Gaming a Selective Admissions System

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Big business

- Test preparation is big business
  - Kaplan had annual revenue of $ 1.5 billion in 2018
  - New Oriental had revenue of $ 4.2 billion in 2020–21
  - Koreans spend $ 20 billion on private tutoring annually (*Financial Times*)
- 15-year olds in out-of-school classes organized by commercial companies (Park et al., 2012):
  - U.K.: 11.4%, U.S.: 10.4%
  - Brazil: 44.2%, Germany: 28.6%, Greece: 52.5%, Latvia: 34.3%, Russia: 37.9%, Spain: 34.0%, Turkey: 37.3%
  - Hong Kong: 30.4%, Korea: 47.5%, Thailand: 47.1%

Shadow education

- fairness issues
- a drain on kids' time and energy
- teaching to the test: "little English is spoken in the lesson, which comprises an explanation of the TOEIC reading comprehension paper" (*Financial Times*)

What we do

- Model private tutoring as a costly but unproductive ("gaming") activity that masquerades low-ability students as high-ability ones
- Three main questions:
  - is tutoring a "rat race"?
  - why does it unravel to earlier and earlier stages of education?
  - what is the optimal selection policy if university has commitment power?

Related Literature

- Costly lying (Frankel and Kartik 2019; 2021; Ball 2021)
  - we have a reward constraint, thus an externality among multiple agents
  - we have two stages
- Cheating in contests (Gilpatric 2010; Gilpatric and Reiser 2017)
  - our reward is derived from beliefs
- Low-powered incentives reduces cheating (Frankel and Kartik 20210; Goldman and Slezak 2006)

One stage of selection

- Total number (mass) of university places is $Q < 1$
- Total number (mass) of high-ability students is $\lambda < 1$
- Benefit from getting into college is B
- Test technology:
  - High ability student always gets score H
  - Low ability student:
    - gets score L if no gaming
    - gets score H if pays C for tutoring
    - tutoring cost has distribution F on $[0, B]$

Admissions system

- University observes test scores but not true ability
- Wants to maximize average ability of its student intake subject to filling its quota
  - admitting a low ability student is better than leaving its slots vacant
- Admissions policy is (X, Y)
  - Prob. of admitting H-scorer is X
  - Prob. of admitting L-scorer is Y

Gaming decision

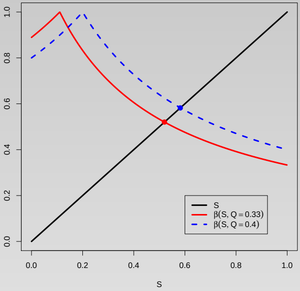
- High ability students don't choose tutoring
- Low ability students choose tutoring if cost is low enough
  - cutoff cost level is S
- Quota constraint is:

$$(\lambda + (1-\lambda)F(S))X + (1-\lambda)(1-F(S))Y = Q$$

Admissions rule

- If $Q > \lambda + (1-\lambda)F(S)$, the quota is loose: $X = 1$ and $Y = \frac{Q-(\lambda+(1-\lambda)F(S))}{1-(\lambda+(1-\lambda)F(S))}$
- If $Q \leq \lambda + (1-\lambda)F(S)$, the quota is tight: $X = \frac{Q}{\lambda+(1-\lambda)F(S)} < 1$ and $Y = 0$
- The benefits from tutoring is $\beta(S) = B(X - Y)$

Strategic substitutes or complements



- Strategic complementarity when the quota is loose
- Strategic substitution when the quota is tight
- Equilibrium is characterized by $S^* = \beta(S^*)$

Equilibrium

- Equilibrium exists
- Largest equilibrium is always a *tight quota* equilibrium
- Equilibrium is unique if $\lambda \geq Q$
- Comparative statics: number of college places increases $\rightarrow$ more students choose tutoring (in largest equilibrium)!

Two stages of selection

- Suppose high schools are identical in quality, does competition for college admissions unravels to a competition for high school entrance?
- High-ability kids always get score h in high school exam; low ability kids get score l if there is no tutoring, or score h if they get tutoring
- Cost of tutoring is δc in high school stage, c in university stage (δ may be larger than or smaller than 1).
  - cost distribution is $F(\cdot)$ on $[0, B]$
  - reflects persistence in tutoring costs (e.g., family background influences tutoring cost at both stages)

Symmetric equilibrium

- It is an equilibrium to have:
  - students randomly get into two high schools (no competition for high school entrance in the first stage)
  - the two schools are identical in all respects and are treated identically by the university (same equilibrium as if there is only one stage)
- But is there another equilibrium?

Why do we care?

SCMP.COM
South China Morning Post

Hong Kong / Education

Tutoring centre's founder defends kindergarten interview ad campaign that went viral

Shirley Zhao
Published: 5:15am, 25 May, 2015
Why you can trust SCMP

The co-founder of a controversial tutoring centre whose training classes for kindergarten interviews have been criticised for putting pressure on toddlers says the classes are only trying to help working parents without making the children's lives "any more miserable than they already are".

Unraveling

- The symmetric equilibrium described earlier is not stable
- Suppose School 1 has more high-ability students by accident (or by history): $\lambda_1 > \lambda_2$
- *Informational externality* that arises from gaming—university treats H-scorers from School 1 more favorably (if $S_1^* = S_2^* > 0$)
- *Rent* for both high-ability and low-ability students to get into School 1
- Competition causes tutoring to unravel to high-school entrance stage
- Selection by School 1 justifies why it has better students

Equal credibility

- Lemma 1(a): H-scorers from the two schools are equally credible (same prob. of having high ability)
  - suppose $K_i > K_j$
  - then H-scorer from School i has higher *priority*—$X_i < 1$ implies $X_j = 0$
    - case 1: $X_i < 1$. Then $X_j = 0 \to$ no one in School j chooses tutoring $\to$ $K_j = 1 \geq K_i$, contradiction
    - case 2: $X_i = 1$. Then all low-ability students in School i choose tutoring
    - if $i = 1$, then violate $q_1 > Q$
    - if $i = 2$, then $K_2 = \lambda_2 < \lambda_1 \leq K_1$, contradiction

Implications of equal credibility

- Lemma 1(b): More low-ability students in School 1 choose tutoring than those in School 2
  - this follows from the fact that $K_i = \lambda_i/(\lambda_i + (1-\lambda_i)S_i^*)$
- Lemma 1(c): H-scorers from School 1 are treated preferentially—$X_1 \geq X_2$
  - if cost distribution were the same, Lemma 1(b) implies $C_1 > C_2$
  - which in turn implies $X_1 > X_2$
  - the proof has to take into account the fact that the cost distributions are different in the two schools due to endogenous sorting in the first stage

Applications

- Abolish university entrance examination
- University relies on only one signal (high school affiliation), instead of two signals (high school affiliation and entrance test score)
- Results in greater gaming in stage 1
- Quality of university student intake is worse with no university exam

Applications (2)

- No ability-sorting in high school
- One-stage selection is worse than two-stage selection in terms of selection outcomes if tutoring cost at the two stages are the same
- Ability-sorting improves university selection outcomes, but total expenditure on gaming can be substantially higher

Applications (3)

- University can (sometimes) strictly improve selection outcomes by committing to low-powered admissions policy:
  - $Y_1, Y_2 > 0$
- But optimal commitment policy still entails preferential treatment:
  - $X_1 - X_2$ is reduced but still positive
  - and some (lower level of) tutoring at both stages remains

Thank you!