Teachers' desired mobility to disadvantaged schools: Do financial incentives matter?

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Overview

Disadvantaged schools in France

Major source of inequality: disadvantaged students are often taught by "low-quality" (e.g. less experienced) teachers (Chetty *et al.* 2014)

Disadvantaged schools programs since 1982 in France

- acknowledgement of social inequality in educational outcomes
- aim at tempering that inequality

Different components in these programs:

- non-financial: support local pedagogical initiatives, favor team work, etc.
- financial: allocate more resources (lower ratio of students per staff); offer a bonus to teachers working in those areas

Research question: Are financial incentives an efficient instrument to attract (high-quality) teachers in disadvantaged schools?

Exploiting a change in financial incentives in REP$^+$ schools

Two types of disadvantaged schools:

- REP schools (*Réseaux d'Éducations Prioritaires*)
- REP$^+$ schools (*Réseaux d'Éducations Prioritaires renforcés*): more disadvantaged, higher bonus

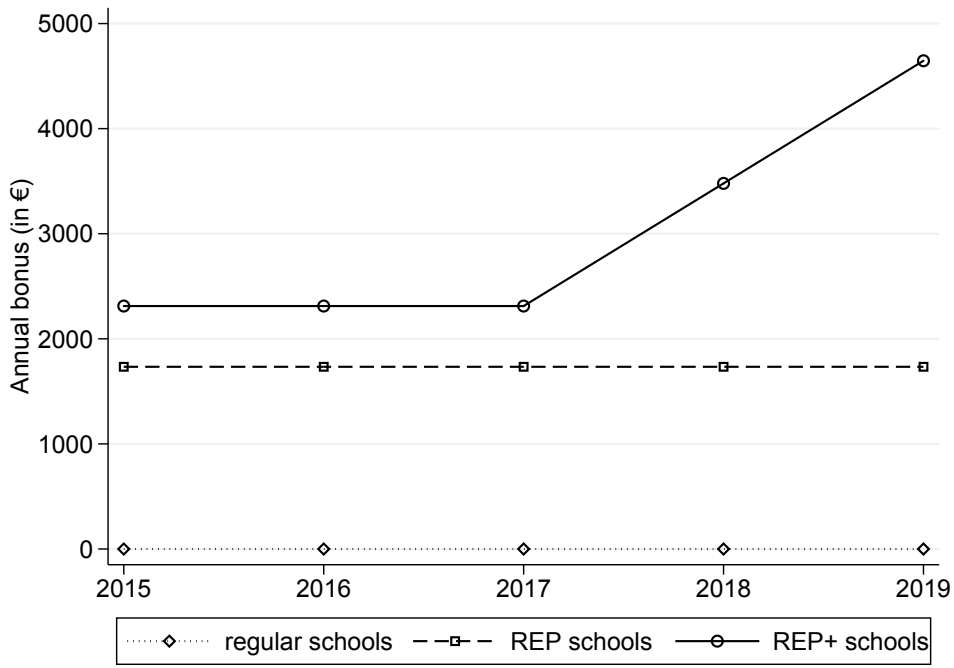


Figure 1: The change in financial incentives in REP$^+$ schools

Literature

- Centralized allocation mechanisms (Fack, Grenet and He 2019; Combe, Tercieux and Terrier 2022). Deferred acceptance (DA) matching algorithm *à la* Gale and Shapley (1962). Theoretically, truthful revelation of preferences if:
  - no application cost
  - uncertainty in admission outcomes

  Empirically, Abdulkadiroğlu *et al.* (2020) make that assumption for uncensored lists
- Teachers consider schools with low-achievement, disadvantaged students or minorities as less attractive: Hanushek *et al.* (2004) in Texas, Falch (2005) in Norway; Scafidi *et al.* (2007) in Georgia; Prost (2013) in France
- Lower attractiveness has, in turn, a negative impact on the quality of pedagogical teams (Benhenda 2020)
- Teachers' experience and stability of pedagogical teams have a positive impact on students' achievement (Rockoff 2004; Rivkin *et al.* 2005; Cowan and Goldhaber 2018)
- Evaluations of programs aiming at enhancing that attractiveness:
  - no effect: Beffy and Davezies (2013); Prost (2013)
  - positive effects, magnitude unclear: Clotfelter *et al.* (2008); Falch (2011); Cowan and Goldhaber (2018); Benhenda and Grenet (2020)
  - depends on type and intensity of financial incentives

Contribution

Our contribution:

- impact of financial incentives on teachers' **desired mobility**
- financial incentives at stake are **substantial** (about 1/5 of young teachers' annual wage)

Measurement of outcome (desired mobility):

- unique data from the internal human resource management of a French educational authority
- teachers' stated preferences from annual rank-ordered lists

Identification strategy:

- relies on the differential variation in financial incentives
- difference-in-differences (DinD) approach (treatment: REP$^+$ schools, comparison: REP schools)
- validity: CTA cannot be rejected (no pre-trend)
- violation of SUTVA? REP schools may, indeed, be contaminated by treatment
  - structural school choice model
  - disentangle financial incentives from unobserved local demand shocks
  - counterfactual simulations (neutralizing change in environment, e.g. local demand conditions)

Preview of results

DinD approach:

- positive and significant effect on REP$^+$ share among (top 1) choices
- heterogeneous effects: more pronounced for younger teachers and teachers already working in disadvantaged areas

School choice model:

- (estimation - 1) financial incentives have enhanced REP$^+$ schools' attractiveness
- (estimation - 2) about €3000 annually to make teachers indifferent between REP$^+$ schools and regular schools
- (counterfactual simulations - 1) most of observed increase in REP$^+$ share among top 1 choices due to financial incentives
- (counterfactual simulations - 2) no diverted demand from REP to REP$^+$
  - 9/10 of increase due to teachers not moving, absent the reform
  - 1/10 of increase due to teachers preferring regular schools

Empirically, cannot reject that REP schools are a valid comparison group.

Overview

Teacher allocation: a centralized mechanism

A two-round process:

1. between educational authorities (*mouvement inter-académique*)
2. within educational authorities (*mouvement intra-académique*)

Second round here: which school within a given educational authority?

Main rules:

- rank-ordered list (ROL) of at most 20 choices, either schools or geographical areas (municipalities, groups of municipalities, *départements*, whole educational authority)
- centralized allocation mechanism based on a priority index (calculated from teacher's characteristics, and type of choice)
- if a teacher gets none of her choices stated on her list, she remains in her current school
- DA matching algorithm *à la* Gale and Shapley (1962): no strategic behavior (truthful revelation of preferences is a dominant strategy)

To Algorithm

Revelation of preferences

Empirical evidence in favor of so-called weakly truth-telling (WTT) assumption:

1. no application cost
2. teachers have a good knowledge of the mechanism: allocation in a school is a major career event
3. uncertainty at the time of application due to incomplete information: colleagues' priority index, and hence school-specific cutoffs, can hardly be predicted
4. ranking schools according to preferences is an official injunction made by both Department of Education and unions

Also claimed by Combe *et al.* (2022)

Strategic behavior might nevertheless occur:

- for censored lists (20 choices): see Abdulkadiroğlu et al. (2020)
- when top 1 choice confers some non-pecuniary bonus on the priority index

We select these lists out of our sample.

Financial incentives in disadvantaged areas

In 2014:

- new classification of disadvantaged areas: REP and REP$^+$ schools (instead of ZEP)
- annual pecuniary bonus perceived by teachers working in those areas
- in REP: €1734
- in REP$^+$ (more disadvantaged): €2312 = (4/3) REP bonus

Gradual increase of REP$^+$ bonus in 2018 and 2019:

- in 2018: €3479 (2 REP bonus)
- in 2019: €4646 (8/3 REP bonus)

What do €4646 represent for French teachers?

- 13.5% of annual wage for a teacher working in public mid-schools
- 19.2% of annual wage for a young (less than 30), low-qualified teacher

The 2018 reform

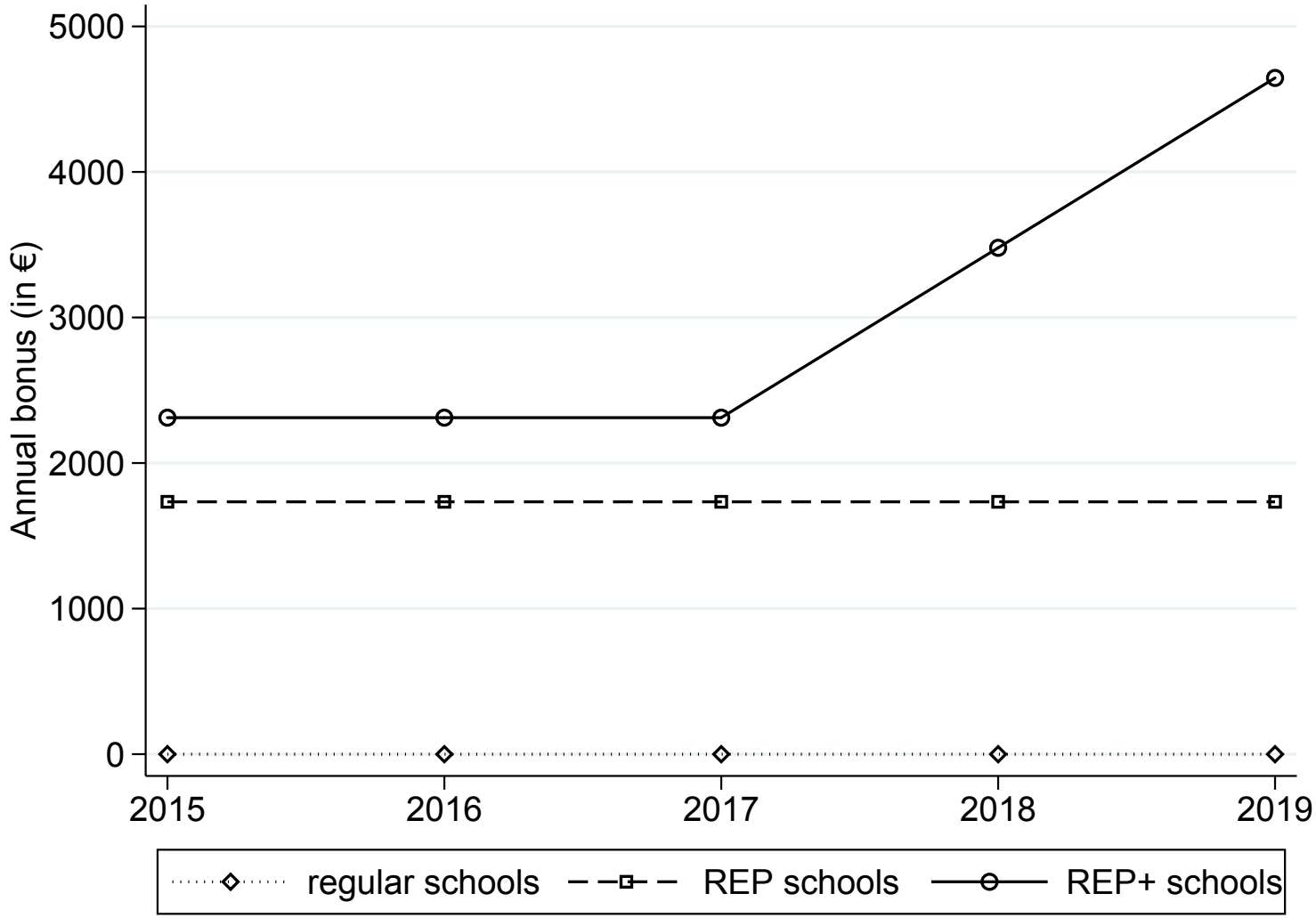


Figure 2: The change in financial incentives in REP$^+$ schools

Data

Issued from the human resources department of Montpellier's rectorate:

- 5 *départements*: Aude, Gard, Hérault, Lozère, Pyrénées-Orientales
- About 215 lower secondary or middle schools (17 REP$^+$ and 15 REP) and 55 upper secondary or high schools (none being classified as disadvantaged)
- About 14000 teachers

Application data from 2nd-round mobility process between 2015 and 2019 matched with teacher characteristics:

- 5902 ROLs
- 3251 teachers already working in Montpellier's rectorate
- 266 schools
- information available on teachers: age, gender, zipcode, subject taught, qualification, seniority, priority index, current school
- information available on schools: lower or upper secondary, zipcode, classification as a disadvantaged school
- we compute commuting times (by road) between teachers and schools

About 10% of ROLs have exactly 20 choices

Share of REP/REP$^+$ schools among all choices

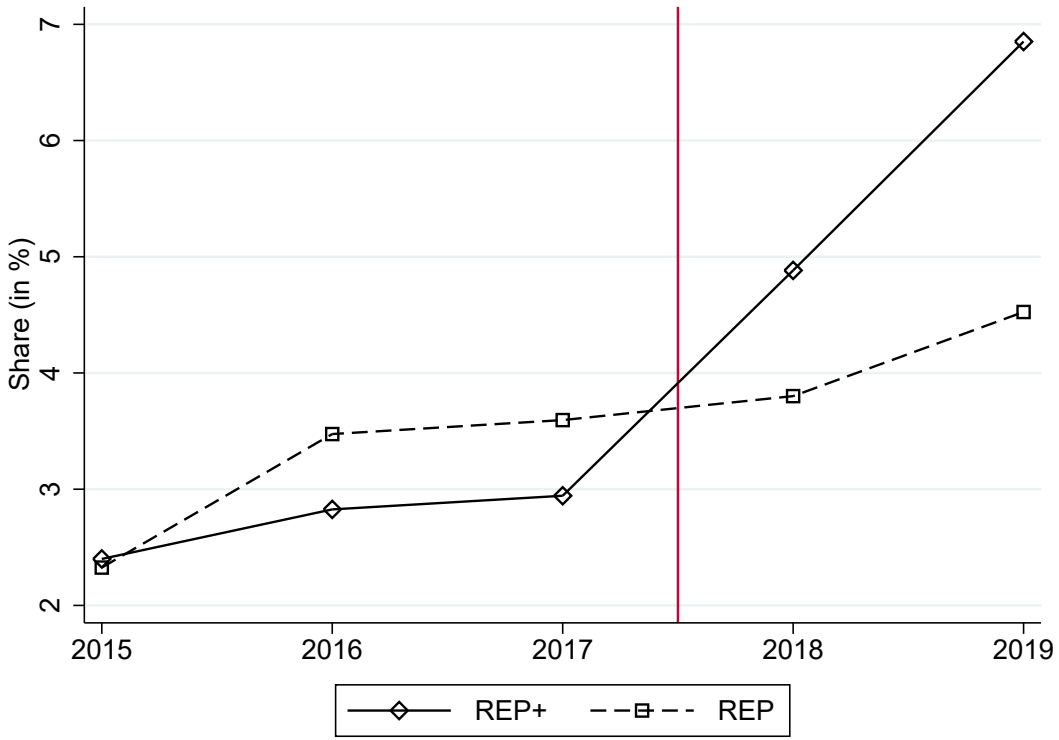


Figure 3: Share of REP/REP$^+$ schools among all choices

Share of REP/REP$^+$ schools among top 1 choices

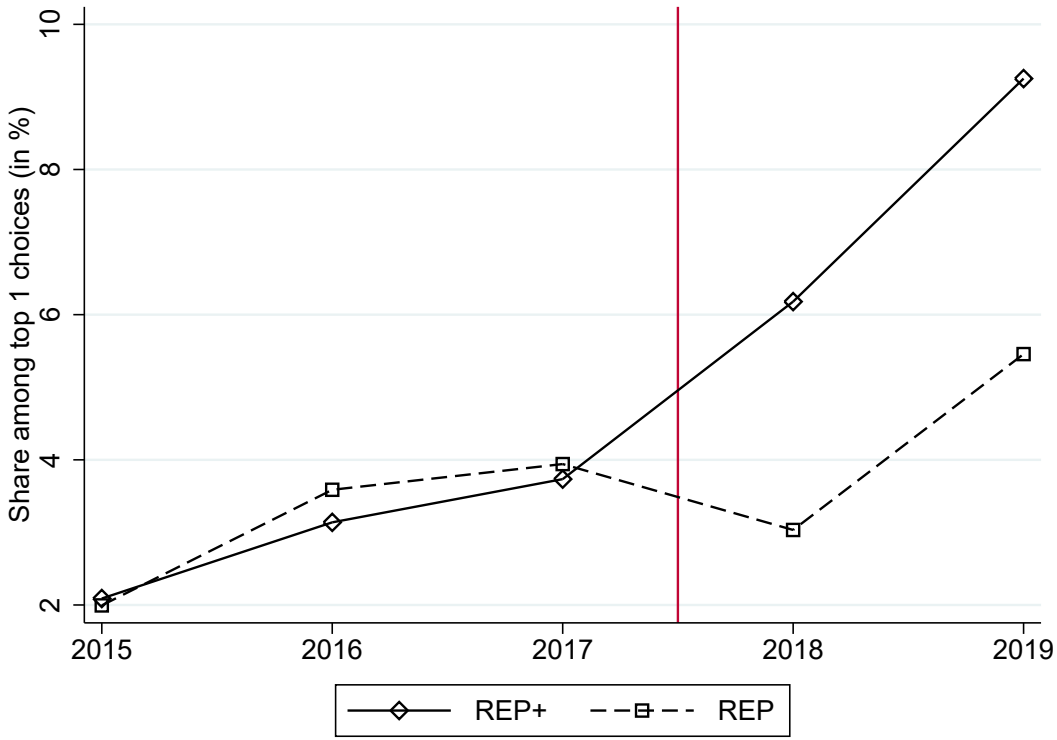


Figure 4: Share of REP/REP$^+$ schools among top 1 choices

Average rank of schools in lists

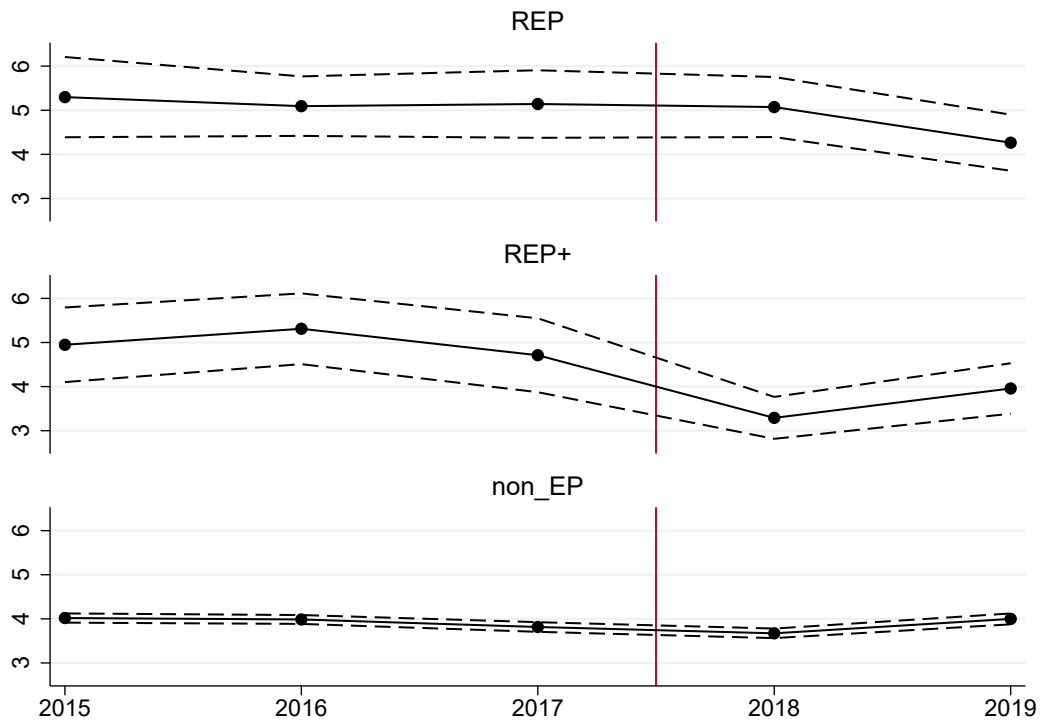


Figure 5: Average rank in ROLs

Overview

Identification strategy

Method: DinD

Treatment group: REP$^+$ schools

Comparison group: REP schools

- REP bonus does not vary over the period
- 17 REP$^+$ schools, 16 REP schools (233 regular schools)
- REP and REP$^+$ are close in terms of (maybe also un-)observed characteristics (e.g. quality of education, char. of teachers, char. of students), shares and rank in lists

Identifying assumption: common trend assumption (CTA) for both groups from 2015 to 2017

- average rank: imprecise (due to small number of schools concerned in the rectorate)

Econometric specification

Aggregating individual lists at teacher $i \times k-$type school $\times$ year t level

- $k-$type: regular, REP or REP$^+$
- but regular schools are removed from estimation sample

Estimating equation:

$$s_{ikt} = a\text{REP}_k^+ + b\text{REP}_k^+ \times \mathbb{1}\{t \geq 2018\} + \nu_t + \mu_{ik} + u_{ikt}, \quad (1)$$

where:

- s_{ikt} is the share of $k-$type schools among all choices
- REP_k^+ is a dummy for REP$^+$ schools
- ν_t is a year FE
- μ_{ik} is a teacher $\times$ REP$^+$ school FE

Clustering of standard errors at the teacher level.

Disentangling financial from other non-financial incentives:

$$s_{ikt} = \tilde{a}\text{REP}_k^+ + \tilde{b}\text{BONUS}_{kt} + \tilde{\nu}_t + \tilde{\mu}_{ik} + \tilde{u}_{ikt} \quad (2)$$

Empirical validity of the identification strategy

Linear increase of REP^+ bonus: exogenous variation to schools' attractiveness (natural experiment)

Plausibility of CTA:

- eyeball evidence (Figures 3, 4, 5)
- event study approach (no pre-trend)

Results: share among all choices

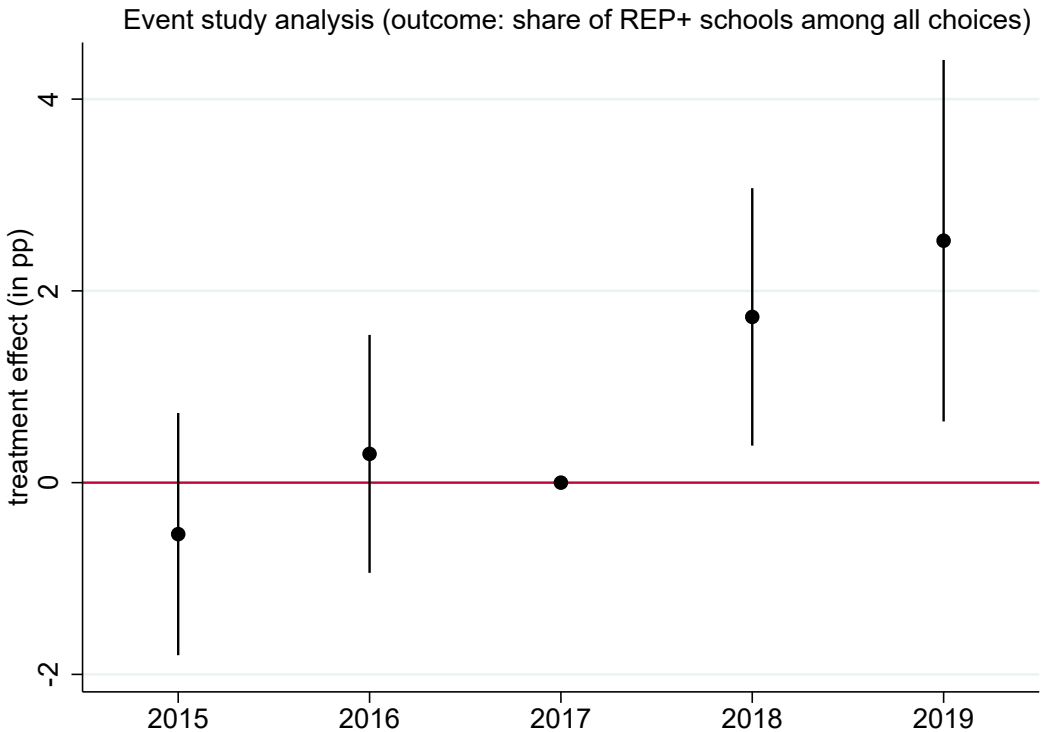
Table 1: DinD estimates (outcome: share of REP$^+$ among all choices)

	(1)	(2)	(3)	(4)
REP$^+$	-0.526*		-1.258***	
	(0.307)		(0.424)	
REP$^+$ $\times$ $\mathbb{1}\{t \geq 2018\}$	2.356***	2.083***		
	(0.585)	(0.587)		
Bonus (in €1,000)			1.317***	1.151***
			(0.338)	(0.355)
Year FE	Yes	Yes	Yes	Yes
Teacher $\times$ REP$^+$ FE	No	Yes	No	Yes
Observations	11,804	11,804	11,804	11,804
R^2	0.004	0.005	0.008	0.005

Note. Comparison group: REP schools. Shares: in %.

Robust standard errors clustered at the teacher level.

Event study


Event study analysis (outcome: share of REP+ schools among all choices)
treatment effect (in pp)
-2
0
2
4
2015
2016
2017
2018
2019

Results: share among top 1 choices

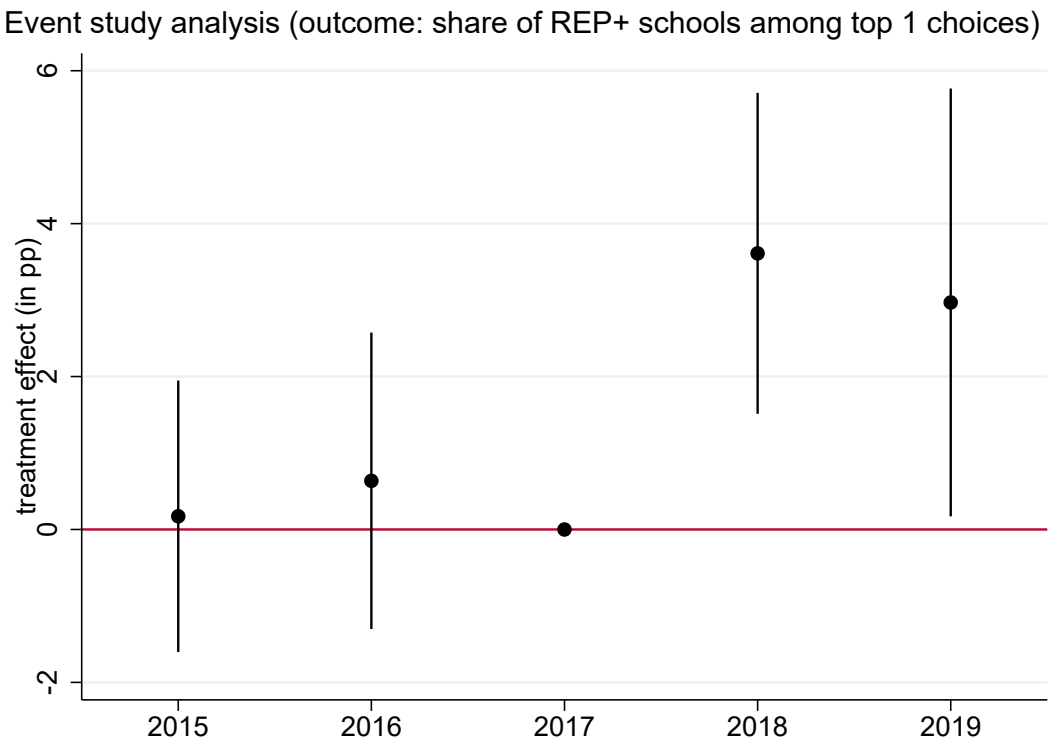
Table 2: DinD estimates (outcome: share of REP$^+$ among top 1 choices)

	(1)	(2)	(3)	(4)
REP$^+$	-0.201		-0.986*	
	(0.407)		(0.564)	
REP$^+ \times \mathbb{1}\{t \geq 2018\}$	3.164***	3.096***		
	(0.819)	(0.862)		
Bonus (in €1,000)			1.591***	1.395***
			(0.468)	(0.503)
Year FE	Yes	Yes	Yes	Yes
Teacher $\times$ REP$^+$ FE	No	Yes	No	Yes
Observations	11,631	11,631	11,631	11,631
R^2	0.005	0.006	0.009	0.004

Note. Comparison group: REP schools. Shares: in %.

Robust standard errors clustered at the teacher level.

Event study


Event study analysis (outcome: share of REP+ schools among top 1 choices)
treatment effect (in pp)
6
4
2
0
-2
2015
2016
2017
2018
2019

Overview

School choice: a justification

Why do we need a school choice model?

- shares sum up to 1: a (rival) discrete-choice model is more appropriate
- put differently, violation of SUTVA (contamination bias, spillovers) is likely: treatment might also affect REP (and regular) schools
- counterfactual simulations: what if no policy change?
- observed increase in REP$^+$ share: business stealing from REP schools? from regular schools? from the outside option?

School choice model

Utility of teacher i ranking school j on year t:

$$U_{ijt} = \delta_{jt} + \varepsilon_{ijt} \equiv \beta \text{BONUS}_{jt} + \alpha_j + \gamma_t + \xi_{jt} + \varepsilon_{ijt} \tag{3}$$

- α_j is attractiveness of school j (school FE)
- γ_t is an aggregate shock common to all schools in educational authority (year FE)
- ξ_{jt} are unobserved local demand schocks (any change in reputation of school j on year t)

Utility of outside option (no transfer):

$$U_{i0t} = \delta_{0t} + \varepsilon_{i0t} \equiv 0 + \varepsilon_{i0t} \tag{4}$$

Assuming i.i.d EV(1) error terms, the share s_{jt} of school j among top 1 choices on year t is:

$$s_{jt} = \frac{e^{\delta_{jt}}}{\sum_{k=0}^{J_t} e^{\delta_{kt}}} \tag{5}$$

Estimation

Estimating equation (Berry 1994):

$$\log s_{jt} - \log s_{0t} = \delta_{jt} \equiv \beta \text{BONUS}_{jt} + \alpha_j + \gamma_t + \xi_{jt} \tag{6}$$

Standard errors are clustered at the school level.

Identifying assumption: exogeneity of change in financial incentives, conditionally on school FE (hence on classification into disadvantaged areas)

Empirically, that classification remained unchanged over the period.

What if $s_{jt} = 0$? Following Gandhi, Lu and Shi (WP 2022), we replace (all) observed shares with their Laplace transform $s_{jt}^L = \frac{N_t s_{jt} + 1}{N_t + J_t + 1}$ where

- N_t: total # of teachers (requesting a transfer or not) on year t
- J_t: # of schools in educational authority on year t

Estimation results:

- $\hat{\beta} = 0.239(0.076)$: **financial incentives enhance schools' attractiveness**
- average difference in $\hat{\alpha}_j$ between REP$^+$ and regular schools about -0.71, hence **from teachers' viewpoint, a bonus of about €3000 should compensate for that attractiveness gap** (N.B. consistently with Figure 4)

Breaking down the evolution of shares

Main interest of the model: decomposing observed variations of shares into 2 channels

- Experiment (a): pure change in financial incentives, i.e. βBONUS_{jt} term
- Experiment (b): pure unobserved local demand shocks, i.e. ξ_{jt} term

Method: Simulate environment (demand conditions and bonus) that prevails in 2018 and 2019, but successively replace parameters with their values in 2017

Experiment (a):

$$\tilde{\delta}^a_{jt} = \hat{\delta}_{jt} - \hat{\beta}\left(\text{BONUS}_{jt} - \text{BONUS}_{j2017}\right) \quad \forall t = 2018, 2019, \tag{7}$$

$$\tilde{s}^a_{jt} = \frac{e^{\tilde{\delta}^a_{jt}}}{\sum_{k=1}^{J_t} e^{\tilde{\delta}^a_{kt}}}, \tag{8}$$

Experiment (b):

$$\tilde{\delta}^b_{jt} = \hat{\delta}_{jt} - \left(\hat{\xi}_{jt} - \hat{\xi}_{j2017}\right) \quad \forall t = 2018, 2019. \tag{9}$$

$$\tilde{s}^b_{jt} = \frac{e^{\tilde{\delta}^b_{jt}}}{\sum_{k=1}^{J_t} e^{\tilde{\delta}^b_{kt}}}, \tag{10}$$

Results

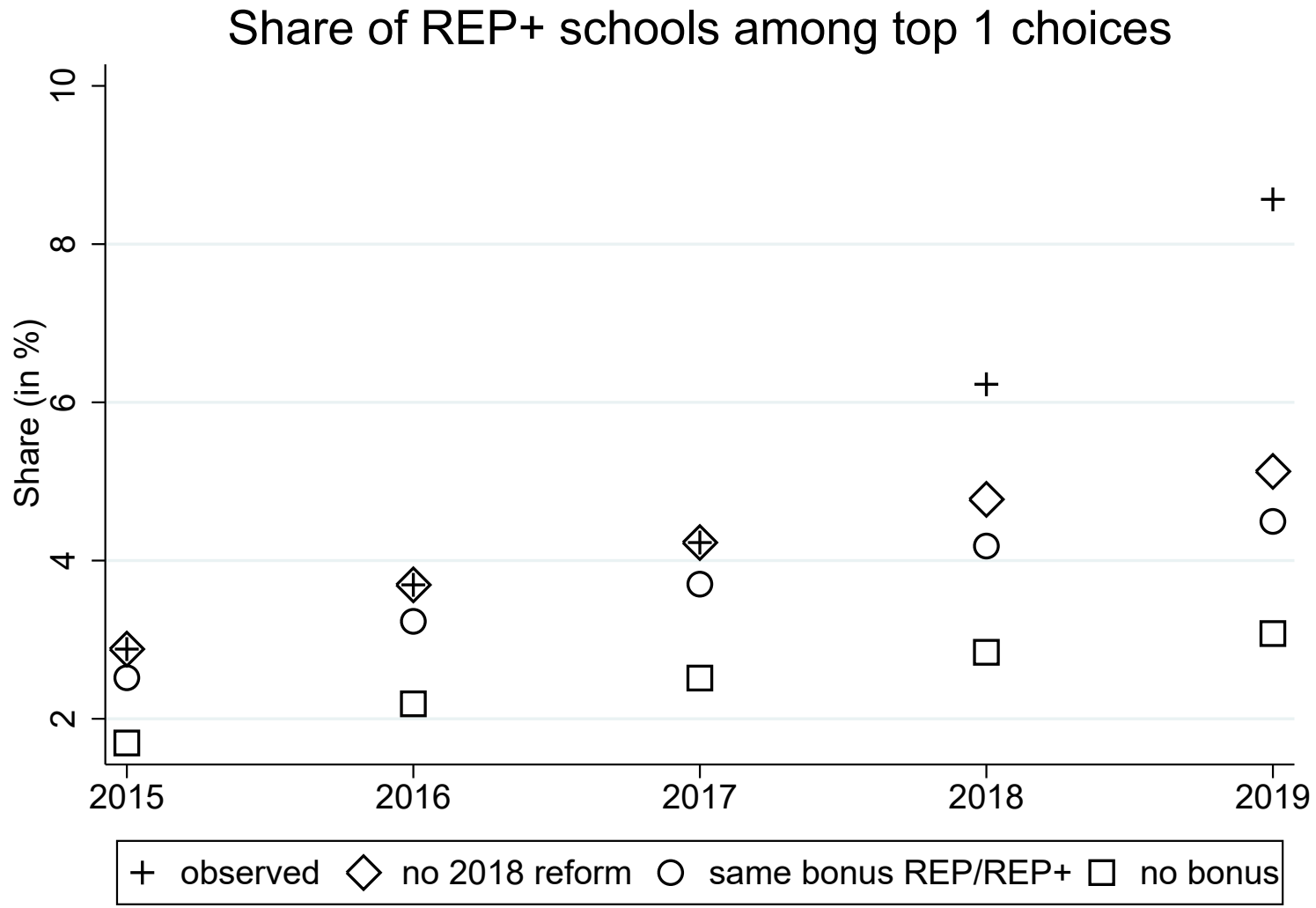
Table 3: Breaking down variations in shares of top 1 choices

	Year	2017	2018	2019
REP$^+$ schools	Observed	4.2	6.2	8.6
	(a) 2017 financial incentives	4.2	4.8	5.1
	(b) 2017 local demand shocks	4.2	5.9	7.4
REP schools	Observed	4.4	3.7	5.6
	(a) 2017 financial incentives	4.4	3.8	5.8
	(b) 2017 local demand shocks	4.4	4.4	4.3
Regular schools	Observed	91.4	90.1	85.8
	(a) 2017 financial incentives	91.4	91.4	89.1
	(b) 2017 local demand shocks	91.4	89.7	88.3

Note. Shares of schools ranked first: in % of rank-ordered lists.

Counterfactual simulations

In a similar vein, consider alternative $\widetilde{\text{BONUS}}_{jt}$ to isolate the sole change in financial incentives:



Conclusion

- Positive and significant effect on share of REP$^+$ schools among (top 1) choices
- Financial incentives have enhanced REP$^+$ attractiveness; a €3000 annual bonus would be enough to compensate for the gap with regular schools
- No diversion of demand from REP schools which look like a valid comparison group; answers concerns raised by possible violation of SUTVA
- Heterogeneous responses to pecuniary incentives (not presented here)
  - ROL model including commuting time
  - teachers less than 30 or already working in disadvantaged schools respond more
- Limit: external validity (single educational authority + quite small # of REP$^+$ schools)
- Extension: cost-benefit analysis of the policy? cost OK, but benefit?
  1. unravel causal chain from incentives to students' achievement (through stability of pedagogical team?)
  2. determine how much DM values students' achievement

Appendix

Matching algorithm: Gale and Shapley (1962)

Rules:

- Step 1:
  - every teacher applies to her first choice
  - every school rejects candidates with lowest priority indices, and that are in excess wrt its capacity; other candidates are admitted temporarily
- Step $k > 1$:
  - every teacher rejected at step $k-1$ applies to his next choice
  - every school rejects candidates with lowest priority indices among new candidates and those admitted at step $k-1$, and that are in excess wrt its capacity; other candidates are admitted temporarily
- Final step: no more rejection

Properties:

- the algorithm ends within a finite number of steps
- stability of the final allocation: no justified envy, i.e. no blocking pair. Each and any teacher is allocated in her preferred school among those feasible ex post (i.e. for which her priority index lies above the school-specific cutoff)
- truthful revelation of preferences is a dominant strategy

Back to mechanism