Does Finance Reform Move Teachers and School Organizations?
California's $23 Billion Effort to Narrow Inequality

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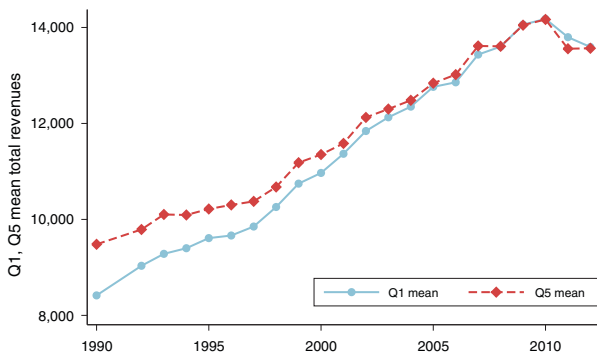Introduction

Data and Measures

Analytic and Estimation Strategy

Findings

Discussion and Policy Implications

Introduction

Equity and Adequacy in School Finance

▶ States have continued to implement aggressive resource-based policies over the past decades, aimed in part at reducing achievement gaps (Lafortune, Rothstein, & Schanzenbach, 2018).
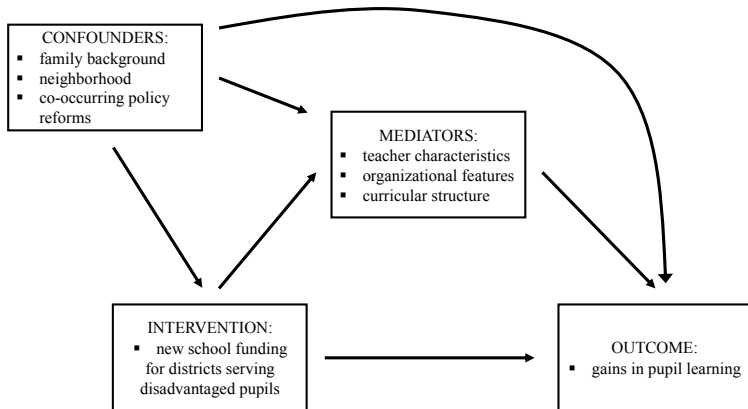
Income Gap in Student Achievement

▶ Yet the achievement gap between the rich and poor students has grown since the early 1970s despite the concurrent improvement in resource equity and adequacy in school finance (Reardon, 2011).

Trend in 90/10 Income Gap in Reading, 1943-2001 Cohorts
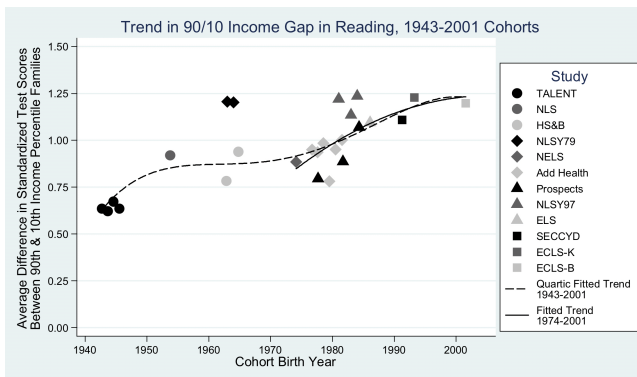
Why? One Plausible Explanation

- ▶ Changes in school resource levels have not been able to alter the existing differentiation in **school quality** between the rich and the poor induced by increasing income segregation.
- ▶ ex) **Teacher sorting**: Poor students tend to attend schools whose teachers are less experienced or qualified, earn lower salaries, and have lower value-added scores than their rich counterparts (Goldhaber, Lavery, & Theobald, 2015).

Focus on *Mediators*

CONFOUNDERS:
- family background
- neighborhood
- co-occurring policy reforms

MEDIATORS:
- teacher characteristics
- organizational features
- curricular structure

INTERVENTION:
- new school funding for districts serving disadvantaged pupils

OUTCOME:
- gains in pupil learning

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

Research Question

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

Data and Measures

The California Case

Per-pupil - Total Current Spending (Elementary-secondary)
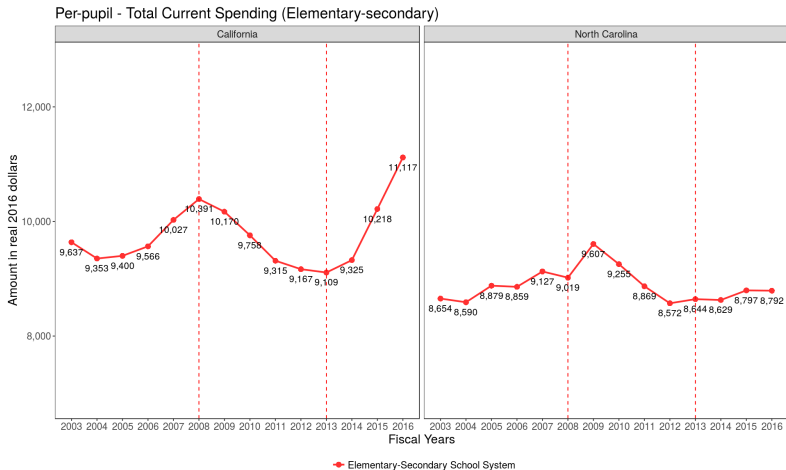
Source: Annual Survey of School System Finances

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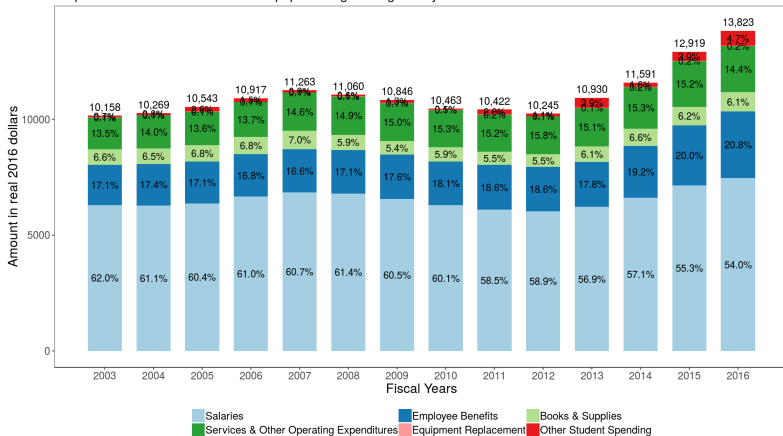▶ https://joonho.shinyapps.io/F33_trends/

Data Sources

We draw on an extensive set of longitudinal administrative data from serveral sources.

▶ The standardized account code structure (SACS) annual financial data

▶ Local Confrol 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)

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
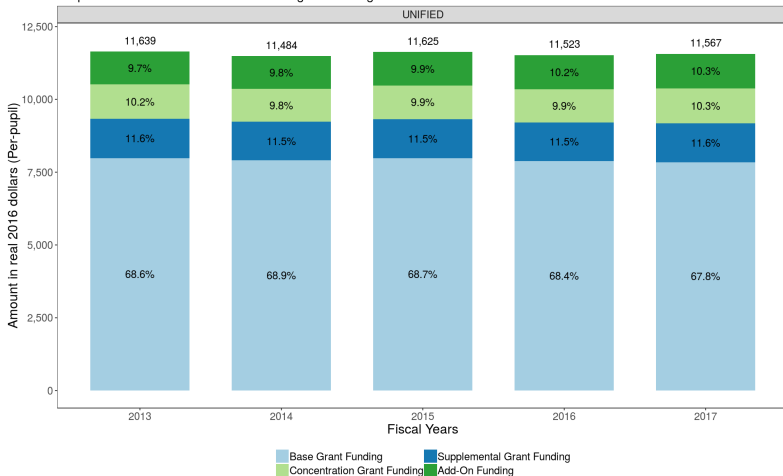Proportions Based on State-level Per-pupil Averages Weighted by ADA

Source: SACS unaudited data

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

LCFF Funding Snapshot Data

LCFF Target Entitlement
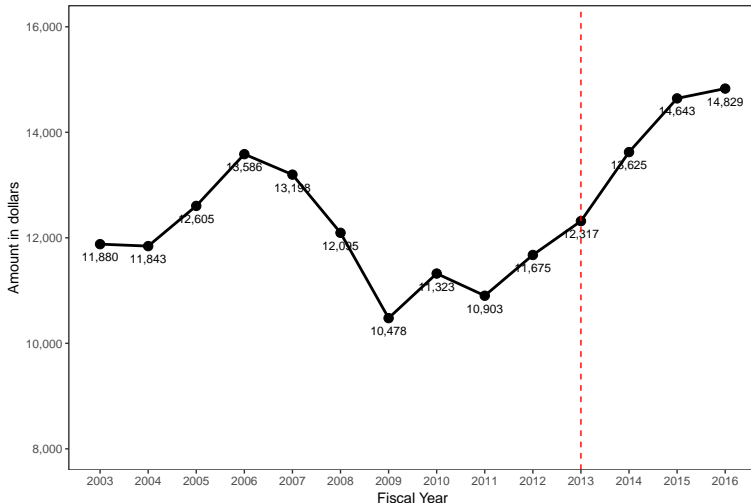Proportions Based on District-level Averages: Los Angeles Unified

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

State Cash Receipts and Disbursements Data

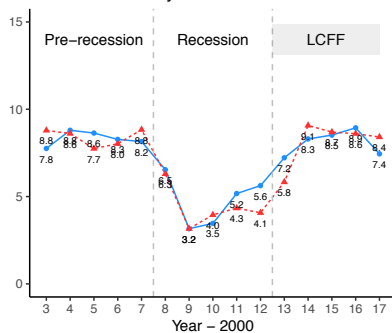State Local Assistance Provided Excluding Education: Per–pupil

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

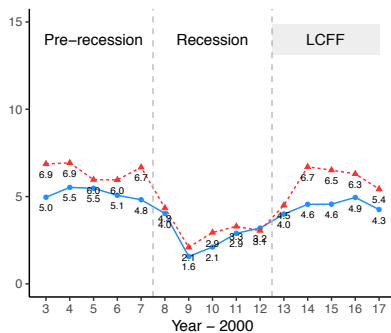Source: The State Controller's Office

CALPADS: Teacher Characteristics

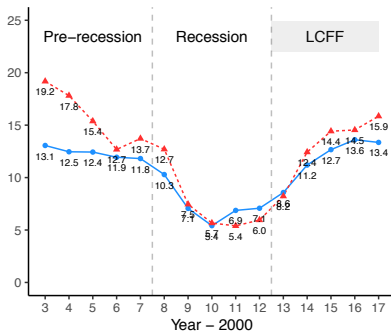**A** % Teachers newly hired in the district

B % Novice teachers

Legend: Q1 mean (Low-poverty schools) · Q5 mean (High-poverty schools)

CALPADS: Teacher Characteristics

C % Probationary teachers

Pre–recession | Recession | LCFF

D % Tenured teachers

Pre–recession | Recession | LCFF

Q1 mean (Low–poverty schools) · Q5 mean (High–poverty schools)
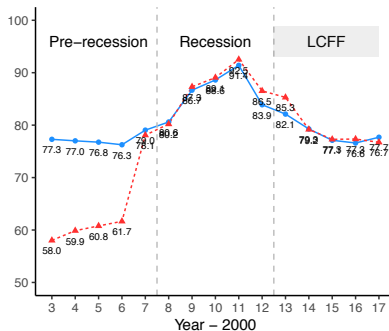
CALPADS: Organizational Features & Curricular Structure

A School average class size (Homeroom class)

Pre–recession | Recession | LCFF

Q1 mean (Low–poverty schools): 22.1, 22.3, 22.4, 22.3, 22.3, 22.4, 26.1, 25.7, 25.6, 25.2, 24.9, 24.3, 24.1, 24.0
21.8, 21.9, 22.0, 21.7, 21.7, 21.6

Q5 mean (High–poverty schools): 21.6, 23.5, 23.8, 24.4, 24.2, 23.6, 23.5, 23.2, 23.3

Year – 2000

B Total number of courses offered (High)

Pre–recession | Recession | LCFF

Q1 mean (Low–poverty schools): 67.8, 68.4, 70.3, 72.1, 74.4, 74.4, 74.3, 79.5, 83.5, 84.1, 84.9, 86.3, 87.8, 90.5

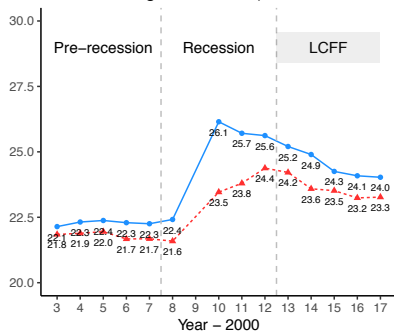Q5 mean (High–poverty schools): 62.0, 59.2, 58.4, 58.5, 62.0, 60.9, 54.0, 59.7, 58.7, 61.3, 62.4, 63.9, 65.6, 66.9

Year – 2000

— Q1 mean (Low–poverty schools)   - ▲ - Q5 mean (High–poverty schools)
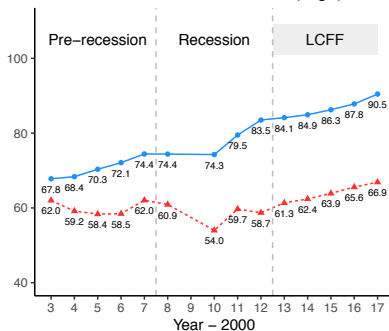
CALPADS: Organizational Features & Curricular Structure

C Class periods assigned to math teachers
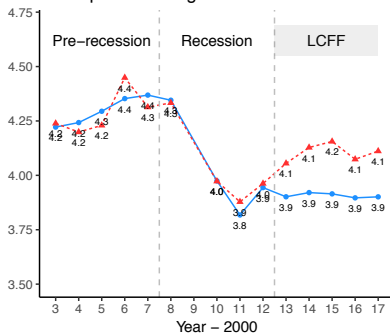
Pre-recession | Recession | LCFF

D % Math classes always approved as A–G

Pre-recession | Recession | LCFF

Q1 mean (Low-poverty schools) · Q5 mean (High-poverty schools)
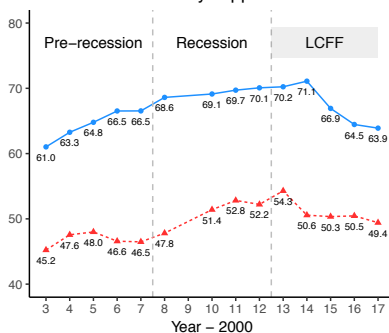
CALPADS: English Learner's Access to Resources

A High school math classes
Avg. %EL in classes taught by the nontenured minus
Avg. %EL in classes taught by the tenured
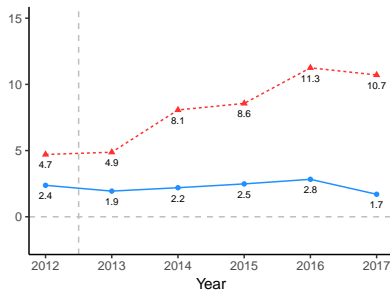
B High school math classes
Avg. %EL in A–G classes minus
Avg. %EL in non–A–G classes
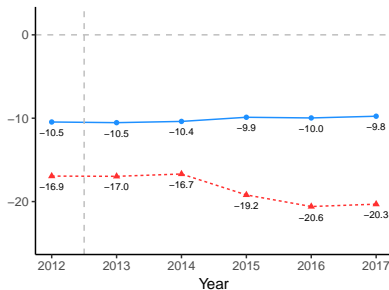
Q1 mean (Low–poverty schools) · Q5 mean (High–poverty schools)

▶ The average percentage of English learners (ELs) in classes
taught by the novice teachers munus 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

▶ School spending is an *endogenous* treatment.

CONFOUNDERS:
- family background
- neighborhood
- co-occurring policy reforms

MEDIATORS:
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INTERVENTION:
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OUTCOME:
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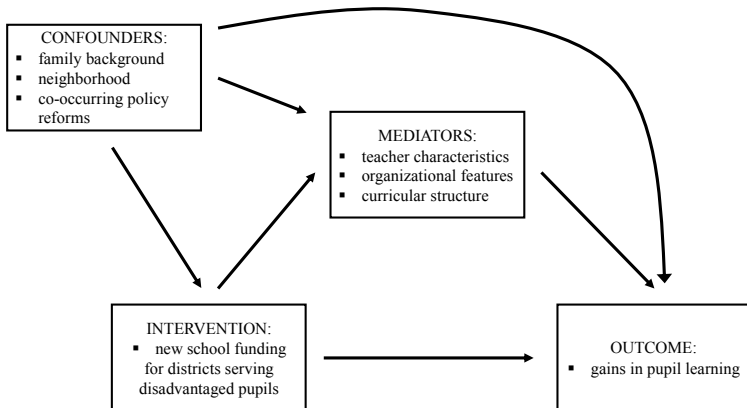
Sources of Exogeneity

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*.

Research Design

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

Step 1. Counterfactual Predictions

Observed vs. Predicted district per–pupil revenues from the State
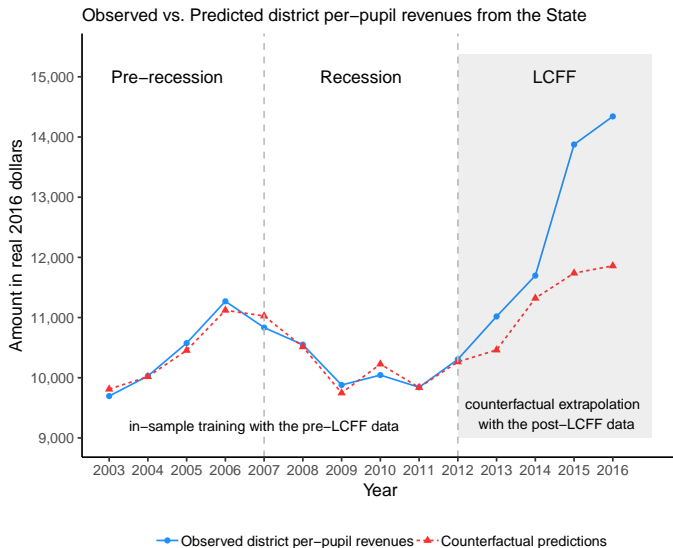
Step 1. Counterfactual Predictions

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

▶ 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}

$$PPE_{dt} = \sum_{z=1}^{10} \sum_{p=0}^{4} \left(I_{\text{Exposure}_d = p} \times I_{\text{Dosage}_d = z} \right) \cdot \alpha_{p,z} +$$

$$\gamma_1 \cdot \widehat{PPR}_{dt} + \mu_d + \lambda_t + v_{dt}$$

▶ The endogenous treatment PPE_{dt}:

   ▶ the district per-pupil spending for district d for year t
   ▶ we excludes 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}

$$PPE_{dt} = \sum_{z=1}^{10} \sum_{p=0}^{4} \left(I_{\text{Exposure}_d = p} \times I_{\text{Dosage}_d = z} \right) \cdot \alpha_{p,z} +$$

$$\gamma_1 \cdot \widehat{PPR}_{dt} + \mu_d + \lambda_t + v_{dt}$$

▶ 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 reflect 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}

$$PPE_{dt} = \sum_{z=1}^{10} \sum_{p=0}^{4} \left(I_{\text{Exposure}_d = p} \times I_{\text{Dosage}_d = z} \right) \cdot \alpha_{p,z} +$$

$$\gamma_1 \cdot \widehat{PPR}_{dt} + \mu_d + \lambda_t + v_{dt}$$

▶ 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 $Dosage_d = \{0.20 \times Base_d^{2013} \times UPP_d^{2013}\} + \{0.50 \times Base_d^{2013} \times \max[UPP_d^{2013} - 0.55, 0]\}$.

$$PPE_{dt} = \sum_{z=1}^{10} \sum_{p=0}^{4} \left(I_{\mathrm{Exposure_d}=p} \times I_{\mathrm{Dosage_d}=z} \right) \cdot \alpha_{p,z} +$$

$$\gamma_1 \cdot \widehat{PPR}_{dt} + \mu_d + \lambda_t + v_{dt}$$

▶ 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.

- 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.
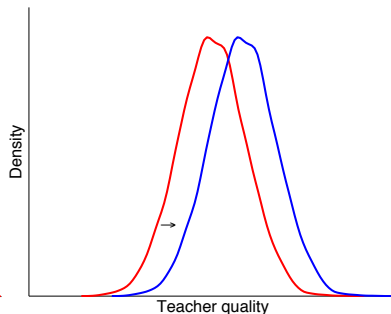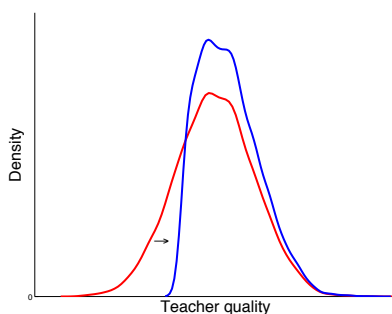
▶ The grouped/multilevel instrumental variable (IV) quantile
  regresion (Chetverikov, Larsen, & Parmer, 2016) allows us to
  estimate the *distributional* or *heterogenous* effects of
  LCFF-induced funding increases on quantiles of the
  within-district distribution of school-level outcomes.
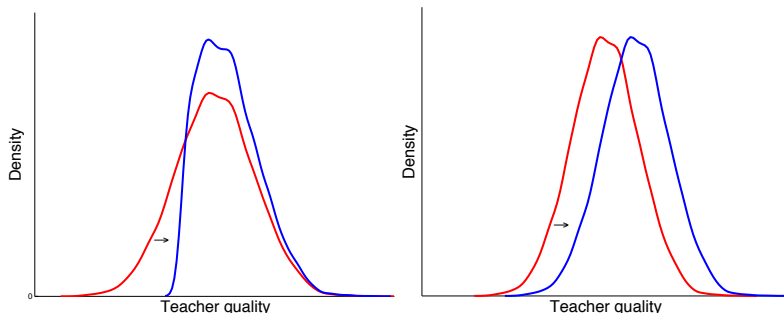
Step 3. The Grouped IV Quantile Regression

Level-1 within-cluster model:

$$Q_{Y_{sdt}}(\tau) = \alpha_{dt}(\tau) + \beta_1 \cdot Enroll_{sdt} + \beta_2 \cdot FRPM_{sdt}, \tau \in (0,1)$$

Level-2 between-cluster model:

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

▶ The cluster is difined as a district-by-year cell.

Step 3. The Grouped IV Quantile Regression

Level-1 within-cluster model:

$$Q_{Y_{sdt}}(\tau) = \alpha_{dt}(\tau) + \beta_1 \cdot Enroll_{sdt} + \beta_2 \cdot FRPM_{sdt}, \tau \in (0, 1)$$

▶ The varying intercept $\alpha_{dt}(\tau)$: the district-by-year-specific conditional quantile of the school level outcome Y_{sdt}, after adusting 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:

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

▶ We are primarily interested in estimating the *difference-in-difference* parameters $\delta_r(\tau)$.

▶ $\delta_r(\tau)$ represnets 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 $\log\widehat{PPR}_{dt}$.
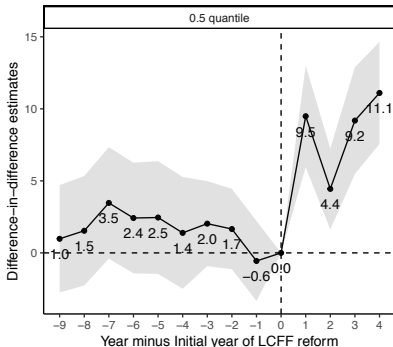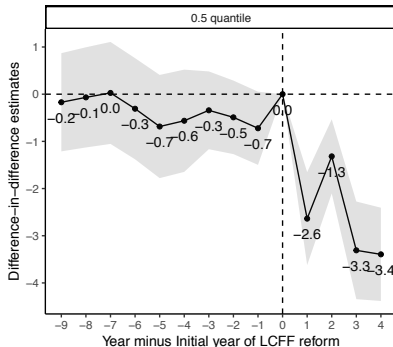
Findings

Teacher Characteristics

- ▶ LCFF-induced increases in funding result in significant increases in the perentages of teachers who were newly hired to their districts, including novice teachers.
- ▶ The newly hired teachers appear most often to be non-tenured (long-term substitutes, probationary).
- ▶ 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
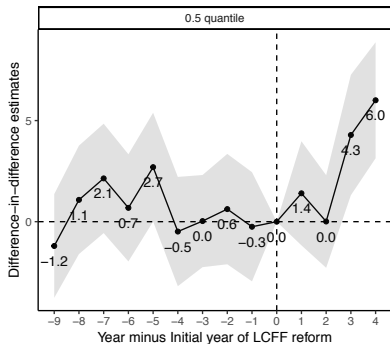

A   % Teachers newly hired in the district

0.5 quantile

B   Years of service in the district (school mean)

0.5 quantile

- ▶ 10% increases in LCFF-induced funding $\rightarrow$ a 0.95 percentage point gain in the share of newly hired teachers in the first LCFF year
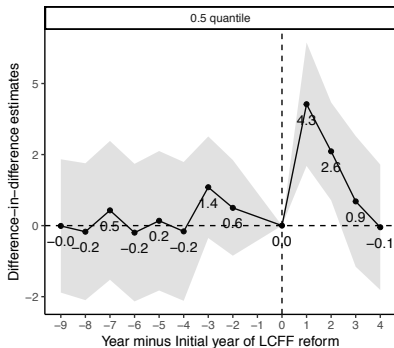
Districts and schools hired rising counts of new teachers
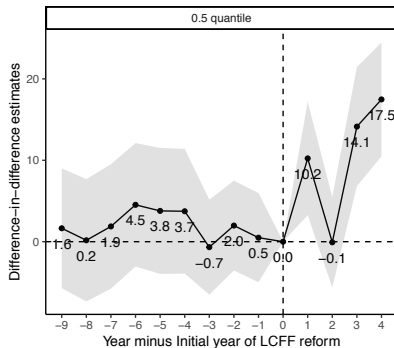

C % Novice teachers

Districts relied on non-tenured teachers

D % Long−term substitutes/temporary employees

0.5 quantile

Difference−in−difference estimates

−0.0 −0.2   0.5   −0.2   0.2   −0.2   1.4   0.6   0,0   4.3   2.6   0.9   −0.1

Year minus Initial year of LCFF reform

E % Probationary teachers

0.5 quantile

Difference−in−difference estimates

1.6   0.2   1.9   4.5 3.8 3.7   −2.0   −0.7   0.5 0,0   10.2   −0.1   14.1   17.5

Year minus Initial year of LCFF reform

Districts relied on non-tenured teachers

F   % Tenured teachers
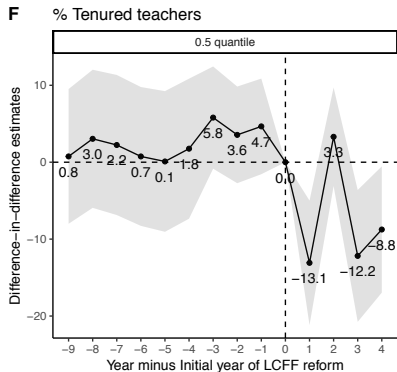
High-poverty schools hired more white teachers

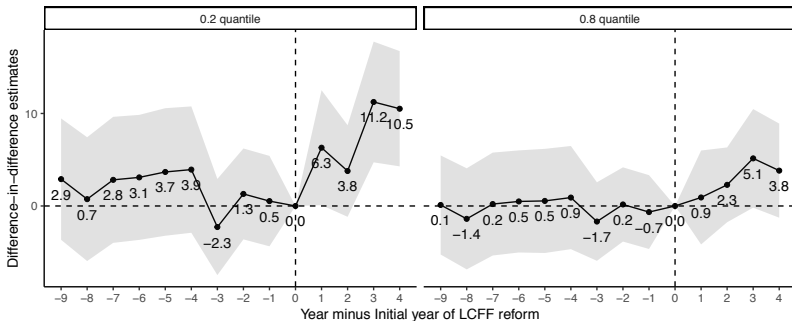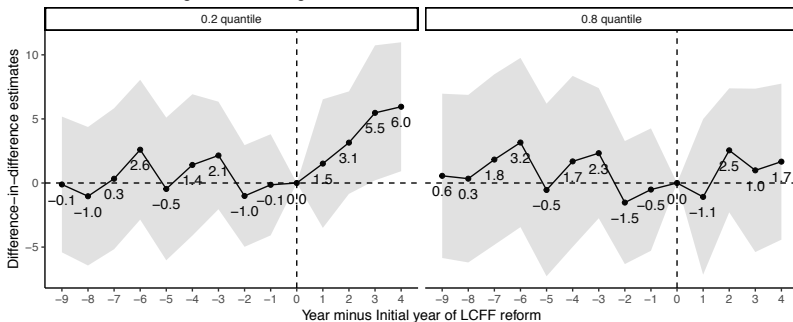

A   % White teachers

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

B % Teachers holding a master's degree or above

Organizational Features & Curricular Structure

- ▶ LCFF-induced funding increases lowered average class size.
- ▶ Schools in district receiveing larger funding increases shrink the count of college-prep courses in proportion to growing number of elective courses.
- ▶ 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
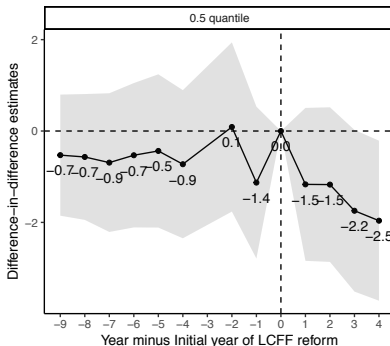

A   Elementary school – Homeroom class
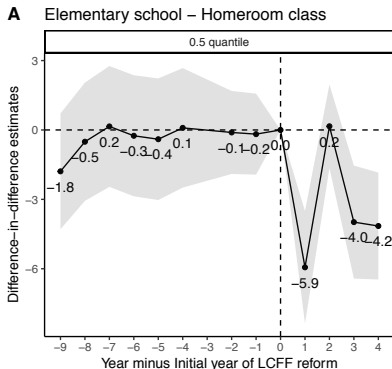
- ▶ Elementary schools show immediate declines in class size after on year of LCFF exposure.
- ▶ Though statistically significant, effect sizes were modest: 10% increase in funding $\rightarrow$ reduce class size by 0.59

LCFF-induced funding increases lowered average class size

B High school – ELA class

0.5 quantile

Difference–in–difference estimates

0.1 −0.3 −0.5 −0.1 −0.4 −1.0 0.5 0.0 −1.7 −1.4 −1.3 −2.4 −2.7

Year minus Initial year of LCFF reform

C High school – Math class

0.5 quantile

Difference–in–difference estimates

−0.7 −0.7 −0.9 −0.7 −0.5 −0.9 0.1 0.0 −1.4 −1.5 −1.5 −2.2 −2.5

Year minus Initial year of LCFF reform
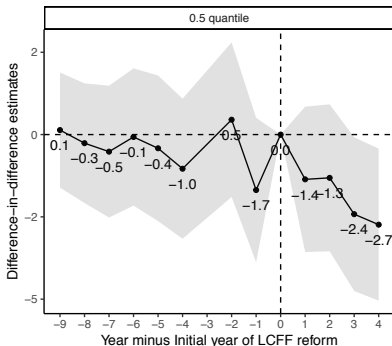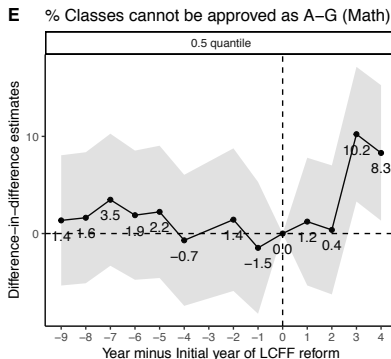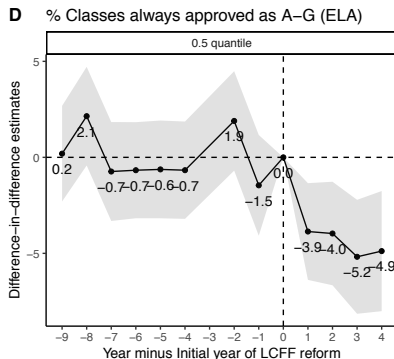
▶ High schools felt the effect incrementally as the exposure to the reform accumulates.

The proportional shrinkage of college-prep courses

D % Classes always approved as A–G (ELA)

0.5 quantile

Difference-in-difference estimates

0.2, 2.1, −0.7, −0.7, −0.6, −0.7, 1.9, −1.5, 0.0, −3.9, −4.0, −5.2, −4.9

Year minus Initial year of LCFF reform

E % Classes cannot be approved as A–G (Math)

0.5 quantile

Difference-in-difference estimates

1.4, 1.6, 3.5, −1.9, 2.2, −0.7, 1.4, −1.5, 0.0, 1.2, 0.4, 10.2, 8.3

Year minus Initial year of LCFF reform

- ▶ 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.
- ▶ But fresh funding did affect the length of the academic year, on average, allowing districts or schools to add additional instructional days.
- ▶ Our findings from the recent California case show that new funding did go for addtional teaching positions.

Between-school Teacher Sorting

- ▶ The schools with lower shares of white or master's holder tend to serve higher-poverty stduents (84.5% white teachers in lowest-poverty schools, 47.6% in highest-poverty schools)
- ▶ The grouped IV quantile regression allowed us to find that the infusion of new LCFF dollars helped high-poverty schools 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.

▶ 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.

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.