Public School Quality Valuation Over the Business Cycle

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Abstract

Over the years 2000 to 2013, the Los Angeles real estate market featured a boom, a bust, and then another boom. We use this variation to test how the hedonic valuation of school quality varies over the business cycle. Following Black (1999), we exploit a regression discontinuity design at elementary school attendance boundaries to test for how the implicit price of school quality changes. We find that the capitalization of school quality is counter-cyclical. While good schools always command a price premium, this premium grows during the bust. Possible mechanisms for these findings include consumers "trading down" from private to public schools during contractions as well as the effects of reduced household mobility during downturns in raising the value of the public school option.

Keywords: Amenities, Business cycles, Hedonic estimation, Housing demand, Public schools

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1 Introduction

Both across and within metropolitan areas, business cycles affect local real estate prices. The Case-Shiller price indices and data produced by Zillow and Trulia document these facts. As these real estate prices change, the implicit prices that buyers pay for local public goods such as good schools and safety are likely to change as well. But the existing compensating differentials literature has not explored how hedonic valuation changes over the business cycle.[1]

In this paper, we study Los Angeles County over the period 2000 to 2013 to examine variation over the business cycle in homeowners' valuations of public school quality.[2] The course of the Los Angeles regional economy resembles the nation's patterns during this period (Figure A.1) but the local housing market faced disproportionately pronounced swings from "boom" to "bust" (Figure 1), making this an attractive setting for exploring these dynamics. Because the standard cross-sectional hedonic pricing approach is subject to the concern that there are omitted variables correlated with key explanatory variables, we follow the lead of Black (1999) and exploit elementary school attendance area boundaries to provide identifying variation in public school quality. Together with comprehensive transaction-level data on sales of homes and annual school-level data on student achievement, this dynamic spatial regression discontinuity approach permits us to study how homeowners' valuations vary with broader economic conditions year-to-year.[3]

Broadly we find that homeowners' valuations are countercyclical – they value improvements in public elementary school quality more during busts than in booms. For instance, between the peak of the local housing market in 2007 and its nadir in 2009 we find that the implied valuation of a five-percent improvement in school quality increased from a level indistinguishable from zero to approximately 1.8 percent of a home's sales price. Our results are robust to the choice of bandwidth, the inclusion of various structural, educational, socioeconomic and geographic control variables, as well as to various specification checks – and they do not appear to be driven by the selection of which homes are sold in each year.

[1] Using Census data, Costa and Kahn (2003) explore long-run decadal trends in the implicit pricing of climate using a nationwide hedonic.

[2] We focus on the valuation of school quality in acknowledgement of the importance of education in child development.

[3] Given the durability of the housing stock and the small flow of new homes in Los Angeles County (only 6.5 percent of the sales in our estimation sample were of homes built since 2000), we generally view year-to-year price dynamics as representing changes in housing demand rather than supply. This permits us to identify changes in homeowners' valuations of hedonic characteristics from changes in home prices directly (Rosen, 1974). We consider this assumption further in Section 5.

Our findings are consistent with at least four explanations: first, that potential buyers "trade down" from private to public schools during economic contractions; second, that the effects of reduced household mobility during downturns raise the value of the option of enrolling children in a high-quality public school; third, that households perceive the return to school quality to be higher during a bust; and fourth, that home prices in the attendance areas of lower-quality elementary schools (but close to higher-quality ones) get bid up during a boom due to "endogenous gentrification" (Guerrieri, Hartley, and Hurst, 2012, 2013). A recent literature has explored how household consumption patterns changed as access to credit decreased during the Great Recession (Mian and Sufi, 2011; Chodorow-Reich, 2014; Jaimovich, Rebelo, and Wong, 2015; Ramcharan, Verani, and Van Den Heuvel, 2016; Benmelech, Meisenzahl, and Ramcharan, Forthcoming). By focusing on one key attribute of housing demand (namely local public school quality), our study builds on this literature.

The remainder of the paper is organized as follows. Section 2 details the econometric model, the dynamic spatial regression discontinuity approach. Section 3 describes the data sources, sample selection method, and estimation samples. Section 4 discusses the main results as well as various specification checks. Section 5 offers potential interpretations for our findings. The final section concludes.

2 Econometric Model

The typical hedonic pricing model explains the sales price of a home as a function of its characteristics, both structural and geospatial (notably, for our purposes, the quality of the local public elementary school). Under these assumptions, the price of home m in location n can be modeled as:

$$\ln(p_{m,n}) = \beta_0 + \beta_q \cdot q_n + \boldsymbol{\beta_s} \cdot \boldsymbol{s_m} + \boldsymbol{\beta_g} \cdot \boldsymbol{g_n} + \epsilon_{m,n} \tag{1}$$

where $p_{m,n}$ is the sales price, q_n is a measure of local public school quality, $\boldsymbol{s_m}$ is a vector of structural characteristics and $\boldsymbol{g_n}$ is a vector of other geospatial characteristics. In this formulation, the primary coefficient of interest, β_q, represents the approximate marginal percent change in the sales price of a home due to a unit change in local public school quality.[4]

[4]It should be stressed that any given household need not have children attending the local elementary school for the housing market to assign a value to its quality. Even if the household has no school-age children (as 81.0% of Los

But unbiased estimation of this coefficient relies on the assumption that the included observables completely explain the observed variation in home prices. If repeated sales of homes (or, failing that, frequent sales in each neighborhood) are observed however, identification may be improved by including house (or neighborhood) fixed effects to non-parametrically control for unobserved but time-invariant variation in factors affecting the sales price. In this neighborhood fixed effects model:

$$\ln(p_{m,n,t}) = \beta_0 + \beta_q \cdot q_{n,t} + \boldsymbol{\beta_s} \cdot \boldsymbol{s_{m,t}} + \boldsymbol{\beta_g} \cdot \boldsymbol{g_{n,t}} + \boldsymbol{\beta_n} \cdot \mathbb{1}_{\boldsymbol{n}} + \boldsymbol{\beta_t} \cdot \mathbb{1}_{\boldsymbol{t}} + \epsilon_{m,n,t} \tag{2}$$

$\mathbb{1}_{\boldsymbol{n}}$ is a vector of neighborhood fixed effects, and $\mathbb{1}_{\boldsymbol{t}}$ is a vector of time dummies accounting for a secular time trend in home prices.[5] If variation in $q_{n,t}$ across time is uncorrelated with changes in unobserved factors in neighborhood n which also affect sales prices, β_q can be identified through variation in $q_{n,t}$ across time within neighborhoods.

Alternately, if there are sharp geographic breaks in local public school quality (e.g. boundaries of elementary school attendance areas), one can improve identification by including fixed effects representing the nearest discontinuity for each home and restricting the estimation sample to the sales of homes nearest these discontinuities (i.e. choosing a tight “bandwidth”). In this spatial regression discontinuity model:

$$\ln(p_{m,n}) = \beta_0 + \beta_q \cdot q_n + \boldsymbol{\beta_s} \cdot \boldsymbol{s_m} + \boldsymbol{\beta_g} \cdot \boldsymbol{g_n} + \boldsymbol{\beta_b} \cdot \mathbb{1}_{\boldsymbol{b}} + \epsilon_{m,n} \tag{3}$$

$\mathbb{1}_{\boldsymbol{b}}$ is a vector of nearest boundary fixed effects. (That is, if the study area is partitioned into school attendance areas and the boundaries between attendance areas are numbered from 1 to B, then each element of the vector, $\mathbb{1}_b$, is non-zero only for homes who share a closest boundary, b.) If variation in q_n across boundaries is not correlated with changes in unobserved factors across boundaries which also affect sales prices, β_q can be identified through variation in q_n across boundaries within nearby bandwidth areas.[6]

Angeles County households did in 2010), or if they do, but they attend a private, charter or magnet school (as 10.8%, 4.8% and 3.6%, respectively, of Los Angeles County students in Kindergarten through 12th grade did in 2009-10), the household pays the market price for the home, which accounts for the preferences of all potential owners. The capitalization of local amenities in home prices helps explain why even childless households may support spending on public schools (Hilber and Mayer, 2009).

[5] If the area under study is large and geographically diverse, a separate time trend for each subregion may be more appropriate. When estimating these models in Section 4, we include time dummies for each of the 20 county subdivisions of Los Angeles County defined by the U.S. Census Bureau in 2010.

[6] All else equal, this suggests that choosing a tighter bandwidth will provide more plausibly valid identification.

Our strategy combines these two approaches, taking advantage of both frequent sales in each neighborhood and discontinuities in school quality across attendance area boundaries. This permits us to see how the market valuation of school quality varies over time – that is, to estimate a different β_q for each time t. In this dynamic spatial regression discontinuity model:

$$\ln(p_{m,n,t}) = \beta_0 + \boldsymbol{\beta_{q,t}} \cdot \boldsymbol{q_{n,t}} \cdot \mathbb{1}_{\boldsymbol{t}} + \boldsymbol{\beta_s} \cdot \boldsymbol{s_{m,t}} + \boldsymbol{\beta_g} \cdot \boldsymbol{g_{n,t}} + \boldsymbol{\beta_{b,t}} \cdot \mathbb{1}_{\boldsymbol{b,t}} + \epsilon_{m,n,t} \tag{4}$$

$\boldsymbol{\beta_{q,t}}$ is a vector of coefficients for public school quality (one for each time t) and $\mathbb{1}_{\boldsymbol{b,t}}$ is a vector of nearest boundary-time period fixed effects (i.e. a different non-parametric time trend for each bandwidth area). So long as variation in $q_{n,t}$ across boundaries at time t is not correlated with changes in unobserved factors across the boundaries within nearby bandwidth areas at time t which also affect sales prices, each element of $\boldsymbol{\beta_{q,t}}$ can be identified through variation in $q_{n,t}$ across boundaries within nearby bandwidth areas at time t.[7]

Because the dynamic spatial regression discontinuity model is our preferred approach in the empirical analysis that follows, the potential threats to identification therein deserve special attention. Specifically, what factors affecting a home's sales price would be both unobserved by the econometrician and likely to vary across an elementary school boundary within a given time period? Though we account for a host of structural and neighborhood characteristics in our analysis, any particular set of control variables is necessarily incomplete and so it remains possible that we may attribute the positive effect of systematic, but unobserved, differences in homes or neighborhoods to observed differences in school quality. A particular concern is that elementary school attendance boundaries are not randomly drawn and thus may proxy for certain attributes. For example, boundaries may coincide with other major breaks (e.g. a school district border, railroad tracks or an elevated highway).[8] In an effort to guard against this potential issue, we often exclude home sales whose nearest elementary school boundary coincides with a district boundary and always control for neighborhood characteristics using census data on socioeconomic characteristics at the

[7] An implicit assumption is that households are myopic – that they do not anticipate changes in public school quality. As Bishop and Murphy (2016) shows, this assumption does not bias hedonic estimates so long as changes over time may be modeled as following a random walk with drift. Under this autoregressive model, the estimated year-to-year transition parameter for our preferred measure of public school quality is 0.93 in Los Angeles County between 2000 and 2013, suggesting that our results will (slightly) underestimate the implicit price of public school quality improvements.

[8] In explaining a series of attendance area boundary changes for the 2015-16 school year, the Los Angeles Unified School District cited a need to "better balance enrollments among several neighboring schools" (Los Angeles Unified School District, 2016).

block group-level.[9]

3 Data

Our sample draws on sales of single-family residences in Los Angeles County during the period January 2000 to December 2013. Data on residential sales and structural characteristics were provided by DataQuick (for 2000 to 2010) and CoreLogic (for 2011 to 2013).[10] Records are excluded from the sample if the sale is not an arms-length transaction, if the sales price is not reported, or if the transaction cannot be matched to the assessor's structural report.

Each transaction is geocoded and assigned to a public elementary school according to attendance area boundaries as of 2002 provided by Los Angeles County.[11] We focus on elementary schools due to the importance of early education in human capital development (Heckman and Carnerio, 2003); they also tend to be smaller than middle or high schools, and so they provide relatively more variation to study. Our primary measure of elementary school quality, the Academic Performance Index (API), comes from the California Department of Education. Biannually between 1999 and 2013, each school was assigned an API on the basis of student achievement in annual statewide aptitude exams – a Base API at the beginning of the school year, and a Growth API at the end. The index ranges in value from 200 to 1000, but schools were encouraged to maintain scores of at least 800. Each transaction is assigned the Growth API reported for the school year ending in the year the transaction closed.

Because the state's formula for API changes somewhat over time, magnitudes of differences across schools are only strictly meaningful within a school year. This complicates our effort to interpret changes in API over time particularly because, as Figure 2 shows, there has been a pronounced compression in the distribution of API within Los Angeles County over the study period. Does a year-to-year increase in API imply a meaningful improvement in school quality or simply "grade inflation" due to changing evaluation criteria? While it's impossible to empirically

[9] Our identification strategy is more likely to hold in areas featuring more variation in our neighborhood controls near elementary school area boundaries. In our .2 mile bandwidth estimation sample, the median (mean) bandwidth area includes home sales in 4 (4.49) distinct census block groups.

[10] CoreLogic purchased DataQuick in 2013. Structural data are accurate as of the most recent assessment.

[11] While transaction year-specific attendance area boundaries would be preferable, geospatial data on elementary school attendance area boundaries are limited, particularly in electronic formats and particularly for years past. Fortunately anecdotal evidence suggests that the boundaries do not change often, and not very quickly when they do (most often in response to major events, such as a school closing) (Black, 1999). Moreover if the boundaries we use are imprecisely measured, that will only serve to attenuate our estimates toward zero.

disentangle these two interpretations, it's important to note that the latter interpretation implies that small improvements in API should be relatively more meaningful in more recent years. So if year-to-year improvements are principally spurious, then small gains in API should, all else equal, become increasingly valuable to homeowners.[12]

API is an attractive summary measure of a school's effectiveness, but school-to-school differences in API are likely correlated with other differences – in school conditions, funding, tax rates, and neighborhood character. The dynamic spatial regression discontinuity design controls non-parametrically for unobservable, time-varying local characteristics that do not change across the elementary school attendance area boundary, but many features of the educational environment other than school quality *per se* do. To address this concern, we regularly include the residence's property tax bill, the school's student-teacher ratio, neighborhood-level socio-economic characteristics and two distance measures – distance to employment centers and distance to the shoreline – as additional control variables.[13]

Summary statistics are presented in Table 1 for the whole sample and the restricted samples of homes located within .3, .2 and .1 miles of a boundary, respectively. The restricted samples exclude sales of homes whose nearest boundary coincides with a school district border, or whose nearest boundary does not feature transactions observed on both sides.[14] While the restricted samples are only a fraction of the size of the full sample, the compositional differences between them are slight.[15] Moreover while the number of transactions varies over time (as shown in Figure 3), the pattern is broadly consistent across all four samples. The trend of typical sales prices is also similar across samples (seen in Figure 4), and generally congruent with the Case-Shiller Home Price Index

[12] We would arrive at the same conclusion, incidentally, even if improvements were meaningful but homeowners only cared about a school's rank, not its absolute level of quality. We explore this possibility further in Section 4.

[13] The property tax for each $1,000 of assess value for fiscal year 2015 is determined by geocoding each structure into tax rate areas provided by the Los Angeles County Auditor-Controller. The student-teacher ratio as of the 2009-10 school year is calculated using data from the California Department of Education. The neighborhood-level socioeconomic characteristics as of 2000 are measured by geocoding each structure into block groups provided by the U.S. Census Bureau. The distance to employment centers is calculated as the employment-weighted average distance to the 40 ZIP code areas with the highest average employment over the period 2000-2010 according to County Business Patterns data.

[14] We also exclude homes within .01 miles of a valid boundary to guard against possible geocoding errors. The unrestricted sample, which includes variation across district boundaries, includes the school district's per-pupil expenditure level as an additional educational environment control variable. The district's per-pupil expenditure as of the 2009-10 school year is calculated using data from the National Center for Education Statistics.

[15] Elementary school attendance areas tend to be smaller in more densely-populated parts of the county. Consequently the restricted samples tend to be more representative of those areas, evidenced here by a slight tendency toward lower-priced and smaller homes, lower quality schools, and poorer, more densely-populated, and more Hispanic, neighborhoods.

for the broader Los Angeles metropolitan area.

4 Results

On average during our study period, homeowners value improvements in local public school quality. Table 2 presents regression results where the marginal effect of an improvement in elementary school quality on sales price is *not* allowed to vary by transaction year. The estimates in the first column reflect the typical hedonic model, while the second, third and fourth columns display estimates for the spatial regression discontinuity model for homes within .3, .2, and .1 miles of a boundary, respectively. (The fifth column shows estimates for the typical hedonic model using the restricted sample of homes within .1 miles of a boundary.)[16] Estimates for all five models report a significant positive marginal effect for elementary school quality on sales price, though the estimates are appreciably smaller for the three models that exploit the geospatial discontinuity around elementary school attendance area boundaries. This does not appear to be entirely a consequence of sample selection; the estimate for the fifth model, though statistically different from that of the first (at the five-percent level), is much closer in magnitude to that than the estimates of the other three. Rather, these findings signal the value of the spatial regression discontinuity approach – that failing to control non-parametrically for local characteristics inflates estimates of homeowners' valuation of school quality improvements.

Identification with this method relies on the assumption that homes on different sides of the elementary school attendance area boundary are sufficiently similar and, to the extent that they are not, that those differences are either observed or uncorrelated with differences in school quality. This assumption cannot be directly tested, but Table 3 gives some suggestive evidence – the results of tests of differences in means of observable characteristics across the boundary for the whole sample as well as for each of the restricted samples. In general, the differences in characteristics other than school quality become smaller and less significant as the bandwidth decreases. Unsurprisingly, homes on the side of the boundary with better school quality tend to have higher sales prices than those on the other side. But they also exhibit more bedrooms and bathrooms, larger living spaces, younger buildings, and higher student-teacher ratios on average, as well as somewhat richer, less

[16] Unless otherwise noted, coefficient estimate standard errors are adjusted for clustering at the elementary school-year level throughout.

dense, more Asian, less Hispanic, better educated, more owner-dominant neighborhood populations – though these differences tend to attenuate as the sample becomes more restricted. The significant socioeconomic differences highlight that elementary school quality differences do influence where households choose to live. But they also suggest that, even for the most restricted sample, it may not be safe to assume that houses on either side of the boundary have identical neighborhood characteristics. All regressions that follow include the full complement of neighborhood controls as a result.

Turning to our principal matter of interest, we find that while homeowners value improvements in school quality on average, their valuation varies over time. In fact, we find that the valuation is broadly counter-cyclical; it is higher around periods of economic contraction than it is around periods of expansion. Table 4 displays regression results where the marginal effect of an improvement in elementary school quality on sales price is permitted to vary by transaction year. The estimates in the first column reflect the typical hedonic model, while the second, third and fourth columns display estimates for the spatial regression discontinuity model for homes within .3, .2, and .1 miles of a boundary, respectively.[17] (Figure 5 illustrates, for each model, the implied change in sales price (for the mean-valued home) associated with a five-percent improvement in school quality (at the mean) for each transaction year.) While the trend implied by the typical hedonic approach varies more wildly than those for the other three, all four models suggest that the valuation was relatively high around the 2001 recession, declined during the mid-decade expansion, rose rapidly during the "Great Recession", and plateaued during the current expansion. This trend is both economically and statistically significant. Using the estimates for the spatial regression discontinuity model with the .2 mile restricted sample, we find that the implied change in sales price (for the mean-valued home) associated with a five-percent improvement in school quality (at the mean) increased from a level indistinguishable from zero to a 1.8 percent increase between the peak of the local housing market in 2007 and its nadir in 2009. And as Table 5 shows using the same estimates, the coefficient estimates for the period 2006-2007 are indeed largely statistically different from those of the period 2000-2002 and those of the period 2009-2013.

An immediate concern is that this apparent trend is driven by selection, not the business cycle. We've already noted that the number of transactions fell significantly between 2005 and 2008, be-

[17]Because these regressions include boundary-year fixed effects, the restricted samples now exclude sales of homes whose nearest boundary does not feature transactions observed on both sides in the same year.

fore leveling off somewhat thereafter. But were the homes sold in any given year not representative of the entire sample? Table 6 exhibits the results of tests of differences in means of observable characteristics across transaction years for the whole sample. Beginning with Panel A, we observe a boom-bust-recovery trend for sales prices, as well as a steady increase in API, as expected. But among observable structural characteristics, there appears to be no systematic difference between homes sold during expansions and those sold during contractions. Only building age exhibits a discernible pattern, but the trend is independent of the business cycle; as the county's housing stock ages, the average home sold grows increasingly old. Looking now at Panels B and C, we find no evidence of any variation in student-teacher ratio, per-pupil expenditures or property tax across transaction years. We do observe some evidence that homes in lower socioeconomic status neighborhoods (i.e. poorer, more Hispanic, less educated, more family-dominant) sell disproportionately in 2005, 2006 and 2009, while homes in higher socioeconomic status neighborhoods change hands disproportionately in 2007 and 2013. While these findings speak to the influence of the subprime mortgage crisis on the local housing market, they do not line up with, and thus do not appear to explain, the counter-cyclical pattern we observe in homeowners' valuations of school quality.

4.1 Specification checks

To explore the robustness of our main result we perform a battery of specification checks. The main results are presented in Table 6; each column represents a deviation from our baseline specification (the dynamic spatial regression discontinuity approach using the .2 mile restricted sample presented in Table 4). Additional supporting evidence is provided in the Web Appendix.

The first three checks concern sample selection. One unique feature of Los Angeles County is the predominance of the Los Angeles Unified School District (LAUSD).[18] To ensure our results are not driven by the (possibly anomalous) experience of this large district, we try excluding all homes within LAUSD from the regression. As the estimates in the first column show, the broad pattern of our findings are maintained in the remaining 68 districts.

Another feature of primary education in Los Angeles County is the prevalence of alternatives to local public school, including both private schools and public choice options such as charter or

[18]The second-largest school district in the country, LAUSD enrolled 43.4 percent of all students in Kindergarten through 8th grade in Los Angeles County for the 2014-15 school year.

magnet schools.[19] If our model is correct and the coefficient estimates are reflective of public school quality valuations, the market price for local public elementary school quality should be relatively higher in communities where these alternatives are less prominent. We test this proposition by excluding all homes within 45 school districts (including LAUSD) in which more than 10 percent of students in Kindergarten through 8th grade enroll in private schools, or more than 10 percent employ a public choice option, from the regression. Consistent with our conjecture, as the results in the second column reveal, almost all of our estimates grow larger under this restriction.[20]

In the Web Appendix, we present estimates of our baseline specification using various subsamples as additional robustness checks. In particular, we recognize that one explanation for the observed countercyclical trend would be if home prices declined during the downturn disproportionately in high foreclosure areas and if foreclosures are more common in low-quality elementary school attendance areas. But as Figures A.2, A.3 and A.4 show, we find no evidence that our main results are driven by selection on cultural background, socioeconomic status or geographical area, respectively. Specifically, Figure A.3 shows that restricting the sample to high foreclosure areas yields estimates broadly similar to our main results.

The last three specification checks relate to measuring school quality and divining what's salient to homeowners.[21] As we discussed in Section 2, one concern with using API is that the values may not be directly comparable over time, and so a given improvement in values may imply different changes in quality in different years. A related concern is that, if primary education is partially a competitive positional good, households may care more about the rank of a school's quality than its level *per se*. To speak to both of these potential issues, we try using API decile rank (by year, among elementary schools in Los Angeles County) as our measure of elementary school quality. Looking at the third column of Table 6, we see that the pattern of our main findings is broadly replicated using this rank-order approach.

Alternately, there may be an issue concerning non-linearities in the estimated marginal effect

[19]In the 2009-10 school year for instance, 10.8%, 4.8% and 3.6%, of students in Kindergarten through 12th grade in Los Angeles County enrolled in private, charter and magnet schools, respectively.

[20]This implies that expanding charter school options, though publicly-funded, may contribute to waning support for traditional public schools. Avery and Pathak (2015) explores the distributional effects of school choice in greater detail.

[21]The salience of API itself does not appear to be at issue. While undoubtedly more households are familiar with API as a measure of public school quality today than when it was first introduced in 1999, the non-monotonic character of our estimated trend suggests that a secular increase in public awareness of API alone cannot explain our main result.

of API – specifically because schools can "fail" (or, in the language of the California Department of Education, be deemed in need of "program improvement") in large part on the basis of their API.[22] If schools moving in and out of program improvement status are driving our results, then it would not be appropriate to interpret our findings as representative of typical improvements in school quality. As a specification check, we include program improvement status interacted with year dummy variables as additional control variables. The results, shown in the fourth column, are largely unchanged, consistent with the interpretation that households value changes in API broadly, not simply as a means to avoid school failure.

Finally, it remains possible that homeowners do not value school quality *per se* as much as they value characteristics of schools that happen to be correlated with API – in particular, the racial composition or economic background of the student body. The tendency for higher socioeconomic status students to attend better schools (e.g. to have better qualified and more experienced teachers) is well documented (Koski and Hahnel, 2008; Clotfelter, Ladd, and Vigdor, 2011). But this very correlation makes it difficult, econometrically, to account for this alternate explanation.[23] Nonetheless we explore this possibility by calculating a "synthetic" API for each school in each year representing the portion of the school quality measure explained by – or at least correlated with – the socioeconomic characteristics of enrolled students.[24] We then include this measure, interacted with a vector of year dummies, as additional control variables, permitting us to test directly how homeowners value the portion of API *not* explained by school demographics. The results are shown in the fifth column of Table 6.[25] Under this strict test, the countercyclical pattern of the coefficients is still present, but most are no longer statistically significant. So while we cannot rule out the possibility that homeowner preferences for high socioeconomic status students, and not for improved

[22]Schools are encouraged to maintain API of at least 800. Those that fall short are issued yearly growth targets. If they fail to maintain adequate progress, the state (or federal government) may intervene, placing the school in "program improvement." Schools that remain in program improvement for several consecutive years risk various sanctions, including closure.

[23]Our neighborhood socioeconomic controls should control for some of this effect. But the census data, measured at the block group-level, may not represent bandwidth areas well and, in any event, may not reflect the population of enrolled students.

[24]Specifically we perform year-specific regressions, using the estimation sample, of API on four school-level demographic variables: the share of enrolled students who identified as African American, as Asian, as Hispanic or Latino, and the share who qualified for free or reduced-price meals. (Due to data limitations, the share of students who qualified for free and reduced-price meals in 2001-2003 was interpolated from the shares reported in 2000 and 2004.) The R^2 of these regressions range from .65 to .81, reflecting the high degree of collinearity among these school-level factors.

[25]Due to the inclusion of a generated regressor, the coefficient estimate standard errors for this specification are the result of 100 bootstrap replications.

school quality *per se*, contribute to the valuations we observe, that alternative interpretation does not appear to account for our main finding of a countercyclical trend.

5 Discussion

Throughout we have assumed that year-to-year price variation reflects changes in housing demand rather than supply. We now present evidence supporting this claim. Only 6.5 percent of the sales in our estimation sample were of homes built since 2000. Moreover, Figure 6 shows estimates of our baseline model using subsamples limited to neighborhoods of little recent construction and to mountainous areas (as identified by Saiz (2010)). Restricting the estimation to these housing supply-constrained areas produces, on balance, coefficient estimates of larger magnitude, suggesting that business cycle fluctuations in residential construction do not principally account for our main results.

At least four explanations are consistent with the observed pattern. First is the possibility that credit-constrained homeowners, in an effort to smooth consumption across the business cycle, are "trading down" from private schools to public alternatives during contractions.[26] We find limited circumstantial evidence that private school enrollment was procyclical during our study period. Figure A.5 shows the share of Los Angeles County students enrolled in private school between 2000 and 2013 for two grade ranges: Kindergarten through 5th grade and Kindergarten through 6th grade.[27] Though there is a secular trend of falling private school enrollment shares over the study period, it does appear to accelerate somewhat during business cycle downturns – exactly when we would expect substitution away from private school to be most pronounced.[28]

A second explanation concerns the option value of local amenities. During periods of economic contraction and home price uncertainty households may change homes less frequently than they do during periods of expansion. Consequently households may be willing to pay relatively more

[26]Jaimovich, Rebelo, and Wong (2015) observes similar substitution patterns among consumers in the accommodation, apparel, restaurant, home furnishing and general merchandise sectors during the 2007-2012 period.

[27]The vast majority of Los Angeles County elementary schools serve students from Kindergarten through either 5th or 6th grade.

[28]Mian and Sufi (2011), Chodorow-Reich (2014), Ramcharan, Verani, and Van Den Heuvel (2016) and Benmelech, Meisenzahl, and Ramcharan (Forthcoming) present a similar consumer credit mechanism, detailing how adverse shocks to household credit channels during downturns work to drive down consumer spending broadly. In our setting, this line of reasoning would manifest as the procyclical availability of easy credit working to bid up the capitalization of school quality in home prices during expansions and depress it during contractions. But indeed our results show the opposite pattern, and so appear inconsistent with this mechanism.

for local amenities (such as public school quality) during busts because the option value of these amenities has increased. For example, a household which may have a child (or simply another child) in the near future will put relatively more stock in the quality of the local elementary school if they expect to live in the neighborhood for a few more years. Figure A.6, which shows the median number of years Los Angeles County householders have lived in their current residence for the years 2000 to 2013, provides some support for this explanation. While the median tenure for owners eased down from 11 to 10 years during the period 2000 to 2006, it jumped to 13 years by 2009 and had only risen a year further by 2013. All else equal we would expect this trend to drive a slow decline, a rapid increase and then a slow rise in homeowners' valuation of local public school quality – which is indeed largely what we find.

A third possibility is that households perceive the return to school quality to be higher during economic contractions. While there is some research linking graduate school enrollment decisions to business cycle fluctuations, comparable analysis for elementary school is scant – in part because primary education has long been universal (at least in the U.S.) and only recently have researchers been able to observe differences in quality across schools consistently (Kniesner, Padilla, and Polachek, 1978; Psacharopoulos et al., 1996; Johnson, 2013). But because the state of the business cycle during early childhood will not have much bearing on conditions during the breadth of one's working years, it seems unlikely that parents put much stake in forecasts of economic growth more than a decade out while making decisions concerning their children's primary education.

Finally we must allow that, despite choosing a tight bandwidth and including many structure, school and neighborhood control variables, we may attribute the effect of systematic, but unobserved, differences in households, homes or neighborhoods across the elementary school attendance area boundary to observed differences in school quality. For instance, perhaps unobservable characteristics of homes fuel a process of "endogenous gentrification" wherein higher-income residents bid up home prices in lower-quality school attendance areas during booms (Guerrieri, Hartley, and Hurst, 2012, 2013). We cannot fully test the likelihood of this concern, but in a recent examination of the hedonic approach, Billings (2015) evaluates the magnitude of this issue by additionally controlling for residential building permits, which proxy for unobserved home renovations. Billings concludes that the implied bias of unobserved structural differences in these studies is a "second-order concern."

6 Conclusion

In this paper, we show that homeowners' valuation of local public school quality is countercyclical. Moreover this variation is economically significant; between the peak of the local housing market in 2007 and its nadir in 2009 we find that the implied valuation of a five-percent improvement in school quality increased from a level indistinguishable from zero to approximately 1.8 percent of a home's sales price. We identify this result with a dynamic hedonic pricing model, exploiting spatial discontinuities at elementary school attendance area boundaries to enhance identification. Our findings are insensitive to a variety of specification checks, and do not appear to be driven either by the selection of homes sold over time or by a secular increase in the salience of our chosen measure of school quality. Instead we suspect that the observed countercyclical pattern stems from the combination of two effects – consumers "trading down" from private to public schools during contractions as well as the effects of reduced household mobility during downturns in raising the value of the public school option – though further research on homeowner decision-making is necessary to estimate their relative importance.

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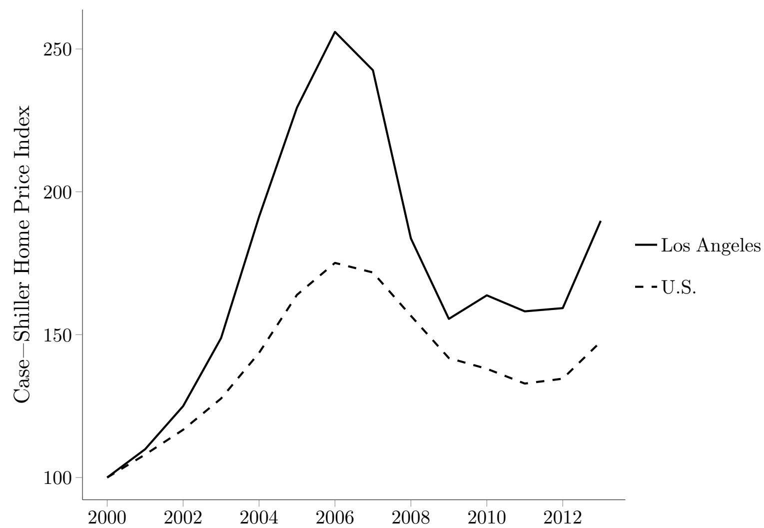
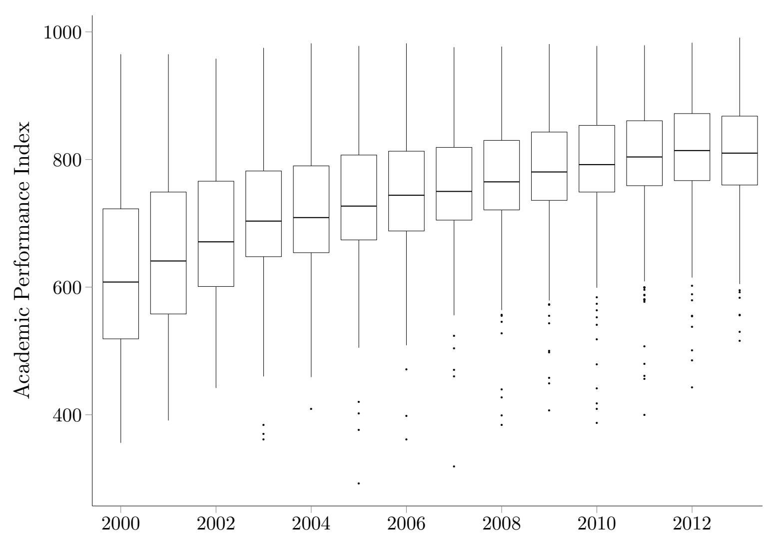
Figure 1: Case-Shiller Home Price Index for Los Angeles Metropolitan Area



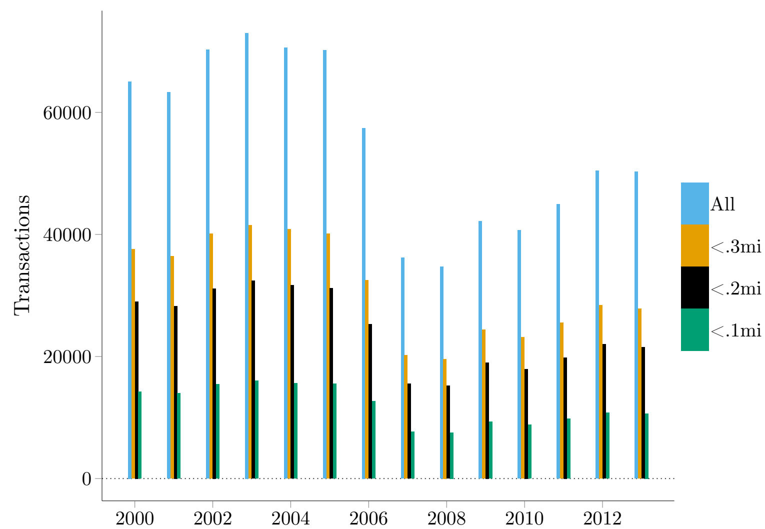
Note: The S&P/Case-Shiller Home Price Indices for the U.S. and the Los Angeles-Long Beach-Anaheim metropolitan statistical area (each normalized so that 2000 is 100) are provided by FRED.

Figure 2: Academic Performance Index of Los Angeles County Schools



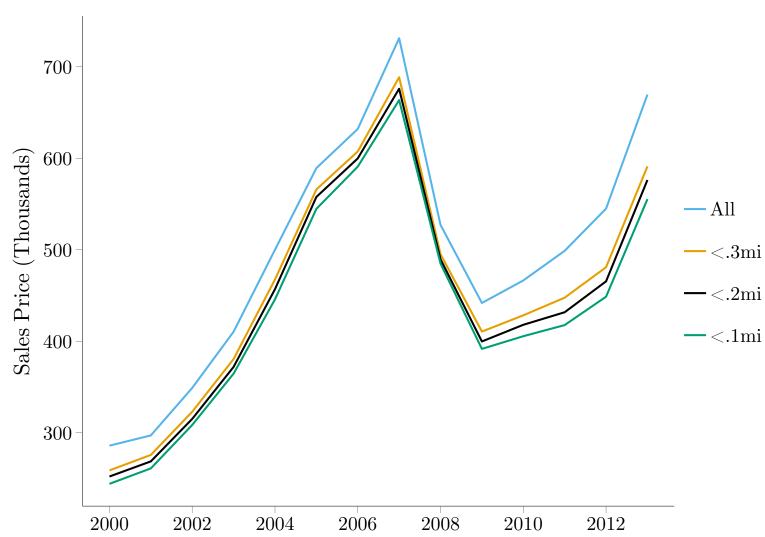
Note: Growth API for Los Angeles County elementary schools provided by the California Department of Education. The bottom and top of the box show the first and third quartiles, respectively, while the band shows the median. The whiskers show the most extreme data points within one-and-a-half inter-quartile ranges of the box. Dots represent outliers.

Figure 3: Count of Transactions by Estimation Sample



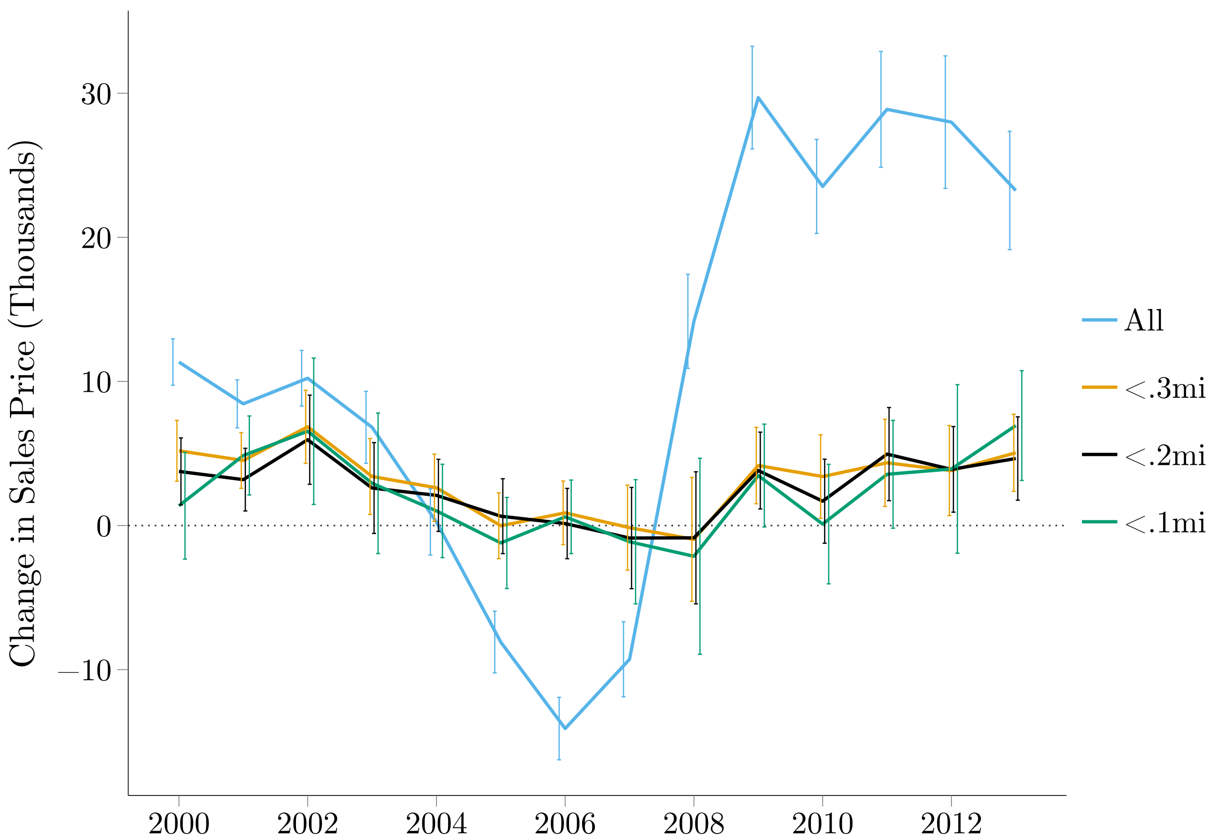
Note: Transaction data provided by DataQuick for 2000-2010 and CoreLogic for 2011-2013.

Figure 4: Mean Sales Price by Estimation Sample



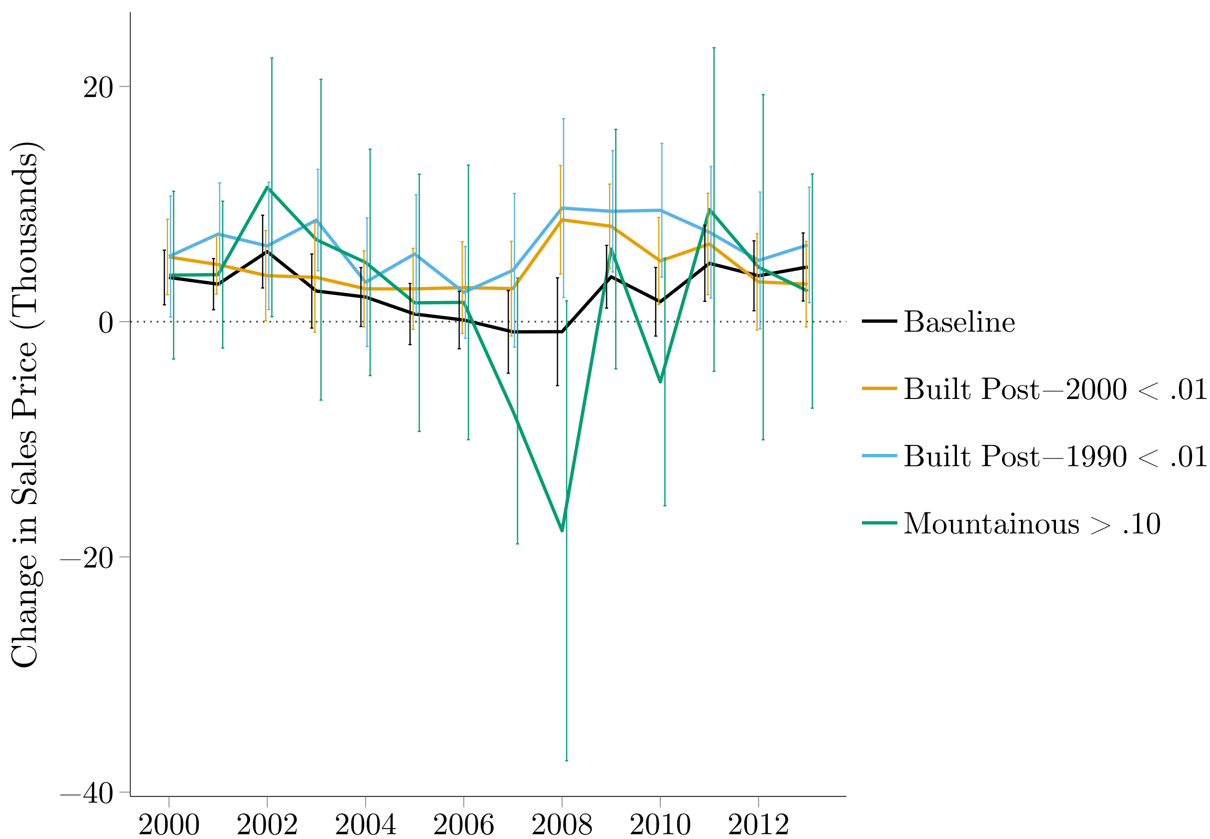
Note: Transaction data provided by DataQuick for 2000-2010 and CoreLogic for 2011-2013.

Figure 5: Homeowners' School Quality Valuation Is Counter-Cyclical



Note: The implied change in sales price (for the mean-valued home) associated with a five-percent improvement in school quality (at the mean) for each transaction year (presented with 95 percent confidence intervals) according to the regressions presented in Table 4.

Figure 6: Subsample Estimation by Local Housing Character



Note: The baseline "<.2mi" specification is presented in Table 4. Transactions included in the low recent construction subsamples if the share of housing units in the block group, according to the American Community Survey (as of 2010), was less than the given value as of the given year. Transactions included in the mountainous subsample if Saiz (2010) identified the share of the tract (as of 2000) as greater than the given value.

Table 1: Summary Statistics[a]

	All	<.3mi	<.2mi	<.1mi
Real sales price ($)	570,344	527,936	516,343	504,128
	(693,435)	(645,990)	(673,663)	(504,044)
Elementary school quality[b]	7.56	7.47	7.44	7.42
	(1.08)	(1.10)	(1.10)	(1.10)
Structure controls				
Bedrooms	3.2	3.1	3.1	3.1
	(0.9)	(0.9)	(0.9)	(0.9)
Bathrooms	2.1	2.0	2.0	2.0
	(1.0)	(1.0)	(0.9)	(0.9)
Living space (square ft.)	1715.7	1630.4	1605.3	1585.9
	(893.8)	(806.3)	(786.0)	(765.1)
Building age	49.9	52.4	52.8	52.7
	(22.9)	(22.2)	(22.3)	(22.6)
Education controls[c]				
Property tax (per $1,000 assessed value)	11.8	11.9	11.9	11.9
	(0.8)	(0.9)	(0.9)	(0.9)
Student-teacher ratio	20.7	20.6	20.6	20.6
	(4.3)	(4.2)	(4.1)	(4.0)
Per-pupil expenditure ($)	11,907	12,152	12,145	12,113
	(2,489)	(2,424)	(2,419)	(2,411)
Socioeconomic controls[d]				
Median household income ($)	57,672	54,421	53,560	53,259
	(26,716)	(24,396)	(23,945)	(23,708)
Population per mi^2	8,908	9,748	10,079	10,308
	(6,323)	(6,381)	(6,518)	(6,626)
Black	0.10	0.10	0.11	0.11
	(0.17)	(0.18)	(0.18)	(0.18)
Asian	0.12	0.12	0.12	0.12
	(0.14)	(0.13)	(0.14)	(0.14)
Hispanic	0.35	0.38	0.39	0.40
	(0.27)	(0.27)	(0.27)	(0.28)
High school graduate (25+)	0.75	0.73	0.72	0.71
	(0.20)	(0.20)	(0.21)	(0.21)
College graduate (25+)	0.26	0.25	0.24	0.23
	(0.19)	(0.18)	(0.18)	(0.18)
Reside with own-children	0.40	0.40	0.41	0.41
	(0.12)	(0.12)	(0.12)	(0.12)
Own residence	0.68	0.66	0.65	0.65
	(0.23)	(0.23)	(0.23)	(0.23)
Geographic controls				
Distance to employment centers (mi.)[e]	20.8	20.0	19.9	19.9
	(9.1)	(8.5)	(8.4)	(8.3)
Distance to shoreline (mi.)	15.1	14.2	14.0	14.0
	(12.9)	(11.9)	(11.6)	(11.5)
Observations	769,140	438,278	340,098	168,016

[a] Means (standard deviations) are reported.

[b] Annual elementary school quality as measured by the California Department of Education's Growth Academic Performance Index (in hundreds).

[c] The property tax represents the tax bill per $1,000 of assessed value for fiscal year 2015. The student-teacher ratio is measured at the elementary school-level as of school year 2009-10. Per-pupil expenditure is measured at the school district-level as of school year 2009-10.

[d] Socioeconomic controls are measured at block group-level as of 2000, and (except for household income and population density) represent shares.

[e] Distance to employment centers is calculated as the employment-weighted average distance to the 40 ZIP code areas with the highest average employment over the period 2000-2010.

Table 2: Local Public School Quality Capitalization

Dependent variable: Real sales price (ln \$)[a]

	All	<.3mi	<.2mi	<.1mi	<.1mi
Elementary school quality[b]	0.039***	0.015***	0.011***	0.008***	0.033***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Structure controls					
Bedrooms	-0.017***	-0.009***	-0.009***	-0.005***	-0.012***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Bathrooms	-0.003	-0.003	-0.017	-0.042***	-0.053***
	(0.011)	(0.008)	(0.010)	(0.005)	(0.005)
Bathrooms^2	0.005***	0.003**	0.005***	0.009***	0.013***
	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)
Living space (ln square ft.)	0.530***	0.488***	0.480***	0.467***	0.503***
	(0.005)	(0.004)	(0.005)	(0.006)	(0.006)
Building age	0.003***	0.001***	0.001***	0.001***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Building age^2	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Education controls[c]	✓	✓	✓	✓	✓
Socioeconomic controls[d]	✓				✓
Geographic controls[e]	✓				✓
Quarter-of-sale dummies	✓	✓	✓	✓	✓
County subdivision-year dummies[f]	✓	✓	✓	✓	✓
Boundary fixed effects		✓	✓	✓	
Number of boundaries		1,585	1,579	1,552	
Observations	769,140	438,278	340,098	168,016	168,016
Adjusted R^2	0.75	0.77	0.76	0.75	0.72
Memo item:					
A five-percent improvement in school quality (at the mean) corresponds to a...					
	1.43%	0.56%	0.39%	0.30%	1.19%
	\$8,283	\$3,222	\$2,267	\$1,770	\$6,935
...change in sales price (for the mean-valued home).[g]					

[a] Coefficient estimates (standard errors) are reported. All standard errors are adjusted for clustering at the elementary school-year-level.

[b] Annual elementary school quality as measured by the California Department of Education's Growth Academic Performance Index (in hundreds).

[c] School controls include structure-level property tax assessment, elementary school-level student-teacher ratio, and (for "All" and the latter "<.1mi") school district-level expenditures per student.

[d] Neighborhood controls include block group-level household income, population density, as well as share black, Asian, Hispanic, high school and college graduate, residing with own children, and owning residence.

[e] Geographic controls include second-order polynomials in distance to employment centers and distance to the shoreline.

[f] The U.S. Census Bureau divided Los Angeles County into 20 subdivisions for statistical purposes in 2010.

[g] Between 2000 and 2013, the mean API among all schools in Los Angeles County was 726.5, and the mean sales price of a single-family residence in the estimation sample was \$580,597 (in 2015 dollars).

Table 3: Tests of Sample Differences Across Elementary School Boundaries[a]

	All[b]	<.3mi	<.2mi	<.1mi
Real sales price (ln $)	0.046***	0.029***	0.028***	0.018*
	(0.010)	(0.010)	(0.009)	(0.010)
Elementary school quality	0.45***	0.43***	0.44***	0.44***
	(0.02)	(0.02)	(0.02)	(0.02)
Structure controls				
Bedrooms	0.033***	0.024***	0.022***	0.015*
	(0.007)	(0.007)	(0.008)	(0.009)
Bathrooms	0.061***	0.041***	0.039***	0.029***
	(0.010)	(0.009)	(0.009)	(0.010)
Living space (ln square ft.)	0.031***	0.021***	0.021***	0.015***
	(0.005)	(0.005)	(0.005)	(0.005)
Building age	-0.71**	-0.90***	-1.06***	-0.86**
	(0.33)	(0.32)	(0.33)	(0.36)
School controls				
Property tax (per $1,000 assessed value)	-0.04***	0.00	0.01	0.01
	(0.01)	(0.02)	(0.02)	(0.02)
Student-teacher ratio	0.695***	0.592***	0.565***	0.471***
	(0.101)	(0.104)	(0.102)	(0.096)
Per-pupil expenditure ($)	-176.5***			
	(41.1)			
Neighborhood controls				
Median household income ($)	2262***	1672***	1784***	1449***
	(371)	(348)	(339)	(357)
Population per mi^2	-391***	-452***	-507***	-418***
	(78.5)	(82.9)	(86.4)	(93.3)
Black	-0.009***	-0.005*	-0.005	-0.004
	(0.002)	(0.003)	(0.003)	(0.003)
Asian	0.011***	0.007***	0.006***	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)
Hispanic	-0.017***	-0.015***	-0.016***	-0.011***
	(0.004)	(0.004)	(0.004)	(0.004)
High school graduate (25+)	0.019***	0.015***	0.015***	0.012***
	(0.003)	(0.003)	(0.003)	(0.003)
College graduate (25+)	0.015***	0.011***	0.011***	0.008***
	(0.003)	(0.003)	(0.003)	(0.003)
Reside with own-children	-0.003	-0.004**	-0.004**	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)
Own residence	0.020***	0.017***	0.016***	0.014***
	(0.003)	(0.003)	(0.003)	(0.003)
Geographic controls				
Distance to employment centers (mi.)	-0.171	-0.064	-0.081	-0.040
	(0.189)	(0.183)	(0.180)	(0.181)
Distance to shoreline (mi.)	-0.057	-0.059	-0.042	0.012
	(0.270)	(0.265)	(0.260)	(0.261)
Observations	645,694	438,278	340,098	168,016

[a]Each cell shows the coefficient estimate (standard error) from a regression of each listed variable on a dummy variable – 1 if the house is on the side of the boundary with higher measured elementary school quality, 0 otherwise. All standard errors are adjusted for clustering at the elementary school-year-level.

[b]118,829 observations included in Table 2 are excluded here because the nearest boundary does not feature transactions observed on both sides.

Table 4: Local Public School Quality Capitalization from 2000 to 2013

Dependent variable: Real sales price (ln \$)[a]

	All	<.3mi	<.2mi	<.1mi
Elementary school quality[b] ×...				
2000	0.054***	0.025***	0.018***	0.007
	(0.004)	(0.005)	(0.006)	(0.009)
2001	0.040***	0.021***	0.015***	0.023***
	(0.004)	(0.005)	(0.005)	(0.007)
2002	0.048***	0.032***	0.028***	0.031**
	(0.005)	(0.006)	(0.007)	(0.012)
2003	0.032***	0.016**	0.012	0.014
	(0.006)	(0.006)	(0.008)	(0.012)
2004	0.001	0.012**	0.010	0.005
	(0.006)	(0.006)	(0.006)	(0.008)
2005	-0.038***	-0.000	0.003	-0.006
	(0.005)	(0.006)	(0.006)	(0.008)
2006	-0.067***	0.004	0.001	0.003
	(0.005)	(0.005)	(0.006)	(0.006)
2007	-0.044***	-0.001	-0.004	-0.005
	(0.006)	(0.007)	(0.009)	(0.010)
2008	0.067***	-0.005	-0.004	-0.010
	(0.008)	(0.010)	(0.011)	(0.016)
2009	0.141***	0.020***	0.018***	0.016*
	(0.009)	(0.006)	(0.006)	(0.009)
2010	0.112***	0.016**	0.008	0.000
	(0.008)	(0.007)	(0.007)	(0.010)
2011	0.137***	0.021***	0.024***	0.017*
	(0.010)	(0.007)	(0.008)	(0.009)
2012	0.133***	0.018**	0.018**	0.019
	(0.011)	(0.008)	(0.007)	(0.014)
2013	0.110***	0.024***	0.022***	0.033***
	(0.010)	(0.006)	(0.007)	(0.009)
Structure controls[c]	✓	✓	✓	✓
Education controls[d]	✓	✓	✓	✓
Socioeconomic controls[e]	✓	✓	✓	✓
Geographic controls[f]	✓	✓	✓	✓
Quarter-of-sale dummies	✓	✓	✓	✓
County subdivision-year dummies[g]	✓			
Boundary-year dummies		✓	✓	✓
Number of boundaries		18,465	18,327	17,459
Observations	769,140	423,302	328,557	162,473
Adjusted R^2	0.76	0.79	0.78	0.77

[a] Coefficient estimates (standard errors) are reported. All standard errors are adjusted for clustering at the elementary school-year-level.

[b] Annual elementary school quality as measured by the California Department of Education's Growth Academic Performance Index (in hundreds).

[c] Structure controls include number of bedrooms, living space and second-order polynomials in bathrooms and building age.

[d] School controls include structure-level property tax assessment, elementary school-level student-teacher ratio, and (for "All") school district-level expenditures per student.

[e] Neighborhood controls include block group-level household income, population density, as well as share black, Asian, Hispanic, high school and college graduate, residing with own children, and owning residence.

[f] Geographic controls include second-order polynomials in distance to employment centers and distance to the shoreline.

[g] The U.S. Census Bureau divided Los Angeles County into 20 subdivisions for statistical purposes in 2010.

Table 5: Estimated Counter-Cyclical Trend Is Statistically Significant

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
2000	0.003	-0.010	0.005	0.008	0.015	0.017**	0.022**	0.022	-0.000	0.010	-0.006	-0.001	-0.004
2001		-0.013	0.003	0.005	0.012	0.014	0.019	0.019	-0.003	0.007	-0.008	-0.003	-0.007
2002			0.016	0.018	0.025***	0.028***	0.032***	0.032**	0.010	0.020**	0.005	0.010	0.006
2003				0.002	0.009	0.012	0.016	0.016	-0.006	0.004	-0.011	-0.006	-0.010
2004					0.007	0.009	0.014	0.014	-0.008	0.002	-0.014	-0.009	-0.012
2005						0.002	0.007	0.007	-0.015	-0.005	-0.020**	-0.015	-0.019**
2006							0.005	0.005	-0.017**	-0.007	-0.023**	-0.018	-0.021**
2007								-0.000	-0.022**	-0.012	-0.028**	-0.023**	-0.026**
2008									-0.022	-0.012	-0.028**	-0.023	-0.026**
2009										0.010	-0.005	-0.000	-0.004
2010											-0.015	-0.010	-0.014
2011												0.005	0.001
2012													-0.004

Note: Each cell displays the difference in the regression coefficient on elementary school quality between the row year and the column year using the estimates for the "<.2mi" specification presented in Table 4.

Table 6: Panel A – Testing the Difference of Means Across Transaction Years

	2000	2001	2002	2003	2004	2005	2006
Real sales price (ln $)	-0.39***	-0.31***	-0.18***	-0.02	0.20***	0.37***	0.44***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Elementary school quality	-1.17***	-0.85***	-0.54***	-0.19***	-0.17***	-0.03	0.08**
	(0.06)	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)
Structure controls							
Bedrooms	-0.00	-0.03*	0.00	-0.01	-0.01	0.00	-0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Bathrooms	0.00	-0.01	0.00	-0.01	-0.02	-0.02	-0.06***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Living space (ln square ft.)	0.01	-0.01	0.01	-0.01	-0.01	-0.01	-0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Building age	-5.32***	-4.48***	-3.69***	-2.49***	-2.25***	-1.82**	0.58
	(0.69)	(0.68)	(0.73)	(0.69)	(0.74)	(0.91)	(0.77)
Observations	14,370	13,938	15,365	16,093	15,730	15,367	12,272

	2007	2008	2009	2010	2011	2012	2013
Real sales price (ln $)	0.47***	0.03	-0.19***	-0.15***	-0.18***	-0.13***	0.10***
	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Elementary school quality	0.36***	0.41***	0.48***	0.62***	0.79***	0.86***	0.87***
	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Structure controls							
Bedrooms	0.01	0.03	-0.03	-0.07***	0.05**	0.07***	0.03
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Bathrooms	0.05	0.02	-0.07***	-0.09***	0.07***	0.10***	0.10***
	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
Living space (ln square ft.)	0.03**	0.01	-0.03***	-0.03***	0.02*	0.04***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Building age	0.61	0.31	3.24***	5.47***	5.57***	6.32***	7.65***
	(0.80)	(0.84)	(0.81)	(0.72)	(0.70)	(0.70)	(0.67)
Observations	7,530	7,247	9,256	8,721	9,427	10,545	10,223

Note: Each cell shows the coefficient estimate (standard error) from a regression of each listed variable on a dummy variable – 1 if the transaction occurred in the given year, 0 otherwise – using the .2 mile restricted sample. All standard errors are adjusted for clustering at the elementary school-year-level.

Panel B – Testing the Difference of Means Across Transaction Years[a]

	2000	2001	2002	2003	2004	2005	2006
Education controls							
Property tax (per $1,000 assessed value)	-0.02	-0.05	-0.04	-0.02	0.03	0.03	0.04
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Student-teacher ratio	0.19	0.21	0.20	0.02	-0.06	-0.59	-0.41
	(0.19)	(0.19)	(0.20)	(0.21)	(0.25)	(0.36)	(0.31)
Per-pupil expenditure ($)	-3.75	-25.21	-27.04	0.62	-19.59	-93.47	11.52
	(104.40)	(106.29)	(105.48)	(105.06)	(105.83)	(111.90)	(109.44)
Socioeconomic controls							
Median household income ($)	569.14	495.74	1114.06	392.66	-1364.25*	-1788.32**	-2713.92***
	(903.84)	(855.86)	(889.40)	(898.02)	(817.03)	(808.88)	(818.74)
Population per mi^2	44.90	79.16	-46.48	-34.17	54.20	84.07	350.57
	(202.66)	(208.25)	(206.23)	(206.47)	(203.85)	(238.43)	(214.44)
Black	-0.00	-0.01	-0.01	-0.01	-0.00	0.01	0.02*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Asian	0.01	0.01	0.01	0.00	-0.00	-0.01	-0.01**
	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	14,370	13,938	15,365	16,093	15,730	15,367	12,272

	2007	2008	2009	2010	2011	2012	2013
Education controls							
Property tax (per $1,000 assessed value)	-0.02	-0.00	0.11**	0.03	-0.01	-0.02	-0.06*
	(0.04)	(0.04)	(0.05)	(0.04)	(0.04)	(0.03)	(0.03)
Student-teacher ratio	0.09	-0.14	0.70***	-0.15	-0.09	0.02	0.15
	(0.20)	(0.29)	(0.12)	(0.24)	(0.21)	(0.21)	(0.20)
Per-pupil expenditure ($)	84.68	-203.32*	98.77	38.02	55.59	74.26	61.09
	(108.62)	(115.85)	(103.37)	(105.70)	(105.82)	(107.22)	(107.17)
Socioeconomic controls							
Median household income ($)	1962.29**	724.11	-1841.60**	-1143.37	667.92	1070.50	3135.02***
	(948.93)	(847.90)	(797.80)	(861.66)	(946.80)	(983.51)	(1027.25)
Population per mi^2	-268.03	-666.27***	213.01	314.48	74.73	-89.43	-425.39**
	(205.67)	(202.14)	(207.41)	(215.40)	(213.44)	(199.09)	(203.94)
Black	-0.01	-0.01*	0.01	0.00	0.01	0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Asian	0.00	-0.00	-0.01	-0.00	-0.01	-0.00	0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Observations	7,530	7,247	9,256	8,721	9,427	10,545	10,223

Note: Each cell shows the coefficient estimate (standard error) from a regression of each listed variable on a dummy variable – 1 if the transaction occurred in the given year, 0 otherwise – using the .2 mile restricted sample. All standard errors are adjusted for clustering at the elementary school-year-level.

Panel C – Testing the Difference of Means Across Transaction Years[a]

	2000	2001	2002	2003	2004	2005	2006
Socioeconomic controls (cont.)							
Hispanic	-0.01	-0.01	-0.01	-0.00	0.01	0.01	0.03**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
High school graduate (25+)	0.01	0.01	0.01	0.00	-0.01	-0.01	-0.02***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
College graduate (25+)	0.01	0.01	0.01	0.00	-0.01	-0.02**	-0.02***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Reside with own-children	-0.00	-0.00	-0.00	-0.00	0.01	0.01**	0.01**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Own residence	-0.00	0.00	0.00	-0.00	-0.01	-0.00	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Geographic controls							
Distance to employment centers (mi.)	-0.35	-0.34	-0.18	0.04	0.45	0.99*	0.37
	(0.38)	(0.37)	(0.40)	(0.40)	(0.46)	(0.55)	(0.50)
Distance to shoreline (mi.)	-0.70	-0.57	-0.30	-0.08	0.66	1.52*	0.67
	(0.53)	(0.52)	(0.57)	(0.57)	(0.66)	(0.79)	(0.71)
Observations	14,370	13,938	15,365	16,093	15,730	15,367	12,272

	2007	2008	2009	2010	2011	2012	2013
Socioeconomic controls (cont.)							
Hispanic	-0.03***	-0.01	0.03***	0.02	0.00	-0.01	-0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
High school graduate (25+)	0.02***	0.01*	-0.02***	-0.01*	-0.00	0.00	0.02***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
College graduate (25+)	0.02***	-0.00	-0.02***	-0.01	0.00	0.01	0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Reside with own-children	-0.01***	-0.00	0.01***	0.01	-0.00	-0.01	-0.02***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
Own residence	0.00	0.02**	0.00	-0.00	0.00	-0.00	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Geographic controls							
Distance to employment centers (mi.)	-0.58	1.19**	-0.03	-0.06	-0.54	-0.62*	-0.62
	(0.40)	(0.52)	(0.44)	(0.43)	(0.38)	(0.38)	(0.38)
Distance to shoreline (mi.)	-0.58	1.70**	0.15	-0.18	-0.77	-0.92*	-0.82
	(0.55)	(0.74)	(0.65)	(0.60)	(0.53)	(0.51)	(0.51)
Observations	7,530	7,247	9,256	8,721	9,427	10,545	10,223

Note: Each cell shows the coefficient estimate (standard error) from a regression of each listed variable on a dummy variable – 1 if the transaction occurred in the given year, 0 otherwise – using the .2 mile restricted sample. All standard errors are adjusted for clustering at the elementary school-year-level.

Table 6: Counter-Cyclical Trend Is Robust to Various Specification Checks

Dependent variable: Real sales price (ln \$)[a]

	Exclude LAUSD[b]	Exclude Private or Choice >10%[c]	API Decile[d]	Program Improvement[e]	Synthetic API[f]
Elementary school quality[b]×...					
2000	0.023***	0.038***	0.005**		0.008
	(0.007)	(0.010)	(0.002)		(0.010)
2001	0.005	0.030***	0.007***		0.016**
	(0.007)	(0.008)	(0.002)		(0.007)
2002	0.016**	0.029***	0.010***		0.022*
	(0.007)	(0.011)	(0.003)		(0.012)
2003	-0.005	0.009	0.004*	0.014*	0.005
	(0.010)	(0.014)	(0.002)	(0.008)	(0.011)
2004	0.006	0.011	0.002	0.011*	0.008
	(0.007)	(0.009)	(0.002)	(0.006)	(0.008)
2005	-0.005	0.002	0.001	0.006	-0.002
	(0.007)	(0.008)	(0.002)	(0.007)	(0.007)
2006	-0.004	0.003	-0.000	0.001	-0.003
	(0.008)	(0.008)	(0.002)	(0.007)	(0.007)
2007	0.003	0.014	-0.002	-0.001	-0.011
	(0.009)	(0.012)	(0.002)	(0.010)	(0.009)
2008	0.020	0.037**	0.000	0.004	-0.030**
	(0.013)	(0.015)	(0.003)	(0.012)	(0.012)
2009	0.024***	0.022*	0.005***	0.032***	-0.004
	(0.008)	(0.012)	(0.002)	(0.008)	(0.008)
2010	0.010	0.028**	0.003*	0.001	-0.009
	(0.010)	(0.011)	(0.002)	(0.008)	(0.008)
2011	0.018**	0.027**	0.006***	0.022**	0.002
	(0.009)	(0.011)	(0.002)	(0.009)	(0.007)
2012	0.011	0.032**	0.005***	0.016**	0.011
	(0.008)	(0.013)	(0.002)	(0.008)	(0.011)
2013	0.017**	0.029***	0.006***	0.021***	0.004
	(0.008)	(0.010)	(0.002)	(0.008)	(0.008)
Structure controls[c]	✓	✓	✓	✓	✓
Education controls[d]	✓	✓	✓	✓	✓
Socioeconomic controls[e]	✓	✓	✓	✓	✓
Geographic controls	✓	✓	✓	✓	✓
Quarter-of-sale dummies	✓	✓	✓	✓	✓
Boundary-year dummies	✓	✓	✓	✓	✓
Number of boundaries	9,805	4,240	18,327	14,222	18,321
Observations	181,321	72,114	328,557	242,224	328,400
Adjusted R^2	0.81	0.74	0.78	0.81	0.78

[a] Coefficient estimates (standard errors) are reported. All specification checks represent deviations from the baseline "<.2mi" specification presented in Table 4. All standard errors are adjusted for clustering at the elementary school-year-level (except for the last specification, where standard errors are the result of 100 bootstrap replications).

[b] This specification excludes all homes within the Los Angeles Unified School District.

[c] This specification excludes homes in 45 (out of a total of 69) school districts (including LAUSD) in which more than 10 percent of K-8 students enroll in private schools, or more than 10 percent of K-8 students employ an educational choice option (e.g. charter, magnet).

[d] This specification uses decile ranks (calculated annually among all Los Angeles County elementary schools) of the California Department of Education's Growth Academic Performance Index as the measure of elementary school quality.

[e] This specification includes the lack of "program improvement" status interacted with a vector of year dummies as additional control variables.

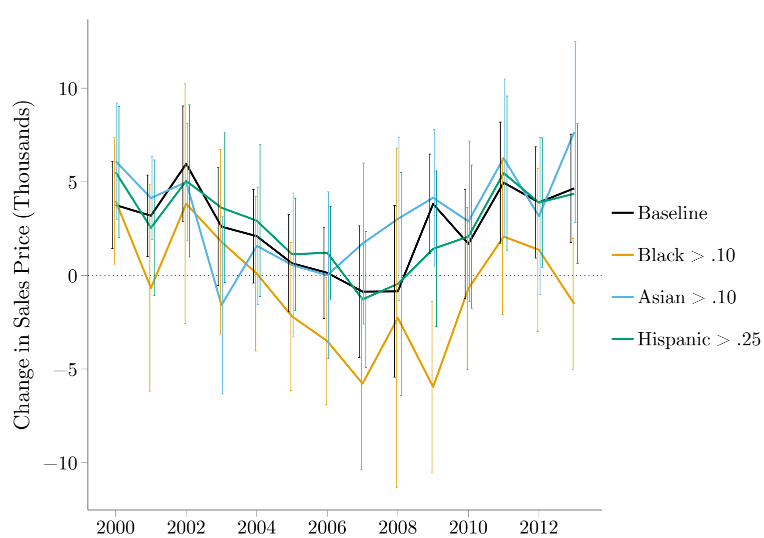
[f] This specification includes a "synthetic" Academic Performance Index interacted with a vector of year dummies as additional control variables. (This value is calculated from a year-specific regression, using the estimation sample, of API on four school-level demographic variables: the share of enrolled students who identified as African American, as Asian, as Hispanic or Latino, and the share who qualified for free or reduced-price meals.) The number of observations differs from that of the baseline regression due to limited cases of missing school-level demographic data.

Web Appendix

Figure A.1: Los Angeles Metropolitan Area GDP Growth

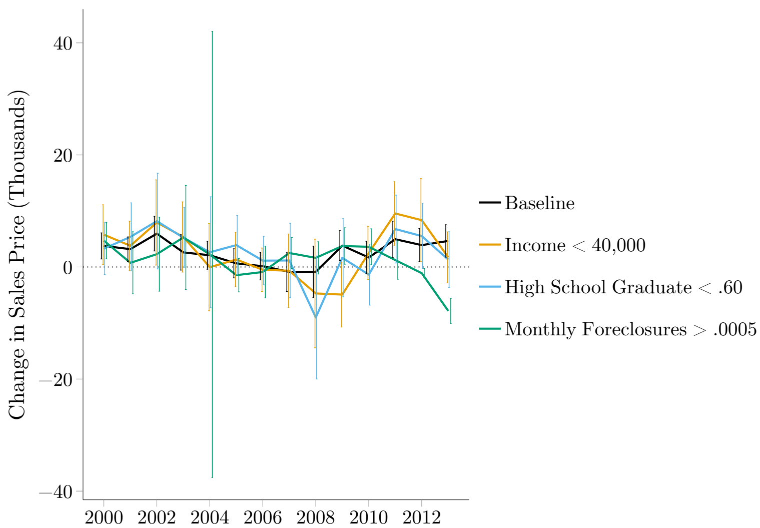
Note: Estimated annual percent changes in current dollars of GDP for the U.S. and the Los Angeles-Long Beach-Anaheim metropolitan statistical area are provided by the BEA.

Figure A.2: Subsample Estimation by Cultural Background



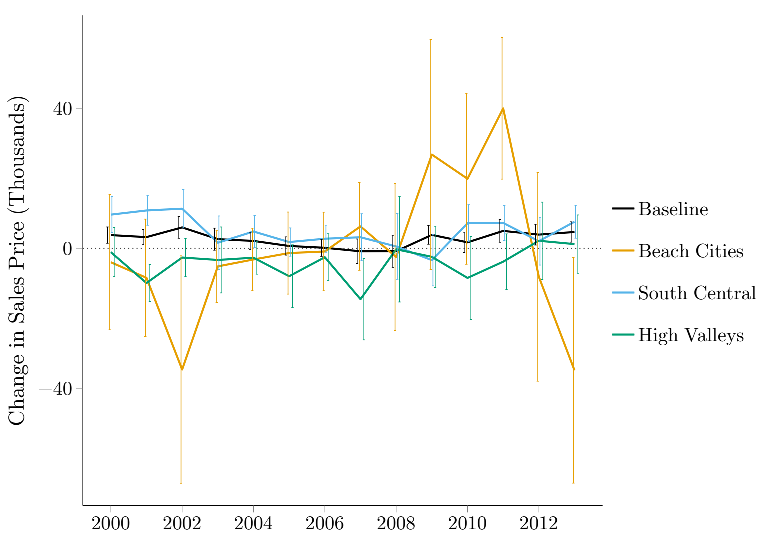
Note: The baseline "<.2mi" specification is presented in Table 4. Transactions included in each subsample if the share of the population residing in the block group (as of 2000) was greater than the given value.

Figure A.3: Subsample Estimation by Socioeconomic Status



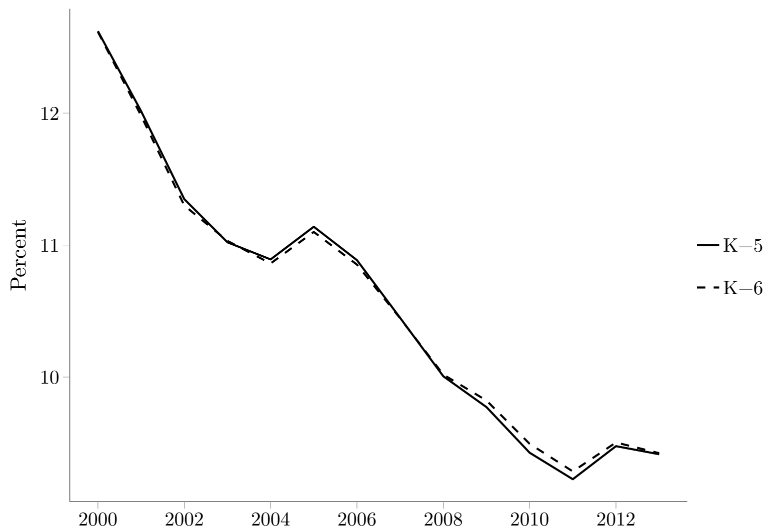
Note: The baseline "<.2mi" specification is presented in Table 4. Transactions included in the low income (alternately, high school graduate) subsample if the share of the population residing in the block group (as of 2000) was less than the given value. Transactions included in the high foreclosure subsample if the rate of monthly foreclosures in the zip code during the transaction year, as reported by Zillow, was greater than the given value.

Figure A.4: Subsample Estimation by Geographic Area



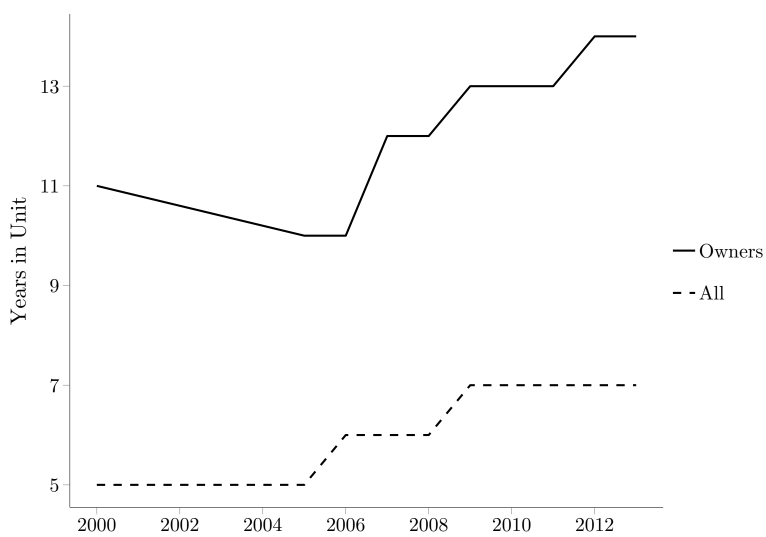
Note: The baseline "<.2mi" specification is presented in Table 4. Transactions included in the: beach cities subsample if the home was located in Agoura Hills, Malibu, Santa Monica, South Bay Cities, Torrance or Palos Verdes; south central subsample if the home was located in South Gate, East Los Angeles, Inglewood, Compton, Long Beach or Lakewood; and high valleys subsample if the home was located in the Antelope Valley or Santa Clarita Valley.

Figure A.5: Share of Los Angeles County Students Enrolled in Private School



Note: Enrollment data provided by the California Department of Education.

Figure A.6: Median Tenure for Los Angeles County Householders



Note: Household tenure data provided by the U.S. Census Bureau – the decennial census for 2000, and the American Community Survey for 2005-2013.