

Does Finance Reform Move Teachers and School Organizations?

California's \$23 Billion Effort to Narrow Inequality

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Introduction

Data and Measures

Analytic and Estimation Strategy

Findings

Discussion and Policy Implications

Introduction

Achievement Gap Fails To Close

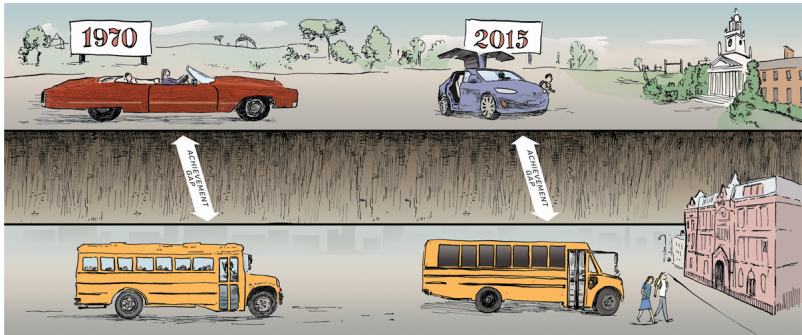


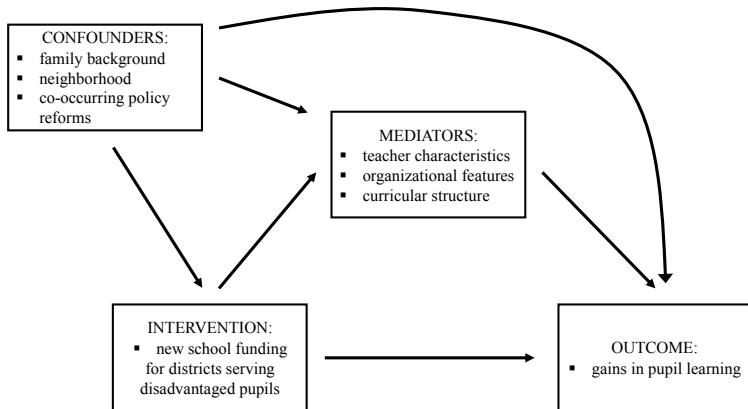
ILLUSTRATION / KURT HOFFMAN

- “Gaps in achievement between the haves and have-nots are mostly unchanged over the past half century” (Hanushek et al., March 2019, *Education Next*)

Why?

- ▶ Despite the concurrent improvement in resource equity and adequacy in school finance over the past decades, why does the income achievement gap persist?
- ▶ “A growing disparity in teacher quality across the social divide may have offset the impacts of (school finance) policies designed to work in the opposite direction.” (Hanushek et al., March 2019, *Education Next*)
- ▶ In other words, changes in school resource levels have not been able to alter the existing differentiation in teacher quality.

Focus on *Mediators*



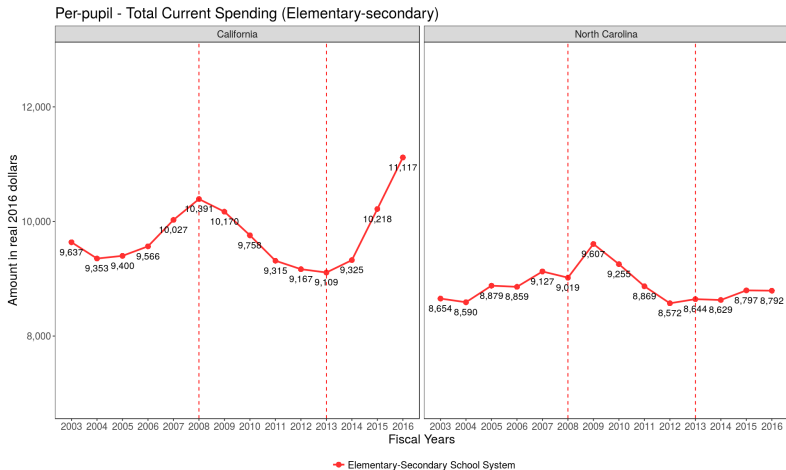
- Uncovering not simply *whether* money matters, but *how* money alter teacher qualities or school organizational features

Research Question

- ▶ Do large increases in per-pupil spending in districts lead to changes in distribution of educational *inputs* (teacher characteristics, school organizational features, and curricular structure) across schools within district in ways that equalize opportunities to learn?

Data and Measures

The California Case



Source: Annual Survey of School System Finances

- ▶ Annual Survey of School System Finances (F-33) data
- ▶ https://joonho.shinyapps.io/F33_trends/

Data

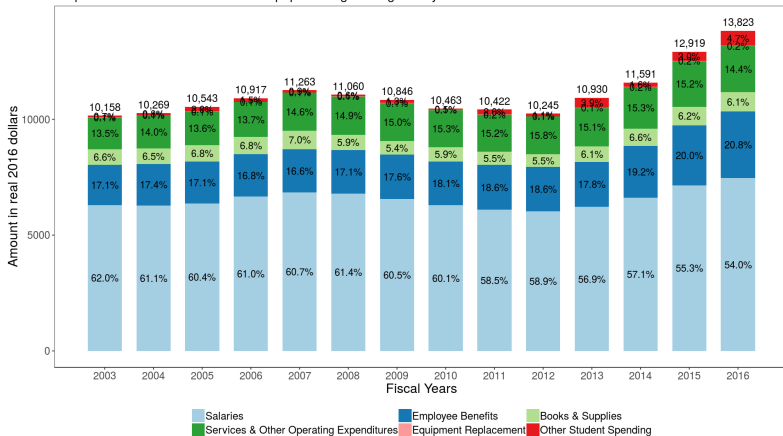
We draw on an extensive set of longitudinal administrative data from several sources:

- ▶ The standardized account code structure (SACS) annual financial data
- ▶ Local Control Funding Formula (LCFF) funding snapshot data
- ▶ Monthly statements of general fund cash receipts and disbursements from the state's fiscal controller
- ▶ The California Longitudinal Pupil Achievement Data System (CALPADS) staff demographic, staff assignment and course data

We built school-by-year panel data sets, 2003-04 to 2016-17, for 6,867 traditional elementary (5,764) and high schools (1,103) in 941 districts in California (excluding charter schools)

SACS Annual Financial Data

Student Spending: Subcategories by Object Codes
Proportions Based on State-level Per-pupil Averages Weighted by ADA



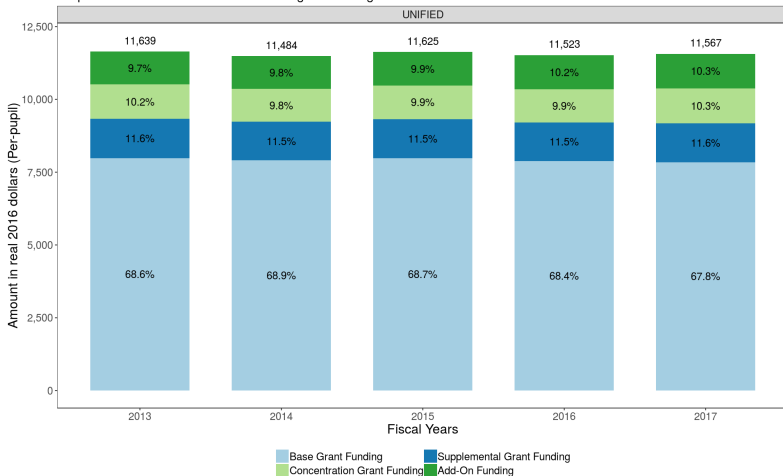
Source: SACS unaudited data

► https://joonho.shinyapps.io/California_School_Finance/

LCFF Funding Snapshot Data

LCFF Target Entitlement

Proportions Based on District-level Averages: Los Angeles Unified



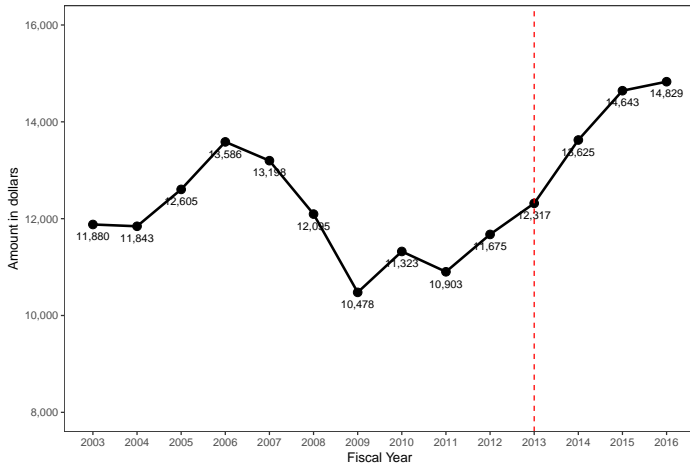
Source: LCFF Funding Snapshot Data

► https://joonho.shinyapps.io/LCFF_Funding_Snapshot/

State Cash Receipts and Disbursements Data

State Local Assistance Provided Excluding Education: Per-pupil

Inflation adjusted using CPI-U deflator (in real 2016 dollars)

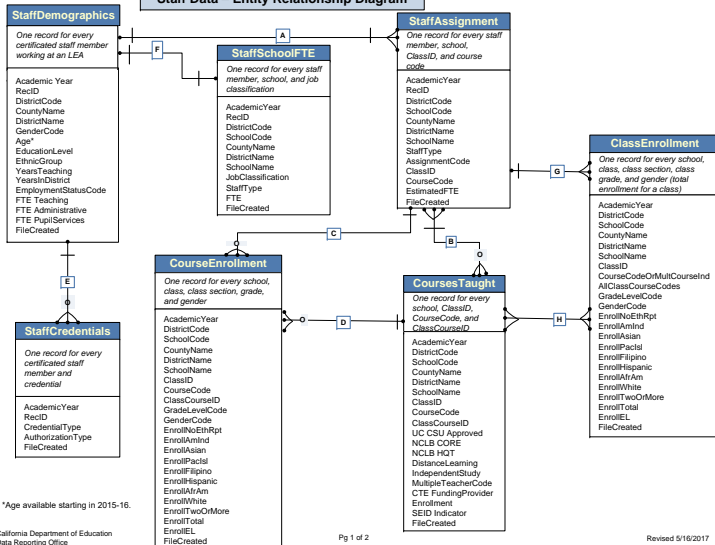


Source: The State Controller's Office

- ▶ School districts' revenues are a function of what the state spends.

CALPADS Staff Data

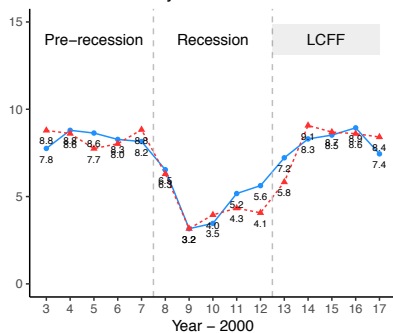
Staff Data – Entity Relationship Diagram



*Age available starting in 2015-16.

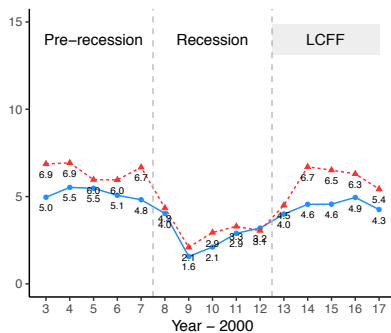
CALPADS: Teacher Characteristics

A % Teachers newly hired in the district



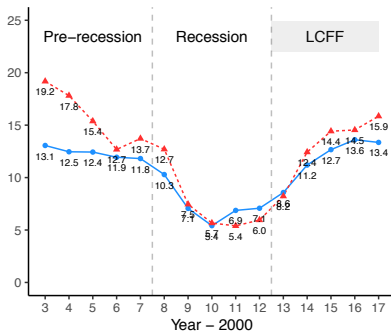
—●— Q1 mean (Low-poverty schools) —▲— Q5 mean (High-poverty schools)

B % Novice teachers



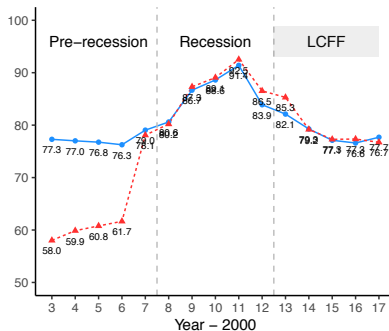
CALPADS: Teacher Characteristics

C % Probationary teachers



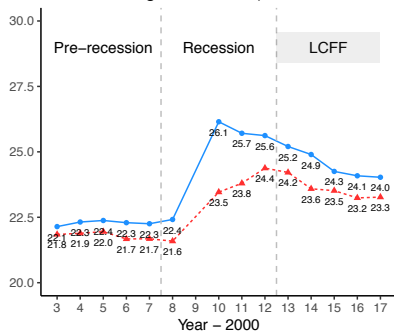
—●— Q1 mean (Low-poverty schools) -▲- Q5 mean (High-poverty schools)

D % Tenured teachers



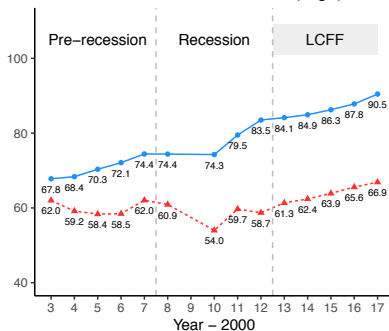
CALPADS: Organizational Features & Curricular Structure

A School average class size (Homeroom class)



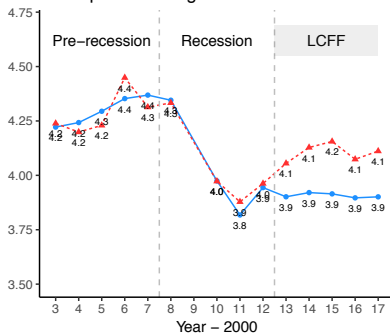
—●— Q1 mean (Low-poverty schools) —▲— Q5 mean (High-poverty schools)

B Total number of courses offered (High)



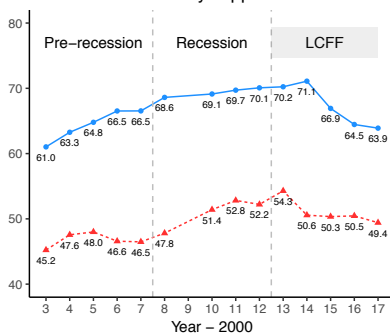
CALPADS: Organizational Features & Curricular Structure

C Class periods assigned to math teachers



—●— Q1 mean (Low-poverty schools) -▲- Q5 mean (High-poverty schools)

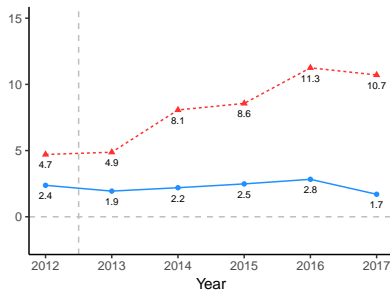
D % Math classes always approved as A-G



CALPADS: English Learner's Access to Resources

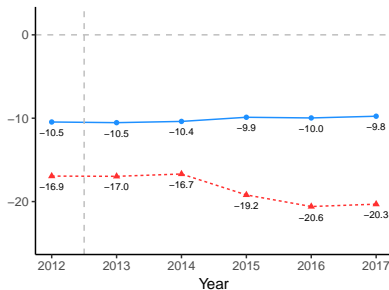
A High school math classes

Avg. %EL in classes taught by the nontenured minus
Avg. %EL in classes taught by the tenured



B High school math classes

Avg. %EL in A-G classes minus
Avg. %EL in non-A-G classes



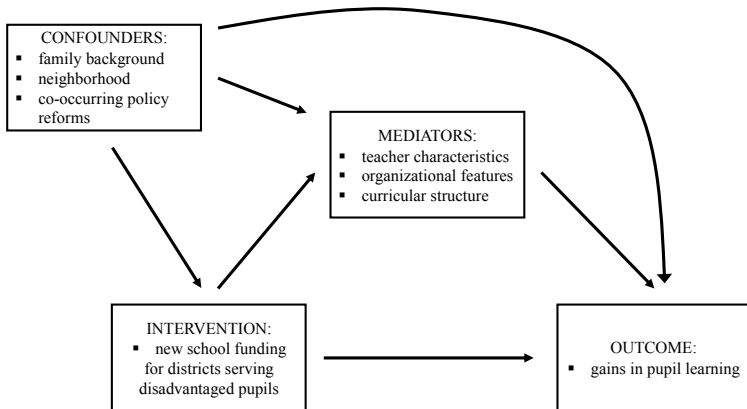
—●— Q1 mean (Low-poverty schools) -▲- Q5 mean (High-poverty schools)

- ▶ The average percentage of English learners (ELs) in classes taught by the novice teachers **minus** the average percentage of ELs in classes taught by the experienced teachers (more than 2 years of experience) within the school

Analytic and Estimation Strategy

The Key Empirical Challenge

- School spending is an *endogenous* treatment.



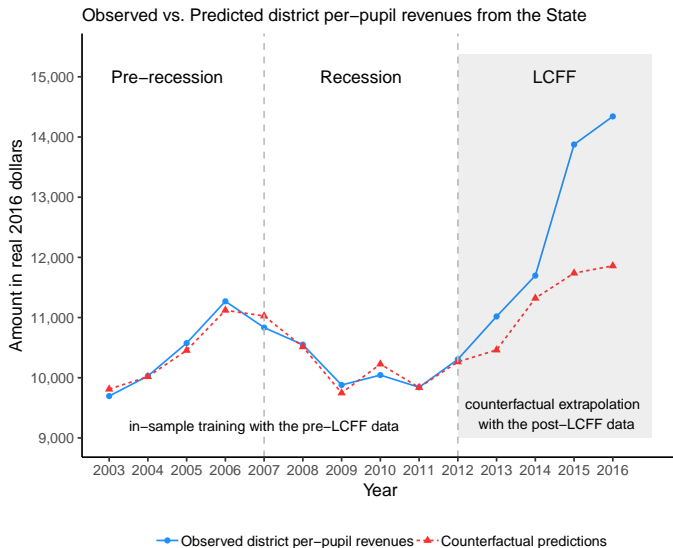
Sources of Exogeneity

1. **The timing of reform events** → an event study framework
 - ▶ assume that the exact timing of school finance reform is as good as random
 2. **The funding formula** → instrumental variable (IV) estimation
 - ▶ leverage only reform-induced variation in funding brought about by the funding formula
- ▶ California's recent school finance reform, the Local Control Funding Formula (LCFF) signed into law in 2013, allows us to leverage both sources by conducting *an event study with a simulated IV approach* (Johnson & Tanner, 2018).

Research Design

- ▶ **Step 1:** Prediction of the counterfactual trends of district per-pupil revenue if LCFF had not occurred
- ▶ **Step 2:** Estimating LCFF-induced exogenous increases in district per-pupil expenditure (The 1st stage of 2SLS)
- ▶ **Step 3:** Estimating the effect of LCFF-induced increases in funding on the within-district distribution of teacher and school-organization outcomes (The 2nd stage of 2SLS)

Step 1. Counterfactual Predictions



Step 1. Counterfactual Predictions

$$PPR_{dt} = \sum_{r=1}^{N_d} I_{r=d} \times (\alpha_{0,r} + \alpha_{1,r} \cdot State_t + \alpha_{2,r} \cdot Local_t) + \lambda_t + \epsilon_{dt}.$$

- ▶ We directly model the predicted district per-pupil revenues as a function of
 1. California's economic cycle
 2. general underlying differences across districts
 3. district-specific sensitivity of revenues to fluctuations in the statewide business cycle

Step 1. Counterfactual Predictions

$$PPR_{dt} = \sum_{r=1}^{N_d} I_{r=d} \times (\alpha_{0,r} + \alpha_{1,r} \cdot State_t + \alpha_{2,r} \cdot Local_t) + \lambda_t + \epsilon_{dt}.$$

- ▶ PPR_{dt} : the district per-pupil revenue from the state for district d for year t
- ▶ $State_t$: expenditures for total *state operations*, excluding education-related categories such as spending on state universities and colleges
- ▶ $Local_t$: the total *local assistance* expenditures outside of spending on K-12 schools, community colleges, and the state teacher retirement system
- ▶ λ_t : a year fixed effect
- ▶ $\alpha_{1,r}$ and $\alpha_{2,r}$ encapsulate the district-specific sensitivity of revenues to changes in statewide expenditures

Step 2. LCFF-induced Exogenous Increases in PPE_{dt}

$$PPE_{dt} = \sum_{z=1}^{10} \sum_{p=0}^4 (I_{\text{Exposure}_d=p} \times I_{\text{Dosage}_d=z}) \cdot \alpha_{p,z} + \gamma_1 \cdot \widehat{PPR}_{dt} + \mu_d + \lambda_t + v_{dt}$$

- ▶ The endogenous treatment PPE_{dt} :
 - ▶ the district per-pupil spending for district d for year t
 - ▶ we excluded district spending categories that are distant from classroom instruction, teacher salaries or student support services, such as debt services, capital outlay and facilities

Step 2. LCFF-induced Exogenous Increases in PPE_{dt}

$$PPE_{dt} = \sum_{z=1}^{10} \sum_{p=0}^4 (I_{\text{Exposure}_d=p} \times I_{\text{Dosage}_d=z}) \cdot \alpha_{p,z} + \\ \gamma_1 \cdot \widehat{PPR}_{dt} + \mu_d + \lambda_t + v_{dt}$$

► Control variables

- time-varying confounder \widehat{PPR}_{dt} : the predicted counterfactual per-pupil revenue for district d for year t estimated from step 1. This reflects the dynamic effect of time-varying structural economic conditions on district revenues that might confound the relationship between the LCFF policy treatment and changes in teacher profiles and school-level organizational features
- μ_d and λ_t are district and year fixed effects respectively

Step 2. LCFF-induced Exogenous Increases in PPE_{dt}

$$PPE_{dt} = \sum_{z=1}^{10} \sum_{p=0}^4 (I_{\text{Exposure}_d=p} \times I_{\text{Dosage}_d=z}) \cdot \alpha_{p,z} + \\ \gamma_1 \cdot \widehat{PPR}_{dt} + \mu_d + \lambda_t + v_{dt}$$

► Instruments:

- Exposure_d : the number of school years after the initial year of LCFF reform for district d . This varies from 0 (pre-LCFF years from 2003, before 2013-14) to 4 (post-LCFF year 2016-17)
- Dosage_d : the LCFF-intended amount of supplemental and concentration grants in 2013. This *simulated IV* is generated from the state funding formula $\text{Dosage}_d = \{0.20 \times \text{Base}_d^{2013} \times \text{UPP}_d^{2013}\} + \{0.50 \times \text{Base}_d^{2013} \times \max[\text{UPP}_d^{2013} - 0.55, 0]\}$.

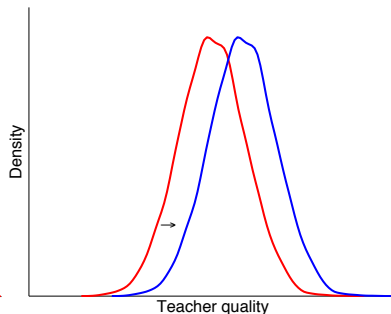
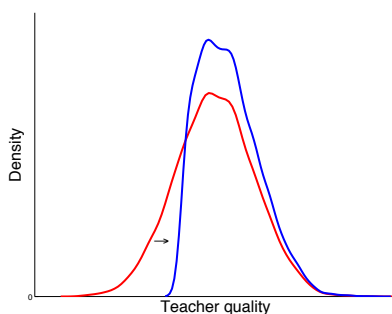
Step 2. LCFF-induced Exogenous Increases in PPE_{dt}

$$PPE_{dt} = \sum_{z=1}^{10} \sum_{p=0}^4 (I_{\text{Exposure}_d=p} \times I_{\text{Dosage}_d=z}) \cdot \alpha_{p,z} + \gamma_1 \cdot \widehat{PPR}_{dt} + \mu_d + \lambda_t + v_{dt}$$

- ▶ Thus, $\alpha_{p,z}$ summarize the LCFF-reform induced exogenous increases in per-pupil spending in districts with dosage decile z after p years from the reform.
- ▶ \widehat{PPE}_{dt} is the per-pupil student spending for district d for year t instrumented by the two sources of exogeneity.

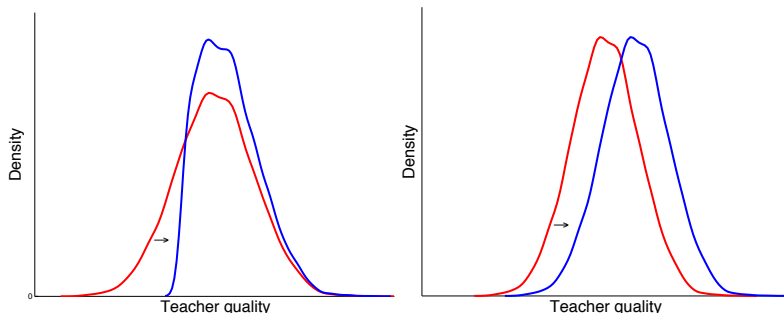
Step 3. The Grouped IV Quantile Regression

- ▶ In finance reform studies, district-level increases in per-pupil spending may have little effect on the district-level *averages* of school quality measures.
- ▶ But they may still move the lower or higher *quantiles* of school quality distributions within a district.



Step 3. The Grouped IV Quantile Regression

- ▶ The grouped/multilevel instrumental variable (IV) quantile regression (Chetverikov, Larsen, & Parmer, 2016) allows us to estimate the *distributional* or *heterogenous* effects of LCFF-induced funding increases on quantiles of the *within-district distribution* of school-level outcomes.



Step 3. The Grouped IV Quantile Regression

Level-1 within-cluster model:

$$Q_{Y_{sdt}}(\tau) = \alpha_{dt}(\tau) + \beta_1 \cdot \text{Enroll}_{sdt} + \beta_2 \cdot \text{FRPM}_{sdt}, \tau \in (0, 1)$$

Level-2 between-cluster model:

$$\alpha_{dt}(\tau) = \sum_{r=-9}^4 (I_{r=t} \times \log \widehat{PPE}_{dt}) \cdot \delta_r(\tau) + \gamma_2(\tau) \cdot \log \widehat{PPR}_{dt} + u_{dt}(\tau)$$

- The cluster is defined as a district-by-year cell.

Step 3. The Grouped IV Quantile Regression

Level-1 within-cluster model:

$$Q_{Y_{sdt}}(\tau) = \alpha_{dt}(\tau) + \beta_1 \cdot \text{Enroll}_{sdt} + \beta_2 \cdot \text{FRPM}_{sdt}, \tau \in (0, 1)$$

- ▶ The varying intercept $\alpha_{dt}(\tau)$: the district-by-year-specific conditional quantile of the school level outcome Y_{sdt} , after adjusting for differences between clusters in the level of the two school-level confounders:
 - ▶ total enrollment (Enroll_{sdt})
 - ▶ percentage of students eligible for free or reduced priced lunch (FRPM_{sdt})
- ▶ Each cluster has one value of $\alpha_{dt}(\tau)$.

Step 3. The Grouped IV Quatile Regression

Level-2 between-cluster model:

$$\alpha_{dt}(\tau) = \sum_{r=-9}^4 (I_{r=t} \times \log \widehat{PPE}_{dt}) \cdot \delta_r(\tau) + \gamma_2(\tau) \cdot \log \widehat{PPR}_{dt} + u_{dt}(\tau)$$

- ▶ We are primarily interested in estimating the *difference-in-difference* parameters $\delta_r(\tau)$.
- ▶ $\delta_r(\tau)$ represents the difference in the effect of $\log \widehat{PPE}_{dt}$ on $\alpha_{dt}(\tau)$ between reference year 2012-13 ($t = 0$, the year prior to June 2013 enactment of LCFF) and t years after (or before) the reference year after controlling for the effect of the time-varying confounder $\log \widehat{PPR}_{dt}$.

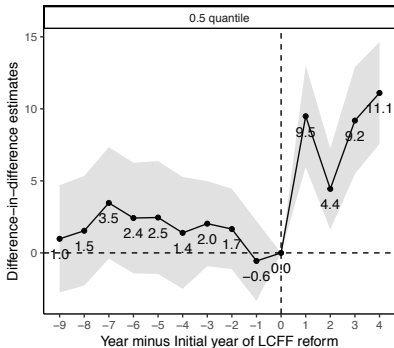
Findings

Teacher Characteristics

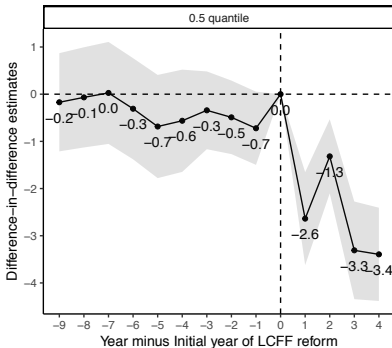
1. LCFF-induced increases in funding result in significant increases in the percentages of teachers who were newly hired to their districts, including novice teachers.
2. The newly hired teachers appear most often to be non-tenured (long-term substitutes, probationary).
3. High-poverty schools hired more white teachers and teachers holding a master's degree or more.

Districts and schools hired rising counts of new teachers

A % Teachers newly hired in the district

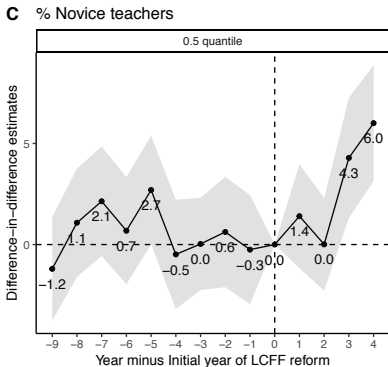


B Years of service in the district (school mean)



- ▶ 10% increases in LCFF-induced funding → a 0.95 percentage point gain in the share of newly hired teachers in the first LCFF year

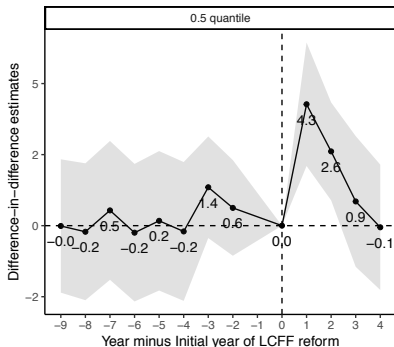
Districts and schools hired rising counts of new teachers



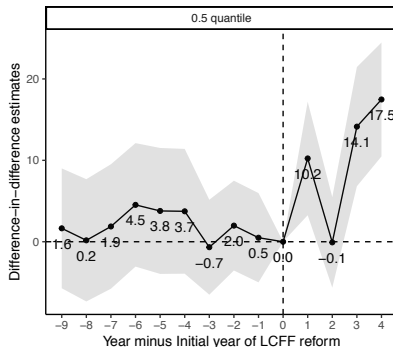
- ▶ The zero pre-LCFF effects lends support to our analytic strategy's ability to isolate the causal effect.
 - ▶ The $\log \widehat{PPR}_{dt}$ completely explains the difference in $\alpha_{dt}(\tau)$ between the reference year and pre-LCFF years
 - ▶ The estimated LCFF-induced increases in funding are not relevant to the changes of outcomes before the reform

Newly hired teachers appear most often to be non-tenured

D % Long-term substitutes/temporary employees

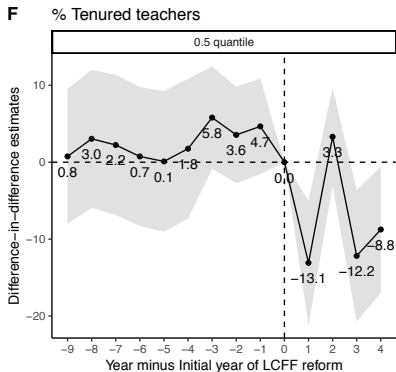


E % Probationary teachers



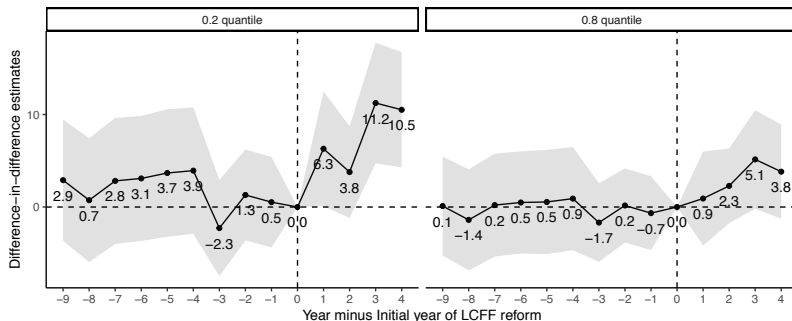
- ▶ The magnitude of effects was the largest for the share of teachers with probationary status.
 - ▶ 10% increases in funding lead to 1.75% point increase in %probationary after four years of LCFF exposures

Newly hired teachers appear most often to be non-tenured



High-poverty schools hired more white teachers

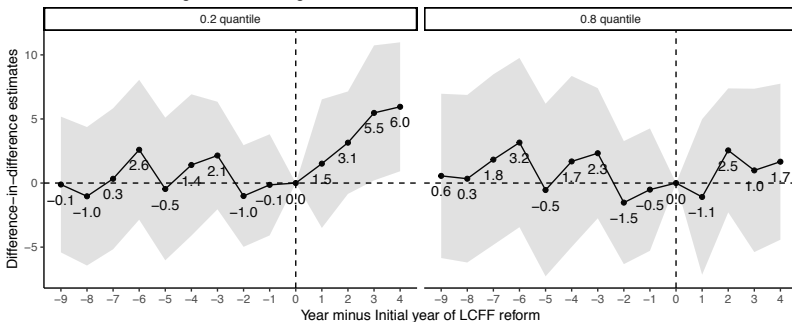
A % White teachers



- ▶ The schools with lower shares of white teachers tended to serve higher-poverty students
 - ▶ 84.5% white teachers in lowest-poverty schools
 - ▶ 47.6% white teachers in highest-poverty schools

... and teachers holding a master's degree or more

B % Teachers holding a master's degree or above

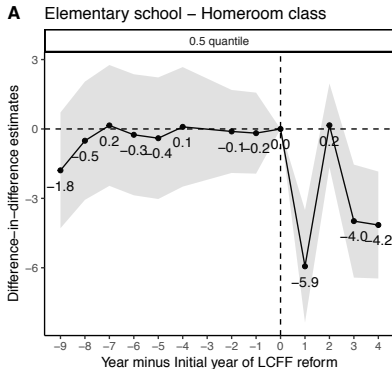


- ▶ The schools with lower shares of white teachers tended to serve higher-poverty students
 - ▶ 48.6% master holders in lowest-poverty schools
 - ▶ 39.2% master holders in highest-poverty schools

Organizational Features & Curricular Structure

1. LCFF-induced funding increases lowered average class size.
2. Schools in district receiveing larger funding increases shrink the count of college-prep courses in proportion to growing number of elective courses.
3. We found no evidence that LCFF-induced funding successfully reduced disparities in access to experienced teachers or A-G courses by EL students.

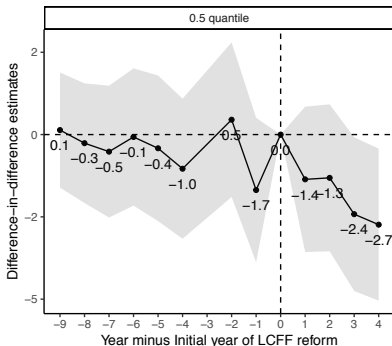
LCFF-induced funding increases lowered average class size



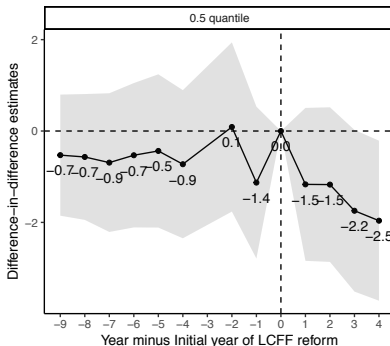
- ▶ Elementary schools show immediate declines in class size after one year of LCFF exposure.
- ▶ Though statistically significant, effect sizes were modest: 10% increase in funding → reduce class size by 0.59

LCFF-induced funding increases lowered average class size

B High school – ELA class

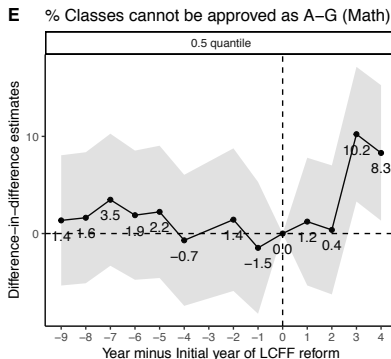
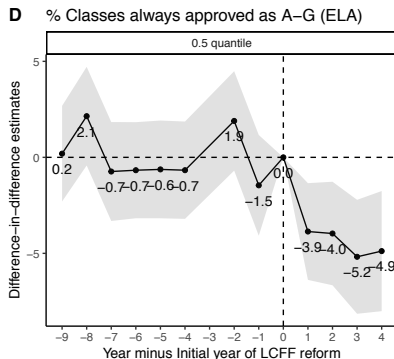


C High school – Math class



- High schools felt the effect incrementally as the exposure to the reform accumulates.

The proportional shrinkage of college-prep courses



- ▶ 10% increase in LCFF-induced funding → lower the % ELA classes always approved as A–G about 0.52 percentage point in the third year of reform
- ▶ This occurs most severely at the higher quantile ($\tau = 0.8$), in schools that began with higher shares of college-prep courses in the reference year

Discussion and Policy Implications

School Quality vs. School Quantity

- ▶ Klopfer (2017) found that finance infusions did not lead districts or schools to hire more teachers or better qualified instructional staff (*school quality*). But fresh funding did affect the length of the academic year, on average, allowing districts or schools to add additional instructional days (*school quantity*).
- ▶ Our findings from the recent California case show that, at least, new funding did go for additional teaching positions.

Between-school Teacher Sorting

- ▶ The grouped IV quantile regression allowed us to find that the infusion of new LCFF dollars helped high-poverty schools (lower tails of the distribution) to attract more white or better highly-educated teachers, mitigating any disproportionate sorting of teachers between schools.

Within-school Teacher Sorting

- ▶ We observe the significant disparities in access to experienced teachers or A-G courses by EL students, which has widened particularly in high-poverty schools during the post-LCFF period.
- ▶ We found no evidence that LCFF-induced funding successfully reduced the disparities.

Within-school Teacher Sorting

- ▶ This raise concern that *within-school* teacher sorting may prevent experienced teachers from being assigned to students who need them most, even when *between-school* teacher sorting can be mitigated by school finance reform.
- ▶ “Collective-bargaining agreements and state laws have granted more-experienced teachers seniority rights, leaving disadvantaged students to be taught by less-effective novices” (Hanushek et al., March 2019, *Education Next*)

The Curricular Structure

- ▶ The curricular structure of high schools began to de-emphasize college-prep courses after 2013 enactment of LCFF.
- ▶ This may have occurred in response to the partial collapse of NCLB and strict testing-and-accountability policies.
- ▶ Or, the hiring of new teachers may have allowed schools the chance to recover lost elective courses during the recession.

Reference

- ▶ Chetverikov, D., Larsen, B., & Palmer, C. (2016). IV quantile regression for group-level treatments, with an application to the distributional effects of trade. *Econometrica*, 84(2), 809-833.
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- ▶ Klopfer, J. (2017). *Labor supply, learning time, and the efficiency of school spending: Evidence from school finance reforms*. Princeton: manuscript.