To what extent are changes in public and private school quality capitalized into local house prices, and how does this affect the net asset value of high-income households in California school districts from 2010–2018?

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April 6, 2025

This project compares the relationship between changes in public and private school quality measures on changes in house prices, focusing on how these measures are capitalized into house prices across California school districts from 2009 to 2018. Specifically, it investigates how public investment in schools is reflected in house prices, particularly in districts with higher concentrations of high-income individuals (i.e., where the top income quintile holds a larger share of total school district

income), as a means of increasing their net asset value. While school quality often influences house prices, there is ongoing debate over the best proxies for school quality. Oates (1969) found expenditure per pupil significant, while Rosen and Fullerton (1977) and Downes and Zabel (2002) did not, instead emphasizing test scores. Gibbons and Machin (2003) found a higher proportion of students meeting educational targets significant, while Figlio and Lucas (2004) found letter grades for elementary schools insignificant. The challenge of separating school quality from neighborhood characteristics is central in these studies. Jud and Watts (1981) controlled for racial demographics and found reading scores had a positive effect; Black (1999) and Kane, Steiger, and Reigg (2005) found positive effects of test scores when controlling for boundary line fixed effects. Bayer, Ferreira, and McMillan (2007) built on Black's method by controlling for sociodemographics along borders, which reduced but did not eliminate the significance of school quality. Hayes and Taylor (1996) regarded value-added measures as theoretically sound, but Brasington (1999) found test scores to be more predictive. Brasington and Haurin (2006) found that both expenditure per pupil and test scores positively affect house prices, but value-added did not. This analysis focuses on student-to-teacher ratio, a measure less emphasized in prior research except for Brasington (1999), to determine if it and public school funding serve as effective proxies for school quality, particularly in high-income areas where such quality may be capitalized into house prices.

The data comes from multiple sources: Kaggle U.S. Schools Dataset (Andrew, 2021), Kaggle U.S. Real Estate Dataset (Sakib, 2021), California Department of Education. (n.d.), Population Reference Bureau. (n.d.), and the U.S. Census Bureau

(n.d.). These datasets span all California school districts from 2009 to 2018, a period marked by economic recovery and shifting housing prices and demand post-2008 financial crisis. The dependent variable is the change in house price at the school district level from 2009 to 2018 (excluding 2009 since it has no prior year for comparison), and is used as a proxy for net asset value growth. All predictor variables are also measured as annual changes at the district level from 2009 to 2018 (excluding 2009).

Changes in student-to-teacher ratio and enrollment rate serve as proxies for individualized attention and school demand, respectively. Lower ratios suggest smaller class sizes and better engagement; higher enrollment implies greater demand. Grade range reflects school specialization. A narrower grade range may indicate a focused curriculum, which can appeal to parents. The number of schools in a district can reflect school policy effectiveness and broader economic well-being, which in turn may attract long-term residents.

Current expense per ADA (Average Daily Attendance) measures the annual cost of education per public school student. An increase signals stronger local investment in school quality. Income inequality is measured by the share of total California school district income held by each quintile. A rising top-quintile share may improve school quality through increased funding via property taxes, potentially driving up house prices and benefiting wealthy households.

Findings show that the combined effect of changes in public school student-to-teacher ratios and changes in income concentration among the highest income quintile is one of the most significant predictors of house price changes at the district level.

OLS regression, regression trees, and a random forest model-derived importance matrix were used to support this conclusion. However, the analysis does not control for factors like school district policies, local tax rates, crime, or population changes. Further work including these controls would enhance accuracy. More detailed house price data could also improve year-over-year measurements of housing price change and the corresponding effect of each school quality indicator.

Public school student-to-teacher ratio changes typically range from one to two students more or less per teacher; private schools range from five fewer to two more students per teacher. Most public schools showed little change in enrollment, while private schools experienced an average 0.02 percentage point decrease. On average, public school districts increased per-student spending by 7.23% annually, with half spending 3.26% or less. The top income quintile saw their share of aggregate California school district household income grow by 0.07 percentage points annually. House price changes averaged 7.46% annually, with a wide variation of 91.33%. However, half the districts saw declines of 3.64% or more. The granularity of school districts and inconsistent data coverage of prices over time may explain unusually high or low year-over-year price changes for some district years.

The highest public funding quintile districts had the largest average increase in house prices of about 14.10%, the highest public education spending change at 20.83%, and a slight average 0.40 increase in public student-teacher ratios, while private student-teacher ratio change was most negative at -1.61, possibly reflecting students switching from private to public school systems or enrollment shifts. Compared to middle and fourth quintiles, these figures suggest that wealthier districts ex-

perienced greater investment and volatility, potentially indicating that school-related changes were more strongly capitalized into local house prices.

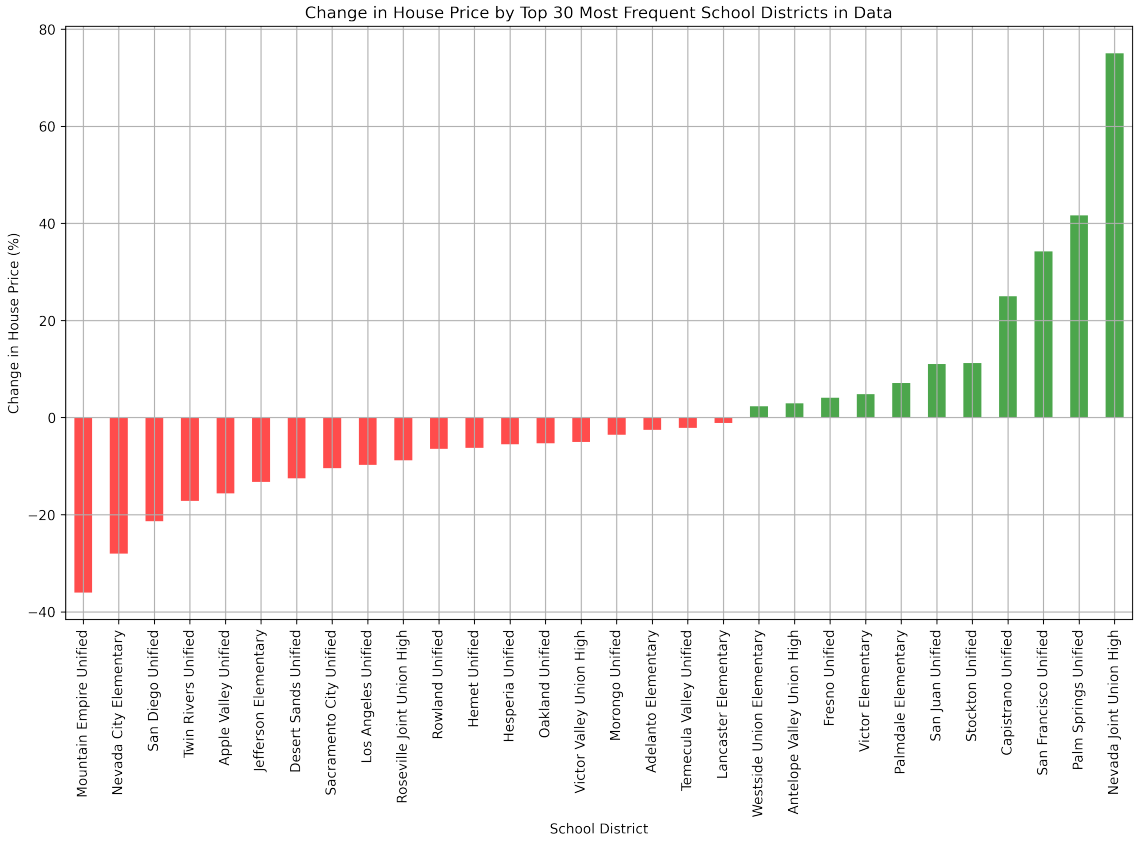

Figure 1: Change in House Price Among Top 30 Most Frequent School Districts in Data

In Figure 1, among the 30 school districts with the most complete house price data, a trend from steep average price declines ($\tilde{3}5\%$) to near-zero change was observed, with 19 experiencing decline and 11 showing positive growth. The latter group saw an initial slow rise followed by a sharper increase around 10%, suggesting most districts hover within 10% of flat growth, while a few exhibit extreme posi-

tive or negative changes. These extremes may be due to data limitations or timing — some districts only have early data affected by the 2008 recession, while others only have post-2015 data when house prices recovered, potentially leading to biased results. This sample provides a snapshot, but all school districts are used in the broader analysis to maximize data coverage.

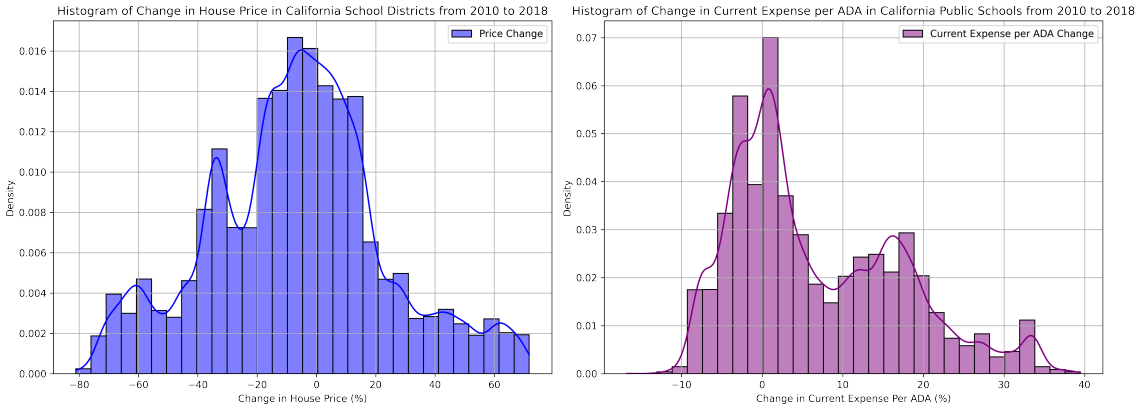

Figure 2: Histogram of Change in House Price and Current Expense Per ADA

The bar chart trend is confirmed in Figure 2 depicting the histogram of house price change, which shows a bell-shaped distribution with most districts clustered around zero change, and fewer districts at the extremes. The histogram distribution on the right is of change in current expense per ADA and is right-skewed, indicating most districts spend less than the average increase in spending, reinforcing insights from the summary statistics.

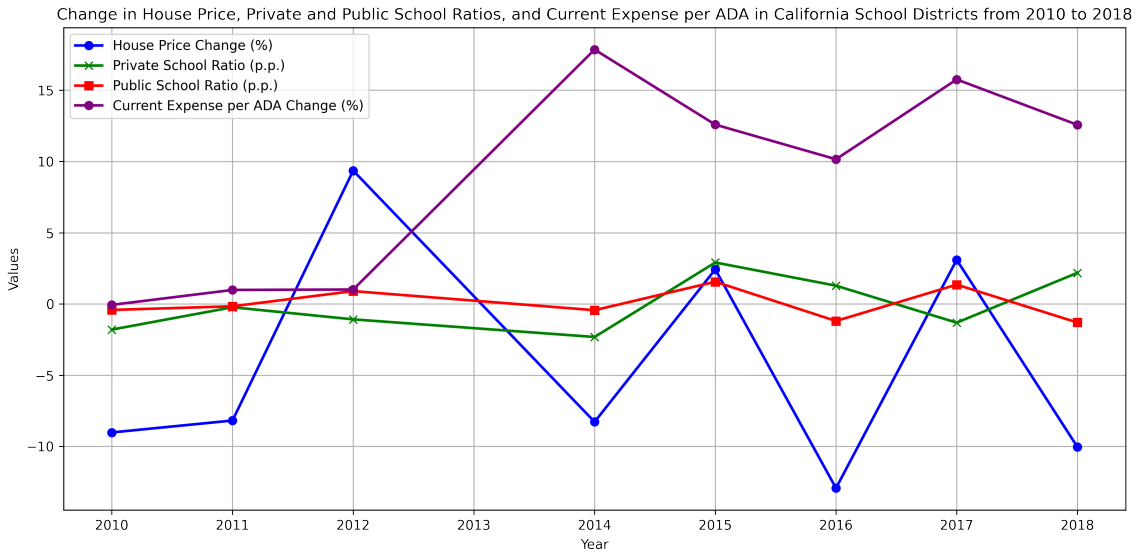

Figure 3: Change in House Price, Public and Private School Student-Teacher Ratio, and Current Expense Per ADA from 2010 to 2018

From 2010 to 2018, changes in public and private student-to-teacher ratios were generally small, typically shifting by one or two students as seen in Figure 3. Interestingly, house price changes tend to move in the same direction as public school student-to-teacher ratio changes, though more pronounced. This could suggest that districts perceived as high quality attract more families, even if it slightly increases class sizes, leading to higher house prices. In contrast, private school student-to-teacher ratios showed no clear relationship with house prices over time.

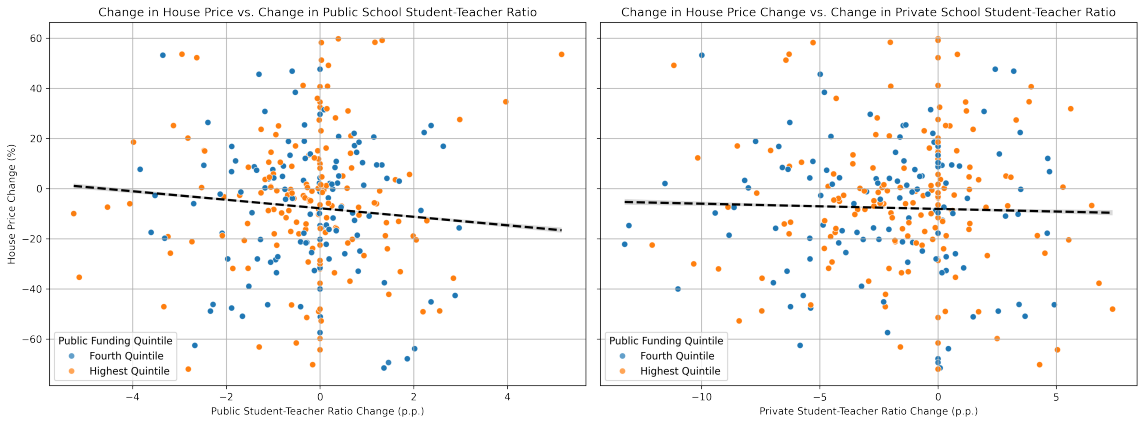

Figure 4: Change in Public and Private School Student-Teacher Ratio on Change in House Prices for Higher Public Funding Quintiles

In Figure 4, there is generally a negative relationship between changes in student-to-teacher ratio and house prices across higher public funding quintiles, particularly in public schools. An increase in students per teacher year-over-year may indicate a decline in school quality, potentially decreasing local house values. This makes student-to-teacher ratio a potential leading indicator for real estate professionals advising high-income clients. A regression model is needed to confirm statistical significance, and a geographic visualization may help reveal regional effects.

From Table 1 in model 4, a one student increase in private school student-teacher ratio is associated with a 1.4% increase in house prices, significant at the 1% level. Although this seems counterintuitive, the low baseline ratio in private schools may mean the effect on quality is minimal. Additionally, more students per teacher can increase tuition revenue, allowing for quality improvements that boost house prices. For high-income parents, tuition nay become an investment that contributes to increased property value. However, when combined with rising income inequality

Table 1: OLS Regression Results for Change in House Prices Using Highest Income Quintile

	Dependent variable: price_%change				
	(1)	(2)	(3)	(4)	(5)
Constant	4.639***	6.488***	8.392***	8.455***	8.559***
	(0.833)	(0.869)	(0.848)	(0.857)	(0.851)
public education spending change × income inequality change				0.055	0.114
				(0.106)	(0.105)
public education spending change	0.118*	0.181***	-0.145**	-0.150**	-0.179***
	(0.060)	(0.061)	(0.060)	(0.061)	(0.060)
income inequality change	20.723***	20.470***	24.311***	23.383***	21.179***
	(1.884)	(1.885)	(1.843)	(2.575)	(2.559)
private grade span change		0.022***	0.016***	0.016***	0.017***
		(0.005)	(0.005)	(0.005)	(0.005)
private enrollment rate change		-95.800***	-102.157***	-102.381***	-116.194***
		(12.228)	(11.882)	(11.890)	(11.864)
private student-teacher ratio change × high school					-1.532***
					(0.224)
private student-teacher ratio change × income inequality change			-15.438***	-15.396***	-14.674***
			(0.574)	(0.580)	(0.577)
private student-teacher ratio change	-0.944***	-0.558***	1.394***	1.394***	1.829***
	(0.105)	(0.145)	(0.159)	(0.159)	(0.173)
public grade span change		-0.201***	-0.167***	-0.167***	-0.165***
		(0.013)	(0.013)	(0.013)	(0.013)
public enrollment rate change		21.160	-47.804	-48.140	-112.464***
		(40.436)	(39.380)	(39.386)	(39.318)
public student-teacher ratio change × high school					5.327***
					(0.338)
public student-teacher ratio change × income inequality change			12.388***	12.407***	12.429***
			(0.576)	(0.577)	(0.573)
public student-teacher ratio change	0.475***	0.518***	0.341**	0.342**	-0.108
	(0.104)	(0.151)	(0.146)	(0.146)	(0.148)
Observations	18174	17923	17923	17923	17923
R^2	0.013	0.028	0.085	0.085	0.100
Adjusted R^2	0.013	0.028	0.085	0.085	0.099
Residual Std. Error	93.256 (df=18169)	92.730 (df=17914)	89.985 (df=17912)	89.987 (df=17911)	89.253 (df=17909)
F Statistic	59.521*** (df=4; 18169)	65.473*** (df=8; 17914)	166.794*** (df=10; 17912)	151.648*** (df=11; 17911)	153.318*** (df=13; 17909)
Note:					*p<0.1; **p<0.05; ***p<0.01

among the highest earners, the model shows a 15.4% decrease in house prices, suggesting that greater inequality and increased class sizes may reduce perceived school quality for the middle class, depressing house values.

In the same model, a one student increase in public school student-teacher ratio corresponds to a 0.34% increase in house prices, significant at the 5% level. This surprising result may reflect additional state funding in response to growing enrollment, improving school quality despite larger classes. The smaller effect compared to private schools could reflect differences in funding levels, tuition per student being greater than additional public funding per student. When combined with top quintile income inequality, house prices rise by 12.4% on average, significant at the 1% level. This may indicate that high-income households support greater school funding

to enhance property values, and those in policymaking positions—often among the top earners—may prioritize such investments.

Model four also shows that a 1% increase in current expense per student correlates with a 0.15% decrease in house prices, significant at the 5% level. This is counter to expectations, as higher spending typically indicates better school quality. However, increased funding may be a reactive measure following the 2008 housing crash, aimed at stimulating house prices. In California, where property taxes fund schools, higher education spending may also mean higher tax burdens, reducing housing demand. When combined with inequality, this variable showed no significant effect.

Also in model four, a one percentage point increase in the highest income quintile inequality is associated with a 23.38% increase in house prices, significant at the 1% level. This large estimate may stem from limited district-level data, potentially inflating results. Still, rising income shares for the top earners signal growing affluence and greater demand for expensive homes, driving prices up.

Across models, private school student-teacher ratio has a weak negative effect on house prices in models one and two, and a positive effect in models three through five. This suggests that when additional controls are introduced, class size increases in private schools are associated with rising house prices. In contrast, the effect of public school student-teacher ratio weakens across models and turns negative in model five, suggesting lower quality perceptions may outweigh funding-related benefits as class sizes increase.

An increase in private school grade span is positively related to house prices, while public school grade span tends to decrease them. Longer private school grade

spans allow students to remain in familiar learning environments, improving the perceived educational experience and boosting housing demand. In public schools, broader grade spans may indicate less specialization, particularly problematic where student-teacher ratios are already high, thus lowering perceived quality.

Several variables across models three to five are statistically significant, some with large coefficients. This could be due to the introduction of interaction terms, but also to limited data availability, which may increase the likelihood of Type I error. Models three to five explain only 8.5% to 10% of the variation in house prices, suggesting poor model fit due to unobserved confounding variables or unmodeled nonlinear relationships.

Table 2: OLS Regression Results for Change in House Prices Using Fourth Highest Income Quintile

	Dependent variable: price_%change				
	(1)	(2)	(3)	(4)	(5)
Constant	5.212***	7.144***	20.853***	20.766***	20.897***
	(0.824)	(0.864)	(4.052)	(4.798)	(4.800)
public education spending change × income inequality change				-0.000	-0.000
				(0.000)	(0.000)
public education spending change	0.185***	0.244***	0.214***	0.227***	0.228***
	(0.060)	(0.060)	(0.061)	(0.067)	(0.067)
income inequality change	6.400***	6.577***	6.617***	6.576***	6.594***
	(1.263)	(1.262)	(1.262)	(1.266)	(1.266)
private grade span change		0.020***	0.019***	0.019***	0.019***
		(0.005)	(0.005)	(0.005)	(0.005)
private enrollment rate change		-102.344***	-105.840***	-107.974***	-107.104***
		(12.236)	(12.255)	(12.400)	(12.434)
private student-teacher ratio change × income inequality change			-0.014***	-0.014***	-0.016***
			(0.003)	(0.003)	(0.004)
private student-teacher ratio change × high school					0.055
					(0.057)
private student-teacher ratio change	-0.927***	-0.482***	-0.238	-0.247	-0.235
	(0.105)	(0.145)	(0.154)	(0.157)	(0.157)
public grade span change		-0.204***	-0.198***	-0.205***	-0.205***
		(0.013)	(0.013)	(0.014)	(0.014)
public enrollment rate change		27.938	20.136	-17.572	-18.959
		(40.517)	(40.844)	(42.818)	(42.843)
public student-teacher ratio change × income inequality change			-0.017**	-0.013*	-0.013*
			(0.007)	(0.007)	(0.007)
public student-teacher ratio change × high school					0.055
					(0.057)
public student-teacher ratio change	0.496***	0.528***	0.814***	1.042***	1.043***
	(0.104)	(0.151)	(0.192)	(0.203)	(0.203)
Observations	18315	17975	17975	17872	17872
R^2	0.008	0.024	0.025	0.026	0.026
Adjusted R^2	0.008	0.023	0.025	0.025	0.025
Residual Std. Error	93.278 (df=18310)	92.932 (df=17966)	92.873 (df=17964)	93.069 (df=17860)	93.070 (df=17859)
F Statistic	36.813*** (df=4; 18310)	54.644*** (df=8; 17966)	46.240*** (df=10; 17964)	43.190*** (df=11; 17860)	39.666*** (df=12; 17859)
Note:					*p<0.1; **p<0.05; ***p<0.01

From Table 2 in model four, private school student-teacher ratio becomes insignif-

icant when the interaction is with the fourth income quintile instead of the highest. However, an additional student per teacher in public schools is associated with a 1.04% increase in house prices, significant at the 5% level. This suggests that public school changes, combined with change in share of aggregate income closer to middle income class, still influence house prices, but to a lesser extent than in higher-income concentrated districts.

A one percentage point increase in income inequality within the fourth income quintile results in a 6.58% increase in house prices, smaller than the effect observed in the highest quintile. The combined effect of this inequality with public school student-teacher ratio shows a 0.013% decrease in house prices, significant at the 10% level, indicating that middle-class inequality has weaker influence on housing. Similarly, the combination of private school student-teacher ratio change and fourth-quintile income inequality decreases house prices by 0.014%, around 15 percentage points less than the highest quintile interaction. These findings suggest that higher-income groups exert more influence over school quality, policy, and hence house prices, and that their residential and schooling choices are driven by both educational quality and the potential to grow net asset value through housing investments.

To enhance this analysis, private school tuition could serve as a proxy for private school quality. This would allow a direct comparison between public and private school funding and their effects on house price growth. High-income individuals often choose to live in affluent neighborhoods and pay for prestigious private schooling, raising perceived neighborhood quality. Typically tuition data is unavailable, but private school rankings may serve as a substitute, found from sources like Niche.com

and privateschoolreview.com. SchoolDigger.com, californiapolicycenter.org, and Ed-Data.org provide additional data on school district rankings and performance.

Private school funding data, such as tuition or endowments, is largely inaccessible. Available data is limited to a small sample of private schools, mostly in major metro areas. Niche.com and privateschoolreview.com provide 2025 data, outside this study's date range. Individual school websites offer limited historic data and would be a lengthy process to collect tuition from all of them. SchoolDigger.com's ranking data is behind a paywall, and Ed-Data.org has exportable performance data. Californiapolicycenter.org was web scraping-friendly, providing 2018 school district rankings and 2019 unrestricted net position per student across nearly 1,000 districts. However, using only 2018 data reduced the sample size, so regression trees used the full dataset and excluded rankings for consistent comparison with OLS regressions.

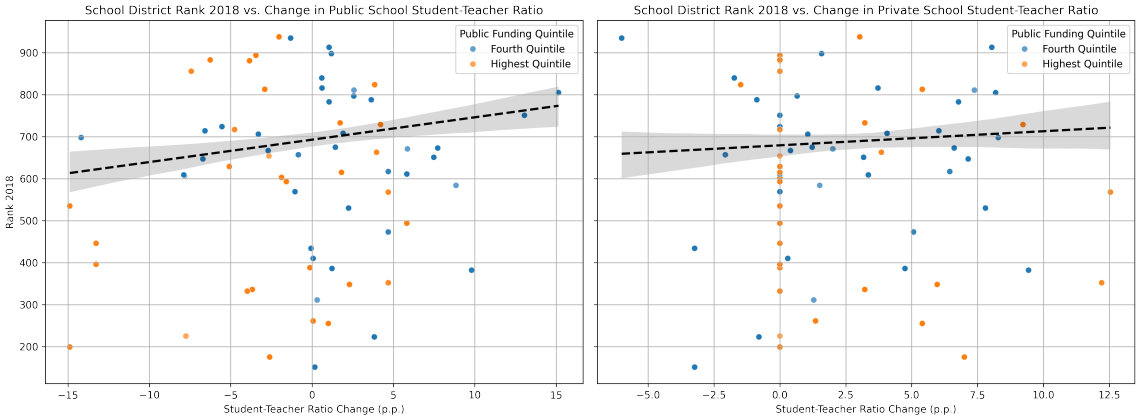

Figure 5: Change in Public and Private School Student-Teacher Ratio on School District in 2018 for Higher Public Funding Quintiles

In Figure 5, fewer students per teacher, especially in public schools, correlate with better rankings, supporting the theory that smaller class sizes improve school quality

and housing values. Furthermore, higher income individuals would more likely invest in property in these districts to potentially increase their net asset value.

The most important feature across regression trees was the combined effect of public school student-teacher ratio changes and income inequality among the top 20% of earners. For instance, districts with this interaction equal to or less than 3.316, a private school enrollment decrease greater than 0.11 percentage points, and a private school student-teacher ratio increase greater than 4.29 had an average predicted 0.2% decrease in house prices. The same conditions with a smaller class size increase predicted a 0.012% decrease. Districts with the interaction greater than 3.316 and a public school enrollment decrease less than 0.013% had a predicted 0.31% increase. If class size decreased by more than four students per teacher, the predicted increase rose to 0.79%, the highest from the preferred tree. The tree's mean squared error (MSE) of 0.1958 implies an RMSE of 0.44 (plus or minus error) percentage points, showing strong performance.

In the full feature regression tree, the same combined effect remained most important, appearing in the branch predicting the highest house price increase of 2.82%. Private school enrollment rate also appeared twice, suggesting similar importance or a more complex/non-linear relationship with change in house price. Other key features included income inequality and private school grade span. The full model captured a more complex structure. With a regularization limit of three splits, the tree avoids overfitting and remains interpretable. Its MSE of 0.1849 (RMSE 0.43%) is slightly lower than the preferred tree's, indicating slightly improved accuracy .

The feature importance matrix supports these findings. The interaction of pub-

lic student-teacher ratio and top income inequality contributed 19.5% of prediction power. Private school enrollment change followed with 15%, and private school student-teacher ratio with top income share contributed 14%, even though it did not appear in the trees. Public education spending contributed only 2.5%, suggesting limited relevance to house price changes, an observation not found in the tress.

Private school grade span changes were more predictive in the regression trees than in OLS regressions. Districts with fewer private school grades may offer more specialized education. The trees' leftmost branches showed that these districts also had high declines in private enrollment, possibly due to exclusivity. These districts had a predicted house price increase of 0.068%, an insight OLS could not capture.

This project analyzed how changes in public and private school quality measures affect house price changes across California districts (2010–2018), focusing on their capitalization into property values. The most important variable was the interaction between public school student-teacher ratio and top quintile income inequality. A rising income share for the top 20% appears to support larger class sizes while maintaining school quality through increased public investment. High-income households may advocate for school funding to enhance education and boost house prices, increasing their asset value. Furthermore, these individuals often hold policymaking roles and influence education spending, possibly to increase their own net asset value.

Future research should gather more complete house price data and control for additional variables like crime, population, and local policies at the district level. This would enable a more accurate analysis of how school quality investments influence property values, especially for the highest income earners.

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