

# Opportunity Cost of Time and the Design of College Admission Mechanisms

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# Motivation

- **Decentralized** allocation mechanisms  $\implies$  **congestion** problems (Roth & Xing, 1997)
- **Centralized** allocation mechanisms:
  - No more congestion
  - At the cost of a **lack of ex-post flexibility**
- Flexibility desirable due to presence of **off-platform options**:
  - Some students will reject their offer
  - Welfare losses for both programs & students if no re-match possible (Kapoor et al., 2021)

# Motivation

- Sequential mechanisms: **Ex-post flexibility** through **multiple single-offer rounds**
- Introduces **dynamic trade-off** in the presence of waiting costs:
  - Utility of potentially receiving a better offer later vs. disutility of waiting
- Dynamic considerations generate an **equity-efficiency trade-off**:
  - + Improve quality of matches by taking into account strength of preferences
  - Potentially generating inequalities
- What are the **distributional** & **welfare** effects of sequential matching procedures?

# This Paper

- Study impact sequential system "APB" for **French college** applicants
- Propose a new **structural model** of application & waiting decisions
- Estimation results:
  - Waiting costs are **substantial**: larger than preference heterogeneity for majors or type of college
  - Waiting costs are **heterogeneous**: higher for low income & male students
- Goal/next step:
  - **Counterfactual** of single-round mechanism
  - Compare welfare

# Outline

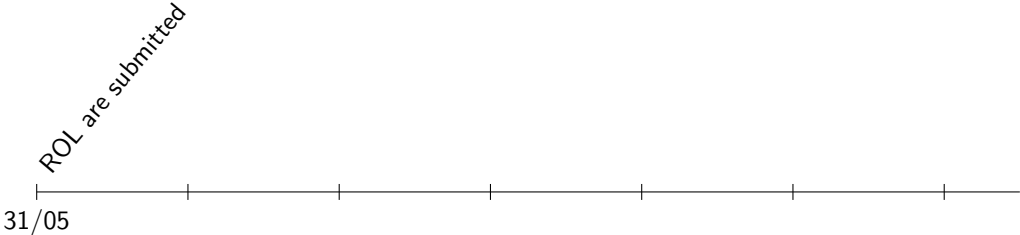
- ① Motivation
- ② Context
- ③ Data & Descriptive Statistics
- ④ Two-Period Model
- ⑤ Preliminary Estimation Results

# Centralized Application Procedure

- Every year, students submit their college applications to an online platform
  - ~ **1 million** students are registered on the platform
  - ~ **15,000 programs** are available on the platform [▶ Programs](#)
- Applicants submit a rank-ordered list (ROL), including up to 36 choices:
- Programs rank students:
  - Non-University programs: discretionary ranking
  - University programs: catchment area & rank in ROL [▶ Map](#)
- Students receive a **unique offer** within a round, determined by DA algorithm [▶ Algorithm](#)

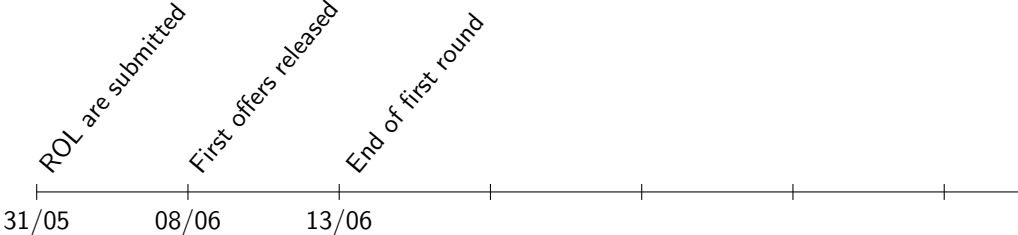
# French HE Application System

Centralized system with three sequential rounds of admission:



# French HE Application System

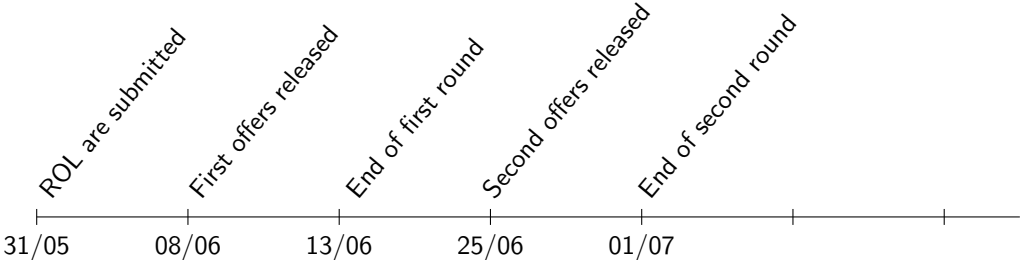
Centralized system with three sequential rounds of admission:





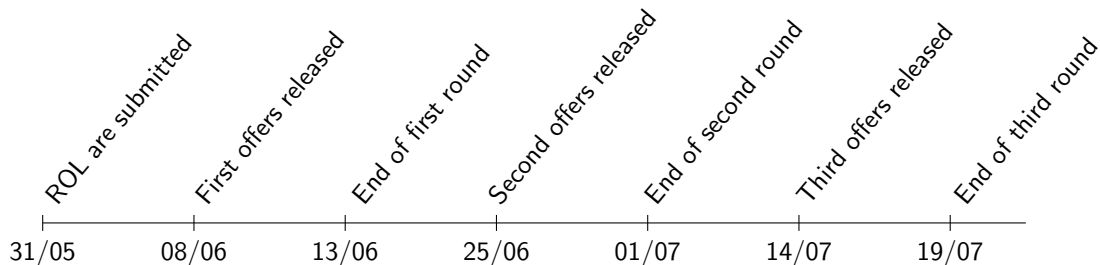
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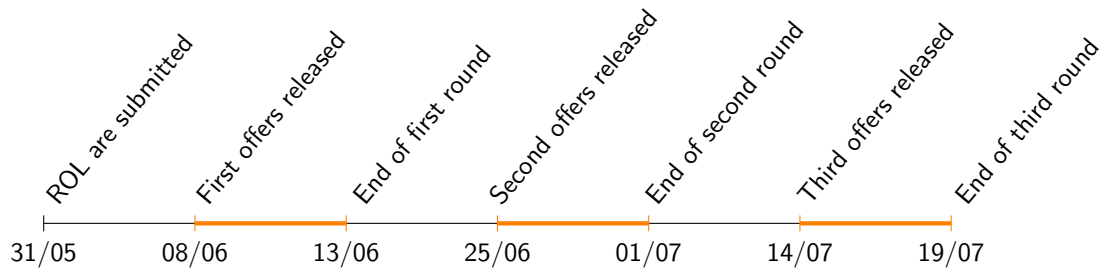
# French HE Application System

Centralized system with three sequential rounds of admission:



## Why is the French Context Relevant?

Centralized system with three sequential rounds of admission:



Within a round, students can either:

1. **Accept** the offer
2. **Drop out** from the platform
3. **Delay**: tentatively accept, but participate in the next round

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**Universe of applicants & programs** available on the platform, 2014-17:

- Student's characteristics: gender, SES of parents, ZIP code, final HS exam honors,...
- Programs' characteristics
- Students' rank-ordered lists
- **Sequential offers** and students' **responses** within the different **rounds**

▶ Descriptive Stat.

## Substantial number of students do not delay

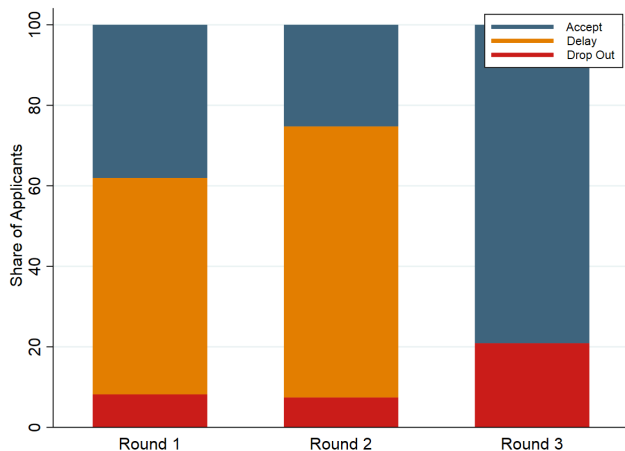
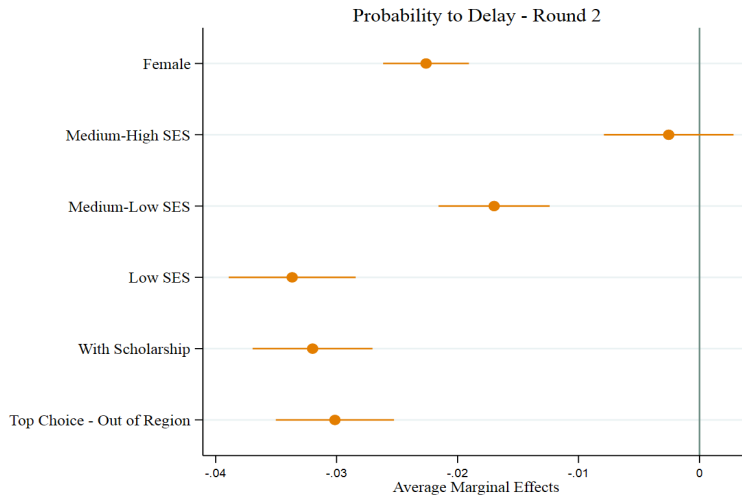


Figure: % applicants using each option, for those receiving an offer outside top-ranked program

# Low SES and female students less likely to delay + location matters



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## First Period: Rank-Ordered List Submission

Student  $i$  of unobserved type  $\tau$  with observed characteristics  $S_i$  forms ROL according to:

$$j_r = \arg \max_{j \in \mathcal{J} \setminus \{j_k\}_{k=1}^{r-1}} u_j(S_i, \tau) + \eta_{ij}$$

$\eta_{ij}$ : iid trembling-hand shock

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Implies **truth-telling** assumption

- Programs' **ranking criteria unknown** for vast majority of programs
- Very difficult to form beliefs over admission chances
- Students are **strongly advised** to rank truthfully

## Second Period: Dynamic Model of Students' Waiting Decisions

Student  $i$  receives offer from  $j_t$  in round  $t$  & and has 3 options:

- If the student **accepts** the offer ( $k=1$ ) from  $j$  at round  $t$ :

$$v_{i1t} = u_{j_t}(S_i, \tau) + \epsilon_{i1t} \text{ if } t = 3$$

$$v_{i1t} = u_{j_t}(S_i, \tau) + \kappa(S_i, \tau)dist_{ij} + \epsilon_{i1t} \text{ if } t < 3$$

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- If the student **delays** her decision ( $k=2$ ) at round  $t$ :

$$v_{i2t} = -\omega(S_i, \tau) + \sum_{j' \in \mathcal{R}_i^{j_t} \cup \{j_t\}} \Pr(j_{t+1} = j') \bar{V}_{it+1} + \epsilon_{i2t}$$

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- If the student **drops out** from the platform ( $k=3$ ) at round  $t$ :

$$v_{i3t} = u_{0t}(S_i, \tau) + \epsilon_{i3t}$$

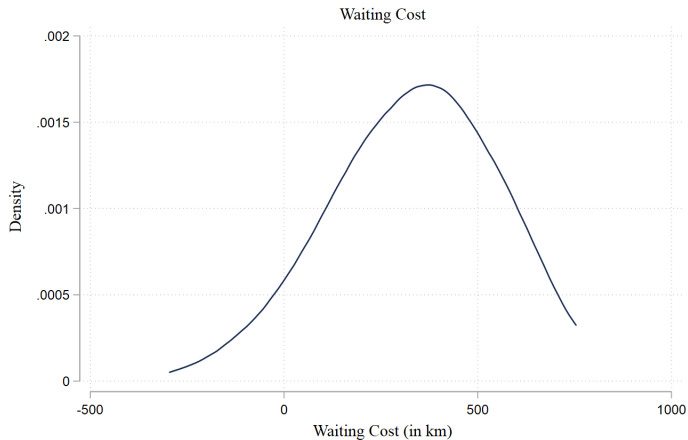
## Identification and estimation: Intuition

- Identification if types are observed by econometrician:
  - Step 1: **ROL** identifies **differences in utility** from programs
  - Step 2: **dynamic** accept/delay/drop out decisions identify other **primitives**
  
- Identification of **unobserved types**:
  - ROL: **correlation** between **program characteristics** within each students' ROL
  - Dynamic model: **correlation** between **students' choices** over different rounds
  
- Estimation without solving dynamic model using Arcidiacono & Miller, 2011 ▶ Estimation

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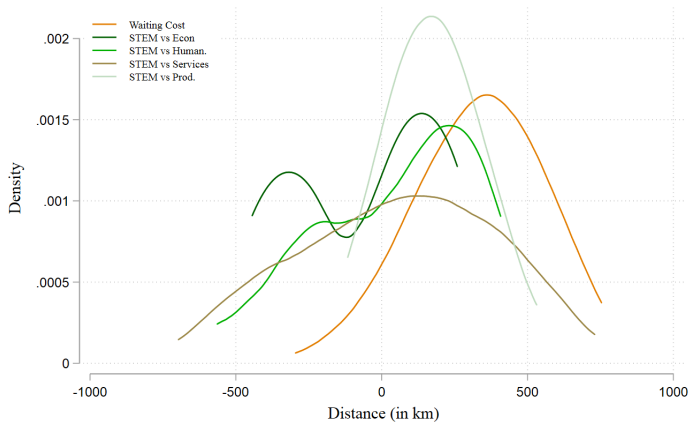
## Waiting Costs are Substantial and Heterogeneous



Median student derives same disutility from **delaying** and accepting college option **342km** further.



## Magnitude comparable to major preference heterogeneity



Only students with substantial gains will be willing to wait.

## Other results

- Low SES and male have higher waiting costs
- Preferences for type of college also diverse
- Distant alternative valued more by female if accepted early

▶ Figures

## Take-Aways & Next Steps

- Sequential mechanisms create **dynamic trade-offs** for students
  - + Higher match quality
  - Disutility of waiting
- Preliminary results: waiting costs are **substantial & heterogeneous**
- Next steps:
  - Investigate further housing market & dorm application decisions
  - Counterfactual: quantify equity-efficiency trade-off, by simulating outcome under one-round mechanism

# French Higher Education System

- Characterized by a high degree of institutional differentiation:
  - **University** programs - **51%**
  - Two-year undergraduate **vocational** programs (Sections de Techniciens Supérieurs) - **22%**
  - Two-year undergraduate **technical** programs (Instituts Universitaires de Technologie) - **11%**
  - Undergraduate **management** and **engineering** schools - **7%**
  - Two-year **selective** programs (Classes Préparatoires aux Grandes Ecoles) - **9%**
- For most programs, admission procedure **centralized** on an online platform

## French Higher Education System

	freq	pct
University - STEM	532267	11.54
University - Econ/Law	479847	10.40
University - Arts/Humanities	666326	14.44
CPGE - STEM	363445	7.88
CPGE - Econ/Law	132798	2.88
CPGE - Arts/Humanities	76396	1.66
DUT - Services	334147	7.24
DUT - Production	267834	5.81
BTS - Services	995739	21.59
BTS - Production	308096	6.68
Other - STEM	274322	5.95
Other - Econ/Law	4183	0.09
Other - Arts/Human	55556	1.20
Other - Services	119479	2.59
Other - Production	2651	0.06
Total	4613086	100.00

# Catchment Areas

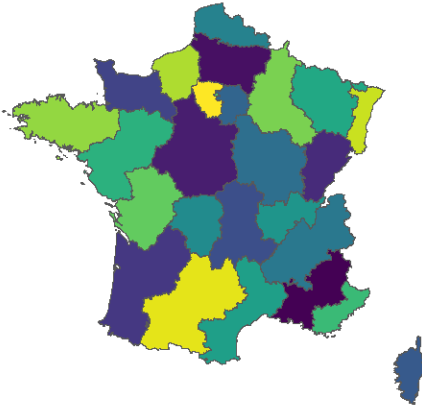


Figure: Catchment Areas

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## College-Proposing DA

- Step 1: Each program proposes to her top-ranked students, up to capacity. Each student tentatively accepts the most preferred program and rejects all others.
- Step  $k \geq 2$ : Any program which was rejected at step  $k - 1$  by any student proposes to its most-preferred acceptable students who have not yet rejected it, up to capacity. If there are fewer remaining acceptable students than number of seats, then it proposes to all. Each student considers both the new offers and the offer held from step  $k - 1$  and tentatively accepts the most preferred; the other program are rejected.
- The algorithm terminates when there are no more rejections.

## Student-Proposing DA

- Step 1. Each student proposes to her first choice. Each program tentatively assigns its seats to its proposers one at a time following their priority order. Any remaining proposers are rejected.
- Step  $k \geq 2$ : Each student who was rejected in the previous step proposes to her next highest choice. Each program considers the students it has been holding together with its new proposers and tentatively assigns its seats to these students one at a time following their priority order. Any remaining proposers are rejected.
- The algorithm terminates when no student proposal is rejected and each student is assigned her final tentative assignment.



	Mean	St. Deviation
Female	0.52	0.50
<i>SES Status:</i>		
High	0.30	0.46
Medium-High	0.15	0.37
Medium-Low	0.29	0.45
Low	0.25	0.43
With Scholarship	0.19	0.39
<i>High-School Track:</i>		
General HS Track	0.60	0.49
Technological HS Track	0.18	0.38
Vocational HS Track	0.22	0.41
<i>Applications &amp; Enrollment:</i>		
# Applications	6.52	5.78
Received An Offer	0.88	0.32
Accept Offer	0.77	0.42
Rank Admission	2	2.19
# of HS Applicants (2015)	570,866	

# An example of the students' dilemma:

## Re: APB : dossier TES prépa ECE

□ par Titinouille16 » 04/07/2014 15:11

Je tiens à vous remercier, tous, pour tous les conseils que vous m'avez donné.

J'ai eu mon bac ES avec mention Bien, et avec une moyenne de 15.7 🙄 Un peu dégouté d'être passé si près de la mention Très bien 🙄

Maintenant, voilà ma situation quant à l'année prochaine :

Je suis accepté à Alfred Kastler, et suite à la seconde phase d'APB, toujours en liste d'attente pour le CIV et Ozenne. J'ai donc téléphoné à Ozenne pour connaître ma position en liste d'attente et ils m'ont répondu qu'ils ne pouvaient pas me le dire. Donc je n'ai aucune idée quant à ma possible acceptation à Ozenne.

Pour le CIV, le responsable de l'internat m'a clairement fait savoir que j'avais peu de chance.

Voilà mon dilemme : dois-je accepter définitivement Alfred Kastler, sachant que j'ai obtenu un logement auprès du GROUS, ou bien faire "Oui mais" pour tenter d'avoir Ozenne ou le CIV, au risque de perdre mon logement pour Alfred Kastler ( je dois répondre avant le 10 et la 3e phase d'admission est le 14 ) ?

“ CITER

Titinouille16

Interne

Messages: 32

Enregistré le: 22/12/2013 16:23

Groupe(s):

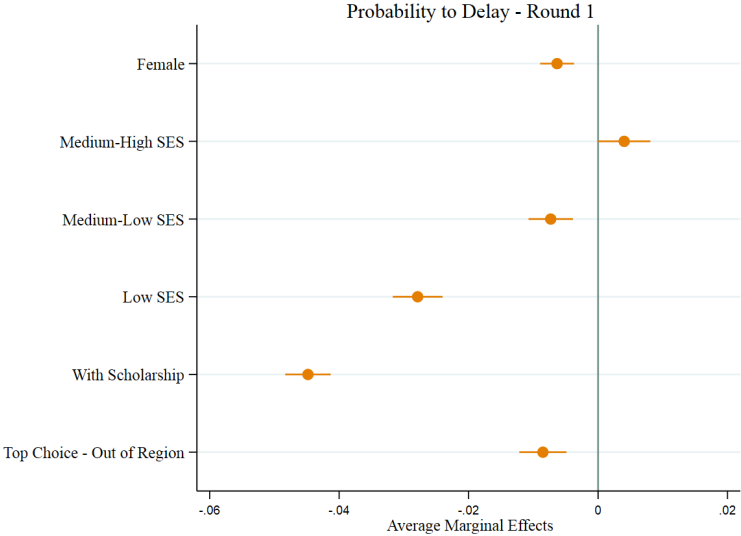
Utilisateurs enregistrés

'Here is my dilemma:

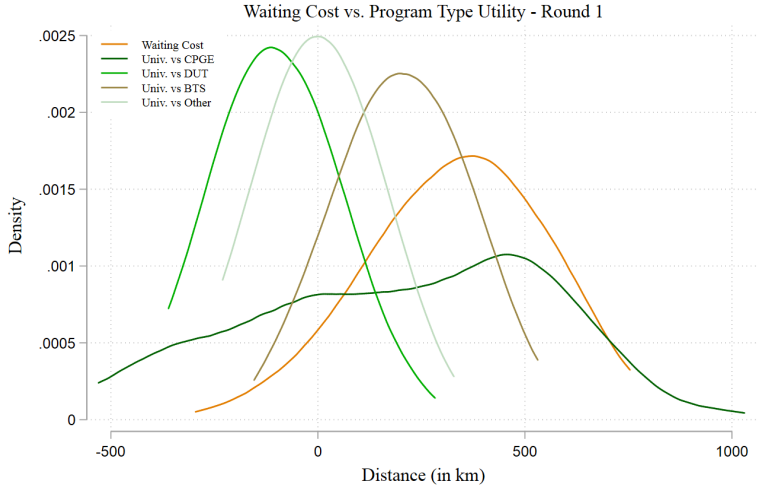
- Should I accept now the offer I got, given that I also have an offer for a student housing unit in the same city,
- or should I use the delaying option to try to get one of my preferred programs, at the risk of losing this accommodation offer?'

# Which students delay their decision?

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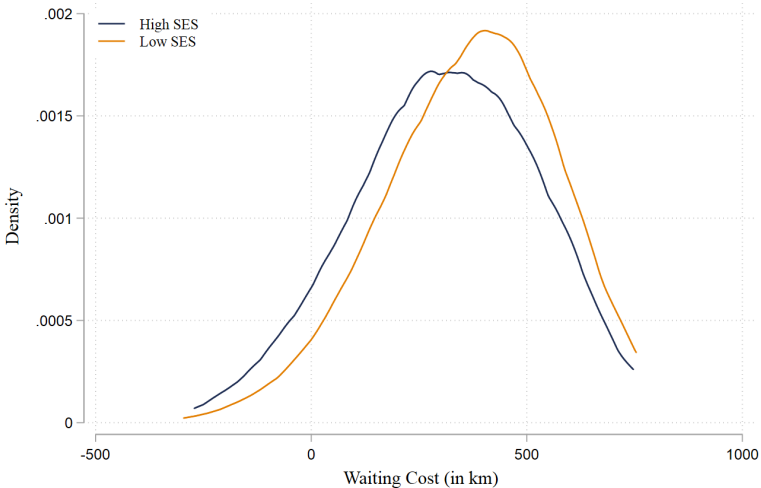


# Results: Waiting Costs are large [▶ Back](#)



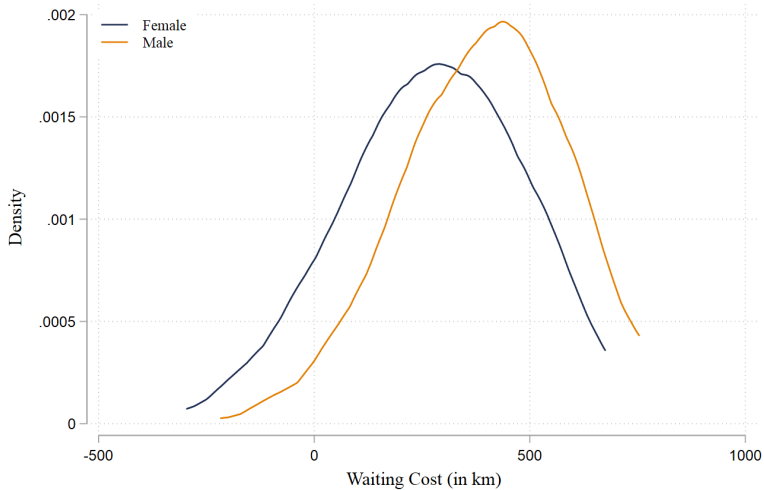
Size comparable to heterogeneity college type preferences

# Results: Waiting Costs are Heterogeneous [▶ Back](#)



Low SES students face a larger waiting costs than high SES students

## Results: Waiting Costs are Heterogenous [▶ Back](#)



Male students face a larger waiting costs than female students

# Contribution to the Literature

▶ Back

- Properties of **sequential assignment mechanisms** Bó & Hakimov, 2016; Luflade, 2018; Chen & Pereyra, 2019; Grenet et al., 2019, Kapor et al., 2020
  - Estimate impact **waiting costs** in sequential mechanisms
- **Dynamic considerations** induced by centralized assignment mechanisms Agarwal et al., 2021; Waldinger, 2021; Larroucau & Ríos, 2021
  - **Simpler estimator** and quantify **welfare** consequences of introducing dynamic trade-off
- **Determinants** of students' higher education choices Altonji et al., 2016; Patnaik et al., 2020
  - Impact of **design of assignment mechanism** in explaining heterogeneity in college and major choice

# Estimation

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Estimation without solving dynamic model using Arcidiacono & Miller, 2011:

- Write  $\bar{V}$  as a function of drop out utility and its Conditional Choice Probability (CCP)
- Assign a random type-weight to each student and use in what follows
- Predict drop out CCPs and probability to receive offers from data
- Estimate utility of programs using exploded logit on ROL data
- Estimate other structural parameters using logit with dynamic correction term on waiting data
- Update type weights using Bayesian formula and repeat until convergence