Impact of Redlining on Modern Day STEM Course Offerings

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Abstract

This paper examines whether the legacy of historical redlining continues to shape access to advanced STEM coursework in U.S. public high schools. Using digitized Home Owners' Loan Corporation (HOLC) maps linked to contemporary Civil Rights Data Collection and National Center for Education Statistics data, I implement a boundary discontinuity design that compares schools located within 0.25 miles of historical redlining boundaries, holding constant broader neighborhood and city characteristics. A national analysis across 113 HOLC-mapped cities shows that schools in historically C- and D-rated neighborhoods are less likely to offer any advanced STEM course and offer fewer calculus, computer science, and physics classes. City-level analyses of Chicago, Detroit, Philadelphia, and Los Angeles reveal similar but context-dependent patterns, with effects strongest in cities characterized by persistent residential segregation. Together, these findings suggest that historical housing discrimination continues to influence the depth and distribution of STEM educational opportunity today.

1 Introduction

Historical redlining policies in the United States have had persistent and far-reaching effects on the spatial distribution of opportunity. The Home Owners' Loan Corporation (HOLC), established in 1933 to stabilize the housing market during the Great Depression, produced residential security maps that assigned neighborhoods grades from "A" (best) to "D" (hazardous). Although these maps were not the sole source of housing discrimination, they codified pre-existing racial and socioeconomic hierarchies into a formal system that shaped credit access, property values, and public investment for decades. Subsequent research has demonstrated that the HOLC's racialized risk assessments not only influenced housing markets but also reinforced patterns of urban inequality that continue to structure access to opportunity today (Aaronson et al. [2021]; Lukes and Cleveland [2021]).

This paper investigates whether the geography of redlining continues to shape access to advanced science, technology, engineering, and mathematics (STEM) coursework in American public schools. Access to advanced STEM education—such as calculus, physics, chemistry, and computer science—plays a crucial role in determining students' college readiness and long-term economic mobility. Yet opportunity to pursue these subjects remains unequally distributed across schools and neighborhoods. While prior studies have linked redlined neighborhoods to disparities in housing, health, and environmental outcomes (Appel [2016]; Hoffman et al. [2020]; Nardone et al. [2021]), few have examined whether redlining continues to shape educational opportunity in the domain of STEM.

Despite a growing body of evidence connecting historical redlining to modern socioeconomic outcomes, an important gap remains in understanding how these legacies manifest in educational opportunity structures, particularly in high-value academic areas like STEM. Existing studies—such as Lukes and Cleveland [2021]—demonstrate that redlined neighborhoods are associated with lower school funding, less diversity, and weaker student performance, but they focus primarily on overall achievement metrics. This paper extends that literature by examining STEM coursework access as a distinct and policy-relevant outcome that connects neighborhood history to long-term economic opportunity. Since STEM fields drive much of the modern labor market's wage growth and innovation, disparities in early access to STEM preparation perpetuate the broader racial and socioeconomic inequalities that redlining helped create. Identifying whether these disparities follow historical redlining boundaries can inform education policy and equity initiatives aimed at mitigating structural barriers to mobility.

To address this question, the study employs a boundary discontinuity design inspired by Aaronson et al. [2021]. Schools located within 0.25 miles of historical HOLC boundaries are compared across adjacent neighborhoods that received different HOLC grades. This approach isolates the local effects of redlining by holding constant broader city-level factors while accounting for modern neighborhood differences. The analysis proceeds in three parts. First, a national analysis is conducted across 113 metropolitan areas with at least three distinct HOLC zones (A–D) to estimate the average relationship between redlining and STEM access. Second, the study performs localized analyses for four major cities—Chicago, Los Angeles, Philadelphia, and Detroit—to explore regional variation in how redlining's legacy interacts with contemporary urban contexts. Together, these analyses aim to provide the first systematic evidence on whether the legacy of redlining extends to inequalities in advanced STEM education, highlighting how historical structures of exclusion continue to shape the geography of educational opportunity.

The remainder of this paper is organized as follows. The Literature Review provides historical background on the HOLC program, summarizes recent research on the modern consequences of redlining, and discusses the link between neighborhood context and educational outcomes. The Methods section outlines the empirical framework, including the boundary discontinuity design and estimation strategy. The Data section describes the sources used in the analysis, including the HOLC maps and Civil Rights Data Collection (CRDC). The Results section presents findings from the national and city-level analyses, while the Discussion interprets these results in light of policy implications and the broader literature on educational inequality. Finally, the Conclusion summarizes the key insights and identifies directions for future research on the long-term educational legacies of redlining.

2 Literature Review

2.1 HOLC History

The Home Owners' Loan Corporation was created in 1933 as part of the New Deal's effort to stabilize housing markets during the Great Depression. One of the agency's most consequential undertakings was the creation of "residential security maps" that graded neighborhoods based on perceived credit risk. These grades—A ("Best"), B ("Still Desirable"), C ("Definitely Declining"), and D ("Hazardous")—were based on a combination of housing conditions, socioeconomic characteristics, and, critically, racial composition (Jackson et al. [2016]; Hillier [2003]). The resulting maps were color-coded, with "redlined" D-graded neighborhoods typically marked by higher concentrations of Black residents, immigrants, and working-class populations.

Although the HOLC's stated purpose was to assess mortgage risk, its appraisal practices institutionalized racial prejudice within federal lending policy (Crossney and Bartelt [2005]; Michney and Winling [2020]). HOLC assessors drew on local realtors and bankers who frequently described racial "infiltration" as a cause for neighborhood decline, embedding racial and ethnic bias into the official record (Hillier [2003]). These maps were subsequently used by the Federal Housing Administration (FHA) and private lenders to restrict mortgage credit, further entrenching patterns of segregation and disinvestment (Greer [2013]; Aaronson et al. [2021]).

While scholars debate whether the HOLC itself originated redlining or simply reflected existing racial divisions (Fishback et al. [2022]), there is broad consensus that its maps shaped the geography of opportunity for generations. They provided a federally sanctioned template that justified unequal investment, influencing where banks lent, where infrastructure developed, and where families could accumulate wealth (Appel [2016]). By codifying racial risk into financial decision-making, the HOLC helped institutionalize the spatial segregation that continues to define American cities today.

2.2 Modern Outcomes of HOLC

Over the past decade, researchers have connected the geography of redlining to a wide range of contemporary social and economic disparities. Using digitized HOLC maps, scholars have shown that formerly redlined areas continue to exhibit lower home values, lower household incomes, and higher racial segregation (Aaronson et al. [2021]; Appel [2016]; Krimmel [2018]). Beyond housing, these areas also show worse environmental and health outcomes—they experience higher exposure to air pollution, urban heat, and chronic disease (Hoffman et al. [2020]; Nardone et al. [2021]; Namin et al. [2020]).

Importantly, redlining's effects extend into the educational domain. Lukes and Cleveland (Lukes and Cleveland [2021]) provide one of the first comprehensive analyses linking HOLC grades to school funding, diversity, and academic performance. They find that schools located in formerly redlined neighborhoods receive significantly less per-pupil revenue, enroll more racially homogeneous student bodies, and have lower average test scores. These findings suggest that historical redlining has a durable influence on the distribution of educational resources, even after controlling for contemporary socioeconomic conditions.

Other scholars echo these patterns. Aaronson et al. (Aaronson et al. [2021]) find persistent disparities in property values and income across HOLC boundaries, implying that local tax bases—and thus school funding—remain affected. Faber (Faber [2021]) demonstrates that redlining amplified racial wealth gaps by shaping who benefited from mid-century housing subsidies. Collectively, this literature portrays redlining as a foundational mechanism linking historical racial exclusion to contemporary inequality across multiple domains. Yet despite growing recognition of redlining's educational consequences, few studies directly examine whether its legacy extends to STEM coursework access, an increasingly important dimension of academic opportunity and future labor market participation.

2.3 The Relationship Between Schools, Neighborhoods, and Student Outcomes

Education systems are deeply intertwined with neighborhood contexts. In the United States, school funding structures rely heavily on local property taxes, meaning that differences in neighborhood wealth directly translate into differences in educational resources (Jackson et al. [2016]; Lafortune et al. [2018]). Because redlining constrained homeownership and suppressed property values in Black and immigrant neighborhoods, it indirectly limited the fiscal capacity of their local schools. Decades of research show that school resources matter for long-term outcomes: districts that received funding increases after school-finance reforms saw higher graduation rates and adult earnings among low-income students (Jackson et al. [2016]).

Neighborhood effects extend beyond funding. Residential segregation—reinforced by redlining—shapes peer composition, teacher quality, and access to advanced coursework (Reardon et al. [2019]; Owens [2018]). Students in racially and economically segregated schools have fewer opportunities to take advanced placement (AP) courses and less exposure to high-level math and science curricula (Card and Giuliano [2016]). Because STEM course access is a strong predictor of postsecondary achievement and STEM degree completion, these early disparities have compounding effects on social mobility (Maltese and Tai [2011]).

Neighborhood opportunity also influences long-term life trajectories. Chetty and Hendren (Chetty and Hendren [2018a]; Chetty and Hendren [2018b]) show that children who grow up in higher-opportunity neighborhoods—defined by income mobility and school quality—achieve higher adult earnings and educational attainment. Historical redlining shaped these neighborhood opportunity structures, meaning that children today may still inherit the consequences of 1930s credit maps through the schools available to them. By examining whether schools in formerly redlined areas are less likely to offer advanced STEM courses, this study extends existing work on redlining and education to a new dimension of academic inequality.

Ultimately, the literature suggests that the HOLC's spatial imprint remains visible in today's educational landscape. Schools continue to reflect the socioeconomic contours of the neighborhoods they serve, and those contours were, in part, drawn nearly a century ago by federal policy. By linking historical redlining to modern STEM access, this paper provides new evidence on how spatially embedded inequalities continue to constrain pathways into high-opportunity fields, reinforcing intergenerational disparities in human capital formation.

3 Methodology

3.1 Data Sources

This study combines historical neighborhood data with contemporary administrative records on U.S. public high schools. Historical redlining boundaries are drawn from digitized Home Owners' Loan Corporation (HOLC) maps compiled by the Mapping Inequality Project. These maps classify neighborhoods into four categories—A ("Best"), B ("Still Desirable"), C ("Definitely Declining"), and D ("Hazardous")—based on assessments made in the late 1930s.

Contemporary school-level data come from two primary sources. The National Center for Education Statistics (NCES) Common Core of Data (CCD) provides information on school characteristics, including grade span, charter and magnet status, and Title I participation. Data on advanced STEM course offerings are drawn from the Civil Rights Data Collection (CRDC), which reports whether high schools offer calculus, computer science, and physics, as well as counts of these courses.

School addresses from the CCD are geocoded and spatially linked to historical HOLC boundaries. All spatial processing is conducted using standard geographic information system methods to ensure consistent alignment across historical and modern datasets.

3.2 Sample Construction

The analytic sample consists of public high schools located in cities for which digitized HOLC maps are available. To focus on schools plausibly affected by historical neighborhood classification while minimizing confounding from broader city-level differences, I restrict attention to schools located within 0.25 miles of a historical HOLC boundary. This restriction allows for comparisons between schools in close geographic proximity but assigned to different HOLC grades.

Schools are further restricted to those with complete information on advanced STEM offerings and key school characteristics. The final national sample includes 1,767 high schools across 113 cities. City-level analyses focus on Chicago, Detroit, Philadelphia, and Los Angeles, which provide sufficient within-city variation in HOLC grades and school locations near boundaries.

3.3 Empirical Strategy

The objective of this study is to estimate whether schools located in historically lower-rated HOLC neighborhoods (Grades C and D) exhibit reduced access to advanced STEM coursework compared to schools in higher-rated neighborhoods (Grades A and B). To isolate the local, quasi-experimental variation produced by discontinuities in HOLC grading, the analysis employs a boundary discontinuity design following Aaronson, Hartley, and Mazumder (2021). This design compares schools in close geographic proximity but assigned to different HOLC grades, thereby holding constant broader spatial factors that evolve smoothly across neighborhoods.

3.3.1 Boundary Discontinuity Framework

HOLC maps exhibit sharp changes in assigned credit grades at their boundaries. These historical grading breaks represent discontinuous variation in perceived mortgage risk that is plausibly exogenous to modern school-level characteristics once contemporary controls are included. To leverage this variation, I restrict the sample to schools located within 0.25 miles (402 meters) of any boundary between two different HOLC grades. This buffer is constructed around the boundary lines separating HOLC polygons.

Each boundary line segment is treated as a comparison unit. Schools are assigned to the boundary_id of the segment whose buffer they fall within. Schools also receive the HOLC grade of the polygon they physically intersect. Schools outside any HOLC polygon or farther than 0.25 miles from any boundary are excluded. This creates a two-sided local comparison sample in which schools on opposite sides of the same historical boundary line are compared.

Identification is obtained by including boundary fixed effects, which absorb all unobserved, boundary-specific characteristics—such as localized housing stock, neighborhood development patterns, and historical socioeconomic conditions. Because the buffer window is narrow, and because schools on both sides are equidistant from the same boundary, the identifying assumption is that potential outcomes would vary smoothly in the absence of historical HOLC grade differences.

3.3.2 Regression Models

The primary model for the binary indicator of STEM access is a logistic regression of the form:

$$\text{logit}(AnySTEM_i) = \alpha + \beta \cdot Redline_i + \gamma X_i + \eta_{b(i)} + \varepsilon_i, \tag{1}$$

where (AnySTEM_i = 1) if school i offers calculus, physics, chemistry, or computer science, (Redline_i = 1) if school i is located in a C or D HOLC area. (X_i) represents school-level controls: Title I indicator, charter school indicator, magnet school indicator, and percent certified teachers. (\eta_{b(i)}) denotes boundary fixed effects, ensuring that identification comes entirely from variation across schools lying on opposite sides of the same historical boundary. Standard errors are clustered at the boundary segment level, consistent with the identification design.

To examine the extensive and intensive margins of STEM access, I also estimate a negative binomial regression for the number of advanced STEM subjects offered:

$$NB(TotalSTEM_i) = \alpha + \beta \cdot Redline_i + \gamma X_i + \eta_{b(i)} + \varepsilon_i, \quad (2)$$

where (TotalSTEM_i) equals the total number of distinct advanced STEM subjects offered (calculus, physics, chemistry, computer science). This model uses a negative binomial specification to account for the over-dispersed distribution of course offerings. Boundary fixed effects and the same set of controls (X_i) are included, mirroring the binary outcome model.

Together, these models estimate whether historically lower-rated HOLC areas exhibit lower probabilities of offering any advanced STEM course and reduced breadth in STEM offerings.

4 Results

4.1 National Level

4.1.1 Distribution of Advanced STEM Access

I begin by documenting how access to advanced STEM coursework is distributed across schools located near historical HOLC boundaries.

Figure 1 presents the percent of schools offering zero to three advanced STEM subjects—calculus, computer science, and physics—by HOLC grade. A clear and monotonic pattern emerges. Schools located in historically A-rated neighborhoods are substantially more likely to offer a full complement of advanced STEM courses, while schools in lower-rated areas are increasingly concentrated among those offering few or no such courses.

In A-rated neighborhoods, nearly half of schools offer all three advanced STEM subjects, whereas only about one-fifth of schools in D-rated neighborhoods do so. Conversely, the share of schools offering no advanced STEM courses rises steadily as HOLC grade worsens, increasing from roughly 21 percent in A-rated areas to nearly 27 percent in D-rated areas. These shifts indicate that disparities in STEM access operate not only through whether advanced coursework is offered at all, but through systematic differences in curricular breadth.

To provide exact magnitudes underlying these distributions, Table I reports the numeric counts and percentages corresponding to Figure 1. The table highlights that declines in STEM access are driven both by a contraction at the top of the distribution—fewer schools offering all three courses—and by an expansion at the bottom, with a growing share of schools offering none. Together, Figure 1 and Table I demonstrate that historical HOLC grades are strongly associated with how advanced STEM opportunities are distributed across schools, even within narrow geographic areas.

Table I. Distribution of Advanced STEM Course Availability by HOLC Grade

HOLC Grade	Total Schools	0 Count	0 %	1 Count	1 %	2 Count	2 %	3 Count	3 %
A	86	18	20.9%	11	12.8%	19	22.1%	38	44.2%
B	303	68	22.4%	53	17.5%	61	20.1%	121	39.9%
C	735	175	23.8%	158	21.5%	176	23.9%	226	30.7%
D	643	173	26.9%	163	25.3%	171	26.6%	136	21.2%

Notes: This table reports the number and percentage of schools offering zero to three advanced STEM subjects within each HOLC grade category. Percentages are calculated within HOLC grade.

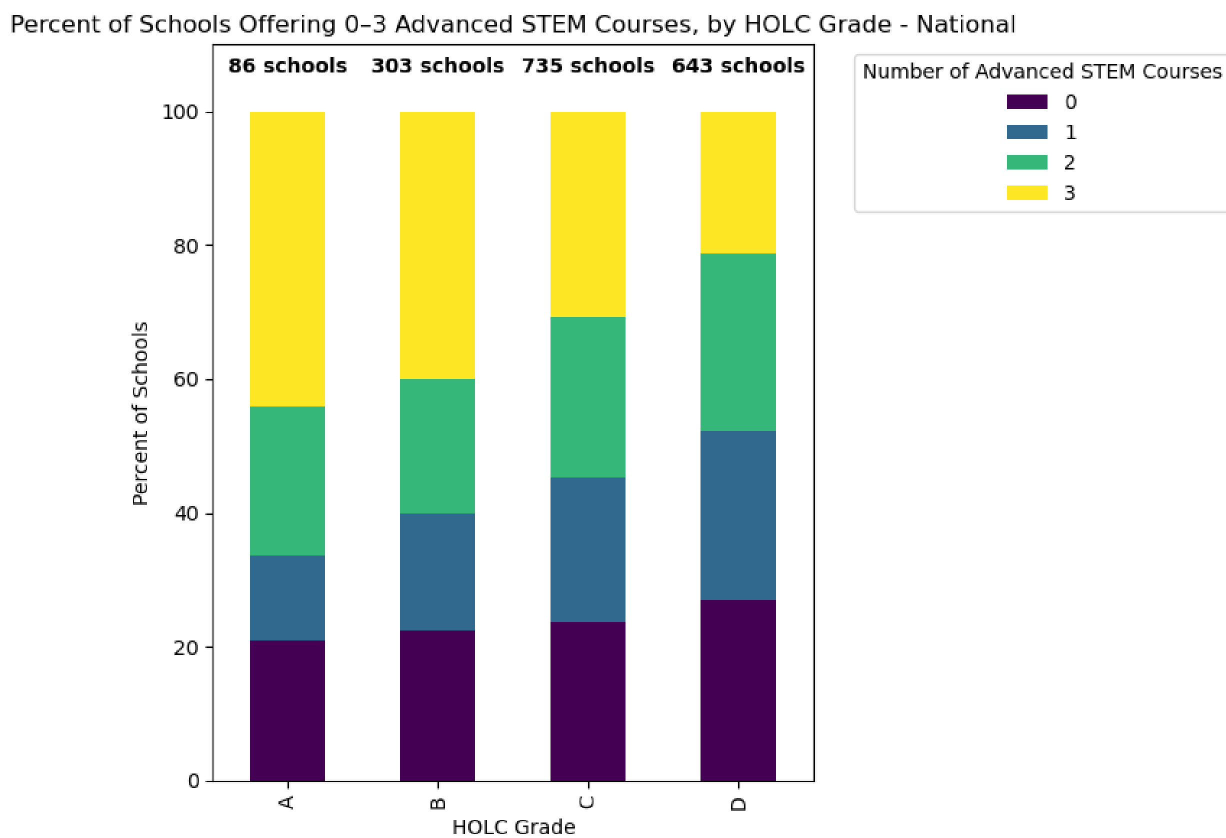


Figure 1: Percent of Schools Offering 0–3 Advanced STEM Subjects, by HOLC Grade
Notes: This figure shows the distribution of high schools offering zero to three advanced STEM subjects (calculus, computer science, and physics) by historical HOLC grade. Percentages sum to 100 within each grade. Sample sizes for each HOLC category are reported above the bars.

4.1.2 Depth of Advanced STEM Offerings

I next examine differences in the depth of advanced STEM instruction across neighborhoods. Figure 2 plots the average number of advanced calculus, computer science, and physics courses offered by schools in each HOLC grade, with error bars representing standard errors.

Across all three subjects, average course offerings decline smoothly and monotonically from A- to D-rated neighborhoods. Schools located in historically A-rated areas offer the greatest depth of advanced coursework, averaging approximately 3.4 calculus classes, 5.6 computer science classes, and over 8 physics classes. These averages fall sharply in lower-rated neighborhoods. In D-rated areas, schools typically offer about one calculus class, just over two computer science classes, and roughly four physics classes.

Importantly, the decline is evident across all STEM disciplines, indicating that reduced access in historically redlined areas reflects broad curricular constraints rather than subject-specific tradeoffs. The limited overlap in error bars across grades suggests that these differences are both substantively large and precisely estimated.

4.1.3 Regression Evidence: Any Advanced STEM Access

I next turn to regression estimates that quantify the relationship between HOLC grade and access to advanced STEM coursework, holding constant observable school characteristics. Table II reports linear probability model estimates predicting whether a school offers at least one advanced STEM course. The first specification uses a binary indicator for whether a school is located in a historically redlined (C- or D-rated) neighborhood, while the second includes categorical indicators for each HOLC grade relative to A-rated areas.

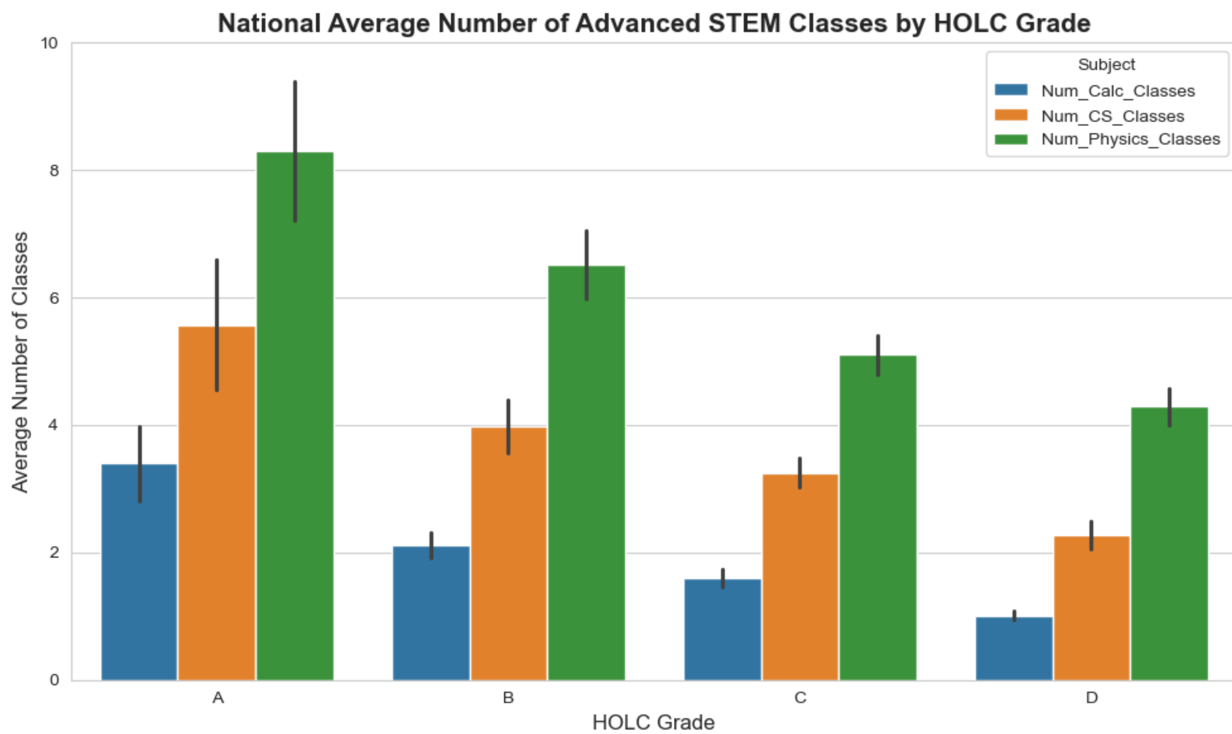


Figure 2: National Average Number of Advanced STEM Classes by HOLC Grade
Notes: This figure shows mean counts of advanced calculus, computer science, and physics courses offered by high schools in each HOLC grade category. Error bars represent standard errors.

Schools located in historically redlined neighborhoods are significantly less likely to offer any advanced STEM coursework. The binary specification indicates a reduction of approximately 10 percentage points in the probability of offering at least one advanced STEM course relative to schools in A- or B-rated areas. The categorical specification reveals a similar gradient: relative to A-rated neighborhoods, schools in C- and especially D-rated areas exhibit lower probabilities of offering advanced STEM courses, while differences between A- and B-rated areas are minimal.

Table II. Effect of HOLC Grade on the Probability of Offering Any Advanced STEM Course

HOLC Grade / Indicator	(1) Binary Redline (C/D)	(2) HOLC Grade Categories
Redlined (C/D)	**-0.105** (0.054)	—
HOLC B	—	0.010 (0.095)
HOLC C	—	-0.052 (0.088)
HOLC D	—	-0.152 (0.099)
Magnet School	0.218*** (0.064)	0.238*** (0.064)
Charter School	-0.080 (0.079)	-0.061 (0.081)

Notes: Each column reports estimates from a linear probability model predicting whether a high school offers at least one advanced STEM course (calculus, computer science, or physics). Column (1) uses a binary indicator for historically redlined neighborhoods (HOLC C or D). Column (2) includes indicator variables for each HOLC grade, with A-rated neighborhoods as the reference group. All specifications include controls for Title I status and teacher certification. The sample consists of 1,767 high schools located within 0.25 miles of a historical HOLC boundary. Standard errors are reported in parentheses. p <.10, * p <.05, ** p <.01, *** p <.001.

4.1.4 Regression Evidence: Breadth of Advanced STEM Offerings

Finally, Table III reports regression estimates for the total number of advanced STEM subjects offered, capturing differences at the intensive margin. The results reveal substantially larger effects than those observed for the binary access outcome. Schools located in historically redlined neighborhoods offer significantly fewer advanced STEM subjects on average than their counterparts in higher-rated areas.

The categorical specification shows a pronounced monotonic gradient across HOLC grades. Relative to A-rated neighborhoods, schools in B-rated areas offer fewer advanced STEM subjects, with larger declines observed for C-rated neighborhoods and the largest reductions occurring in D-rated areas. The magnitude of these estimates mirrors the sharp drops in average course counts observed in Figure 2.

Table III. Effect of HOLC Grade on the Number of Advanced STEM Subjects Offered

HOLC Grade / Indicator	(1) Binary Redline (C/D)	(2) HOLC Grade Categories
Redlined (C/D)	**-6.675**** (2.290)	—
HOLC B	—	-3.124 (3.462)
HOLC C	—	-5.874 (3.557)
HOLC D	—	**-12.474*** (3.663)
Magnet School	3.267 (3.480)	4.644 (3.505)
Charter School	-11.718*** (2.998)	-10.758*** (2.989)

Notes: This table reports OLS estimates relating historical HOLC grade to the total number of advanced STEM subjects offered by a high school (0–3). Column (1) compares schools in historically redlined (C/D) neighborhoods to those in A/B neighborhoods. Column (2) includes categorical HOLC grade indicators, with A-rated neighborhoods as the reference group. All specifications include controls for Title I status and teacher certification. The sample consists of 1,767 high schools located within 0.25 miles of a historical HOLC boundary. Standard errors are reported in parentheses. p <.10, * p <.05, ** p <.01, *** p <.001.

4.1.5 Summary of National Findings

Across the national sample of high schools located near historical HOLC boundaries, the legacy of redlining remains clearly visible in access to advanced STEM education. Descriptive evidence shows a consistent redistribution of schools away from offering a full suite of advanced STEM courses and toward offering few or none as HOLC grades worsen. Regression estimates confirm that these patterns persist after accounting for observable school characteristics and local context.

Importantly, the effects of redlining are far more pronounced along the intensive margin than the extensive margin. While the probability of offering any advanced STEM coursework declines modestly from A- to D-rated neighborhoods, the breadth of STEM offerings falls sharply. This suggests that historical housing discrimination continues to shape not just whether STEM opportunities exist, but the depth and quality of those opportunities—an outcome with meaningful implications for students' college readiness and long-term access to STEM careers.

4.2 City-Level Analyses: Chicago, LA, Philadelphia, Detroit

To complement the national analysis, I examine how the relationship between historical HOLC grades and advanced STEM course offerings varies across four large metropolitan areas: Chicago, Los Angeles, Philadelphia, and Detroit. These cities were selected because each contains substantial historical redlining coverage and sufficient variation in school locations relative to HOLC boundaries. As in the national analysis, I restrict the sample to high schools located within 0.25 miles of a historical HOLC boundary, ensuring that comparisons are made across geographically proximate neighborhoods.

The goal of this section is not to compare cities to one another directly, but rather to assess whether the national patterns documented above persist within individual urban contexts, and to identify where and why deviations may emerge.

4.2.1 Descriptive Patterns Within Cities

Figure 3 provides a spatial overview of historical HOLC grades and advanced STEM course availability across the four cities. Schools are overlaid on HOLC maps and shaded by the number of advanced STEM courses offered. In Chicago and Detroit, the spatial distribution closely mirrors national expectations: schools located in A- and B-rated neighborhoods are more likely to offer multiple advanced STEM courses, while those in C- and D-rated areas are more likely to offer fewer options.

Philadelphia exhibits a similar but less pronounced spatial gradient. In part, this reflects the limited number of present-day high schools located within historically A-rated neighborhoods, which reduces the contrast between categories within the boundary-restricted sample. Los Angeles stands out as the least spatially consistent with national patterns. Schools offering multiple advanced STEM courses are dispersed across HOLC grades, including in historically lower-rated neighborhoods.

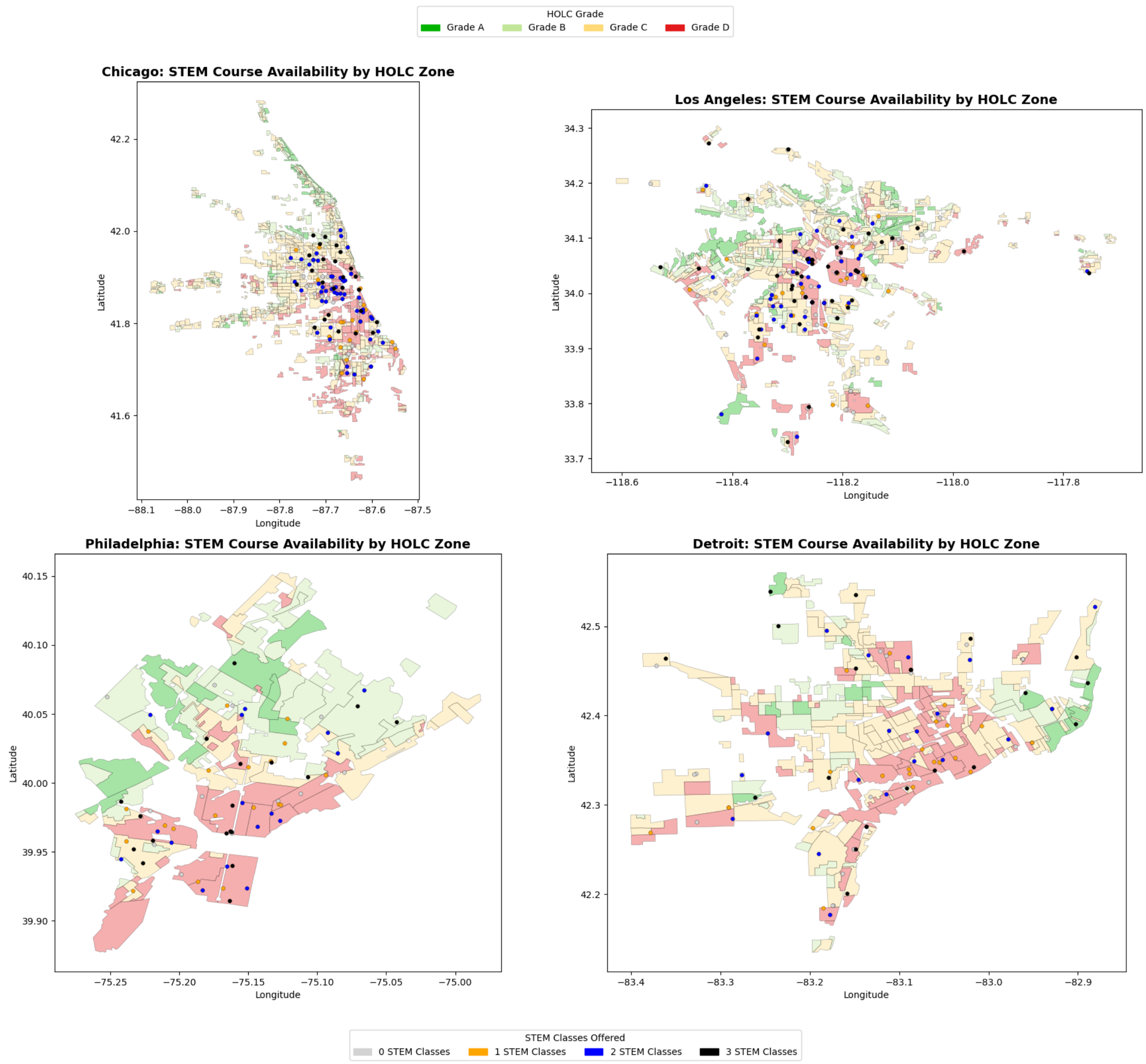


Figure 3: HOLC Neighborhoods and STEM Course Availability, Four Major Cities
Notes: This figure maps historical HOLC grades (A–D) for Chicago, Los Angeles, Philadelphia, and Detroit, with high schools overlaid and shaded by the number of advanced STEM courses offered (0–3).

4.2.2 Depth of Advanced STEM Offerings Within Cities

To move beyond spatial patterns and examine differences in instructional depth, Figure 4 reports the average number of advanced calculus, computer science, and physics courses offered by schools in each HOLC grade category within each city.

Chicago and Detroit display clear and monotonic declines in advanced STEM offerings as HOLC grades worsen. These patterns closely parallel the national results and are especially pronounced in physics and computer science. Philadelphia shows more modest declines, with greater variability across grades, reflecting smaller sample sizes in A-rated neighborhoods and increased noise in the estimates.

Los Angeles again diverges from the national pattern. Average course counts for C- and D-rated neighborhoods are comparable to—or in some cases exceed—those in A- and B-rated areas. This divergence suggests that the relationship between historical neighborhood ratings and present-day STEM access is weaker in Los Angeles than in the other cities examined.

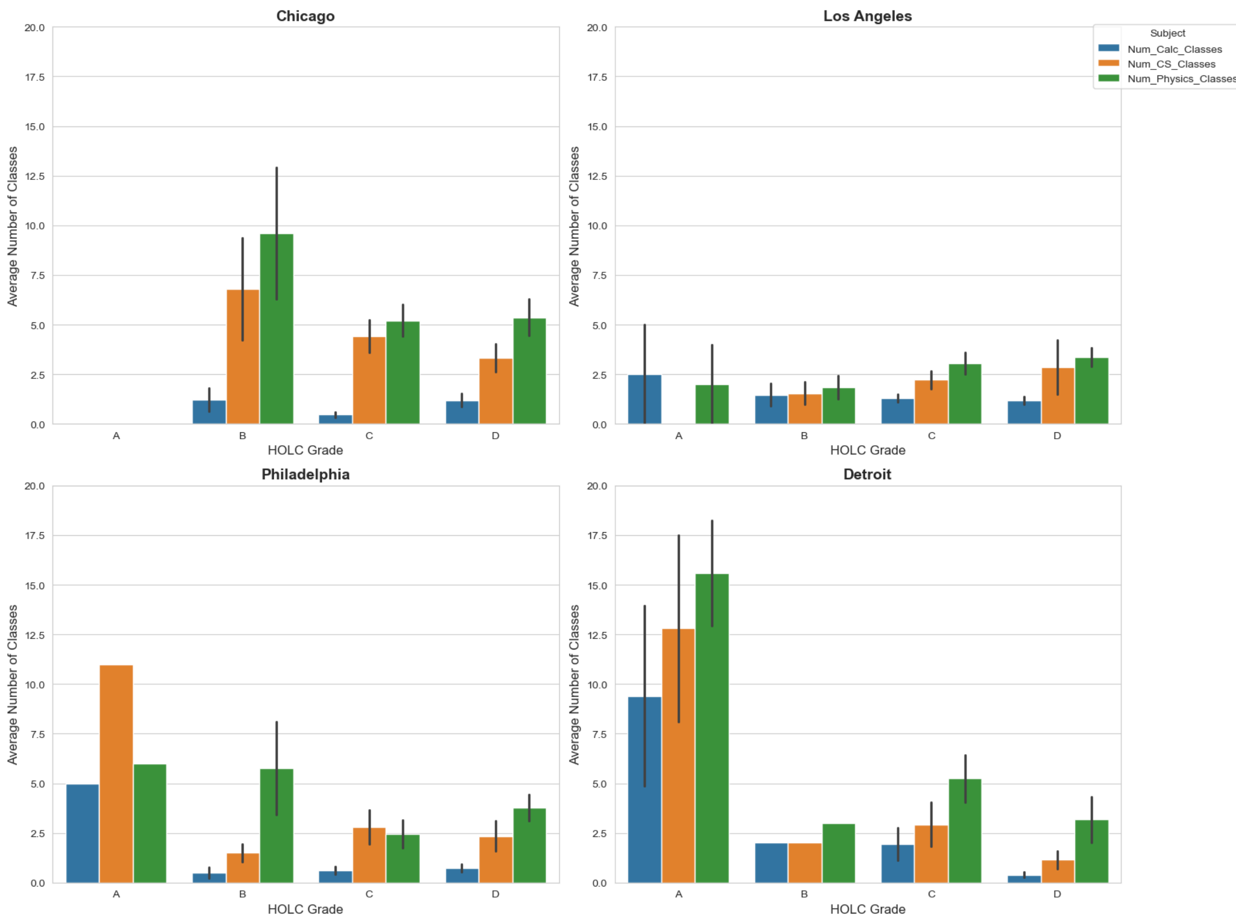


Figure 4: Average Number of Advanced STEM Courses by HOLC Grade, Four Cities
Notes: This figure reports mean counts of advanced calculus, computer science, and physics courses by HOLC grade within each city. Error bars represent standard errors.

4.2.3 Regression Evidence Within Cities

To formally quantify these relationships, Table IV summarizes binary redline regression estimates for each city, comparing schools located in historically redlined (C/D) neighborhoods to those in A/B neighborhoods. Two outcomes are considered: (1) the probability that a school offers at least one advanced STEM course, and (2) the total number of advanced STEM courses offered.

Chicago and Detroit exhibit large and negative redline effects across both outcomes. In Chicago, schools in historically redlined neighborhoods are substantially less likely to offer any advanced STEM coursework and offer fewer courses overall. Detroit shows even larger magnitudes, particularly for the total number of advanced STEM courses, underscoring the persistence of historical disadvantage in cities with entrenched patterns of segregation and disinvestment.

Philadelphia's estimates are smaller in magnitude and less stable across outcomes, consistent with the muted descriptive patterns observed earlier. Los Angeles is the only city where the estimated redline effects are positive for both outcomes, indicating that schools in historically redlined neighborhoods are, on average, slightly more likely to offer advanced STEM courses and to offer more such courses overall.

Table IV. City-Level Binary Redline Effects on STEM Access

City	Binary Redline Effect (Any STEM)	Binary Redline Effect (Total STEM)
Chicago	-0.174*** (0.042)	-6.050 (7.003)
Detroit	-0.283*** (0.060)	-24.488* (11.180)
LA	0.079 (0.135)	2.425 (1.681)
Philly	0.084 (0.130)	-2.290 (3.089)

Notes: This table reports binary regression estimates comparing schools in historically redlined (C/D) neighborhoods to those in A/B neighborhoods within each city. Negative coefficients indicate reduced STEM access in C/D areas. All specifications include controls for Title I status, teacher certification, and magnet/charter status. The sample consists of 1,767 high schools located within 0.25 miles of a historical HOLC boundary. Standard errors are reported in parentheses. p <.10, * p <.05, ** p <.01, *** p <.001.

Table V extends the analysis by estimating categorical HOLC grade effects within each city, allowing for comparisons across B-, C-, and D-rated neighborhoods relative to A-rated areas.

Chicago and Detroit again display clear monotonic declines across HOLC grades for both outcomes, reinforcing the national finding that lower historical neighborhood ratings are associated with reduced access to advanced STEM coursework. Philadelphia's estimates fluctuate in sign and magnitude, reflecting limited A-rated coverage and increased sampling variability. Los Angeles consistently exhibits positive coefficients across categories, suggesting that historical HOLC grades align less closely with present-day school resources in that city.

Table V. City-Level Categorical HOLC Grade Effects on STEM Access

City	AnySTEM_B	AnySTEM_C	AnySTEM_D	TotalSTEM_B	TotalSTEM_C	TotalSTEM_D
Chicago	0.365***	0.166**	0.220***	3.126	-3.362	-2.416
	(0.055)	(0.051)	(0.051)	(5.438)	(2.463)	(2.043)
Detroit	-0.005	-0.252***	-0.318***	-30.992	-27.265*	-32.183**
	(0.054)	(0.075)	(0.087)	(26.540)	(12.219)	(11.994)
LA	0.187	0.202	0.288	0.468	2.475	3.261
	(0.720)	(0.709)	(0.709)	(6.529)	(6.448)	(6.625)
Philly	-0.218	-0.082	-0.142	-14.872	-16.957*	-16.036*
	(0.177)	(0.171)	(0.143)	(7.961)	(7.590)	(7.578)

Notes: This table reports regression estimates comparing each HOLC grade (B, C, and D) to A-rated neighborhoods within each city. All specifications include controls for Title I status, teacher certification, and magnet/charter status. The sample consists of 1,767 high schools located within 0.25 miles of a historical HOLC boundary. Standard errors are reported in parentheses. p <.10, * p <.05, ** p <.01, *** p <.001.

4.2.4 Comparison to National Patterns

Taken together, the city-level analyses demonstrate that the national relationship between historical redlining and advanced STEM access is not driven by a single metropolitan area. Chicago and Detroit closely replicate the national pattern, with large and persistent reductions in both the likelihood and breadth of advanced STEM offerings in historically lower-rated neighborhoods. Philadelphia shows weaker and less precise effects, largely due to sample limitations rather than an absence of underlying disparities.

Los Angeles represents a meaningful departure from the national trend. Rather than indicating a reversal of redlining's effects, this divergence likely reflects the city's distinct educational geography, including extensive postwar development and the concentration of magnet and specialized schools in historically lower-rated central neighborhoods. These institutional features weaken the alignment between historical HOLC boundaries and present-day school resources.

Overall, the city-level results reinforce the conclusion that redlining's educational legacy is robust but locally contingent. In cities with stable neighborhood structures and persistent segregation, historical housing discrimination continues to shape access to advanced STEM education. Where urban development and school placement have evolved more dramatically, the relationship becomes more diffuse, though disparities in STEM depth remain evident.

5 Discussion

The results provide evidence that historical redlining continues to shape access to advanced STEM coursework, particularly along the intensive margin. Nationally, schools located in historically C- and D-rated neighborhoods are not only less likely to offer any advanced STEM course but also offer fewer distinct advanced STEM subjects. These findings suggest that educational disparities linked to redlining operate through reductions in curricular depth rather than complete exclusion from STEM instruction.

One plausible mechanism underlying these patterns is the persistence of fiscal and institutional constraints in historically disinvested neighborhoods. Because school funding in the United States remains closely tied to local property values, neighborhoods that experienced decades of suppressed homeownership and investment may continue to face resource limitations that restrict the ability to staff and sustain advanced coursework. Advanced STEM classes, particularly physics and computer science, often require specialized teachers and smaller class sizes, making them especially sensitive to budget constraints.

Teacher labor market dynamics may further reinforce these disparities. Schools in historically marginalized neighborhoods may face greater difficulty attracting and retaining teachers with specialized STEM credentials, leading administrators to prioritize core graduation requirements over advanced offerings. Over time, these staffing challenges can become self-reinforcing as limited course availability reduces student demand and institutional justification for expanding advanced programs.

City-level heterogeneity highlights the importance of local context in mediating these mechanisms. In Chicago and Detroit—cities characterized by long-standing residential segregation and relatively stable neighborhood boundaries—the relationship between HOLC grade and STEM access closely mirrors the national pattern. In contrast, Los Angeles exhibits weaker and sometimes reversed associations. This divergence may reflect the city's distinct educational geography, including the concentration of magnet and specialized schools in historically lower-rated neighborhoods and substantial postwar development that weakened the alignment between HOLC boundaries and present-day school resources.

Alternative explanations must also be considered. Measurement error in historical boundaries or contemporary course reporting could attenuate estimated effects, particularly in cities with fewer A-rated neighborhoods. Additionally, selective school placement—such as the siting of magnet programs in historically disadvantaged areas—could bias estimates upward in some contexts, as appears plausible in Los Angeles. While the boundary discontinuity design mitigates many confounding factors, it cannot fully account for all post-HOLC policy interventions that reshaped local educational landscapes.

From a policy perspective, these findings suggest that addressing educational inequality requires attention not only to student access but also to the depth of curricular offerings. Policies aimed at expanding advanced STEM coursework in historically disadvantaged neighborhoods—such as targeted funding for specialized teachers or incentives for advanced course development—may help disrupt the persistence of historically rooted disparities. Importantly, the heterogeneity observed across cities indicates that such interventions must be tailored to local institutional contexts rather than applied uniformly.

6 Conclusion

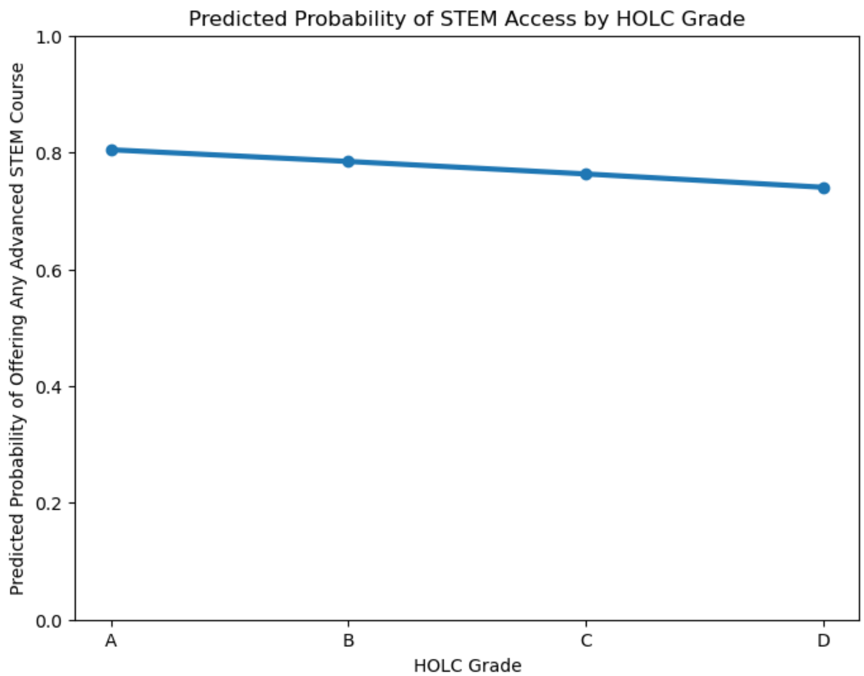
This paper provides evidence that historical redlining continues to influence access to advanced STEM coursework in U.S. public high schools. Using a boundary discontinuity design, I show that schools in historically lower-rated neighborhoods offer fewer advanced STEM courses than nearby schools in higher-rated areas, with particularly strong effects in cities characterized by persistent segregation. These disparities operate primarily through reductions in curricular depth rather than complete exclusion from STEM instruction.

Future research could build on these findings by examining how advanced STEM course availability translates into downstream outcomes such as STEM college enrollment or labor market trajectories. Further work could also explore the role of district-level policies and school choice mechanisms in mediating the legacy of redlining. More broadly, the results underscore that historical housing discrimination continues to shape educational opportunity in subtle but consequential ways, reinforcing the need for place-based approaches to educational equity.

7 Appendix

7.1 Appendix A. Additional Figures

Figure A.1. Predicted Probability of Offering Advanced STEM Courses by Historic HOLC Grade



7.2 Appendix B. Full Regressions with Controls

Table B.1. Any STEM - Binary Redline

term	Coef (SE)	p
Intercept	0.771 (0.173)	<.001
Redline_CD	-0.105 (0.054)	0.051
MAGNET_FLAG	0.218 (0.064)	<.001
CHARTER_FLAG	-0.080 (0.079)	0.314
PCT_CERTIFIED_FTE	-0.000 (0.002)	0.878
TITLE1_FLAG	0.147 (0.056)	0.009**

Table B.2. Any STEM - Grade Categories

term	Coef (SE)	p
Intercept	0.783 (0.194)	<.001
C(grade_cat, Treatment(‘A’))[T.B]	0.010 (0.095)	0.915
C(grade_cat, Treatment(‘A’))[T.C]	-0.052 (0.088)	0.554
C(grade_cat, Treatment(‘A’))[T.D]	-0.152 (0.099)	0.124
MAGNET_FLAG	0.238 (0.064)	<.001
CHARTER_FLAG	-0.061 (0.081)	0.449
PCT_CERTIFIED_FTE	-0.001 (0.002)	0.778
TITLE1_FLAG	0.146 (0.057)	0.010**

Table B.3. Total STEM Classes - Binary Redline

term	Coef (SE)	p
Intercept	23.512 (8.454)	0.005**
Redline_CD	-6.675 (2.290)	0.004**
MAGNET_FLAG	3.267 (3.480)	0.348
CHARTER_FLAG	-11.718 (2.998)	<.001
PCT_CERTIFIED_FTE	-0.057 (0.086)	0.510
TITLE1_FLAG	5.475 (2.734)	0.045*

Table B.4. Total STEM Classes - Grade Categories

term	Coef (SE)	p
Intercept	26.984 (9.246)	0.004**
C(grade_cat, Treatment(‘A’))[T.B]	-3.124 (3.462)	0.367
C(grade_cat, Treatment(‘A’))[T.C]	-5.874 (3.557)	0.099
C(grade_cat, Treatment(‘A’))[T.D]	-12.474 (3.663)	<.001
MAGNET_FLAG	4.644 (3.505)	0.185
CHARTER_FLAG	-10.758 (2.989)	<.001
PCT_CERTIFIED_FTE	-0.072 (0.088)	0.413
TITLE1_FLAG	5.794 (2.713)	0.033*

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