Simultaneous Screening and College Admissions

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College Admissions: A Decentralized Two-Sided Matching with Uncertainty

- School's screening devices, such as purpose statements, exams, interviews, are inherently imperfect. Thus uncertainty is a crucial factor in college admissions processes.
- Moreover, some schools even put restrictions for students to apply for other programs, to which we refer as "Simultaneous Screening."
- In recent years, the practice of simultaneous screening has gained greater public awareness as higher education expands.

Simultaneous Screening is Widespread: Why?

- In the United States, Early decision programs require accepted students to attend the school beforehand.
- In China, Japan, Korea, and Taiwan, where exams are commonly used to screen students, setting the entrance examination on the same day restricts students to attend only one of the exams.
- We are interested in whether simultaneous screening can be explained as a school's strategy to enroll better students.

Past Studies and New Findings

- Early decisions are typically adopted by lower ranked (but still selective) colleges (Avery, Fairbanks, and Zeckhauser, 2003).
- Using a signaling model, Avery and Levin (2010) show that relatively lower ranked colleges may enroll some highly desired students who are uncertain about their abilities in the early decision program (i.e., the Competitive Effect).
- However, this effect is not supported by previous empirical studies (Jensen and Wu, 2010; Chapman and Dickert-Conlin, 2012).

We show that such an effect is sensitive to the difference of the prestige between schools.

Indeed, by using a natural experiment in Taiwan, we are able to control the school's prestige, and for the first time the competitive effect of simultaneous screening is confirmed.

Outline of the Talk

- The Model and its Predictions
- Empirical Results
- Conclusion and Future Work

Players and Preferences

- There are 2 schools and 3 students in the model.
- The set of students is $S = \{s_i : i = 1,2,3\}$, where i is the unobservable type (**quality**) and only the student s_i know its own type i.
- The set of schools is $G = \{A, B\}$, and, for simplicity, each of them only admits one student.
- Schools have the same preference over student's quality:

$$v_j(s_i) = v_i \text{, where } v_1 > v_2 > v_3 > 0 \text{ for } j = A, B; \quad (1)$$

i.e., $s_1 \succ_j s_2 \succ_j s_3$ for $j = A, B$.

(Henceforth Good, Normal, Bad students)

- Students also have the same utility function representing $A \succsim_i B$:
(Henceforth A is the Best and B is the Second Best School)

$$u_i = \begin{cases} a & \text{if } s_i \text{ is enrolled by } A \\ b & \text{if } s_i \text{ is enrolled by } B \\ 0 & \text{if } s_i \text{ is not enrolled} \end{cases}, \text{ where } a > b > 0 \text{ for } i = 1,2,3. \quad (2)$$

- a, b are called the **prestige** of the Best and the Second Best School, respectively.

Entrance examination

- Exam is an imperfect screening device: students of higher quality perform better in an exam statistically, but not for sure.

- To model this, let an exam be a random mapping from students to the pseudo types (exam rankings), i.e., $S \to T = \{t_k : k = 1,2,3\}$ such that

$$(s_1, s_2, s_3) \to (t_1, t_2, t_3) \text{ with probability } 1/3; \quad (3)$$

$$(s_1, s_2, s_3) \to (t_2, t_1, t_3) \text{ with probability } 1/3; \quad (4)$$

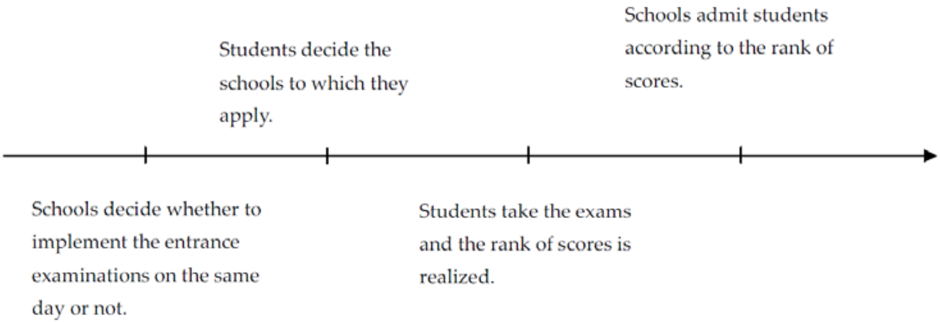
$$(s_1, s_2, s_3) \to (t_1, t_3, t_2) \text{ with probability } 1/3. \quad (5)$$

- Once an examination is implemented, the common realization of t_k, the exam ranking, is observed by both schools.

Strategies of Schools and Students

- School A first announces the "date" of its examination; school B then decides whether to have the same date as school A's exam date or not.
- When the schools implement exams in the same date, students simultaneously take exams from either A or B. When the exam dates are different, students can take exams from A, B, or Both.
- We focus on the Subgame Perfect Nash Equilibrium (SPNE) in the first two stages. The choices after the exam result reveals are straightforward.

Timeline


Students decide the schools to which they apply.
Schools admit students according to the rank of scores.
Schools decide whether to implement the entrance examinations on the same day or not.
Students take the exams and the rank of scores is realized.

Equilibrium Analysis: the Second Stage

- *When* A *and* B *have different examination dates, all students will apply for both schools.*
- *When* A *and* B *have the same examination date, depending on the value of* b*, the equilibrium strategy profiles for students could be* $(\tilde{s}_1, \tilde{s}_2, \tilde{s}_3) = (A, A, B)$, $(\tilde{s}_1, \tilde{s}_2, \tilde{s}_3) = (A, B, B)$ *, or* $(\tilde{s}_1, \tilde{s}_2, \tilde{s}_3) = (B, A, A)$. *In particular,* $(\tilde{s}_1, \tilde{s}_2, \tilde{s}_3) = (B, A, A)$ *is possible only if* $b \in [2a/3,\ a]$. *But* $(\tilde{s}_1, \tilde{s}_2, \tilde{s}_3) = (A, B, B)$ *is also possible when b is in that range.*

Equilibrium Analysis: the First Stage

- In the first stage, the two schools simply compare their expect utility of using a conflicting strategy with that of using an avoiding strategy.
- When the two schools have different exam dates, the expected utilities for A and B are

$$E[v_A \mid \tilde{d}_A \neq \tilde{d}_B] = \frac{2}{3} \times v_1 + \frac{1}{3} \times v_2, \tag{6}$$

$$E[v_B \mid \tilde{d}_A \neq \tilde{d}_B] = \frac{1}{3} \times v_1 + \frac{1}{3} \times v_2 + \frac{1}{3} \times v_3 \tag{7}$$

Equilibrium Analysis

- When the two schools have the same exam dates, the expected utilities for A and B are summarized in the following table:

	$(\tilde{s}_1, \tilde{s}_2, \tilde{s}_3)$	$E[v_A \mid (\tilde{s}_1, \tilde{s}_2, \tilde{s}_3)]$	$E[v_B \mid (\tilde{s}_1, \tilde{s}_2, \tilde{s}_3)]$
$b \in (0,\ a/2)$	(A,A,B)	$\frac{2}{3}v_1 + \frac{1}{3}v_2$	v_3
$b \in (a/2,\ 2a/3)$	(A,B,B)	v_1	$\frac{2}{3}v_2 + \frac{1}{3}v_3$
$b \in (2a/3,\ a)$	(A,B,B)	v_1	$\frac{2}{3}v_2 + \frac{1}{3}v_3$
	(B,A,A)	$\frac{2}{3}v_2 + \frac{1}{3}v_3$	v_1

Main Result

When the two schools have similar prestige such that $b > b^*$*, where* $b^* \in (2a/3,\ a)$*,* B *have an incentive to conflict with* A *on the examination date because the expected quality of enrolled students will be higher. In other cases of* $b < b^*$*,* B *will never conflict with* A*.*

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Competition among Top universities in Taiwan

- National Taiwan University (NTU) is generally considered as the best university in Taiwan in almost every discipline.
- In 2008, 4 other top-ranked universities jointed an alliance called the University System of Taiwan (UST). Since then, UST has always chosen to have exam dates that conflict with NTU. However, UST also gives its departments the option to set their own exam dates.
- This provides a unique opportunity to test our model implications, because prior to 2008, some schools of UST had chosen to conflict with NTU, in which case all of their departments had to hold exams in the same date, even though each department had different prestige.

Retardation rate as a proxy for student quality

- The retardation rate of students is the ratio of students who study for more than the regular (two) years.
- We assume that others being equal, student quality in a department is negatively correlated to its retardation rate.
- We use a fixed-effect model to control for department-specific endogenity, such as quality of departments, department's standard for graduation, and so on.

Competitive effect on the quality of students at UST, Overall

	Retardation rate models		
Independent variables	Model 1	Model 2	Model 3
Conflicting with NTU	4.05** (2.03)	4.05** (2.03)	4.01** (2.00)
Conflicting with other Tops		0.15 (1.19)	0.46 (1.18)
UST dummy (2008)			- 8.39*** (2.10)
Number of faculty	0.26 (0.16)	0.26 (0.16)	0.25 (0.16)
Time Trend	1.05*** (0.19)	1.06*** (0.19)	1.67*** (0.24)
Unemployment rate	3.66*** (1.04)	3.65*** (1.05)	2.45** (1.08)
Observations	657	657	657
Adjusted R^2	0.06	0.06	0.09

Effects on the Departments with similar prestige

- UST departments in the fields of Electrical Engineering and Computer Science have higher rankings than other departments at UST, and almost tie with corresponding departments at NTU.
- According to the model's prediction, we should expect that conflicting strategies should have better effects on students' quality for Electrical Engineering and Computer Science departments than other departments.
- Data suggests that conflicting with NTU significantly reduces the retardation rates in these departments, whereas overall it has the opposite effect.

UST Electrical Engineering and Computer Science Departments

Independent variables	Retardation rate models		
	Model 1	Model 2	Model 3
Conflicting with NTU	- 6.99* (4.16)	- 7.60* (4.16)	- 7.15* (4.10)
Conflicting with other Tops		2.12 (1.50)	2.06 (1.47)
UST dummy (2008)			- 6.81* (3.44)
Number of faculty	0.51*** (0.18)	0.51*** (0.18)	0.43** (0.18)
Time Trend	1.17*** (0.41)	1.23*** (0.41)	1.82*** (0.50)
Unemployment rate	2.47 (1.68)	2.13 (1.69)	1.45 (1.70)
Observations	98	98	98
Adjusted R^2	0.371	0.378	0.395

Do Departments Gain from Choosing the Exam Dates?

- After 2008, the departments in UST have the freedom to choose whether to conflict with NTU or not.
- According to the model, departments should respond differently according to their prestige compared to that of the corresponding departments of NTU. A "revealed preference" argument suggests for those departments that changed their choices, the quality of enrolled students should improve.
- Using their performance after 2008 as a baseline, we are able to calculate the gain from adopting the optimal strategies.

	Retardation rate models		
Independent variables	Model 1	Model 2	Model 3
Optimal	-7.13*** (2.00)	-7.37*** (2.02)	-5.44*** (2.07)
Conflicting with other tops		0.77 (0.85)	0.76 (0.84)
UST dummy			-7.12*** (1.87)
Number of faculty	0.33** (0.13)	0.32** (0.13)	0.32** (0.13)
Time trend	0.60 (1.10)	0.63 (1.10)	0.62 (1.09)
Unemployment rate	2.49*** (0.69)	2.52*** (0.69)	1.79** (0.71)
Observations	1050	1050	1050
Adjusted R2	0.122	0.141	0.134

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Findings

- When schools screen the students they admit, it could create an additional level of strategic interaction. We develop a decentralized two-sided matching model with an imperfect screening device to analyze the school conflict problem, and test the model with a data set in Taiwan.
- Our empirical result suggests that only the departments in the second best school that have similar rankings with the best school (i.e EE and CS) can benefit from using a conflicting strategy, which is consistent with the model's prediction.
- Moreover, when schools set up the exam date at the departmental level, we show that departments' choices are consistent with the model of maximizing student quality.

Some Limitations

- Measures of student’s “quality”; other characteristics that schools may desire.
- Theoretically, extend Avery and Levin (2010) and Chade, Lewis, and Smith (2011) ; empirically, measurement of “fitness.”

Future Research

- Do schools as a whole benefit from allowing simultaneous screening?
- How about students?
- Testing other roles played by simultaneous screening: avoid revealing screening results (Jumping the curse, Lee, 2009).

Thank you!

Conflicting effect on the retardation rates of students at NTU

	Dependent variables		
Independent variables	Male rate	Female rate	Total rate
Conflicting with UST	- 0.08	3.04	1.62
	(1.75)	(1.67)	(1.11)
Conflicting with other Tops	0.07	- 2.15	- 0.29
	(2.32)	(2.05)	(1.37)
UST dummy	6.20	5.08	1.89
	(3.84)	(3.66)	(2.45)
Number of faculty	0.43	- 0.05	0.26
	(0.30)	(0.28)	(0.19)
Time Trend	- 0.37	- 0.04	0.005
	(0.35)	(0.33)	(0.22)
Unemployment rate	1.93	- 0.69	1.10
	(1.48)	(1.41)	(0.94)
Observations	393	393	393
Adjusted R^2	0.021	0.019	0.021

NTU Electrical Engineering and Computer Science Departments

Independent variables	Dependent variables		
	Male rate	Female rate	Total rate
Conflicting with UST	- 1.16	- 5.70	- 1.50
	(1.46)	(3.57)	(1.48)
Conflicting with other Tops	3.22	- 1.82	2.75
	(2.34)	(5.70)	(2.36)
UST dummy	2.59	6.39	2.22
	(4.39)	(10.70)	(4.43)
Number of faculty	0.80**	- 0.30	0.69**
	(0.32)	(0.79)	(0.33)
Time Trend	0.46	1.31	0.61
	(0.55)	(1.34)	(0.55)
Unemployment rate	3.30**	0.34	2.78*
	(1.52)	(3.71)	(1.54)
Observations	45	45	45
Adjusted R^2	0.47	0.12	0.45