Examining the Reach of Targeted School Funding

Technical Appendices

CONTENTS

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Appendix A. Data Overview

Data Sources

This report uses a variety of data sources publicly provided by the California Department of Education (CDE). There are three main types of data: district-level financial data; school-level enrollment and demographic records; school, district, and state-level student outcome data; and school-level expenditure data. We describe each below:

District-level financial data: For 2003–onwards, financial data are reported at the district level through the Standardized Account Code Structure (SACS). The CDE maintains unaudited databases of district finances using this accounting system. These data allow for detailed accounting of revenue streams, spending categories, and fund balances. The data also contain annual average daily attendance (ADA) totals for each district, which are used to construct per pupil spending measures.

To construct measures of district-level per pupil expenditures we follow the conventions of Bruno (2018) in aggregating categories in the financial data.[1] We exclude, transfers between districts, and net pension liabilities. We also exclude charter schools filing independently of their affiliated district's general fund, as well as charter-specific funds that account for operations of charters filing through an affiliated district, but outside of its general fund.[2] A small share of charter schools report financial information through an affiliated district's general fund; we therefore include ADA for these schools in the ADA of the affiliated district.[3]

We then aggregate to the district-year level to construct district-year total expenditures. Student spending is a subset of total expenditures that excludes pre-K and adult education, Public Employees' Retirement System (PERS) reductions, capital expenditures (minus equipment replacement), retiree benefits, non-agency spending, and debt service. Other expenditures subcategories are defined based on the relevant SACS "object" codes.

We also rely on LCFF summary data for the 2018-19 to 2021-22 fiscal years, available from CDE. These data are used to get actual LCFF supplemental and concentration grant totals for each district.

School-level enrollment and demographic records: Data on school and district enrollment, English Learner (EL) status, and student socio-demographic characteristics are also maintained by the CDE. Data on the "unduplicated" count of students, relevant for LCFF supplemental and concentration grant calculations, are available at the school and district levels beginning in 2013, the first year of LCFF. School-by-grade enrollment, both overall and broken down by race/ethnicity/gender, as well as by EL status, is available going back to 1982. We collect school and district-level free and reduced-price lunch meal (FRPM) totals from three different files: for 2004–2021, we use the FRPM files, while for 2003, we use the AFDC files, which are available back to 1988.

School-level financial records: School-level expenditure data reporting became mandatory under the federal Every Student Succeeds Act (ESSA), and three years of California data (2018-19 to 2020-21) are publicly available from the California Department of Education. The data contain per-student expenditures for each school, broken down into central and school-site specific expenditures. The data then report expenditure levels for each category via federal or state and local funding sources.

Student test score outcomes: We rely on test score data publicly available from the CDE. Data are available at multiple levels of aggregation: the lowest being the school-grade-subject-subgroup-year, and the highest being the

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[1] Despite minor differences in sample construction from Bruno (2018) (detailed below), our calculations of mean total and student expenditures per pupil are within $40 (0.25%) and $65 (0.5%) of his calculations for 2016–17, respectively.

[2] For more information on spending in charter schools and the data limitations that make these calculations difficult, see Atchison et al. (2018).

[3] Charter school ADA is not available in the SACS data in 2008 and earlier. Fortunately, the charter share in the early 2000s was small, and most still reported financial information independently of the general fund of an affiliated district, meaning this limitation has a negligible impact on overall results.

state-subject-year. Scores from 2002-03 through 2012-13 come from the California Standards Test (CST), while data from 2014-15 to 2021-22 are from the Smarter Balanced (SBAC) exams.[4] We examine both scores in terms of the share meeting grade level standards (often deemed the "percent proficient") and the mean scale scores; scale scores are standardized by the statewide student-level mean and standard deviation to ensure comparability of the scores (as relative measures, within grade-year-subject) over time.

Sample Restrictions

In order to reduce the impact of measurement error and extreme outliers on the analyses in this report, we restrict the sample in the following ways, depending on the level of analysis and outcome under consideration.

District financial outcomes: Across most analyses, we restrict attention only to those districts with an average daily attendance (ADA) of at least 250 in every year. While small districts are an important and often understudied population, district financial operations and staffing patterns are often quite different from larger districts, making it difficult to compare.[5] The 250 ADA cutoff is common in the literature comparing finances of districts across the state; it is used by Bruno (2018) and others in earlier work. We also exclude districts that have atypically high or low per pupil student expenditures in a given year. District-years where per pupil student spending is above 500% or below 20% of the California mean in that year are excluded. There are very few such spending outliers (less than 0.1% of observations).[6]

Taken together, these result in the exclusion of many districts, but few students. 37% of district-years are excluded, most of them from very small districts: in total, these districts enroll only 2% of the state's public K–12 students. Thus, the main analysis sample covers 98% of students in the state.

Test score outcomes: We use aggregate test score data at the district-grade-subject, and district-grade-subject-subgroup level from the Smarter Balanced assessments (SBAC). SBAC scores are available from 2014-15 to 2021-22, except for 2019-20, when the exam was cancelled due to the pandemic. We also exclude 2020-21 as participation was optional and take-up rates were low. There was no statewide exam in 2013-14, the transition year between the California Standards Test (CST) and the SBAC. We use both scale scores and proficiency rates. Test score records are only publicly available for cell sizes with 10 or more students. Cells (e.g., a district-grade-subject-year) with fewer than 10 students are therefore excluded from all analyses.

School-level expenditure analyses: For school-level expenditure analyses using the ESSA data, we make a small number of exclusions, mostly due to missing data or implausibly high expenditure levels. First, we exclude a small number of schools we could not merge to the enrollment data described above. Next, some schools did not report expenditure data; these schools are excluded, and we exclude any districts for which non-reporting schools make up more than 5% of total student enrollment. We further exclude small schools with fewer than 50 students (which may have very different expenditure patterns), schools with total school spending greater than $100,000 per student (which we deem implausible), and, to further restrict the influence of outliers, we exclude schools that spend less than 20% or more than 500% of the mean school spending in the data after the exclusion of the extreme outliers above $100,000 per student (equivalent to the exclusion criteria mentioned above for district-level financial records). Taken together, these restrictions exclude 6.7% of students and 14.3% of schools in the state.

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[4] There was no comparable statewide test for 2013-14, due to the switch from CST to SBAC. There was no SBAC exam in 2019-20, due to the COVID-19 pandemic. We exclude SBAC exam in 2020-21 due to low participation.

[5] These small districts are most often rural or remote districts, which generally have very different cost structures than the typical district.

[6] Some of these appear to be coding errors, although it is difficult to verify or correct these, and thus we exclude these observations.

When examining how within-district spending patterns relate to LCFF spending, we restrict to districts that we can merge to "LCFF Snapshot" financial records available from CDE. For analyses where a district-level relationship between school spending and LCFF funding is estimated, we rely only on those districts with 10 or more schools.

Appendix B. LCAP Collection and Data Extraction

LCAP Data Collection Description: Our team attempted to collect the annual LCAP reports for all 1,021 districts in California for the 2021-22 school year. After a round of web scraping and downloading LCAPs from district and COE websites, we successfully collected 1,008 LCAPs. Next, the planned total expenditure tables were extracted from 795 districts. We had to drop 213 districts during this process because of myriad inconsistencies in the LCAP spending tables that presented challenges to our automated process to compile and extract data from the tables. For example, some expenditure tables were scanned into LCAP reports, some tables had been saved as images, some tables were rotated horizontally in reports, and additional other formatting inconsistencies. Then, 724 district LCAP total expenditure tables were cleaned and appended together to form a single data set. We could not append tables from an additional 71 districts because some used total expenditure table formats that were significantly different from the template given by CDE, and there were issues exporting table data from certain LCAP files to Python.

Afterwards, the data went through another round of cleaning where 32 districts' total expenditure were deemed too time consuming to fix. These district total expenditure tables had a significant portion of the cells with information in incorrect cells, information in cells being combined with other cells in incorrect columns, and rows being incorrectly added together, among other issues. Our final data set included the planned total expenditure tables from 692 districts. This data set covers 69% of districts and 81% of all students in California.

Each district's total expenditure table reports what actions the district is taking to meet their individual goals, and the amount of money the district is planning on spending for each action step. Table B1 defines each of the different variables found in the LCAP total expenditure table for a typical district. Some districts added a "Scope" or "Notes" variable to further describe particular actions but these variables only appeared in a handful of districts and these variables contained mostly empty values. As a result the "Scope" and "Notes" variables were dropped from the dataset.

TABLE B1
Definitions of Total Expenditure Table Components

Term	Description
Goal	An overarching objective the district hopes to achieve. Districts can have one or more goals.
Goal Number	An integer representing a certain goal.
Action	An individual step that will be taken to progress towards achieving the goal.
Action Number	An integer representing a certain action.
Action Title	A short description of an individual step a district will take to progress towards a goal.
Student Group(s)	A segment of a district's students grouped by one or more demographic characteristics.
LCFF Spending	The funding a district plans to spend from their LCFF allocation on an action.
Other State Spending	Planned district spending from other state funding programs/formulas other than the LCFF on an action.
Federal Spending	The funding a district plans to spend that was allocated from the federal government on an action.
Local Spending	The funding a district plans to spend that was allocated from local funding sources on an action.
Total Spending	The sum of LCFF spending, Other State Spending, Federal Spending, and Local Spending on an action.

Other Data Sources: In order to evaluate the extent to which districts' planned to spend funding on high-need student groups in their 2021-22 LCAP reports, Our team combined the final LCAP data set with several other data sets including California Department of Education (CDE) enrollment data and demographic data for the 2021-22 school year, LCFF summary data from the CDE for the 2021-22 school year, and district financial data from the 2021-22 school year. These data allowed us to compare district planned spending reported in the LCAP total expenditure tables to district funding allocations from LCFF. Our team also merged 2021-22 Education Demographic and Geographic Estimates (EDGE) files from the National Center for Education Statistics (NCES) to have access to county and locale codes for geographic analyses.

Proportionality Analyses: The proportionality analyses serve as metrics to compare reported planning spending in district LCAP total expenditure tables to other financial information in district total expenditure tables or LCFF allocation data from CDE. Given that high-need student groups (low income, English learners, foster youth, students with disabilities, and students experiencing homelessness) are of interest to this report, our team elected to focus a substantial amount of analysis on the extent to which districts are planning to spend funding on these student groups. As a result, we created indicator variables for each major student group in out LCAP total expenditures table data set based off of the information in the "Student Group(s)" variable. The remaining student groups that did not receive an indicator variable were clumped together in another indicator variable called "Other". These indicator variables allowed us to aggregate the planned amount of funding for specific subsets of student groups, which serve as inputs for our proportionality metrics.

It is important to note that the aggregation of financial data for each of these student groups serves as an upper bound. Many rows in our main data set are targeted towards multiple different student groups for the same amount of planned funding. For the purposes of this report, our team chose to attach the entire amount of funding (if any) in each funding variable to each of the different student groups (if there are more than one) mentioned in a row in our data because there is not a clear way to parse out how much planned funding is supposed to go to different student groups in the same row.

Listed below are the proportionality metrics we analyzed as a part of this research:

- The share of LCFF funding on a district's LCAP to be spent on any high-need student subgroup(s)
- **Any High-Need (AHN) spending versus Supplemental & Concentration (S&C) funding**: The ratio of high-need spending planned on a district's LCAP to that district's supplemental and concentration funding.
- **LCAP total spending versus LCFF funding**: The ratio of planned spending on an LCAP to total LCFF funding a district receives.
- **Total spending versus S&C funding**: The ratio of planned total spending on an LCAP to that district's supplemental and concentration funding.
- **Total LCFF spending versus S&C funding**: The ratio of total planned LCFF spending on an LCAP to that district's supplemental and concentration funding.

Table B2 below provides an example of each ratio for Fremont Unified.

TABLE B2

Fremont Unified proportionality metrics

Ratio name	Statistic
Planned AHN LCFF spent on AHN students	51.0%
Planned AHN LCFF spending versus S&C funding	63.7%
Planned LCAP total spending versus total LCFF funding (base and S&C)	62.6%
Planned Total spending versus S&C funding	125.0%
Planned Total LCFF spending versus S&C funding	99.4%

SOURCES: Fremont Unified LCAP; Authors' calculations

NOTES: The table shows the different ratios described above for the Fremont Unified school district.

TABLE B3

The ratio of planned spending on an LCAP to total LCFF funding a district receives

Statistics	All Districts	Concentration	Non-concentration
Mean	58.7%	58.4%	59.4%
P5	8.2%	11.8%	6.3%
P25	21.7%	26.7%	11.5%
P50	45.8%	45.8%	32.7%
P75	94.3%	91.1%	99.8%
P95	131.2%	124.8%	134.1%

SOURCES: District LCAP total expenditure tables; Authors' calculations

NOTES: The table depicts the ratio of planned spending on an LCAP to total LCFF funding a district receives for the following statistics: the mean (average), 5th percentile, 25th percentile, median, 75th percentile, 95th percentile, and standard deviation. Reported statistics are weighted by enrollment. Concentration districts refer to districts with at least 55% of students classified as high-need. Non-concentration districts refer to districts under the 55% high-need threshold. The observations making up the top 1% of this ratio were excluded because they were considered drastic outliers.

TABLE B4

The ratio of planned total spending on an LCAP to that district's supplemental and concentration funding

Statistics	All Districts	Concentration	Non-concentration
Mean	575.5%	321.4%	1076.5%
P5	87.0%	85.6%	103.5%
P25	140.0%	121.5%	193.8%
P50	264.3%	187.6%	532.8%
P75	541.4%	425.7%	1547.4%
P95	1915.4%	785.3%	3464.2%

SOURCES: District LCAP total expenditure tables; Authors' calculations

NOTES: The table depicts the ratio of planned total spending on an LCAP to that district's supplemental and concentration funding for the following statistics: the mean (average), 5th percentile, 25th percentile, median, 75th percentile, 95th percentile, and standard deviation. Reported statistics are weighted by enrollment. Concentration districts refer to districts with at least 55% of students classified as high-need. Non-concentration districts refer to districts under the 55% high-need threshold. The observations making up the top 1% of this ratio were excluded because they were considered drastic outliers.

TABLE B5

The ratio of total planned LCFF spending (on any students) on an LCAP to district's supplemental and concentration funding

Statistics	All Districts	Concentration	Non-concentration
Mean	354.1%	228.8%	603.0%
P5	82.3%	82.3%	88.5%
P25	99.4%	92.3%	105.3%
P50	187.6%	187.6%	267.9%
P75	368.1%	321.3%	1008.8%
P95	1340.3%	600.6%	1703.2%

SOURCES: District LCAP total expenditure tables; Authors' calculations

NOTES: The table depicts the ratio of total planned LCFF spending on an LCAP to that district's supplemental and concentration funding for the following statistics: the mean (average), 5th percentile, 25th percentile, median, 75th percentile, 95th percentile, and standard deviation. Reported statistics are weighted by enrollment. Concentration districts refer to districts with at least 55% of students classified as high-need. Non-concentration districts refer to districts under the 55% high-need threshold. The observations making up the top 1% of this ratio were excluded because they were considered drastic outliers.

TABLE B6

Unweighted for all ratios

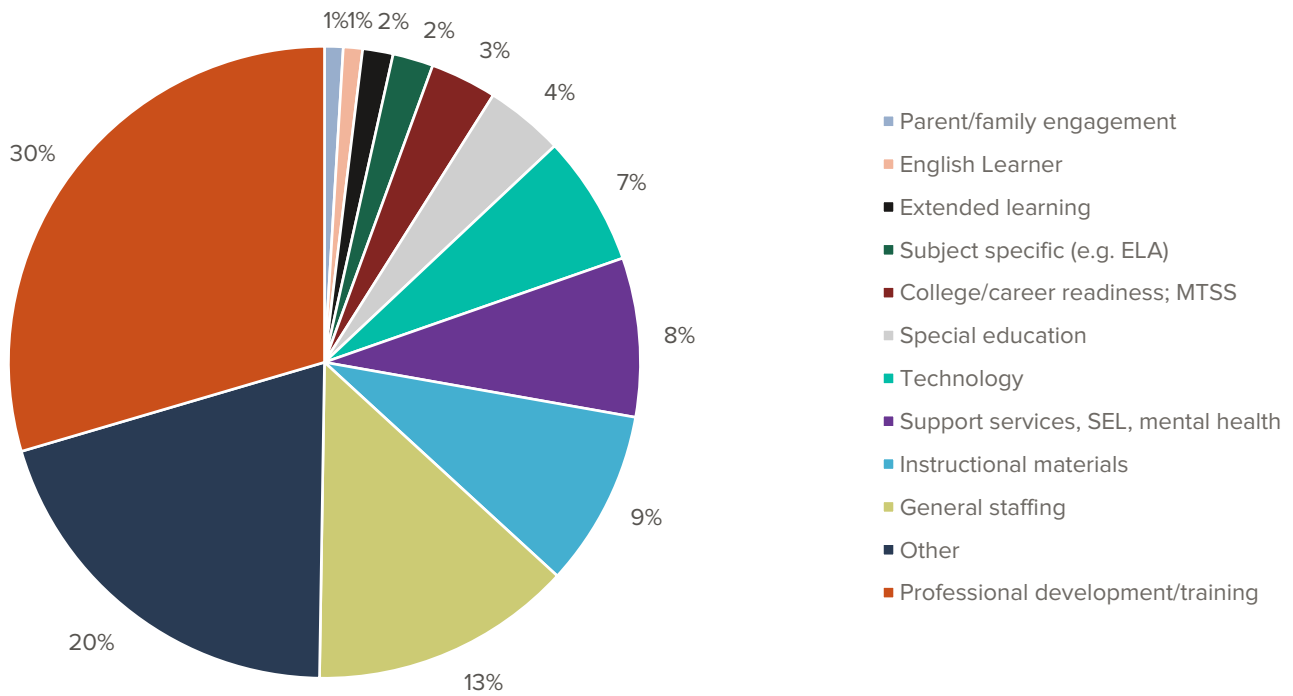| Statistics	LCFF spent on AHN students	AHN spending versus S&C funding	LCAP total spending versus LCFF funding	Total spending versus S&C funding	Total LCFF spending versus S&C funding
Mean	42.5%	162.6%	65.3%	805.2%	370.8%
P5	2.3%	10.5%	7.7%	86.5%	71.5%
P25	15.0%	82.0%	21.2%	127.7%	93.8%
P50	34.1%	93.5%	37.1%	288.8%	150.2%
P75	69.9%	115.6%	95.4%	718.4%	414.7%
P95	100%	451.0%	147.1%	3210.9%	1450.2%
SD	31.7%	350.0%	83.2%	1620.0%	463.0%

SOURCES: District LCAP total expenditure tables; Authors' calculations

NOTES: The table each ratio for the following statistics: the mean (average), 5th percentile, 25th percentile, median, 75th percentile, 95th percentile, and standard deviation. Enrollment weighted refers to a weighted average where district enrollment acts as the weight. Concentration districts refer to districts with at least 55% of students classified as high-need. Non-concentration districts refer to districts under the 55% high-need threshold. The observations making up the top 1% of this ratio were excluded because they were considered drastic outliers.

Share of LCAP planned spending by subcategory

- Parent/family engagement
- English Learner
- Extended learning
- Subject specific (e.g. ELA)
- College/career readiness; MTSS
- Special education
- Technology
- Support services, SEL, mental health
- Instructional materials
- General staffing
- Other
- Professional development/training

SOURCE: District LCAP total expenditure tables; Authors' calculations.

NOTE: Share of LCFF planned spending on district LCAPs, coded to broad subcategories. Categories coded using machine learning and hand-coding of action titles and contained words (see text above).

Top 50 most common expenditure actions for planned LCFF spending
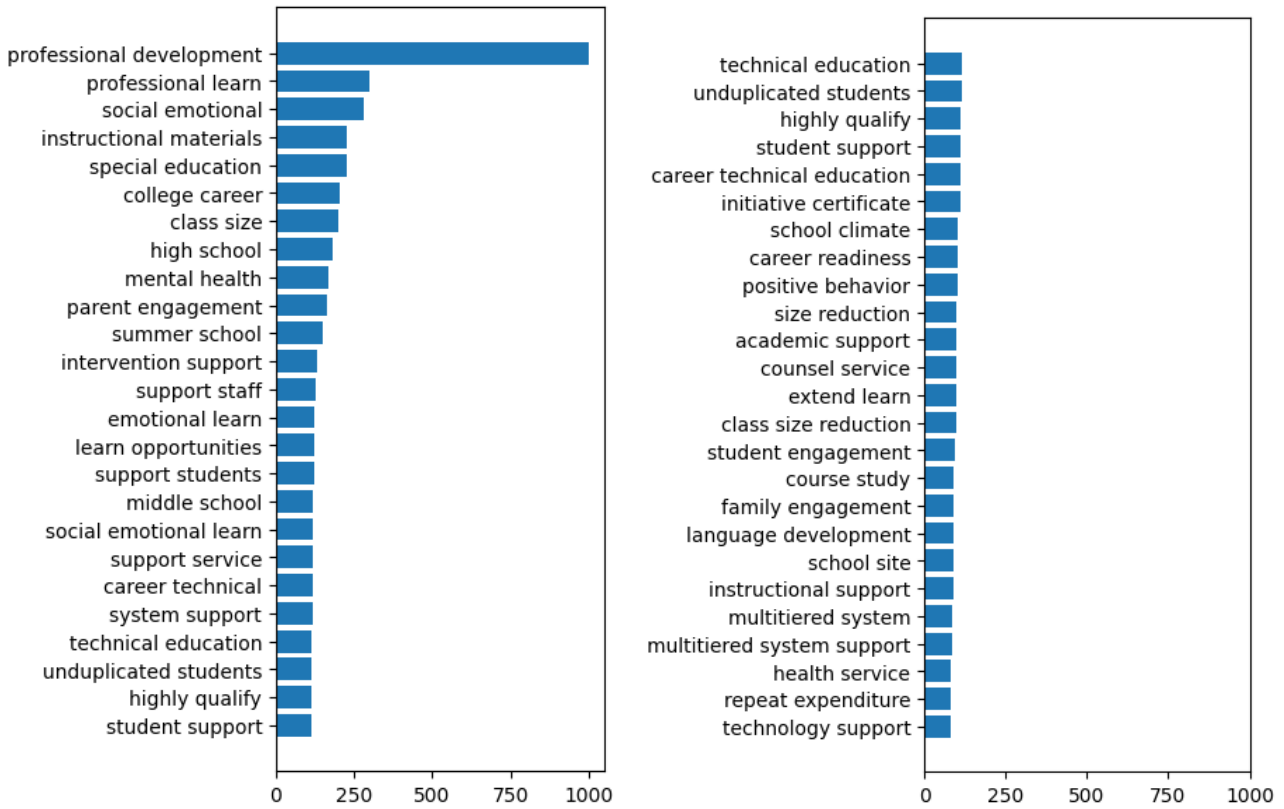
SOURCE: District LCAP total expenditure tables; Authors' calculations.

NOTE: This figure focuses specifically on two- and three-word phrases in district LCAP action titles where planned LCFF spending is nonzero.

Appendix C. Estimating Targeting Using Site-Level Spending Data

There is no formal accounting mechanism for tracking how and where supplemental and concentration (hereafter S&C) dollars are spent by districts across the state. However, using school site spending data and information on schools' high-need shares, we can understand the extent to which spending is higher in schools that have higher shares of high-need students – and therefore generate S&C dollars for their districts.

To do this, we rely on the "LCFF Snapshot" and ESSA school site spending files for 2018-19 through 2020-21 provided by CDE. Among other things, the LCFF Snapshot files details the amount of S&C grant funding received by a district. Then, using the number of high-need students at each school site in a district, we calculate the S&C grant funding generated by a school site: we allocate total S&C dollars within a district based on the number of high-need students at each site, and then divide the total S&C dollars at each school site by that school's total enrollment.

We then estimate the relationship between school site spending from local and state sources[7] and the S&C dollars generated at a school site. Specifically, for a school $s(d)$ in district d, we estimate equation (3):

$$(1) \qquad SiteSpend_{s(d)} = \alpha + \beta_1 S\&C_{s(d)}^{fund} + +\Gamma X_{s(d)} + \gamma_d + \epsilon_{s(d)}$$

In our primary specifications we include district fixed effects, γ_d, as we are interested in the *within*-district change in spending given different levels of S&C funding generated at a site. In our most preferred specification, we also include school-level controls for enrollment in the various grade ranges that determine base grant funding (K-3, 4-6, 7-8, and 9-12), $X_{s(d)}$, which also account for any differences in spending patterns by school level. Standard errors are clustered by district.

Tables C1-C3 report these estimates separately for 2018-19, 2019-20, and 2020-21, respectively. Intuitively, β_1 estimates by how many dollars site-level spending increases for an additional dollar of funding generated at a school site. A coefficient of 1 would be consistent with perfect targeting of S&C dollars: for every dollar in funding a school site generates under the LCFF formula, the district spends 1 dollar more at that site.

There are some caveats to this exercise. First, it relies on the assumption that all centrally administered spending is equally allocated across school sites. This may not always hold in practice; for example, a central expense like educational software to use districtwide to help English Leaner students would show up as a central expense even if its specific purpose is targeted towards improving outcomes for high-need students.

Second, and more generally, we cannot look explicitly at how and where S&C dollars are spent; we only have access to overall site spending from state and local funding sources. This means that how districts spend their other funding sources will influence this relationship. If districts also spend more on high-need school sites from their other funding sources, we might expect a coefficient that is even greater than one. On the other hand, if districts spend less on high-need students out of their other funding sources, then a district could technically perfectly target their S&C funding but still have a β_1 coefficient less than 1. However, this would indicate that S&C funding crowds out other funding, which would violate the spirit of LCFF – that additional dollars should be used to increase services for high-need students, not supplant spending that they would have otherwise received.

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[7] We exclude spending from federal funding sources, as this would operate outside of the funding formula. We also exclude central expenses, as by definition in the school site spending data, are constant across all schools in the same district.

Finally, we estimate separate regressions for each district – analogous to equation (1) but excluding the fixed effects – to estimate a district-specific relationship between spending and S&C funding, β_1^d. This estimation is restricted only to districts with 10 or more schools. The distribution of β_1^d is reported in Figure 11 in the main text.

TABLE C1
Regression estimates for site-level spending (2018-19)

	(1)	(2)	(3)	(4)	(5)
S&C Dollars Per Pupil	0.40	0.72	0.60	0.47	0.46
	(0.28)	(0.16)	(0.13)	(0.14)	(0.13)
School K-3 Enrollment			-0.27		
			(0.10)		
Log(School K-3 Enrollment)				-656.49	
				(131.02)	
School 4-6 Enrollment					-4.33
					(0.40)
School 7-8 Enrollment					-3.01
					(0.27)
School 9-12 Enrollment					-2.39
					(0.19)
N	7117	7117	7117	7117	7117
District Fixed Effects		X	X	X	X

SOURCES: California Department of Education, ESSA school site spending reports, LCFF summary files, and school enrollment files; Authors' calculations.

NOTES: Regression estimates via equation (1). Regressions are weighted by school enrollment. Columns 2 thru 5 include district fixed effects. Standard errors in parentheses are clustered by district.

TABLE C2
Regression estimates for site-level spending (2019-20)

	(1)	(2)	(3)	(4)	(5)
S&C Dollars Per Pupil	0.36	0.76	0.60	0.47	0.44
	(0.24)	(0.12)	(0.10)	(0.11)	(0.10)
School K-3 Enrollment			-0.37		
			(0.09)		
Log(School K-3 Enrollment)				-764.55	
				(121.13)	
School 4-6 Enrollment					-4.21
					(0.38)
School 7-8 Enrollment					-3.24
					(0.25)
School 9-12 Enrollment					-2.34
					(0.17)

N	7572	7572	7572	7572	7572
District Fixed Effects		X	X	X	X

SOURCES: California Department of Education, ESSA school site spending reports, LCFF summary files, and school enrollment files; Authors' calculations.

NOTES: Regression estimates via equation (1). Regressions are weighted by school enrollment. Columns 2 thru 5 include district fixed effects. Standard errors in parentheses are clustered by district.

TABLE C1
Regression estimates for site-level spending (2020-21)

	(1)	(2)	(3)	(4)	(5)
S&C Dollars Per Pupil	0.33	0.84	0.69	(0.53)	0.73
	(0.26)	(0.16)	(0.14)	(0.13)	(0.13)
School K-3 Enrollment			-0.36		
			(0.10)		
Log(School K-3 Enrollment)				-831.26	
				(185.31)	
School 4-6 Enrollment					-0.11
					(0.51)
School 7-8 Enrollment					-1.52
					(0.45)
School 9-12 Enrollment					-0.50
					(0.26)
N	7471	7471	7471	7471	7471
District Fixed Effects		X	X	X	X

SOURCES: California Department of Education, ESSA school site spending reports, LCFF summary files, and school enrollment files; Authors' calculations.

NOTES: Regression estimates via equation (1). Regressions are weighted by school enrollment. Columns 2 thru 5 include district fixed effects. Standard errors in parentheses are clustered by district.

Appendix D. Regression Kink Discontinuity Model and Estimates

Estimating the impact of additional LCFF funding requires one to be careful to correctly account for contemporaneous changes and trends that were not due to the formula. Most importantly, funding increased substantially for all districts following 2012-13 due to the improved economic situation in the state (Figure 2). For this reason, we rely on *relative* comparisons across districts that received different funding increases under LCFF to identify the effect of these *relative* funding increases on student outcomes. Furthermore, the switch from CST to SBAC complicates attempts to use relative trends in test scores over time to analyze the impact of LCFF funding on student outcomes. Instead, we rely on an alternative strategy that only uses within-year comparisons across districts.

Specifically, we employ a "Regression Kink Design" (RKD) that estimates whether the slope of test scores with respect to district share high-need changes across the concentration grant threshold at 55%. The intuition is as follows: the funding formula has a "kink" at 55% high-need, above which each additional high-need student provides even greater funding to the school district. If the additional funding for these districts – specifically the concentration grant funding, for districts with more than 55% high-need – has impacts on student outcomes we would expect to see a kink in the relationship between district share high-need and outcomes emerge.

Key for this design to estimate the causal impact of the funding formula is the assumption that the changes at the 55% threshold are as good as random. For example, there should be no discontinuous changes at the kink point between other district characteristics (such as racial/ethnic shares, the share eligible for free and/or reduced-price lunch, etc.) and the district share high-need; Figure D15 provides evidence that this is indeed the case.

Figure D1 provides motivation for this empirical design. As expected under the revenue limit system which did not fund schools based on their share high-need, there is no discontinuous relationship between funding and share high-need in 2012-13.[8] However, 7 years later in 2019-20, there is indeed a notable kink in the slope between funding and share high-need, as would be expected given the gradual implementation and funding of the funding formula.[9]

Figures 11 in the main text (percent meeting standards) and Figure D2 (average standardized scale scores) show the analogous relationships between district share high-need and student test scores, in 2012-13 and 2020-21, including data within 40 percentage points on either side of the 55% cutoff. The visual difference is less striking, but the change in slope at the kink point is apparent. There is a slight kink in the slope in 2012-13 at the 55% concentration grant threshold, but this is not statistically significant, and the corresponding change in slope is much larger. Thus, just looking at the raw data, it appears as though the *change in slope* at the 55% threshold is increasing over time after LCFF, providing suggestive evidence that the additional concentration grant dollars are indeed leading to increases in student academic performance.
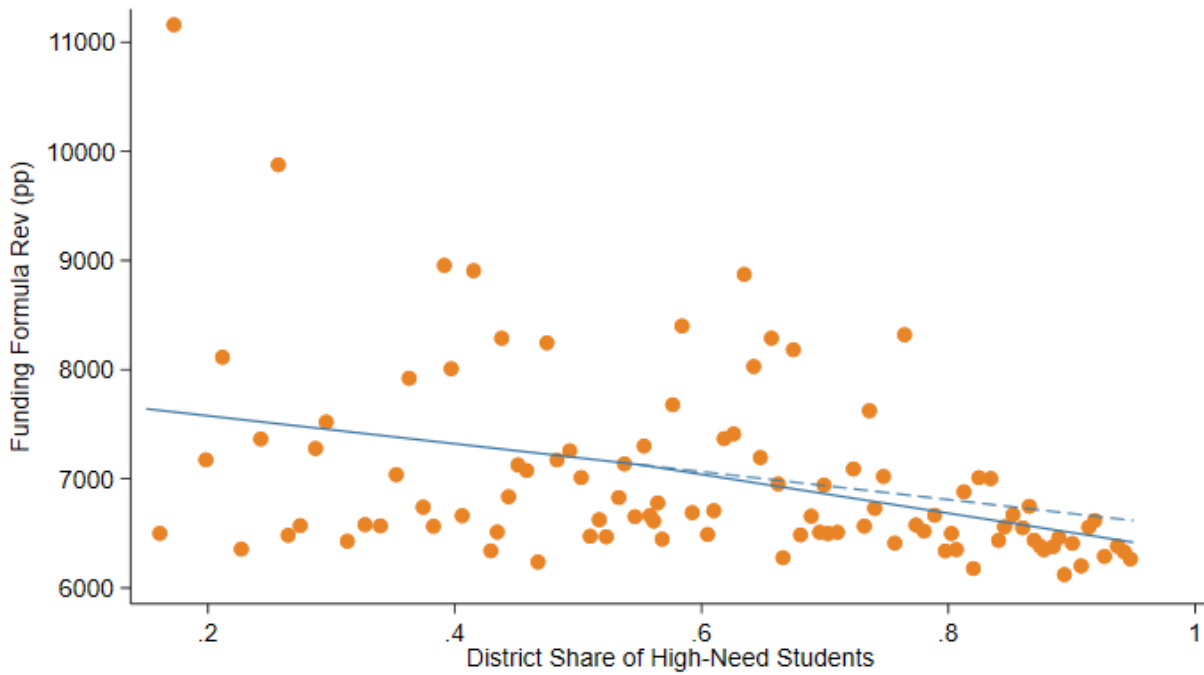
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[8] We use a district's share high-need in 2013-14, the first year for which data are available.

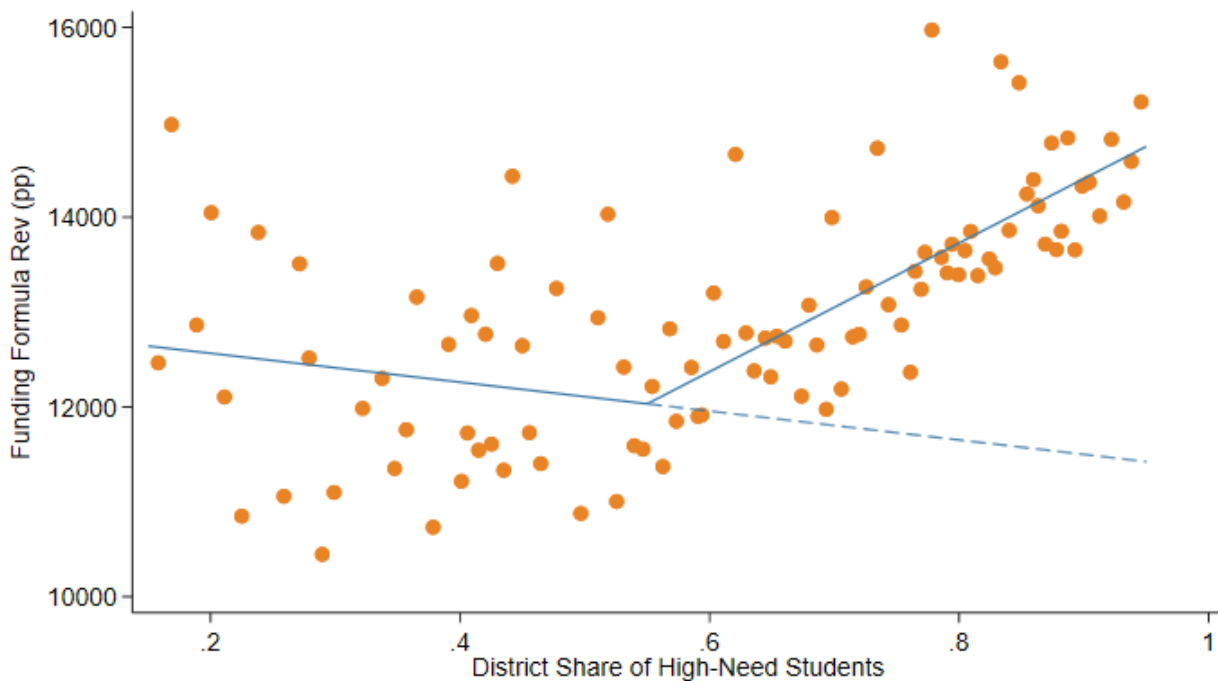[9] Indeed, in Figure D3 we see that the kink in funding grows over time.

Relationship between formula revenues and district share high-need, 2012-13 and 2019-20 (bandwidth=40%)
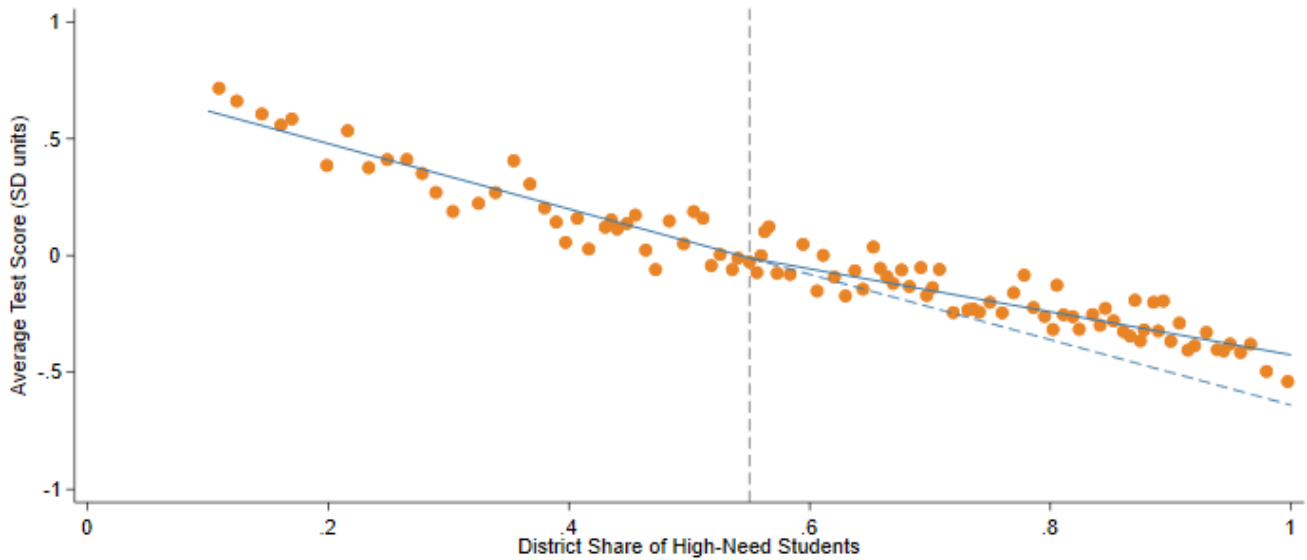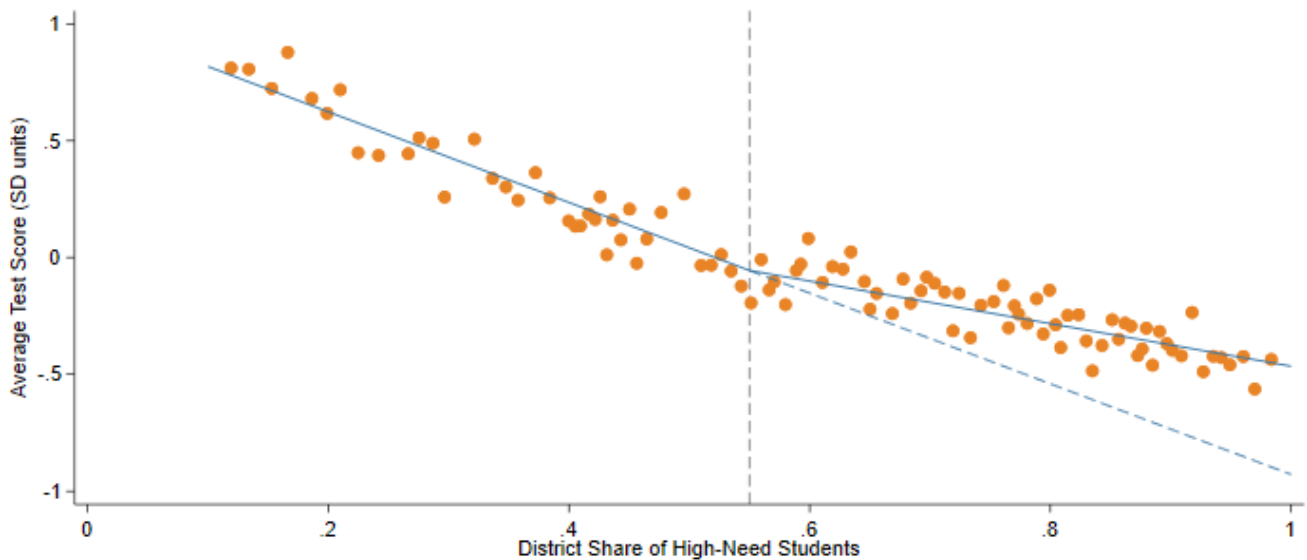
Panel 1: 2012-13

Panel 2: 2021-22

SOURCE: California Department of Education, enrollment and SACS district finance data; Author's calculations.

NOTE: Each dot is a "bin" depicting mean funding formula revenues per pupil in 2012-13 (top panel) and 2019-20 (bottom panel), within a narrow range of share high need, the share meeting standards in 2012–13 (top panel) and 2021–22 (bottom panel). Only districts within 40% of the cutoff on either side are shown. Solid blue line displays the line of best fit above and below the 55% cutoff; the dashed blue line extrapolates the line of best fit from below the 55% cutoff. Each dot contains an equal number of districts (unweighted), and shows the average for different values of high-need share.

Relationship between mean scale scores and district share high-need, 2011-12 and 2021-22 (bandwidth=40%)

Panel 1: 2012-13

Panel 2: 2021-22

SOURCE: California Department of Education, California Assessment of Student Progress and Performance research files, enrollment files; Authors' calculations.

NOTE: Each dot is a "bin" depicting mean test scores per pupil in 2012-13 (top panel) and 2019-20 (bottom panel), within a narrow range of share high need, the share meeting standards in 2012–13 (top panel) and 2021–22 (bottom panel). Only districts within 40% of the cutoff on either side are shown. For comparability over time, only test scores in grades 3–7 are included. Solid blue line displays the line of best fit above and below the 55% cutoff; the dashed blue line extrapolates the line of best fit from below the 55% cutoff. Each dot contains an equal number of district-grade-subject observations (unweighted); binned averages and lines of best fit are adjusted for average differences in the share meeting standards across grade-subject exams.

To formally estimate these relationships, we estimate regressions separately for each year of data using a linear slope in the share high-need relative to the 55% kink point. Specifically, we estimate equation (2):

$$(2) \qquad y_{d,gs} = \alpha + \beta_1(x_d - 0.55) + \beta_2(x_d - 0.55) * 1[x_d > 0.55] + \Gamma X_d + \gamma_{gs} + \phi_{c(d)} + \epsilon_{dgs}$$

Where $y_{d,gs}$ is a test score outcome in a given year for a district-grade-subject combination, and x_d is the district share high-need in a given year. Here, β_1 gives the slope of the outcome with respect to district share high-need, while β_2 estimates the change in slope – or the kink. We also include grade-subject fixed effects γ_{gs} , county fixed effects $\phi_{c(d)}$, and district-level controls X_d. For non-test score regressions using district level outcomes, we exclude these fixed effects but still use controls. Standard errors are clustered by district. In our main specifications for test scores we estimate equation (2) using a bandwidth of +/- 20%. Smaller bandwidths produce similar but noisier estimates. Estimates are also similar for larger bandwidths (Figures D5 and D6), but we select smaller bandwidths due to concern over bias in the linear specification.[10] For district-level finance outcomes, we report larger bandwidths (+/- 40%); estimates are similar but noisier at smaller bandwidths.

Figure D3 reports estimates of β_1 for per pupil funding formula revenues. Point estimates are statistically significant at the 5% level in 6 of the 8 post-LCFF years (excluding 2013-14, the first year of implementation), and statistically significant at the 10% level in the others. The point estimate in 2021-22 is $10,401, implying that a 40% increase in the share high-need above 55% (equivalent to going from 55% to 95% high-need) would increase funding per pupil by nearly $4,200. The adjusted base grant per pupil (ADA) in 2021-22 ranged from $8,215 to $10,057 depending on the grade level; per the formula this implies an increase in funding ranging from roughly $2,800 to $3,600 per pupil going from 55% to 100% high-need. The RKD estimates for funding are therefore consistent, though slightly higher, than what would be expected under the formula.

FIGURE D3
RKD estimates for funding, by year (bandwidth =40%)
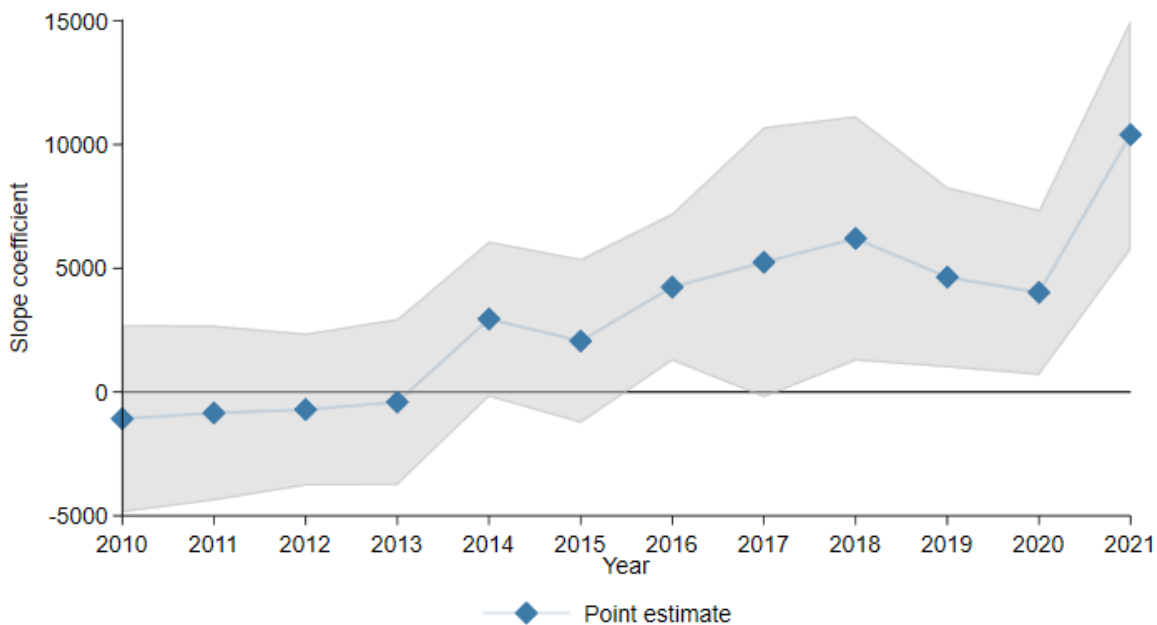
SOURCE: California Department of Education, SACS district finance data, enrollment files; Authors' calculations.

NOTE: Figure shows equation (2) estimates of the change in slope (kink) at the cutoff for funding formula revenues per pupil, by year. Year corresponds to fall year. Shaded area shows 95% confidence interval; standard errors are clustered by district.

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[10] Indeed, for larger bandwidths some of the point estimates in the early LCFF years or even before LCFF are statistically significant. For smaller bandwidths, point estimates for pre-LCFF years are always small and never statistically significant, providing evidence the equation (2) is not erroneously finding effects due to nonlinearities in the relationship between test scores and share high-need.

Figure 12 and Figure D4 report estimates for test scores – Figure 11 in the main text reports estimates for the share at or above grade level standards, while Figure D4 below reports analogous estimates with 95 percent confidence intervals, for mean test scores both percent meeting or exceeding standards (top panel) and in standard deviation units (bottom panel). Estimates of equation (2) that correspond to Figure 12 are included below in Table D1. Both test score measures show a similar pattern – estimates are small and insignificant, and only several years after LCFF do they become large and statistically significant (starting in 2017-18). This provides evidence supporting the validity of the RKD design, as there is no discontinuous relationship in outcomes around the cutoff in the early years of LCFF nor the years prior to the implementation of LCFF.

We also report estimates of effects for revenues and test scores (in share at or above standards) by bandwidth for 2021-22, the most recent year for which we have test score data (Figures D5 and D6). Estimates are similar across bandwidths, although estimates are far noisier for small bandwidths. We ultimately select a bandwidth of 20% as our baseline specification, to minimize potential biases from nonlinearities as we increase the bandwidth. Table D2 uses estimates for test scores and revenues to calculate the implied increase in test scores per $1,000 in average annual spending.

We report estimates of heterogeneity by grade, subject, student subgroup, and school characteristics in Tables D3-D6. Regressions by grade and subject, and are equivalent to equation (2), with the slope and kink in slope interacted with grade or subject indicator variables. Estimates are generally imprecise and we cannot reject differences in effects by subgroup.

Finally, placebo estimates of district-level demographics provide little evidence of other changes at the threshold (Figure D7). Only one variable (the district share Latino) is statistically significant (and moves in the opposite direction from what would cause upward bias in test score estimates). Nevertheless, we still control for these variables in all regressions. Figure D8 reports a placebo test where we estimate the change in slope for different choices of the kink point, ranging from 30% high need to 80% high-need. Estimates are only positive and significant when using a kink point of 50% or 55%, providing evidence that nonlinearities elsewhere besides the 55% cutoff are not influencing test score kink estimates.

RKD estimates for test scores by year (bandwidth=20%). Top panel: percent proficient; bottom panel: standard deviation units
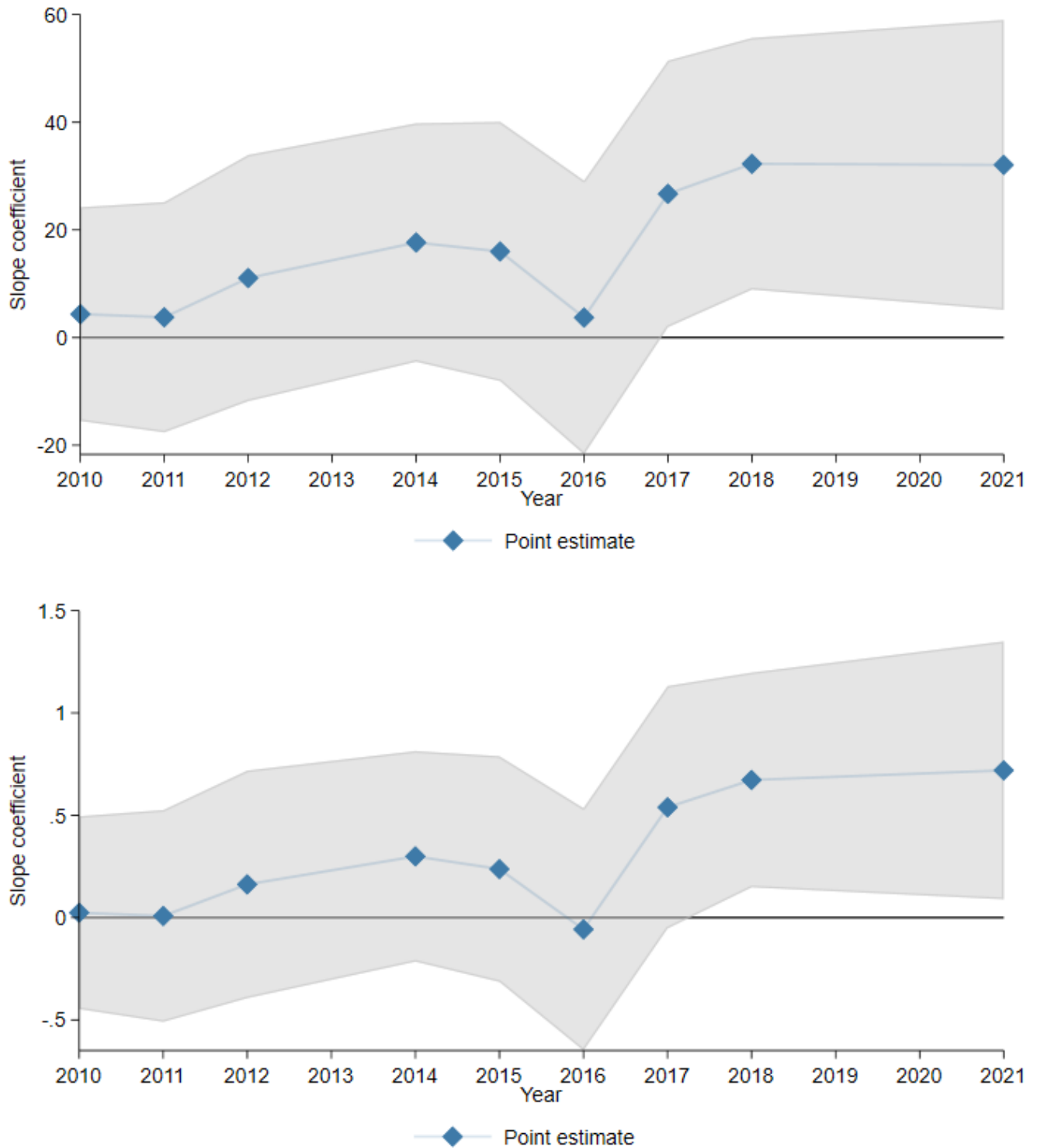
SOURCE: California Department of Education, California Assessment of Student Progress and Performance research files, enrollment files; Authors' calculations.

NOTE: Figure shows equation (2) estimates of the change in slope (kink) at the cutoff for test scores in standard deviation units, by year. Year corresponds to fall year. Shaded area shows 95% confidence interval; standard errors are clustered by district.

TABLE D1
Estimates of equation (2) for share at or above standard (corresponding to Figure 12, bandwidth=20%)

	2010	2011	2012	2014	2015	2016	2017	2018	2021
UPP Slope	-44.61***	-45.31***	-49.18***	-58.96***	-61.51***	-54.53***	-73.49***	-67.96***	-61.10***
	(6.226)	(6.899)	(7.001)	(6.877)	(7.505)	(8.088)	(7.655)	(6.944)	(7.978)
Change in Slope (Kink)	4.360	3.773	11.06	17.66	15.99	3.729	26.70*	32.28**	32.08*
	(10.10)	(10.87)	(11.63)	(11.26)	(12.25)	(12.93)	(12.59)	(11.88)	(13.69)
Observations	4473	4495	4513	3920	3942	3995	4014	3989	3888
Grade-Subject Fixed Effects	X	X	X	X	X	X	X	X	X
County Fixed Effects	X	X	X	X	X	X	X	X	X
Demographic Controls	X	X	X	X	X	X	X	X	X

SOURCES: California Department of Education, California Assessment of Student Progress and Performance research files, enrollment files; Authors' calculations.

NOTES: Table reports estimates of Beta 1 and Beta 2 from equation (2) for the share at or above standard. Standard errors are in parentheses, and are clustered by district. * p<.10, ** p<.05, *** p<.01.

TABLE D2
With cumulative funding from concentration grants, test scores continue to improve over time for high-need districts (estimates for 95% high-need districts)

Test Year	Years of LCFF funding	Total relative funding increase over all LCFF years (for 95% high-need)	Relative test score increase (% proficient)	Relative test score increase (std. dev.)	Test score increase per $1,000/yr (% proficient)	Test score increase per $1,000/yr (std. dev. units)
2017–18	5	$5,643	10.7pp	0.22.	9.5pp	0.19
2018–19	6	$8,127	12.9pp	0.27	9.5pp	0.20
2021–22	9	$15,758	12.8pp	0.29	7.3pp	0.16

SOURCES: California Department of Education, California Assessment of Student Progress and Performance research files, SACS district finance data, and enrollment files; Authors' calculations.

NOTES: Uses estimates from equation (2) for the change in slope (kink) at the cutoff for funding formula revenues per pupil and test scores. For test scores we estimate separate effects for percent proficient and scale scores (in standard deviation units). See Technical Appendix D for full details on estimation. Dollar amounts are inflation adjusted to 2022 dollars.

TABLE D3
Effects by grade level (2021-22, bandwidth=20%)

	G3	G4	G5	G6	G7	G8	G11
UPP Slope	-67.25***	-64.42***	-56.14***	-70.49***	-58.01***	-59.81***	-76.97***
	(11.81)	(10.70)	(11.93)	(11.36)	(11.50)	(11.00)	(17.25)
Change in Slope (Kink)	28.89	38.62**	27.00	43.45**	24.12	30.94*	79.99***
	(19.55)	(17.67)	(19.31)	(18.21)	(19.00)	(17.88)	(27.80)
Observations	584	584	586	588	568	570	408

Subject Fixed Effects	X	X	X	X	X	X	X
County Fixed Effects	X	X	X	X	X	X	X
Demographic Controls	X	X	X	X	X	X	X

SOURCES: California Department of Education, California Assessment of Student Progress and Performance research files, enrollment files; Authors' calculations.

NOTES: Table reports estimates of Beta 1 and Beta 2 from a single regression equivalent to equation (2) restricted to a specific grade-level. Dependent variable is the share at or above standard in 2021-22. Standard errors are in parentheses and are clustered by district. * p<.10, ** p<.05, *** p<.01.

TABLE D4
Effects by subject and student income (2021-22; bandwidth=20%)

	ELA	Math	Low-income	Non-low-income
UPP Slope	-59.94***	-62.26***	-30.73***	-38.07***
	(8.720)	(8.055)	(8.658)	(9.467)
Change in Slope (Kink)	29.57**	34.58**	27.44	13.99
	(14.47)	(14.25)	(13.98)	(16.93)
Observations	1944	1944	7617	7617
Grade-Subject Fixed Effects	X	X	X	X
County Fixed Effects	X	X	X	X
Demographic Controls	X	X	X	X

SOURCES: California Department of Education, California Assessment of Student Progress and Performance research files, enrollment files; Authors' calculations.

NOTES: Table reports estimates of Beta 1 and Beta 2 from regressions equivalent to equation (2), estimated separately by subject or student group. Student subgroup regressions rely on district-grade-subject-subgroup scores. Dependent variable is the share at or above standard in 2018-19. Standard errors are in parentheses and are clustered by district. * p<.10, ** p<.05, *** p<.01.

TABLE D5
Effects estimated separately by student race (2021-22; bandwidth=20%)

	Asian	African American	Hispanic/Latino	Filipino	White
UPP Slope	-50.39***	-46.72***	-30.45**	-46.68***	-11.39
	(15.06)	(9.818)	(12.42)	(9.448)	(12.47)
Change in Slope (Kink)	-33.72	-22.10	29.08*	-26.16	3.758
	(29.63)	(21.35)	(15.88)	(25.34)	(18.34)
Observations	11651	11651	11651	11651	11651
Grade-Subject Fixed Effects	X	X	X	X	X
County Fixed Effects	X	X	X	X	X
Demographic Controls	X	X	X	X	X

SOURCES: California Department of Education, California Assessment of Student Progress and Performance research files, enrollment files; Authors' calculations.

NOTES: Table reports estimates of Beta 1 and Beta 2 from a single regression equivalent to equation (2) where Beta 1 and Beta 2 are interacted with student race, and data are at the district-grade-subject-subgroup level. Dependent variable is the share at or above standard in 2018-19. Standard errors are in parentheses, and are clustered by district. * p<.10, ** p<.05, *** p<.01.

TABLE D6
Effects by student EL status (2021-22; bandwidth=20%)

|	Fluent English Proficient/ English Only	Initially Fluent English Proficient	Reclassified EL	EL
UPP Slope	-55.99***	-53.89***	-30.68**	-50.56***
	(8.566)	(9.402)	(11.44)	(11.14)
Change in Slope (Kink)	19.21	-41.97**	41.82**	25.64*
	(14.73)	(20.89)	(19.65)	(14.00)
Observations	13781	13781	13781	13781
Grade-Subject Fixed Effects	X	X	X	X
County Fixed Effects	X	X	X	X
Demographic Controls	X	X	X	X

SOURCES: California Department of Education, California Assessment of Student Progress and Performance research files, enrollment files; Authors' calculations.

NOTES: Table reports estimates of Beta 1 and Beta 2 from a single regression equivalent to equation (2) where Beta 1 and Beta 2 are interacted with student race, and data are at the district-grade-subject-subgroup level. Dependent variable is the share at or above standard in 2018-19. Standard errors are in parentheses, and are clustered by district. * p<.10, ** p<.05, *** p<.01.

FIGURE D5
RKD estimates for revenues, 2021-22, by bandwidth
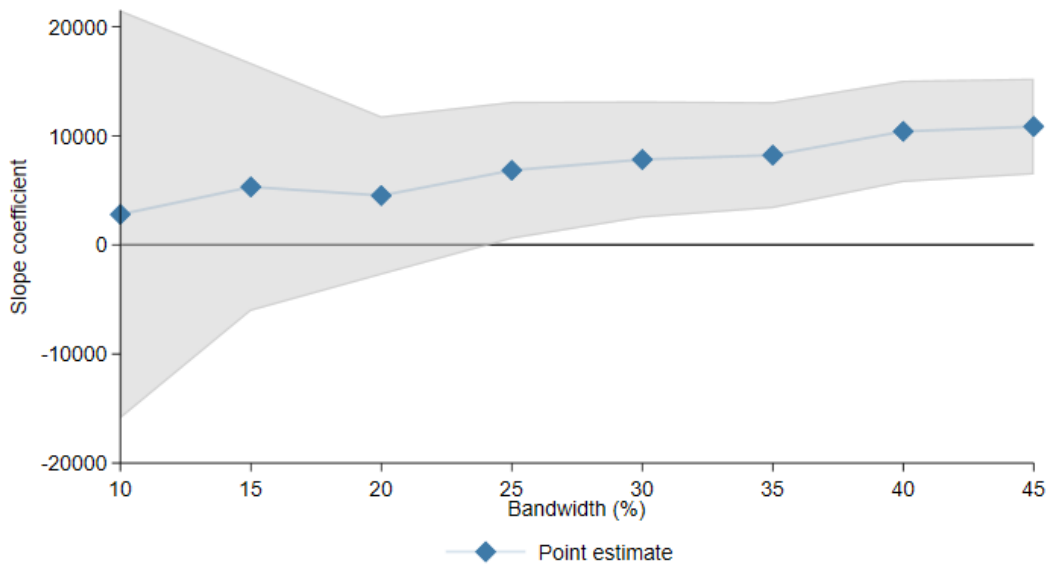
SOURCE: California Department of Education, SACS district finance data, enrollment files; Authors' calculations.

NOTE: Figure shows equation (2) estimates of the change in slope (kink) at the cutoff for funding formula revenues per pupil, for different bandwidths. Estimates only shown for 2018-19. Shaded area shows 95% confidence interval; standard errors are clustered by district.

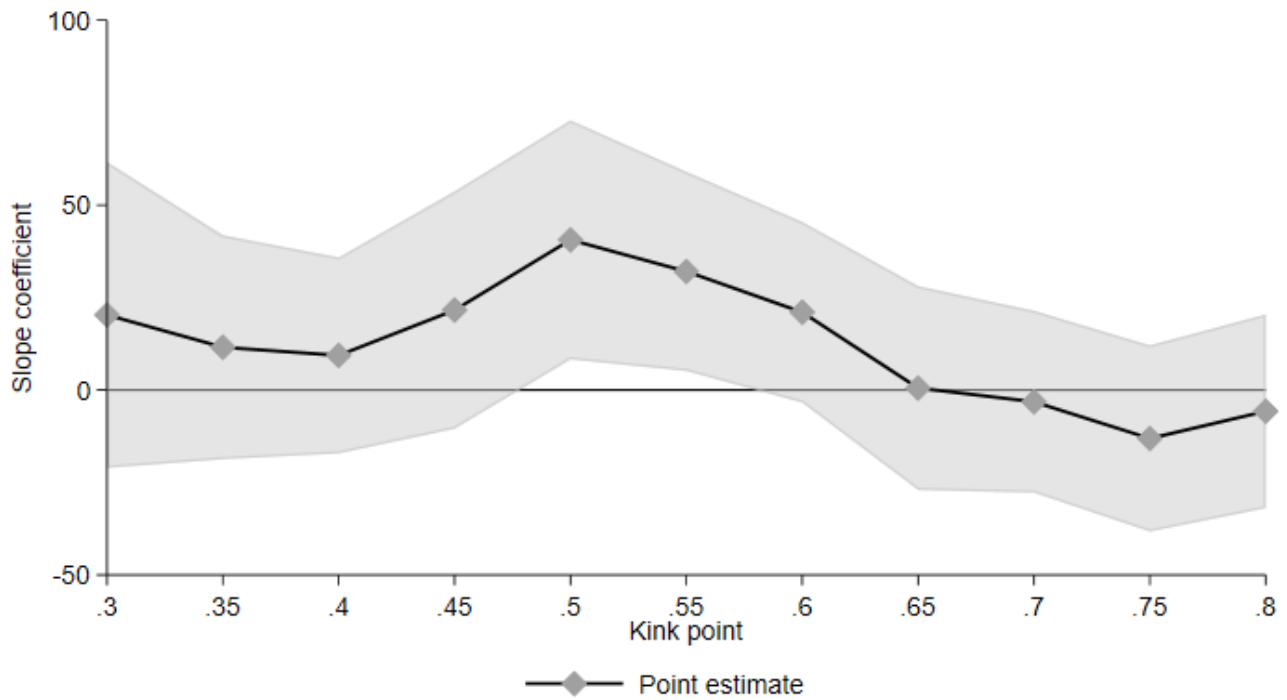## FIGURE D6
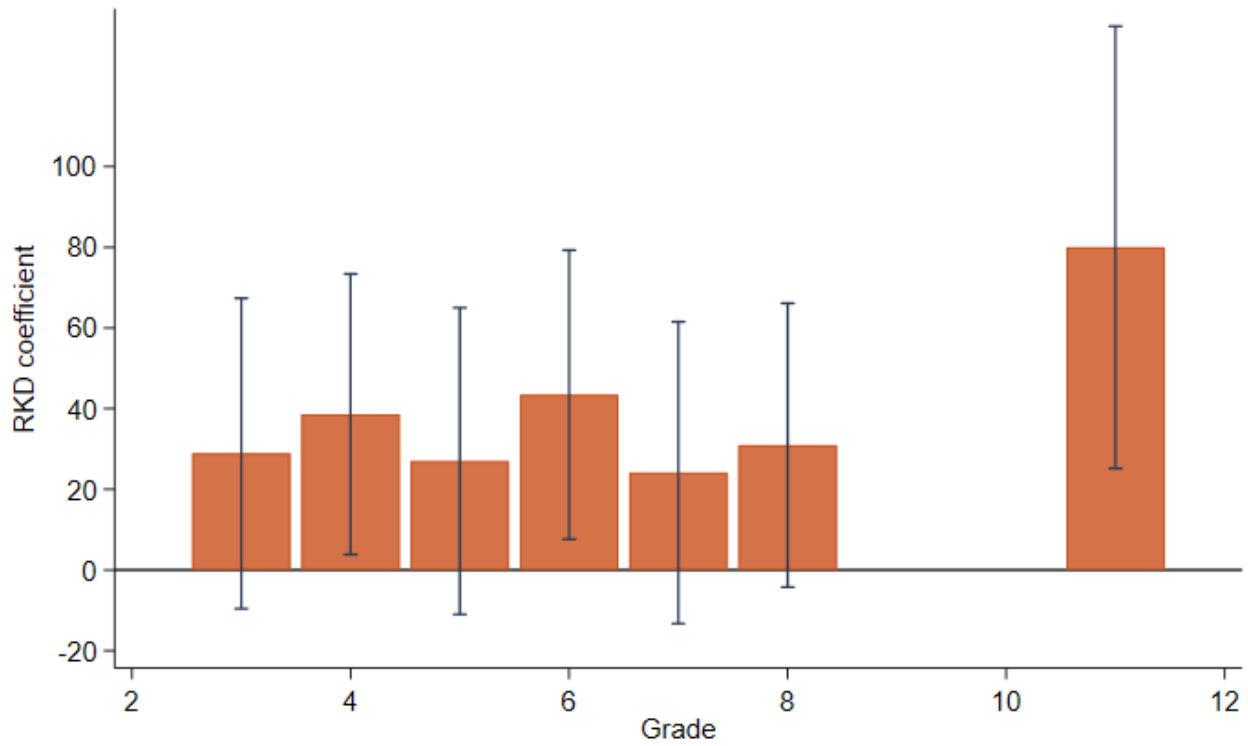RKD estimates for test scores, 2021-22, by bandwidth (share at or above standard)
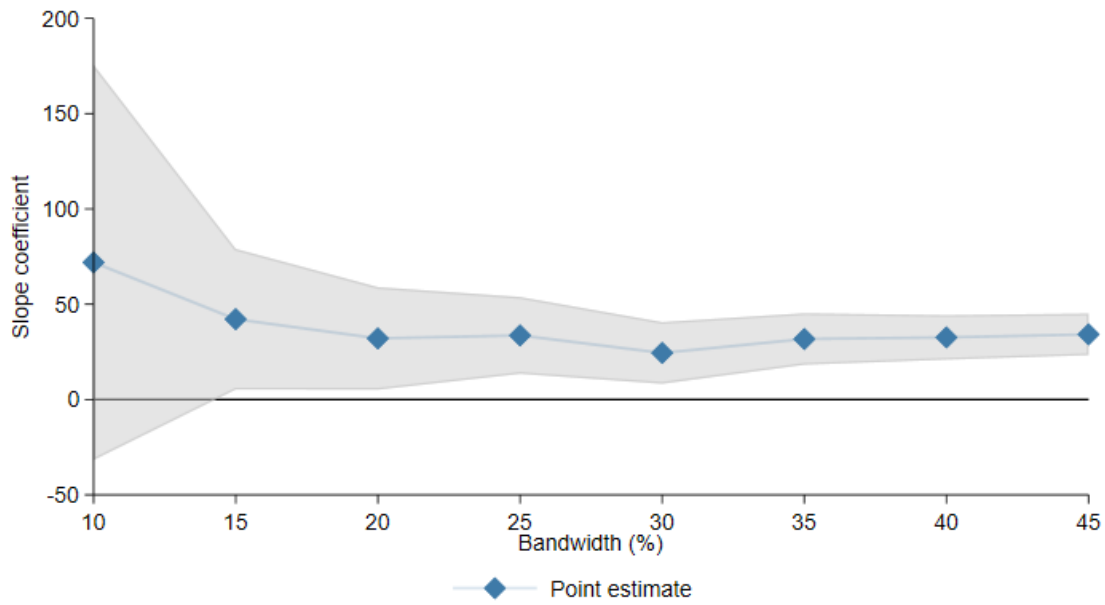
SOURCE: California Department of Education, California Assessment of Student Progress and Performance research files, enrollment files; Authors' calculations.

NOTE: Figure shows equation (2) estimates of the change in slope (kink) at the cutoff for the mean share at or above standards on the 2021-22 SBAC, for different bandwidths. Shaded area shows 95% confidence interval; standard errors are clustered by district.

FIGURE D7
RKD estimates for race/income, 2021-22 (bandwidth=20%)
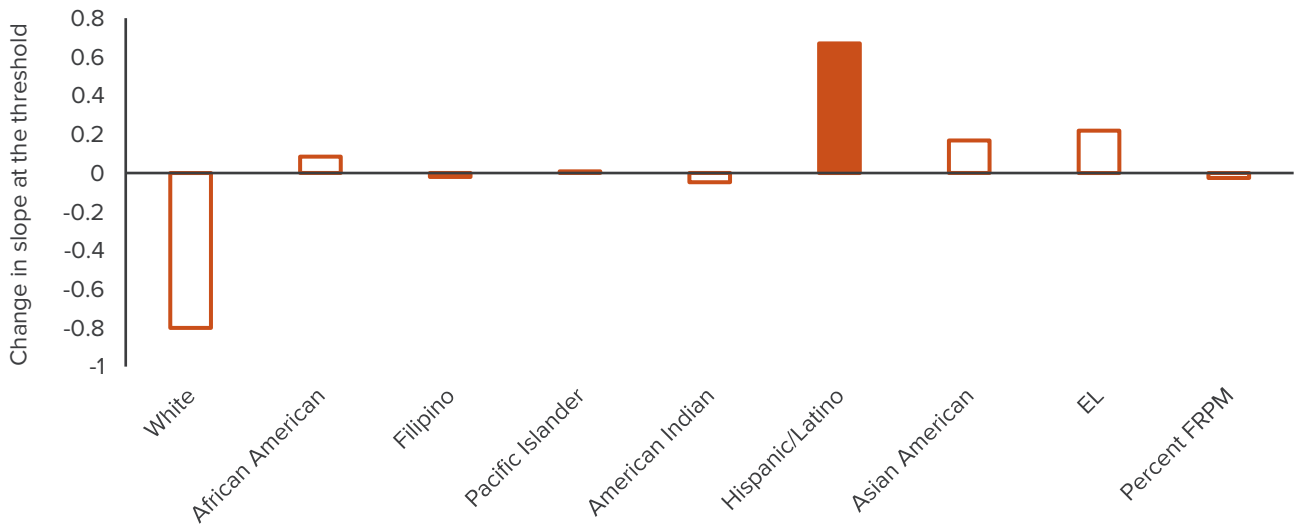
SOURCE: California Department of Education, school enrollment files; Authors' calculations.

NOTE: Figure shows equation (2) estimates of the change in slope (kink) at the cutoff for different demographic characteristics in 2021-22. Solid bars denote statistical significance at the 5% level, diagonal lines denote significance at the 10% level; standard errors are clustered by district.

FIGURE D8

Placebo RKD estimates by choice of cutoff (proficiency rates, 2021-22, bandwidth=20%)
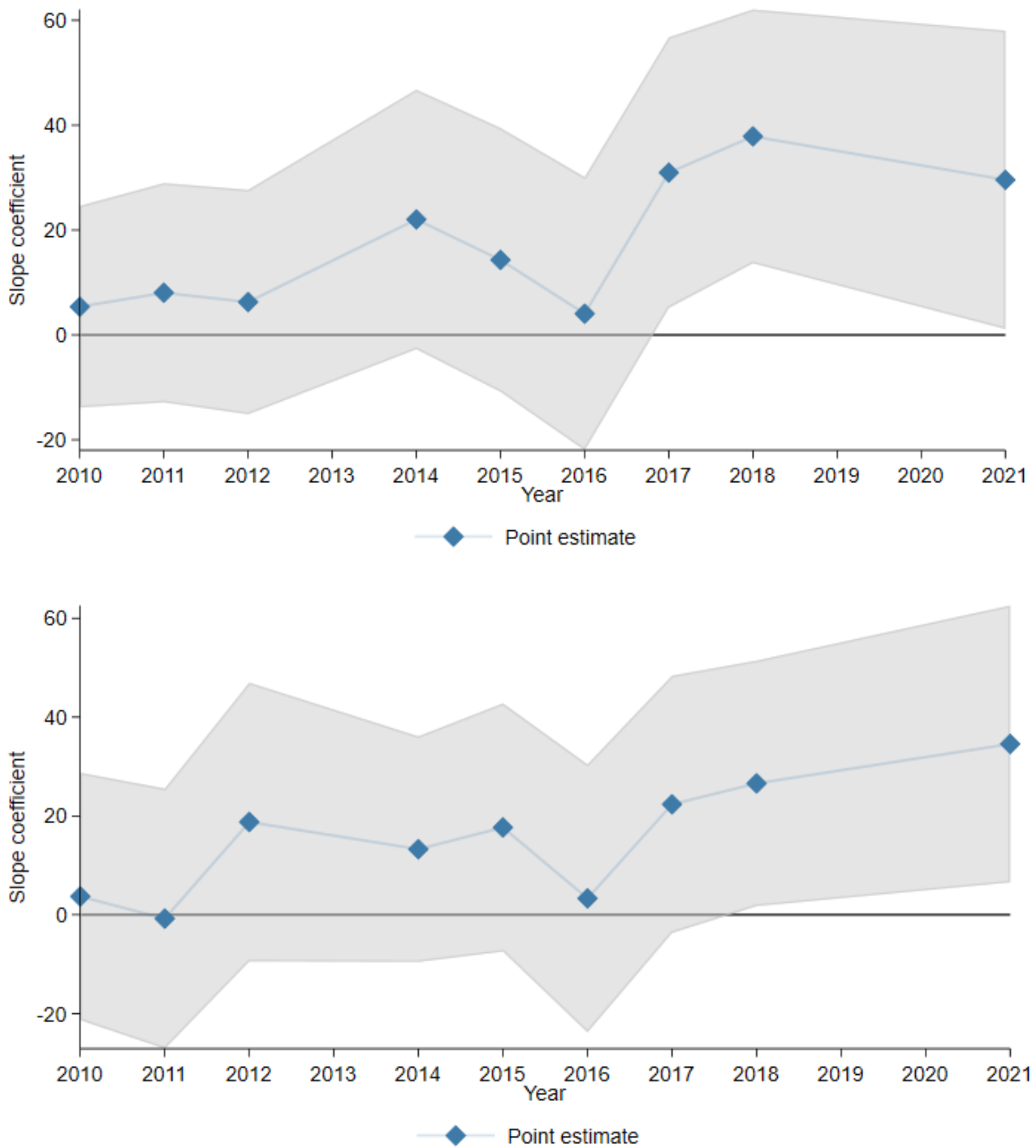

SOURCE: California Department of Education, California Assessment of Student Progress and Performance research files, enrollment files; Authors' calculations.

NOTE: Figure shows equation (2) estimates of the change in slope (kink) at the cutoff for the mean share at or above standards on the 2021-22 SBAC, for different difference choices of the cutoff (+/- 25pp from 55% cutoff). Shaded area shows 95% confidence interval; standard errors are clustered by district.

Estimated change in test score slope, by grade level (2021-22)

SOURCE: California Department of Education, California Assessment of Student Progress and Performance research files, enrollment files; Authors' calculations.

NOTE: Figure shows equation (2) estimates of the change in slope (kink) at the cutoff for percent proficient, by grade, using only data from 2021-22. Bars show 95% confidence intervals; standard errors clustered by district.

FIGURE D10

RKD estimates for test scores in ELA (top panel) and math (bottom panel) by year, (Bandwidth=20%).

NOTE: Figure shows equation (2) estimates of the change in slope (kink) at the cutoff for test scores in standard deviation units, by year. Year corresponds to fall year. Shaded area shows 95% confidence interval; standard errors are clustered by district.

Appendix E. Supplemental Tables and Figures

Spending Increases Since 2012-13 to 2021-22 by Student Group (Excluding Basic Aid Districts)

	Spending increase since 2012-13	Share in concentration districts	Share in non-concentration districts	Correlation with high-need share (district-level)
High-Need	$7,200	84%	16%	1
Non-high-need	$5,748	47%	53%	-1
Low-income	$7,259	85%	15%	0.98
Non-low-income	$5,832	50%	50%	-0.98
English Learner	$7,226	83%	17%	0.63
Non-EL	$6,548	67%	33%	-0.63
American Indian	$6,263	73%	27%	0.02
Asian	$5,939	45%	55%	-0.49
Black	$7,278	82%	18%	0.26
Filipino	$6,316	60%	40%	-0.30
Latino	$7,215	84%	16%	0.84
White	$5,640	47%	53%	-0.69

SOURCES: California Department of Education, SACS district finance data and enrollment files; Author's calculations.

NOTES: Assumes districts spend equally on all students. Excludes basic aid districts. Excludes independent charter schools and district-affiliated charter schools not reporting on a districts' general fund. Excludes districts with fewer than 250 students.

Hypothetical Targeting Example: After Increase of $2000 per high-need student

Panel A: High-need students

| High-Need Students	Share high-need	Avg increase per pupil	Avg per high-need, equal spending	Avg per high-need, 50% targeted	Avg per high-need, 100% targeted	Avg per high-need, 50% regressive
Districts:						
Lowest-need	0-30%	$421	$466	$1,233	$2,000	$233
Lower-need	30-55%	$884	$905	$1,452	$2,000	$452
Higher-need	55-80%	$1,362	$1,378	$1,689	$2,000	$689
Highest-need	80%+	$1,740	$1,744	$1,872	$2,000	$872
Statewide:	65%	$1,296	$1,443	$1,722	$2,000	$722

Panel B: Non-High-need students

Non-High-Need Students	Share non-high-need	Avg increase per pupil	Avg per non-high-need, equal spending	Avg per non-high-need, 50% targeted	Avg per non-high-need, 100% targeted	Avg per non-high-need, 50% regressive
Districts:						
Lowest-need	0-30%	$421	$409	$204	$0	$471
Lower-need	30-55%	$884	$868	$434	$0	$1,227
Higher-need	55-80%	$1,362	$1,329	$664	$0	$2,799
Highest-need	80%+	$1,740	$1,717	$858	$0	$7,550
Statewide:	35%	$1,296	$1,025	$513	$0	$2,353

SOURCE: California Department of Education, enrollment files; Author's calculations.

NOTES: Each district has 5 students. Increase is $2000 per high-need student. See text for complete explanation. Equal spending scenario assumes districts spend equally on students. 50% targeted scenario assumes half of money is spent specifically on high-need students, with the rest distributed equally across students. 100% targeted scenario assumes all is spent on high-need students. 50% regressive scenario assumes half is spent on *non-high-need* students, with the rest spent equally. Enrollment data from 2022-23 used to calculate spending increases. Charter schools not reporting on a district's general fund are excluded.

FIGURE E1
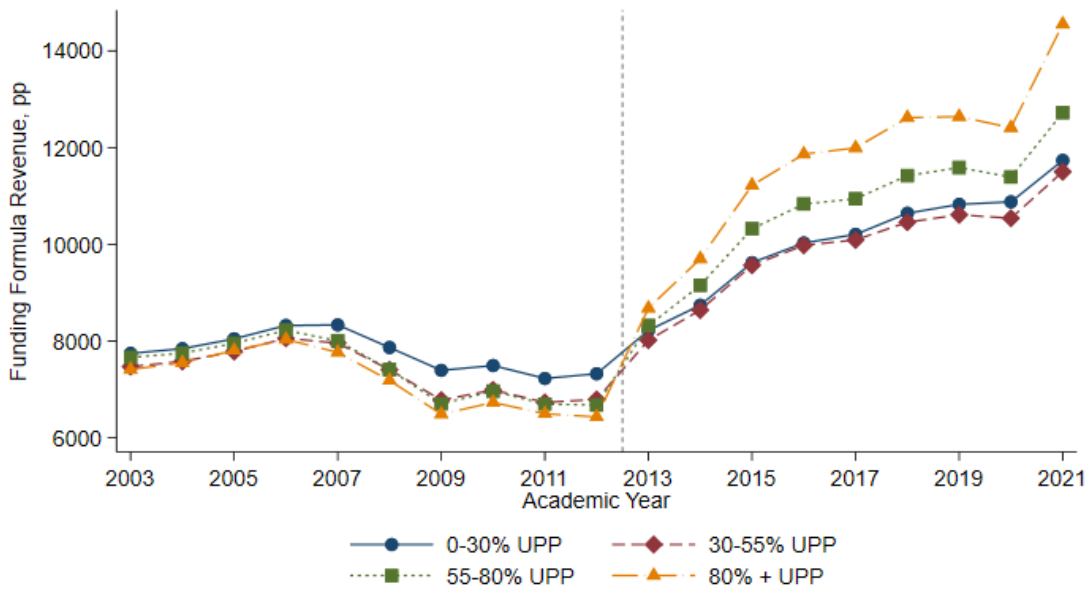Hypothetical funding formula revenues for a district with the same grade distribution as the state
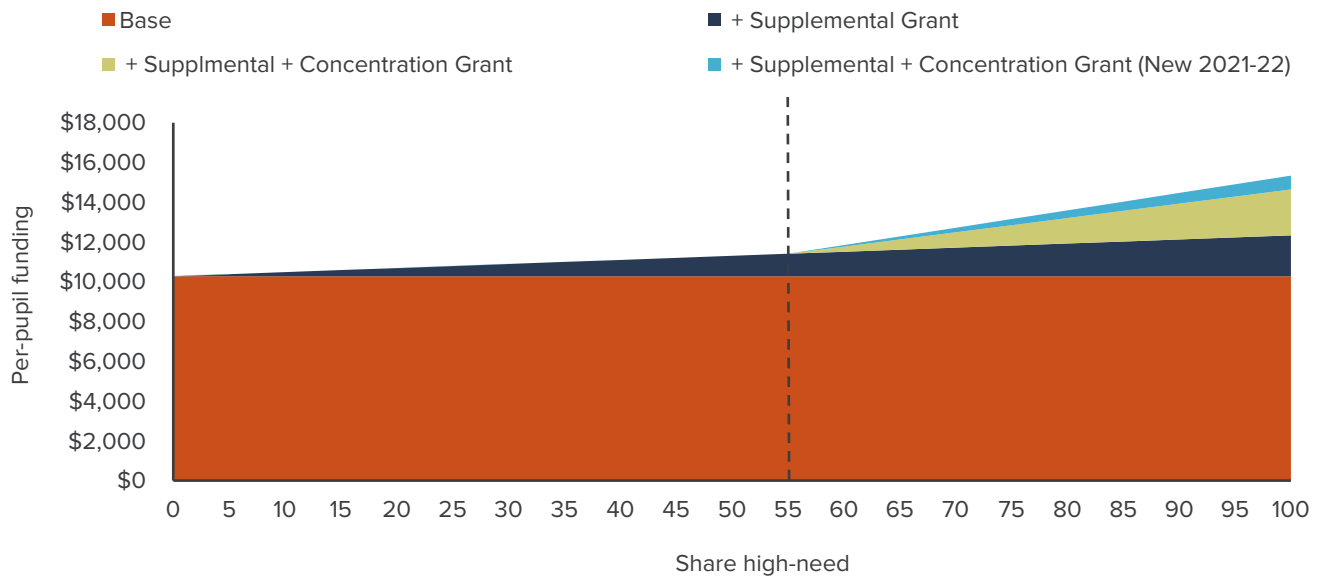
SOURCE: California Department of Education.

NOTE: UPP refers to the "unduplicated pupil percentage" of economically disadvantaged, English Learner, and foster youth in a district. Top panel shows the percent increase in base grant funding for a district with a given share of high-need students. The bottom panel shows the actual per-pupil amounts using 2022-23 LCFF grant amounts, computed for a "representative" district that has the same enrollment shares across grades as statewide, with no additional add-on funding.

FIGURE E2
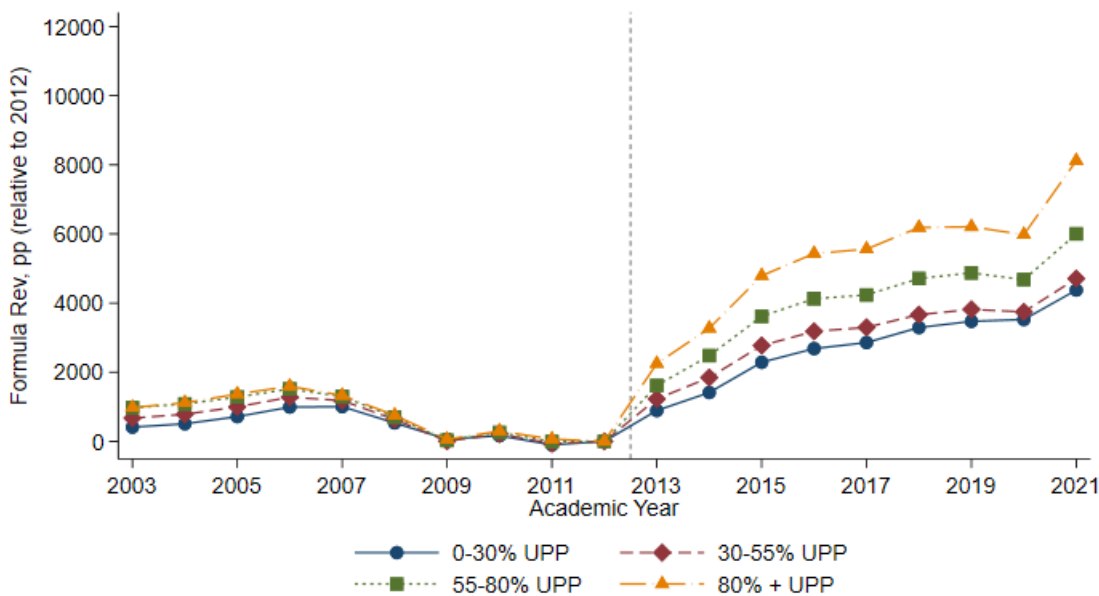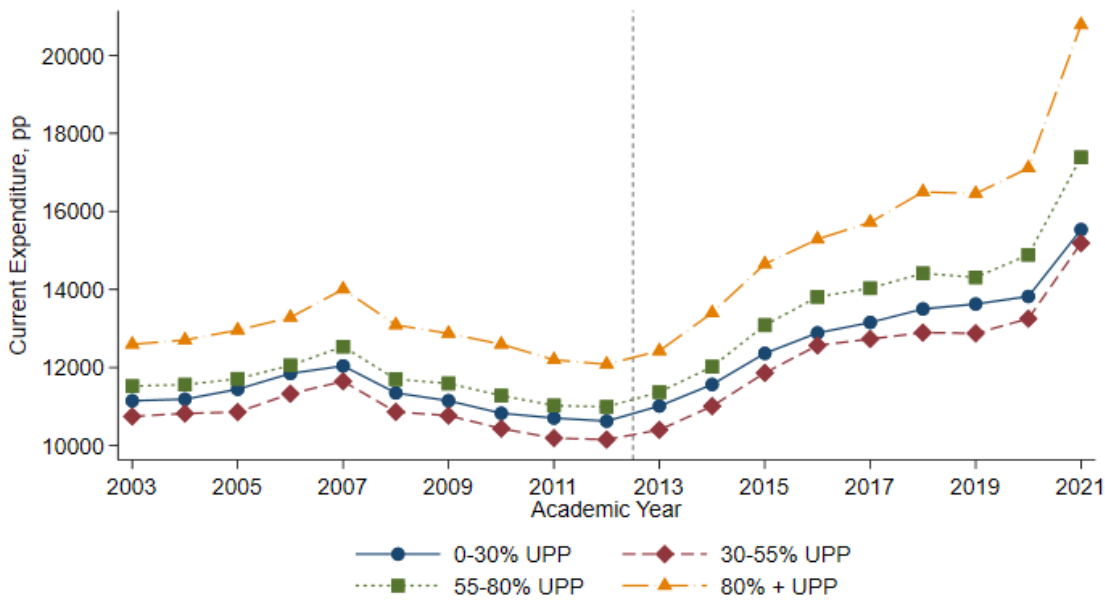Funding Formula Revenues per pupil

SOURCE: California Department of Education, SACS district finance data and enrollment files; Author's calculations.

NOTE: Figure plots the yearly total funding formula revenues per pupil, in inflation-adjusted 2021 dollars. UPP refers to the "unduplicated pupil percentage" of economically disadvantaged, English Learner, foster youth, and homeless students in a district. Averages are weighted by average daily attendance (ADA). Districts with ADA less than 250 are excluded. Districts with greater than 500% or less than 20% of California mean spending per pupil or funding formula revenues per pupil are excluded.
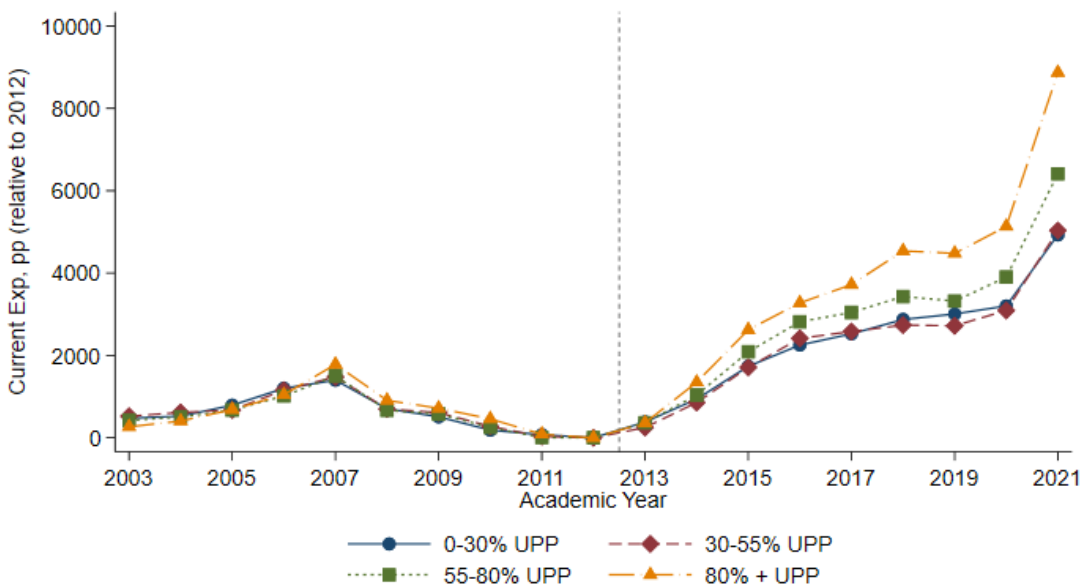
FIGURE E3
Funding Formula Revenues per pupil, relative to 2012-13

SOURCE: California Department of Education, SACS district finance data and enrollment files; Author's calculations.

NOTE: Figure plots the yearly total funding formula revenues per pupil, relative to 2012-13, in inflation-adjusted 2021 dollars. UPP refers to the "unduplicated pupil percentage" of economically disadvantaged, English Learner, foster youth, and homeless students in a district. Averages are weighted by average daily attendance (ADA). Districts with ADA less than 250 are excluded. Districts with greater than 500% or less than 20% of California mean spending per pupil or funding formula revenues per pupil are excluded.
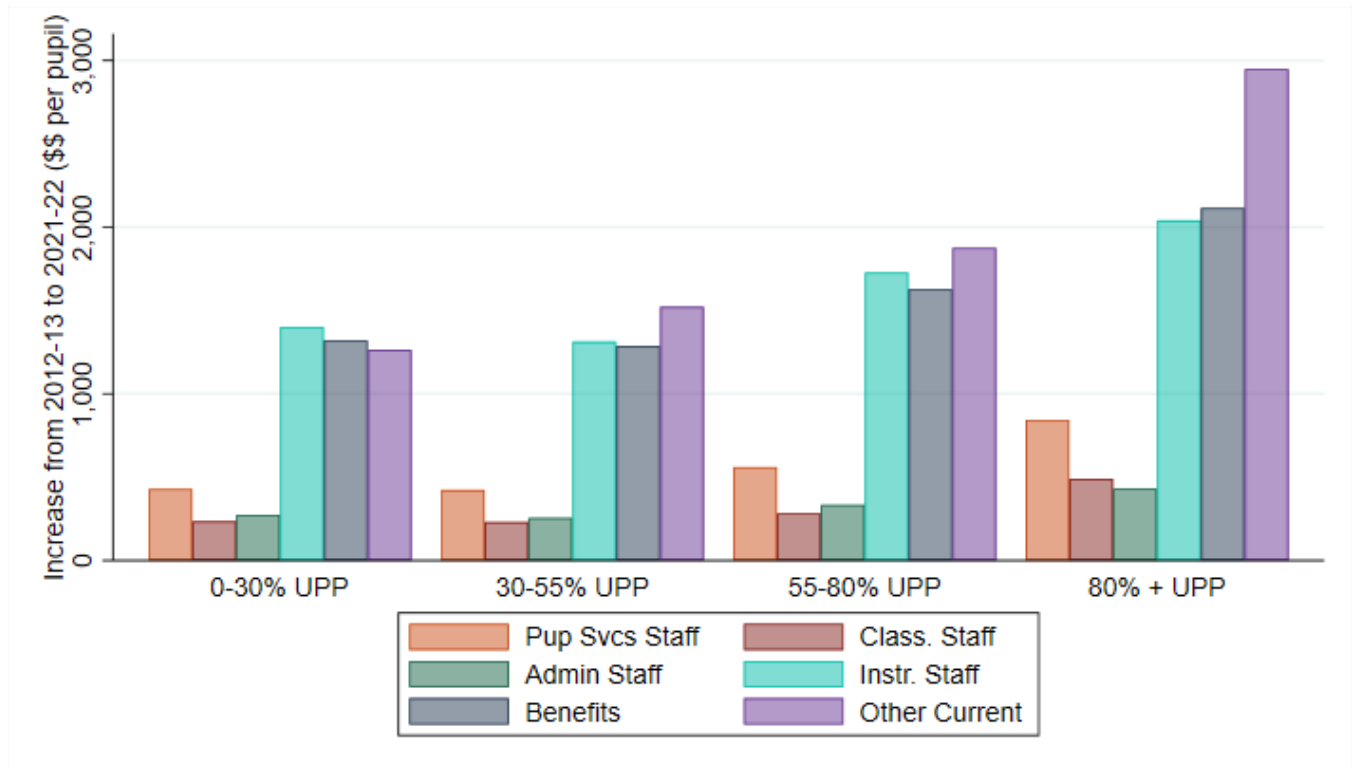
FIGURE E4
Current Spending per pupil

SOURCE: California Department of Education, SACS district finance data and enrollment files; Author's calculations.

NOTE: Figure plots the yearly current K-12 student spending per pupil, in inflation-adjusted 2021 dollars. UPP refers to the "unduplicated pupil percentage" of economically disadvantaged, English Learner, foster youth, and homeless students in a district. Averages are weighted by average daily attendance (ADA). Districts with ADA less than 250 are excluded. Districts with greater than 500% or less than 20% of California mean spending per pupil or funding formula revenues per pupil are excluded.

FIGURE E5
Current Spending per pupil, relative to 2012-13

SOURCE: California Department of Education, SACS district finance data and enrollment files; Author's calculations.

NOTE: Figure plots the yearly current K-12 student spending per pupil, relative to 2012-13, in inflation-adjusted 2021 dollars. UPP refers to the "unduplicated pupil percentage" of economically disadvantaged, English Learner, foster youth, and homeless students in a district. Averages are weighted by average daily attendance (ADA). Districts with ADA less than 250 are excluded. Districts with greater than 500% or less than 20% of California mean spending per pupil or funding formula revenues per pupil are excluded.

Increase in Current Spending Category, relative to 2012-13

SOURCE: California Department of Education, SACS district finance data and enrollment files; Author's calculations.

NOTE: Figure plots the change in spending on current spending subcategories, from 2012-13 to 2021-22, in inflation-adjusted 2021 dollars. UPP refers to the "unduplicated pupil percentage" of economically disadvantaged, English Learner, foster youth, and homeless students in a district. Averages are weighted by average daily attendance (ADA). Districts with ADA less than 250 are excluded. Districts with greater than 500 percent or less than 20 percent of California mean spending per pupil or funding formula revenues per pupil are excluded.

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