Need-based, Ability-based, Ability and need based

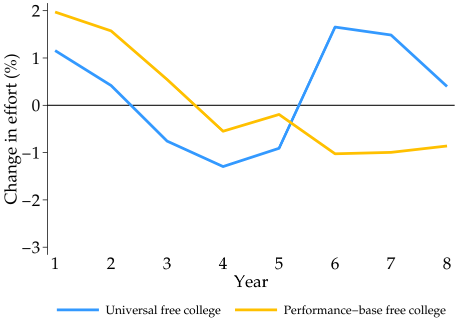
Key margins for students

1. **Extensive margin:** Composition of student body $\Rightarrow$ Enrollment
2. **Intensive margin:** $\Rightarrow$ Graduation
   - Loss of urgency effect $\Rightarrow$ less effort
   - Substitution effect: More $\Rightarrow$ more effort
   - Risk effect $\Rightarrow$ more effort.

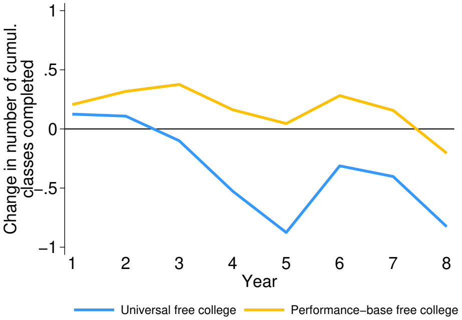
# Aggregate Education Outcomes from FREE Tuition

| | Data | Baseline | Universal | Perf-Based |
|---|---|---|---|---|
| Enrollment rate (%) | 32.3 | 32.3 | 62.7 | 56.7 |
| Eligible students (%) | | | 100.0 | 100.0 |
| | | | | |
| Graduation rate (%) | 45.6 | 45.1 | 43.0 | 47.4 |
| - Existing students | | | 45.5 | 51.0 |
| - New students | | | 40.5 | 42.5 |
| | | | | |
| On-time grad rate | 15.1 | 15.1 | 13.6 | 15.7 |
| - Existing students | | | 13.8 | 15.9 |
| - New students | | | 13.3 | 15.5 |
| | | | | |
| HS complete COLL(%) | 14.7 | 14.5 | 27.0 | 26.9 |

# Free college: Changes in Effort and Cumulative Classes




a. Δ effort wrt to baseline (%)




b. Δ number of cumulative classes

# Heterogeneity Outcomes: Enrollment

| | a. Baseline Enrollment Rate | | | b. Universal Free College: Change | | | c. Perfomance-based Free College: Change | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Ability** | | | | | |
| **Income** | High | Mid | Low | High | Mid | Low | High | Mid | Low |
| High | 83.8 | 65.7 | 39.6 | 7.7 | 12.8 | 21.5 | 7.9 | 10.8 | 14.1 |
| Mid | 73.2 | 47.7 | 27.4 | 15.6 | 28.2 | 25.5 | 15.9 | 23.1 | 20.4 |
| Low | 51.4 | 26.2 | 13.7 | 34.5 | 44.4 | 32.1 | 32.3 | 35.7 | 22.5 |

- Both programs raise enrollment rates for every student group.

- Universal has the greatest effects on low-income students (budget-constrained).

- Performance-based less impact on low ability/income students.

# Heterogeneity Outcomes: Graduation Existing Students

| | a. Baseline Graduation Rate | | | b. Universal Free College: Change | | | c. Perfomance-Based Free College: Change | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Ability** | | | | | |
| **Income** | High | Mid | Low | High | Mid | Low | High | Mid | Low |
| High | 59.3 | 44.1 | 26.3 | -2.5 | -1.8 | 7.2 | 3.4 | 2.7 | 4.4 |
| Mid | 55.6 | 39.9 | 29.9 | -2.2 | 3.3 | 0.7 | 4.6 | 6.3 | 5.2 |
| Low | 53.3 | 42.6 | 32.2 | -1.4 | 4.0 | -1.8 | 7.7 | 8.6 | 2.6 |

- Universal raises the graduation rate of some student groups but lowers it for others.

- Performance-based raises graduation rates for *all* student groups because it eliminates the loss-of-urgency effect.

- New students performance-based better than universal (42.5 v. 40.5 percent).

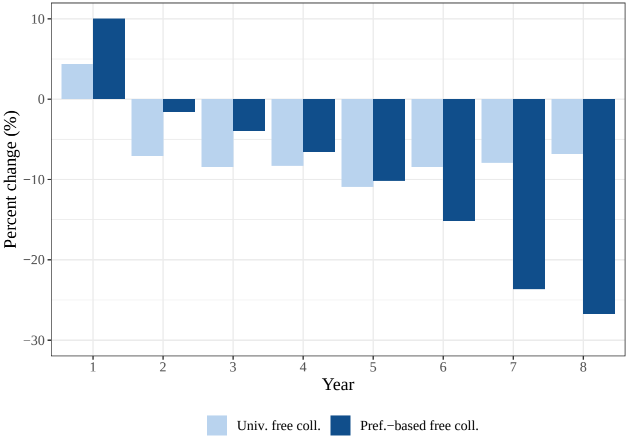
# Percent of High School Graduates That Complete College

| | a. Baseline Percent of High School Graduates | | | b. Universal Free College: Change | | | c. Perfomance-Based Free College: Change | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Ability** | | | | | |
| **Income** | High | Mid | Low | High | Mid | Low | High | Mid | Low |
| High | 49.7 | 29.0 | 10.4 | 2.3 | 4.2 | 10.1 | 7.8 | 6.8 | 6.1 |
| Mid | 40.7 | 19.1 | 8.2 | 6.8 | 13.8 | 8.0 | 13.0 | 13.7 | 8.6 |
| Low | 27.4 | 11.1 | 4.4 | 17.2 | 21.7 | 9.5 | 23.7 | 20.5 | 8.2 |

- Universal is more effective for low-income with low/middle ability and for high income low ability $\Rightarrow$ Challenged to graduate on-time.

- Performance-based is at least as effective for the rest.

# How much policy change risk?




Year 1: The perceived risk increases relative to the baseline

Years 2-8: Performance-based generates a lower reduction in perceived risk.

# Cost-Benefit Analysis

- The baseline simulations assume **FREE lunch**. This is a positive bias towards the policy, but the impact on graduation is small.

- Performed simulations with **tax funding**, with a small impact on education outcomes because ALL workers pay the college subsidy.

**Cost-benefit analysis** (policy makers language): Cost $\Rightarrow$ Outcomes

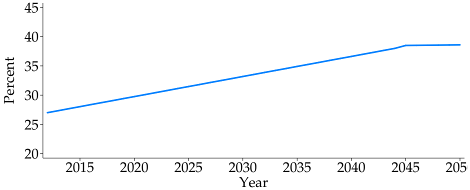
- Universal free college is effective but it is expensive. You provide subsidies to students already going to college.
- Performance-based policies more cost-effective.
- Need-based policies are still very expensive because increase enrollment and but not new graduates.

# Equilibrium and College Premium

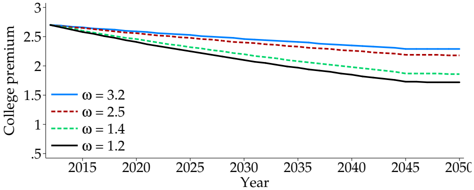
What is the impact of education outcomes in the college premium?

$$\triangle \ln \left( \frac{w_t^{coll}}{w_t^{hs}} \right) = \triangle \ln \left( \frac{A_t^{coll}}{A_t^{hs}} \right) - \frac{1}{\omega} \triangle \ln \left( \frac{N_t^{coll}}{N_t^{hs}} \right) \quad (1)$$

The skill premium depend on $\omega$ and $N_t^{coll}, N_t^{hs}$




a. Labor Force Share of College Graduates




b.College Premium

# Conclusions

- We estimate a dynamic choice model of college decisions.
- Can FREE college raise enrollment and graduation?
  - Limited impact if it is universal.
  - More impactful and cost-effective if it introduces incentives (but also brings additional risk to students)
  - Lots of interesting distributional effects.
- Effort is the amount of mental or physical exertion required to achieve a goal.
- Effort and ability are connected, and it is critical to understand why for low ability students it is more costly to study.
- Effort is also a skill/ability that students need to learn.