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# The Role of Public Space: Libraries and Racial Inequality in Education

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#### Abstract

Gaps in educational outcomes between white and non-white children in the United States are still stark. Public infrastructure potentially mitigates these inequalities. This paper examines the impact of public library closures, a loss of public indoor space, on U.S. educational outcomes between 2009 and 2018. Analyzing geo-located data on library closures and using an event study approach, findings reveal that test scores declined in school districts that experienced closures. The effect is especially pronounced in districts with a predominantly nonwhite student body. A further mechanism analysis suggests that losing quiet study space and internet access might be key drivers behind this effect.

**Keywords:** Public libraries, education, event study, inequality, race **JEL Codes:** I24, H52, J15, C33

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### 1 Introduction

The U.S. school system is still highly segregated leading to substantial gaps in educational outcomes between white and non-white children (Caetano & Maheshri, 2023; Card & Rothstein, 2007; Monarrez, 2023; Reardon et al., 2019). These disparities not only contribute to heightened inequality in terms of higher education and income but also give rise to other negative consequences, such as higher crime rates (Deming, 2011; Rumberger, 2010). A potential means to offset this development is the presence and support of public and community institutions—so-called "social solutions" (Saez, 2021)—public libraries being particularly important in the United States.

Pubic libraries are essential social infrastructure that offer one of the few indoor spaces free and open to everyone, and are, thus, a potentially important tool to mitigate inequalities (Klinenberg, 2019). Gilpin et al. (2023) find that an additional \$200 per child investment in public libraries increases reading test scores by 0.02 standard deviations. The effects are mainly driven by white and Asian students' improved test scores. Libraries are also important for communities as a whole: library programs for adults increase labor force participation (Ferreira Neto, 2023). Porter (2015) finds that public libraries' extended opening hours in Los Angeles reduced crime rates. Economic historians find that the expansion of public libraries in the U.S. was largely driven by urbanization and a diverse migrant population and highlight these public spaces' importance for non-white communities (Kevane & Sundstrom, 2014). Aside from economics, there is a large literature on libraries and social capital in the information and library sciences (Aabø, 2005; Ferguson, 2012; Johnson, 2010; Vårheim et al., 2008; Wojciechowska, 2020). A systematic literature review by Stenstrom et al. (2019) stresses the public libraries' significance for vulnerable populations and community development.

The crucial role that public libraries play in addressing inequality underscores the importance of understanding how library closures—and the ensuing loss of public space—affect and shape communities. This paper analyses how public library closures influence students' educational performance in the United States between 2009 and 2018. Public school test scores of students between grade 3 and 8, aged 8 to 14,

are the main outcome. Using library closures in school districts as treatment shocks, I identify a causal connection between library closures and educational outcomes: a closure leads to a statistically and economically significant decline in test scores of around 0.02 standard deviations.

Public libraries offer more than just books—they provide access to the internet and computers, programs for children and adults, and quiet space. All these dimensions are of greater importance to poorer individuals—they are more likely to live in crowded spaces, without internet access, and with fewer books. In 2020, Chandra et al. (2020) found that around 30 percent of K-12 students in the U.S. have inadequate access to the internet or digital devices. The closure of public libraries, therefore, might additionally limit the resources of people who are socioeconomically worse off. Thus, I conduct heterogeneity analyses differentiating by race and socioeconomic status. I find that school districts where most children are non-white suffer significantly more from public library closures. Closures do not significantly influence performance gaps *within* school districts between non-white and white children as well as gaps between boys and girls.

To shed more light on potential mechanisms, I focus on who uses libraries and how. First, I estimate the effect separately for math and reading outcomes. The effect size for math scores is almost double than that of reading scores, with a reduction of 0.025 and 0.011 standard deviations respectively. Bhatt (2010) finds that public libraries increase the time children spend reading and their homework completion rates, which might explain some of this effect. Next, I differentiate between the kind of library outlet that was closed—central library, branch library or bookmobile. The effect is entirely driven by the closure of branch libraries. This might indicate that internet access and the space a public library provides are essential, as the shutdown of bookmobiles, which merely offer access to books, has no effect. Lastly, I show that internet use is more important in school districts with a predominantly non-white student body.

Overall, this paper adds to the literature about racial inequality in education by exploring new aspects and mechanisms beyond current research, like the role of quiet study space and internet access. It is also, to my knowledge, the first paper looking at the nationwide effects of library closures, therefore, contributing to the broader discourse on the impact of public infrastructure on social inequalities. I aim to provide a deeper understanding of the multifaceted nature of educational disparities, emphasizing the role of accessible public resources such as libraries.

### 2 Data on Public Libraries and Education

**Public Library Data.** The Public Libraries Survey (PLS, Pelczar et al., 2023) offers data on the near-universe of public libraries in the United States with a response rate of around 97 percent. There is rich information on finances and usage, as well as openings and closings of libraries and their branches. My sample covers the years 2009 to 2018, including on average 8,972 public libraries in 49 states<sup>1</sup>, reporting 819 library closures and 688 openings. I discuss closures in more detail below. In this paper, I include all kinds of library outlets – from central libraries to branch libraries and bookmobiles (see Table 1 for an overview).

	Mean Number of Outlets per Year	Number of Closures from 2009 to 2018	Number of Openings from 2009 to 2018
Central Library	8,972	101	105
Branch Library	7,647	452	450
Bookmobile	651	262	133
Other	3	4	0
Sum	17,273	819	688

Table 1: Public Library Outlets between 2009 and 2018

*Notes:* This table shows all kinds of library outlets and their number of closures betweeen 2009 and 2018. *Source:* Own calculations, data: Public Library Survey (PLS)

**Educational Data.** Educational outcome data come from the Educational Opportunity Project at Stanford University (SEDA, Reardon et al., 2023), which collects standardized test scores for school districts. In the U.S., federal law requires U.S. schools to perform yearly, standardized tests for math and Reading Language and Arts (RLA or reading from here on) from grade 3 to 8. However, states can design these tests

<sup>&</sup>lt;sup>1</sup>I include all states except Alaska and Hawaii, Puerto Rico and other U.S. territories.

following their own standards. These data are then collected by the U.S. Department of Education and made comparable across states and years by SEDA.<sup>2</sup> They are centered around 0, so negative values indicate that a grade in a school district in a specific year performed worse than the average. The data are available for the school years 2008/09 to 2017/18. These cohort-standardized test scores for each school district, in each year, for each available grade and subject are my main outcome variable. SEDA includes a wide range of control variables from the racial composition of the school district to information about housing and other socio-demographic variables. In 2018, there were 18,274 school districts on the United States mainland. SEDA offers data for 12,838 school districts, which I restrict in my main specification to a balanced panel between 2009 and 2018, leaving me with 564,260 observations for 5,940 school districts. I use the unbalanced panel in a robustness check later on.

The SEDA data is based on the 2019 Elementary and Unified School District Boundaries provided by the National Center for Education Statistics (NCES). Using the provided shapefile, I create a treatment variable, indicating whether and when a library unit within the school district closed. For districts with multiple closures over time, I consider the first closure as the treatment.

Table 2 shows summary statistics for all school district-grade-subject-year observations, those without a closure (not treated) and those where at least one library unit closed (treated). In total, 348 school districts witnessed a library closure. There is a clear difference between the two: treated school districts have on average worse math and reading outcomes, have more libraries and more students. Treated school districts tend to have similar public school fundings per student. They tend to be poorer and the share of non-white students is higher. However, bear in mind that they do not need to be similar in level to identify an effect, but merely in trend. The pre-trends of my analysis offer evidence that trends in both groups are indeed similar.

<sup>&</sup>lt;sup>2</sup>For more details see the documentation of the SEDA 4.1 data.

	All	Not Treated	Treated
SEDA Test Scores			
Mean Math Score	0.02	0.03	-0.09
SD Math Score	0.10	0.10	0.07
Mean Reading Score	0.01	0.01	-0.06
SD Reading Score	0.10	0.10	0.07
Public Libraries, School Districts and Fu	nding		
Mean Number of Libraries	1.57	1.37	4.68
Mean Number of Students	344	296	1134
Log Mean School Funding per Student	11.95	11.95	11.94
School District Characteristics			
Majority Non-White (in %)	18.77	17.81	34.68
Mean Poverty Rate (in %)	13.96	13.76	17.19
Mean Income (Log)	10.79	10.79	10.70
Mean Unemp Rate (in %)	7.37	7.29	8.64
N (District-Grade-Subject-Year Obsv.)	564,260	532,260	32,000

Table 2: Summary Statistics

Source: own calculations, data: Educational Opportunity Project at Stanford University (SEDA) and Public Library Survey (PLS).

### 3 Empirical Strategy and Identification

To identify the causal effect of library closures on math and reading test scores, I estimate an event study model following Miller (2023):

$$y_{dgst} = \sum_{j \in -8\dots0\dots8} \gamma_j \times D_{d,t-j} + \alpha_d + \delta_{zt} + \epsilon_{dgst}, \tag{1}$$

where  $y_{dgst}$  is the cohort-standardized test score in school district *d*, for grade *g* and subject *s* in the year *t*.  $D_{d,t-j}$  indicates the distance from the year in which a library unit was closed within the school district *d*. I include school district fixed-effects  $\alpha_d$  and state-year fixed-effects  $\delta_{zt}$ . I estimate the same specification using the estimator by Sun and Abraham (2021) in order to account for the staggered treatment (as school districts are treated at different points in time). The standard errors are clustered at the school district-level, as it is the level on which treatment takes place. I bin the first and the last period because of lack of support.

Figure 1: Public Libraries in the United States and their Closures between 2009 and 2018



Source: Own calculations, data: Public Library Survey (PLS) and U.S. Census Bureau

#### Ι

**Identification Strategy.** I can clearly identify the effect of library closures on school performance, using information on their timing and geo-location. The PLS states the reason why a library unit drops out of the panel—aside from closures it documents temporary closures, mergers with another library, or other administrative changes.<sup>3</sup> Figure 1 shows that library closures were geographically equally distributed among the U.S. between 2009 and 2018. There also do not seem to be any time trends in closures (see figures A1 and A2 in the appendix). The amount of openings is similar to the number of closures in my sample, however, these two events are only very weakly correlated (r = 0.11, for absolute numbers over time see figure A3 in the appendix). Another concern might be restorations; their numbers are around 10 percent of those of closures. To be sure, I exclude libraries that were restored after the closure in a robustness check. Reasons for closures might be manifold as Koontz et al. (2009) document: lack of use,

<sup>&</sup>lt;sup>3</sup>For more details see the documentation of the 2021 PLS data.

reduction of funding and the opening of another library facility being among the most common reasons. To address the lack of use, I regress the annual opening hours of a library on dummies for each year before the closure—non of these dummies are statistically significant. Since a reduction in public library funding might be connected to public school funding, I control for public school funding in my main specifications.

### 4 **Results**

The event study plot in Figure 2 shows the results for my main specification—estimating the effect of a library closure within a school district on the average test scores of students aged between 8 and 14. There are small and statistically insignificant pre-trends, which are jointly zero in both specifications.





Time to treatment

This figure shows the results of the event study design specification as seen in equation (1) using TWFE and the Sun and Abraham (2021) estimator. Pre-trends are jointly zero. *Source*: own calculations, data: Educational Opportunity Project at Stanford University (SEDA) and Public Library Survey (PLS).

The event study plot clearly shows that library closures have a lasting negative effect on students' test scores. The average treatment effect on the treated (ATT, see Table 3, column (1)) is -0.0185, meaning that a library closure reduces test scores by approximately 0.02 standard deviations. This effect size is in line with the previous literature using SEDA data. For example Gilpin et al. (2023) find a 0.01 standard deviation increase of test scores after libraries receive additional funding in the short-run, and a 0.02 standard deviation increase in the long-run.

One major concern regarding identification is the funding of public schools and public libraries. Since both are primarily funded by local and state sources, with only a small amount of federal funding, this might be a concern. If closures take place because of reduced funding for both, public libraries and public school, this could lead to worse test scores due to reduced school funding rather than the closure of the library itself. Therefore, I use data from the NCES on public school funding for each school district as a control. The results are robust to this addition (see column (2) in table 3). As expected, more public school funding significantly increases students test scores.

Dependent Variable:	Test Scores			
Model:	(1)	(2)	(3)	(4)
Library Closure (ATT)	-0.0185***	-0.0180***	-0.0179***	-0.0179***
	(0.0062)	(0.0062)	(0.0062)	(0.0062)
log(Funding)		0.0359***	0.0356***	0.0356***
		(0.0104)	(0.0104)	(0.0104)
Fixed-effects				
School district	Yes	Yes	Yes	Yes
State-Year	Yes	Yes	Yes	Yes
Subject-Year			Yes	Yes
Grade-Year				Yes
Fit statistics				
Dep. var. mean	0.01475	0.01514	0.01514	0.01514
Observations	564,259	562,034	562,034	562,034
R <sup>2</sup>	0.67768	0.67671	0.67759	0.68059

Table 3: ATT calculated using the Sun and Abraham (2021) estimator

*Notes:* This table shows the average treatment effect on the treated (ATT) of the event study design specification as seen in equation (1) using the Sun and Abraham (2021) estimator. Clustered (School district) standard-errors in parentheses. Signif. Codes: \*\*\*: 0.01, \*\*: 0.05, \*: 0.1. *Source*: own calculations, data: Educational Opportunity Project at Stanford University (SEDA), Public Library Survey (PLS) and National Center for Education Statistics (NCES).

**Robustness.** I perform several robustness checks for this main specification. Including grade-year  $\delta_{gt}$  and subject-year  $\delta_{st}$  fixed-effects also does not change the results significantly (see colum (3) and (4) in figure 3). Then, I re-estimate my model using the unbalanced rather than the balanced panel. The effect, though smaller, is still significant and the sign does not change (see Table B1 column (3) and (4) in the appendix). Next, I exclude all libraries that were restored after the closure, which I can clearly identify in my sample. This applies to 23 school districts in the balanced and 47 in the unbalanced sample. Table B2 in the appendix shows the results of this exercise, which remain almost unchanged.

#### 4.1 Heterogeneity Analysis

To offer more detailed insights into this negative effect of library closures on students' grades, I conduct heterogeneity analyses regarding race and poverty – always controlling for funding. I also explore performance gaps within rather than between school districts.

**Race.** First, I differentiate between school districts where the majority of the student body is white or non-white. SEDA offers a variable indicating what percentage of the student-body is white. I create a dummy variable that is 0 if this variable is below 50 percent and 1 if it is larger than that. The results in table 4 columns (1) and (2) clearly show that districts with a majority of non-white students drive the negative effect. For majority-white school districts, the ATT is almost zero and not statistically significant. In school districts with a predominantly non-white student body, a library closures reduces test scores by almost 0.03 standard deviations. Figure 3 shows that the negative effect for majority non-white districts is significant for four years following the closure.

While public school funding has a large and statistically significant effect on test scores in predominantly white districts, this is not the case for predominantly non-white school districts. Knight (2022) finds that majority-Black schools spend more funds

on security personnel than majority-white schools. This reduces resources for measures that increase students' performance and might explain the insignificant effect.



Figure 3: Estimates for the Effect of a Library Closure on the Cohort-Standardized Test Scores by Race



This figure shows the results of the event study design specification as seen in equation (1) using the Sun and Abraham (2021) estimator. Results are estimated separately for for majority white (over 50 percent of the student body is white) and majority non-white school districts. Pre-trends are jointly zero. *Source*: own calculations, data: Educational Opportunity Project at Stanford University (SEDA) and Public Library Survey (PLS).

**Poverty.** Next, to illustrate that this is indeed more a story about race rather than poverty, I estimate the main specification separately for school districts with high and low poverty, using the districts poverty rate. A school district counts as "high poverty" if the poverty rate is larger than the median. The results can be seen in table 4 columns (3) and (4). There is indeed a statistically significant reduction of test scores in school districts with high levels of poverty. However, the effect is only half of the effect concerning racial inequality. Figure A4 in the appendix illustrates this in more detail, using an the share of children who are eligible for free lunch as an additional measure for poverty.

Dependent Variable:	Test Scores			
-	Race		Poverty	
Model:	Majority	Majority	High	Low
	white	non-white	poverty	Poverty
	(1)	(2)	(3)	(4)
Library Closure (ATT)	-0.0031	-0.0268***	-0.0147*	-0.0103
	(0.0074)	(0.0100)	(0.0075)	(0.0097)
log(Funding)	0.0475***	0.0077	0.0038	0.0457***
	(0.0112)	(0.0209)	(0.0131)	(0.0157)
Fixed-effects				
School district	Yes	Yes	Yes	Yes
State-Year	Yes	Yes	Yes	Yes
Fit statistics				
Dep. var. mean	0.08683	-0.29673	-0.12962	0.18875
Observations	456,885	105,040	305,492	255,398
R <sup>2</sup>	0.60622	0.62872	0.59806	0.61185

Table 4: ATT for the Heterogeneity Analysis for Race and Poverty

*Notes:* This table shows the average treatment effect on the treated (ATT) of the event study design specification as seen in equation (1) using the Sun and Abraham (2021) estimator. These are estimated separately for majority white (over 50 percent of the student body is white) and majority non-white, and for majority poor and majority non-poor school districts (poverty rate is larger than the median). Clustered (School district) standard-errors in parentheses. Signif. Codes: \*\*\*: 0.01, \*\*: 0.05, \*: 0.1. *Source*: own calculations, data: Educational Opportunity Project at Stanford University (SEDA) and Public Library Survey (PLS).

**Performance Gaps.** The SEDA database also offers variables for performance gaps *within* a school district, though there are lots of missing values and therefore the number of observations is a lot smaller. Interestingly, the closure of a library does not significantly influence performance gaps within school districts. The only performance gap that increases over time is those between Black and white students, however, there are clear pre-trends, so these findings should be interpreted with caution. Figure A5 in the appendix shows that neither the gaps between white and non-white students and female and male students were affected. This hints at the fact that it is not an individual story but one about the systematic under-funding of non-white communities—school districts with a majority of non-white children suffer the most, *including* the white children that go to school in these districts.

#### 4.2 Mechanisms

The results so far clearly indicate that public library closures have statistically and economically significant negative effects on students' educational outcomes, especially in predominantly non-white communities. Through which channels these effects occurs is not clear a priori. Potentially, apart from the access to books, the rationing of quiet studying space, limited access to the internet or study material could influence test score performance. To shed light on these mechanisms I, first, re-estimate my main specification separately by subject, followed, second, by kind of outlet and, third, resort to information on internet use from the PLS and the American Time-Use Survey (ATUS) to give an exploratory insight into how people spend their time at libraries.

**Subject.** First, I conduct the prior analysis separately for math and language scores. Table B3 in the appendix shows the ATT separately by subject. The effect size for the math score is almost double than that of the language score, with a reduction of 0.025 standard deviations. Figure A6 in the Appendix shows the event study estimates for this specification. The fact that math test scores are more affected than reading scores might be a first hint at the importance of study space and libraries' amenities rather than just books and reading.

**Kind of Library Outlet.** Next, I re-estimate the ATT separately for each kind of library outlet—central library, branch library and bookmobile. A central library is the main building of an administrative library entity. A branch library is a unit in a separate building with paid staff and/or regularly scheduled opening hours, whereas a bookmobile is a "truck or van that carries an organized collection of library materials" (Pelczar et al., 2023, p.F-7). Table 5 shows that results are only significant for branch libraries. Bookmobiles, which solely provide access to books or additional reading material, have no statistically significant effect, as do central libraries, which are more likely to be close to town centers. This suggests that the loss of study space and internet access are important drivers of the negative effect on test scores.

Dependent Variable: Model:	Bookmobile	Test Scores Branch Library	Central Library
Library Closure (ATT)	-0.0132 (0.0091)	-0.0218** (0.0085)	-0.0137 (0.0239)
<i>Fixed-effects</i> School district State-Year	Yes Yes	Yes Yes	Yes Yes
<i>Fit statistics</i> Dep. var. mean Observations R <sup>2</sup>	0.01931 542,455 0.67236	0.01666 546,475 0.67427	0.02003 533,274 0.67002

Table 5: Estimates for the Effect of a Library Closure by Kind of Library Outlet

*Notes:* This table shows average treatment effect on the treated (ATT) of the event study design specification as seen in equation (1) using the Sun and Abraham (2021) estimator. These are estimated separately for school districts with closures of bookmobiles, branch libraries and central libraries. I again control for public school funding in this specification. Clustered (School district) standard-errors in parentheses. Signif. Codes: \*\*\*: 0.01, \*\*: 0.05, \*: 0.1. *Source:* own calculations, data: Educational Opportunity Project at Stanford University (SEDA) and Public Library Survey (PLS).

What People Do at Libraries. To further illustrate the importance of quiet study space and internet access, I offer some exploratory evidence using information on internet use at public libraries from the PLS and time-use data from the ATUS. The ATUS, a comprehensive and representative time-use survey conducted annually since 2003, captures the activities of individuals aged 15 and older—what they do, with whom, and, most importantly, where. This allows me to filter for activities that are carried out at libraries to give more details about them.

Detailed in table B4 in the appendix are the top ten activities, ranked by total time spent, for both low and high-income individuals. For those with higher incomes, the most frequent library activity is "Reading for personal interest," whereas for the lower income group, it is "Research/Homework for class, degree, certificate, or license." This additionally highlights the importance of the quiet study space which libraries offer. Activities such as "Socializing and communicating with others", "Attending meetings" and "Volunteer activities" position libraries as active public spaces for communities. The PLS surveys how often public internet computers were used per year, figure 4 shows the number of internet uses scaled by the visits in each library to account for library size. While internet use declined between 2009 and 2018, most likely because of an increase in smartphone usage, figure 4 clearly indicates that there is a large gap between predominantly white and predominantly non-white school districts. This showcases the greater importance of publicly available computers with internet access for non-white communities.



Figure 4: Mean Internet Use by Race between 2009 and 2018

*Source*: own calculations, data: Educational Opportunity Project at Stanford University (SEDA) and Public Library Survey (PLS).

### 5 Conclusion

In conclusion, this paper underscores the critical role of public libraries in mitigating educational disparities, particularly in the context of the persistently segregated school system in the United States. I demonstrate a causal and significant effect of library closures on educational outcomes, with a reduction of 2 percentage points of a standard

deviation in test scores. This effect is consistent with the existing literature, as seen for example in Gilpin et al. (2023).

Heterogeneity analyses indicate that the effects of library closures are particularly pronounced in school districts with a predominantly non-white student body. This is also in line with the results by Gilpin et al. (2023), who demonstrate that increased funding positively influences reading test scores for predominantly white and Asian students. Thus, my findings add to the existing literature on racial inequalities in education in general (Caetano & Maheshri, 2023; Card & Rothstein, 2007; Monarrez, 2023; Reardon et al., 2019).

The section on mechanisms sheds further light on why exactly public libraries are important for racial equality in education. It suggests that the availability of quiet study space and internet access, rather than educational materials like books and magazines, play a pivotal role in influencing educational outcomes. This aligns with the insights from Bhatt (2010), who emphasizes the positive impact of public libraries on homework completion rates.

These findings carry significant policy implications, which should include additional support and increased funding for public libraries as essential components of social infrastructure. Strengthening public services, including libraries, not only addresses educational disparities but might potentially reduce other dimensions of inequality. As public libraries offer a wide array of resources beyond traditional educational materials, including internet access and quiet study space, support for these institutions can help to redress existing inequities in the American school system.

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# Appendix

# **A** Figures

Figure A1: Share of Public Libraries that Closed between 2009 and 2018 by Region



Source: Own calculations, data: Public Library Survey (PLS) and U.S. Census Bureau



Figure A2: Public Libraries that Closed between 2009 and 2018 by Year of Closure

Source: Own calculations, data: Public Library Survey (PLS) and U.S. Census Bureau



Figure A3: Public Libraries that Closed and Opened between 2009 and 2018

data: Public Library Survey (PLS) and U.S. Census Bureau

Figure A4: Estimates for the Effect of a Library Closure on the Cohort-Standardized Test Scores by Poverty



This figure shows the results of the event study design specification as seen in equation (1) using TWFE and the Sun and Abraham (2021) estimator. Pre-trends are jointly zero. *Source*: own calculations, data: Educational Opportunity Project at Stanford University (SEDA) and Public Library Survey (PLS).



Figure A5: Estimates for the Effect of Library Closures on Performance Gaps

This figure shows the results of the event study design specification as seen in equation (1) using TWFE and the Sun and Abraham (2021) estimator. Pre-trends are jointly zero. *Source*: own calculations, data: Educational Opportunity Project at Stanford University (SEDA) and Public Library Survey (PLS).

Figure A6: Estimates for the Effect of a Library Closure on the Cohort-Standardized Test Scores by Subject



This figure shows the results of the event study design specification as seen in equation (1) using TWFE and the Sun and Abraham (2021) estimator. Pre-trends are jointly zero. *Source*: own calculations, data: Educational Opportunity Project at Stanford University (SEDA) and Public Library Survey (PLS).

### **B** Tables

Table B1: ATT calculated using the Sun and Abraham (2021) estimator for the unbalanced panel

Dependent Variable:	Test Scores				
•	Balan	Balanced Panel		Unbalanced Panel	
Model:	Base	Add Funding	Base	Add Funding	
	(1)	(2)	(3)	(4)	
Library Closure (ATT)	-0.0185***	-0.0180***	-0.0099**	-0.0106**	
	(0.0062)	(0.0062)	(0.0047)	(0.0046)	
log(Funding)		0.0359***		0.0267***	
		(0.0104)		(0.0060)	
Fixed-effects					
School district	Yes	Yes	Yes	Yes	
State-year	Yes	Yes	Yes	Yes	
Fit statistics					
Dep. var. mean	0.01475	0.01514	0.03058	0.03119	
Observations	564,259	562,034	1,128,089	1,119,995	
$\mathbb{R}^2$	0.67768	0.67671	0.71669	0.71568	

*Notes:* This table shows the average treatment effect on the treated (ATT) of the event study design specification as seen in equation (1) using the Sun and Abraham (2021) estimator. Clustered (School district) standard-errors in parentheses. Signif. Codes: \*\*\*: 0.01, \*\*: 0.05, \*: 0.1. *Source*: own calculations, data: Educational Opportunity Project at Stanford University (SEDA), Public Library Survey (PLS) and National Center for Education Statistics (NCES).

Dependent Variable:	Test Scores			
-	Balanced Panel		Unbalanced Panel	
Model:	Base	Add Funding	Base	Add Funding
	(1)	(2)	(3)	(4)
Library Closures (ATT)	-0.0179***	-0.0174***	-0.0118**	-0.0126***
	(0.0064)	(0.0064)	(0.0048)	(0.0048)
log(Funding)		0.0344***		0.0260***
		(0.0104)		(0.0060)
Fixed-effects				
School district	Yes	Yes	Yes	Yes
State-Year	Yes	Yes	Yes	Yes
Fit statistics				
Dep. var. mean	0.01524	0.01563	0.03107	0.03169
Observations	562,139	559,914	1,123,297	1,115,203
R <sup>2</sup>	0.67742	0.67644	0.71599	0.71496

Table B2: ATT calculated using the Sun and Abraham (2021) estimator excluding Districts where a Closed Library was Restored

*Notes:* This table shows the average treatment effect on the treated (ATT) of the event study design specification as seen in equation (1) using the Sun and Abraham (2021) estimator excluding all school districts in which a library unit was restored. Clustered (School district) standarderrors in parentheses. Signif. Codes: \*\*\*: 0.01, \*\*: 0.05, \*: 0.1. *Source*: own calculations, data: Educational Opportunity Project at Stanford University (SEDA), Public Library Survey (PLS) and National Center for Education Statistics (NCES).

Dependent Variable:	able: Test Scores		
Model:	Language	Math	
	(1)	(2)	
Variables			
Library Closure (ATT)	-0.0254***	-0.0113**	
-	(0.0081)	(0.0056)	
log(Funding)	0.0428***	0.0296***	
	(0.0129)	(0.0101)	
Fixed-effects			
School district	Yes	Yes	
State-Year	Yes	Yes	
Fit statistics			
Dep. var. mean	0.02057	0.01030	
Observations	264,729	297,304	
R <sup>2</sup>	0.70251	0.72169	

Table B3: ATT calculated using the Sun and Abraham (2021) estimator separately for Language and Math Test Scores

*Notes:* This table shows the average treatment effect on the treated (ATT) of the event study design specification as seen in equation (1) using the Sun and Abraham (2021) estimator separately for language and math test scores. Clustered (School district) standard-errors in parentheses. Signif. Codes: \*\*\*: 0.01, \*\*: 0.05, \*: 0.1. *Source:* own calculations, data: Educational Opportunity Project at Stanford University (SEDA), Public Library Survey (PLS) and National Center for Education Statistics (NCES).

High Income		Low Income		
Activity in a Library	Intensity	Activity in a Library	Intensity	
Reading for personal interest	245.56	Rsrch/HW for class	227.21	
Rsrch/HW for class	218.33	Reading for personal interest	111.75	
Insufficient detail in verbatim	129.31	Computer use for leisure	82.33	
Work, main job	70.04	Job search activities	73.50	
Computer use for leisure	51.48	Insufficient detail in verbatim	59.85	
Job search activities	28.93	Work, main job	21.85	
Attending meetings	21.88	Socializing and communicating	13.30	
Television and movies	17.08	Volunteer activities	12.99	
Teaching, leading, counseling	15.36	Attending meetings	9.20	
Looking after children	13.12	Personal e-mail and messages	7.95	

Table B4: Top Ten Activities in Libraries by Income and Intensity (Time spent in Hours)

*Notes:* Intensity is calculated as the sum of occurrences of a certain activity in a library times the average time spent on the activity in a library in hours. *Source:* own calculations, data: American Time Use Survey (ATUS).