What Affects the Availability of Extracurricular Clubs in High Schools?

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Abstract

Previous research strongly links extracurricular activities to positive youth development. While school offerings and student participation jointly determine the outcome of extracurricular activities, previous studies have primarily focused on student participation. In contrast, this study shifts the focus to school offerings. We compile complete lists of extracurricular clubs provided by hundreds of American high schools and analyze factors impacting their availability, including school size, household income, pupil/teacher ratio, racial demographics, and online presence. We find that, despite the constraints of school demographics, schools still have abundant opportunities to take initiatives in improving offerings in extracurricular activities.

Keywords: Extracurricular activities, school size, socioeconomic status, pupil/teacher ratio.

Introduction

American youth have been active in extracurricular activities. More than half of American teenagers who attend school participate in some form of organized extracurricular activities (Mahoney et al., 2006). Furthermore, the 1999 National Survey of America's Families (NSAF) reported that 83% of 12- to 17-year-olds participated in at least one extracurricular activity during the past year (Moore et al., 2000).

Past studies have provided compelling evidence of a strong connection between positive youth development and active engagement in organized extracurricular activities (Busseri et al., 2006; Darling et al., 2005; Eccles et al., 2003; Eccles & Templeton, 2002; Feldman & Matjasko, 2005; Fredricks & Eccles, 2005, 2006; Gardner et al., 2008; Gilman et al., 2004; Marsh & Kleitman, 2002; Peck et al., 2008; Reeves, 2008). Participation in such activities has been found to be linked to a reduction in problem behaviors and an improvement in academic performance (Mahoney et al., 2005). Furthermore, these advantages may extend into young adulthood, predicting academic achievements and fostering prosocial behaviors (Zaff et al., 2003).

Due to the significance of extracurricular activities in youth development, researchers have been studying the factors that affect youth participation in these activities for over half a century. Previous studies have primarily focused on the “demand side” of the student-school relationship, specifically, student participation. These studies mostly conduct surveys on individual students and analyze how factors like school size (Kleinert, 1969; McNeal Jr, 1999) and socioeconomic status (Feldman & Matjasko, 2007) affect the participation rates.

In contrast, this study adopts a distinct approach by shifting the focus towards the “supply side,” specifically, the availability of extracurricular clubs offered by high schools. We compile complete lists of clubs provided by hundreds of high schools and analyze factors that affect the availability of these clubs. This insight from the supply side complements prior demand-side research and offers valuable support to policymakers and school administrators. First, as a crucial enabler, a large and diverse set of engaging club offerings attracts students with different interests to extracurricular activities. Second, as a key indicator, the quantity and variety of club offerings also reflect the overall climate and health of extracurricular activities at the school level.

To acquire the supply-side data, we conducted an extensive sampling process, searching through thousands of school websites to identify a final list of 229 schools whose websites provided comprehensive lists of their offered clubs. Examples of these websites can be found in references (Club list example 1, 2023; Club list example 2, 2023).

By utilizing the supply-side data, we aim to answer the questions described below. We will also provide brief summaries of the findings associated with these questions.

Q1*: How does the size of a school impact the number of clubs offered by the school?*

Findings: The number of clubs offered by a school follows the trend of $\sqrt{X_{\text{enroll}}}$, where X_{enroll} is the school’s student enrollment. The correlation between school size and the number of clubs has a coefficient of 0.63 and p<0.001. Consequently, the number of clubs per student follows the trend of $\sqrt{X_{\text{enroll}}}/X_{\text{enroll}}$ (i.e., $1/\sqrt{X_{\text{enroll}}}$). This implies that although larger schools offer a wider array of club options, their clubs have either larger sizes or lower participation rates, or both, leading to reduced engagement. Although previous research has extensively highlighted the negative effects of larger school sizes on student participation (Leithwood & Jantzi, 2009; Morgan & Alwin, 1980; Schaefer et al., 2011; Schoggen & Schoggen, 1988; Stevens & Peltier, 1994), to our knowledge, this study is the first to precisely quantify the $1/\sqrt{X_{\text{enroll}}}$ pattern of clubs per student. This quantification sheds light on the root cause of many observations documented in prior research.

***Q2**: How does the household income impact the number of clubs?*

Findings: We use the fraction of students in a school receiving free or reduced-price lunch, denoted as X_{lunch}, as a gauge of household income. A higher X_{lunch} indicates lower income. Household income is positively correlated with the number of clubs, and schools in the higher-income group on average have 16.7 more clubs than those in the lower-income group. Furthermore, when X_{lunch} is less than 40%, an increase in X_{lunch} leads to a decrease in the number of clubs. However, when X_{lunch} exceeds 40%, a further increase in X_{lunch} no longer affects the number of clubs. For context, the average value of X_{lunch} for schools is 50%. These findings suggest that the advantages of having more clubs are primarily observed in higher-income schools, while average-income schools do not significantly differ from lower-income schools. More precisely, the nonlinear impact of X_{lunch} on the number of clubs can be effectively modeled using a logistic function.

***Q3**: How does the pupil/teacher ratio impact the number of clubs?*

Findings: At first glance, there seems to be a positive correlation between the pupil/teacher ratio and the number of clubs, implying that a decrease in the number of teachers leads to an increasein the number of clubs. However, this counterintuitive outcome is primarily due to schools with higher pupil/teacher ratios mostly being large schools, which generally offer more clubs. Once the influence of school size is excluded, the number of clubs exhibits a negative correlation withthe pupil/teacher ratio. Specifically, a controlled experiment shows that among schools of comparable sizes, schools with lower pupil/teacher ratios, on average, have 9.3 more clubs than those with higher pupil/teacher ratios.

***Q4**: How do racial demographics impact the number of clubs?*

Findings: At first glance, racial demographics seem to impact the number of clubs, as they are correlated with school size and household income, which directly affect the number of clubs. However, after excluding their indirect influence through school size and household income, racial demographics by themselves do not significantly affect the number of clubs. Specifically, both t-test and multiple regression results independently confirm that, among schools with comparable student enrollments and household incomes, but significant differences in their racial demographics, no significant difference exists in their club offerings.

***Q5**: To what extent do school initiatives matter in boosting club offerings?*

Findings: Our analysis shows that for schools with identical demographic values in school size, household income, and pupil/teacher ratio, the top 1/4 performing schools offer 3.2 times more clubs than the bottom 1/4 performing schools. This significant difference emphasizes the pivotal role of school initiatives in enhancing club offerings.

Summary: While the discussion so far has focused on the number of clubs, our analysis shows that a school's club count is very strongly correlated with its club variety. Specifically, the correlation between a school's club variety and the logarithm of its club count has a coefficient of 0.94 and $p < 0.001$. Therefore, by focusing on club count, club variety is also automatically addressed to a large extent. In summary, the aforementioned findings suggest that, in terms of their impact on the number of clubs offered by schools, the factors are ranked in the following order:
school size > household income > pupil/teacher ratio ≫ racial demographics. Moreover, despite the constraints of certain hard-to-change demographics such as school size, schools still have ample opportunities to take initiatives to improve club offerings.

Background on High School Extracurricular Clubs

American high schools are secondary schools typically covering grades 9–12. Nearly every high school offers certain school-sponsored extracurricular clubs overseen by the school administration. These clubs provide students with opportunities to engage in a wide variety of activities, including STEM (e.g., robotics), career path (e.g., Future Farmers of America), arts (e.g., drama), social issues (e.g., LGBTQ+ rights), student association (e.g., Black Student Union), leadership and community service (e.g., Key Club), political awareness (e.g., Junior State of America), competition (e.g., Model United Nations), school-community building (e.g., newspaper), culture (e.g., Chinese traditional clothing), intramural sports (e.g., mountain biking), hobbies (e.g., chess), and religions (e.g., Catholicism).

The quantity and variety of clubs provided by high schools are influenced by various factors, ultimately impacting students' participation. For instance, smaller schools might struggleto gather enough students interested in starting a Latin club, while larger schools might have a surplus of students vying for club leadership positions, resulting in the over-manning effect (Barker & Gump, 1964). Moreover, schools with a high pupil/teacher ratio, indicating fewer teachers, may struggle to find a teacher with the necessary bandwidth or expertise to oversee a specific club. Finally, schools predominantly composed of students from lower-income families might face financial constraints preventing the establishment of clubs like robotics.

The following sections of this paper explore factors affecting club availability. We beginby detailing our data collection methodology, followed by an extensive analysis of the data.

Data Collection

We used data from the American National Center for Education Statistics (NCES) (NCES, 2023) for information about school sizes, free or reduced-price lunch, pupil/teacher ratios, and racial demographics. In addition, we collected complete lists of clubs offered by many schools.

Out of all the American public schools that have data reported by NCES for the school year 2021-2022, we selected high schools for this study based on the following criteria. We excluded schools that do not offer grade 12 and only counted students in grades 9–12. Throughout the rest of this paper, the term "students" only refers to grade 9–12 students in a school, excluding students from other grades, if present. We focused on physical schools and excluded virtual schools. Finally, we excluded schools that provided no information about their free or reduced-price lunch program, as well as schools that did not report their pupil/teacher ratio. This resulted in a total of 21,064 schools which enrolled a total of 14,030,023 grade 9–12 students. We refer to these schools as "candidate schools" or "all schools" throughout the rest of this paper.

Sampling of Schools

We first present the characteristics of schools, followed by a description of our school sampling methodology. Figure 1 shows the cumulative distribution of school count and student count as a function of school size. The "*all schools*" curves represent the 21,064 schools. The "*sampled schools*" curves represent 229 schools that were randomly selected from the 21,064 schools for this study. We will describe the selection of these schools later.

As an example of how to read the figure, the data point in the green circle on the "*by school count (all schools)*" curve means that 50% (see the Y-axis) of all schools have 357 (see the X-axis) or fewer students. Similarly, the data point in the green square on the "*by student count (all schools)*" curve means that 50% of all students across all schools are enrolled in schools that each have 1,434 or fewer students.

These data highlight a significant divergence between school count and student count. While the majority of schools are small, the majority of students are enrolled in larger schools. This affects how we select the sampled schools. Initially, we selected the sampled schools in a way that ensured, in Figure 1, the curve of "*by school count (sampled schools)*" closely matched the curve of "*by school count (all schools)*." However, this led to a lack of sufficient data points for large schools because small schools make up the majority. Specifically, schools with 1,000 or fewer students account for 75% of all schools while hosting only 34% of all students. To address this issue, we intentionally sampled more schools of larger sizes. This leads to the divergence of the "all schools" curves and the "sampled schools" curves in the figure. We will delve further into this topic during the data analysis.

Collecting Club Data

The NCES data contains no information about extracurricular clubs offered by schools. To collect such data, traditional approaches would typically resort to surveys to contact individuals at specific schools, with approvals from numerous ethics committees. However, this approach is challenging to scale to hundreds of schools nationwide, which might be a key reason why, after more than half a century of research on extracurricular activities, there are still no publicly available large-scale datasets providing complete lists of clubs offered by many schools.

In the Internet era, we instead take an innovative approach to collect club data from schools' public websites. Interestingly, the shift to online learning during the COVID-19 pandemic facilitated this data collection process, as an increasing number of schools have adopted websites as a primary channel for communication.

Specifically, we sampled thousands of schools, searched their respective websites, and identified 229 schools with complete lists of clubs they offer. None of these 229 schools come from the same school district. It is important to note that while many school websites include information about a limited subset of clubs as examples, they do not present a comprehensive list of all available clubs. We have excluded these schools from our study. On average, it takes searching through more than 15 schools to identify one with sufficiently complete club data. Consequently, we conducted searches across thousands of schools to identify the 229 sampled schools. In total, the 229 schools hosted 221,300 students andoffered 5,983 clubs.

Among a school's clubs, this study excludes clubs for varsity sports such as swimming and baseball for two reasons: (1) They form a substantial category on their own and merit a separate, dedicated study, and (2) the treatment of varsity sports on school websites is highly inconsistent. While some schools classify them as clubs, others categorize them separately under athletics. Furthermore, common varsity sports are frequently not reported on websites, despite the likelihood that most schools offer them. For the sake of maintaining consistency in this study, we have excluded varsity sports and intend to explore them in future work. However, we do include intramural sports in this study, such as trapshooting and mountain biking, as they tend to be consistently reported as clubs on different school websites. Similarly, we excluded student council and class-specific clubs such as Class 2025 because almost every school has these clubs, but the practice of whether to include them as clubs on school websites is inconsistent.

Data Analysis and Findings

In this section, we analyze the impact of various factors on the number of clubs offered by schools. For convenience, the variables used in our analysis are summarized in Table 1, and the basic school statistics are summarized in Table 2.

Our goal is to develop a multiple regression model for predicting the number of clubs (Y_{club}) offered by a school, based on a set of independent variables, including school size (X_{enroll}), the proportion of students receiving free or reduced-price lunch (X_{lunch}), the pupil-teacher ratio (X_{teacher}), and the proportions of students from various racial backgrounds (X_{race}, such as X_{white}, X_{hispanic}, X_{black}, etc.). Unfortunately, blindly dumping all these variables into a linear regression model would not yield meaningful results. Consider the following straightforward linear model.

$$Y_{\text{club}} = \beta_0 + \beta_1 f(X_{\text{enroll}}) + \beta_2 X_{\text{lunch}} + \beta_3 X_{\text{teacher}} + \sum_{\text{race}} \beta_{\text{race}} \cdot X_{\text{race}} + \in$$

Fitting data to this model seemingly yields an acceptable prediction accuracy, with an adjusted R^2 of 0.571, meaning that 57.1% of the variance in Y_{club} can be explained by this model. However, the resulting bias term β_0 is as large as 82.7, with $p < 0.001$. This large bias is highly unreasonable since the mean of Y_{club} is only 29.1. Moreover, when X_{enroll} approaches zero, meaning a diminishing school size, Y_{club} should also approach zero, rather than taking on the large bias value of 82.7. Finally, the regression result of this model indicates that several variables representing racial demographics, such as X_{white}, X_{black}, X_{hispanic}, and $X_{\text{native\_american}}$, impact Y_{club} with statistical significance. Later, our more detailed analysis will show that this conclusion is incorrect.

Moreover, even if we remove the bias term β_0 from the model to force Y_{club} to approach zero when X_{enroll} approaches zero, as well as removing all X_{race} terms to reduce noises, it still yields counterintuitive results, not to mention its low prediction accuracy. Specifically, this model's coefficient for X_{teacher} takes a positive value, implying that as a school reduces the number of teachers without changing its student population, the school would offer even more clubs. This result is counterintuitive and turns out to be incorrect.

To understand the root cause of the aforementioned problems, we first thoroughly examine the characteristics of each variable to guide the design of an effective model. Without relying on any assumption of a specific form of the model, we often resort to t-tests in controlled experiments to validate that our intended roles for variables in the model actually match the reality. This process helps us discover and address issues such as nonlinearity, heteroscedasticity, and multicollinearity.

Impact of School Size

Our analysis starts with the school size factor. For an initial intuitive grasp of the impact of school size, we plot in Figure 2 the relationship between school size (X_{enroll}) and the number of clubs (Y_{club}) for the 229 sampled schools. Each dot in the figure represents one school, and the "*moving average*" curve shows the overall trend. To compute the moving-average curve, we first sort the schools according to their sizes. Then, for each group of 10 consecutive schools in the sorted list, we calculate their average school size (x) and average number of clubs (y). These mean values are then plotted as one data point (x, y) on the moving-average curve. By iterating this procedure for all groups of 10 consecutive schools in the sorted list, the complete moving-average curve can be plotted.

The moving-average curve reveals a strong positive correlation between X_{enroll} and Y_{club}. The Pearson correlation coefficient is 0.63, with $p < 0.001$. To further understand their relationship, we fit the data to the following model:$\mathrm{Y_{club}} = \beta_1 \mathrm{f}(\mathrm{X_{enroll}}) + \in$. Note that this modeldoes not have a bias term because, intuitively, when X_{enroll} approaches zero, Y_{club} should also approach zero. This is also confirmed by the trend in Figure 2.

After exploring various forms of $f(\cdot)$, including $f(x) = x$, $f(x) = \sqrt{x}$, $f(x) = \sqrt[3]{x}$, $f(x) = \log(x)$, and a logistic function, we find that $f(x) = \sqrt{x}$ yields the best fit, specifically, with the following coefficient:

$$Y_{\text{club}} = \beta_1 f(X_{\text{enroll}}) + \epsilon = 0.95\sqrt{X_{\text{enroll}}} + \in \approx \sqrt{X_{\text{enroll}}} \tag{1}$$

This function is also plotted in Figure 2, showing good alignment with the moving-average curve. Note that we fit the function to the entire dataset instead of the moving-average curve, which merely aids visualization.

We derive several observations from Figure 2. First, the simplicity of the function is appealing, indicating a square root relationship between Y_{club} and X_{enroll}. Second, it reveals the nonlinear nature of their relationship, highlighting the necessity for a square root transformation of X_{enroll} in the final multiple regression model. Finally, as the school size increases, the prediction error also increases, indicating the presence of heteroscedasticity. This issue requires attention in the final multiple regression model.

In Figure 2, one might note that a big fraction of the sampled schools are relatively small, i.e., with 500 or fewer students. This is because most schools are smaller schools, as shown by the curve of "*by school count (all schools)*" in Figure 1. To have sufficient samples for larger schools, we already intentionally sampled a bigger fraction of larger schools, as shown by the curve of "by school count (sampled schools)" in Figure 1.

Finally, from Figure 2, one might be inclined to assume that students at smaller schools are at a disadvantage, given their schools offer fewer clubs. However, Figure 3 presents a contrasting perspective, unveiling that the number of clubs per student is, in fact, higher in smaller schools. Because the number of clubs follows the trend of $\sqrt{X_{\text{enroll}}}$, the number of clubs per student follows the trend of $\sqrt{X_{\text{enroll}}}/X_{\text{enroll}} = 1/\sqrt{X_{\text{enroll}}}$. On one hand, students at smaller schools enjoy better opportunities for leadership roles and active club engagement. On the other hand, smaller schools have a reduced variety of club choices.

Impact of Pupil/Teacher Ratio

In addition to school size, the pupil/teacher ratio (X_{teacher}) also affects the number of clubs. For an initial intuitive grasp, we graph in Figure 4 the 229 sampled schools based on their X_{teacher} and X_{enroll} values. Surprisingly, the figure appears to imply a positive correlation between X_{teacher} and Y_{club}, which is confirmed by a correlation coefficient of 0.20 and $p < 0.01$. It seems counterintuitive for schools with a higher X_{teacher} (meaning fewer teachers per student) to have more clubs, as schools rely on teachers to assume advisory roles for each club.

Further investigation reveals that this counterintuitive result is merely a side effect of the correlation between X_{teacher} and X_{enroll}, as depicted in Figure 5. The seemingly paradoxical relationship between X_{teacher} and Y_{club} is primarily driven by the fact that larger schools, with higher X_{teacher}, tend to have more clubs, rather than the direct impact of X_{teacher} on Y_{club}.

To assess the true impact of X_{teacher}, we design a t-test between two groups of schools categorized by higher and lower X_{teacher} values, respectively, while ensuring the two groups have comparable characteristics in school size. As portrayed in Figure 5, smaller schools generally exhibit lower X_{teacher} values. Consequently, if we were to partition the groups solely based on raw X_{teacher} values, the lower-X_{teacher} group would largely consist of smaller schools, and the higher-X_{teacher} group would mainly include larger schools. This would result in a comparison predominantly between schools of differing sizes, which is undesirable.

To prevent this, we follow the division lines in Figure 6 to create school groups for comparison. Specifically, we first sort the schools by their sizes. For every 30 adjacent schools in the sorted list with similar school sizes, we identify division lines that divide the 30 schools into three groups of equal sizes with higher, medium, and lower X_{teacher} values, respectively. As observed in the figure, these division lines ascend as school size increases, accommodating the tendency for larger schools to have higher X_{teacher} values. Through this approach, schools assigned to the higher- and lower-X_{teacher} groups possess comparable X_{enroll} values, averaging 790 and 879, respectively. In contrast, their X_{teacher} values differ significantly, averaging 19 and 11, respectively. These characteristics align well with the experiment's objectives.

We compare the higher- and lower-X_{teacher} groups in Figure 7. The figure shows that, after excluding the influence of school size, schools in the lower-X_{teacher} group tend to have more clubs. A t-test between the two groups validates that the difference is statistically significant, with t-statistic=-2.42 and $p<0.02$. On average, schools in the lower-X_{teacher} group have 9.3 more clubs than those in the higher-X_{teacher} group. This contrasts with the seemingly positive correlation between X_{teacher} and Y_{club}.

Furthermore, Figure 7 illustrates that the gap in Y_{club} values between the two groups tendsto widen as X_{enroll} increases. This suggests that X_{enroll} magnifies the impact of X_{teacher}, which is why we will employ X_{enroll} as a multiplicative factor for other independent variables such as X_{teacher} in the final multiple regression model.

Impact of Household Income

Next, we analyze the impact of household income by using X_{lunch} as an indicator of household income. X_{lunch} is calculated as m/X_{enroll}, where m is the number of students eligible for free or reduced-price lunch. A lower X_{lunch} indicates a higher income.

To assess whether we need to exclude the influence of school size before analyzing the impact of X_{lunch}, we calculate the correlation between X_{lunch} and school size. Unlike school size's strong correlation with X_{teacher}, it has little correlation with X_{lunch}, reflected in a correlation coefficient of -0.08 and $p = 0.22$. This suggests that we can directly observe the impact of X_{lunch} on Y_{club} without needing to exclude the influence of school size.

Figure 8 illustrates the relationship between X_{lunch} and Y_{club}. When X_{lunch} is less than 40%, an increase in X_{lunch} tends to cause a decrease in Y_{club}. However, when X_{lunch} exceeds 40%,a further increase in X_{lunch} no longer affects Y_{club}. Because this flattening-out effect is well-represented by a logistic function, it is an appropriate choice for depicting how X_{lunch}impacts Y_{club}. Specifically, the logistic function depicted in Figure 8 aligns well with the moving-average curve. Its parameters, K, X_0, L, and C are inferred using the Levenberg-Marquardt algorithm to fit the data. Our empirical evaluation further demonstrates thatamong various functions we explored, the logistic function offers the best fit.

Because of the nonlinear relationship between Xlunch and Yclub, we will apply the following nonlinear transformation to Xlunch in the final multiple regression model.

$$g(X_{\text{lunch}}) = \frac{1}{1+e^{-K(X_{\text{lunch}}-X_0)}} = \frac{1}{1+e^{-13.8\,(X_{\text{lunch}}-0.049)}} \tag{2}$$

g(Xlunch) is graphed in Figure 9. Within the domain of [0,1] for Xlunch, the range of g(Xlunch) starts at 0.337 and levels off at 1 when Xlunch approaches approximately 0.4.

Overall, because the curve in Figure 8 flattens out when X_{lunch} exceeds 40%, it suggests that in terms of the impact on club count, there is a significant difference between the higher- and middle-income groups, but there is little difference between the middle- and lower-income groups. For context, the average value of X_{lunch} for all schools is 50%.

To further quantify the statistical significance of the impact of household income, we follow the method shown in Figure 6 to partition the 229 sampled schools into three groups based on the values of X_{lunch}: one-third higher-income schools (i.e., lower X_{lunch}), one-third middle-income schools, and one-third lower-income schools. We compare Y_{club} of the higher- and

lower-income groups, as depicted in Figure 10. The figure shows that the higher-income group has more clubs than the lower-income group, specifically, with an average difference of 16.7 clubs. For context, on average a school has 26.1 clubs. A t-test between these groups confirms that their difference is statistically significant, with t-statistics=-4.77 and $p < 0.0001$.

Similar to Figure 7, Figure 10 also shows that the disparity in Y_{club} values between the two groups tends to expand as X_{enroll} increases. This implies that X_{enroll} amplifies the influence of X_{lunch}, which is why we will include X_{enroll} as a multiplicative factor for other independent variables in the final multiple regression model.

Impact of Racial Demographics

In this section, we analyze the impact of racial demographics. We begin by examining the largest racial group, the White students. For each school, we compute the fraction of White students as $X_{\text{white}} = w/X_{\text{enroll}}$, where w is the number of White students in the school. X_{white} is correlated with school size, with a coefficient of -0.34 and $p < 0.0001$. This indicates that larger schools tend to have smaller proportions of White students. Moreover, X_{white} is even more strongly correlated with X_{lunch}, with a coefficient of -0.54 and $p < 0.0001$. This indicates that lower-income schools tend to have smaller proportions of White students.

Since both X_{enroll} and X_{lunch} influence how X_{white} impacts Y_{club}, to assess the true effect of X_{white} in a controlled environment, we design an experiment to compare two groups of schools with comparable values in both X_{lunch} and X_{enroll}, but differ significantly in their X_{white} values. The subsequent procedure outlines our approach. First, we sort the 229 sampled schools by their X_{lunch} values and partition the sorted list into N_{lunch} buckets. Each bucket comprises the same number of schools, and the schools within the same bucket have similar X_{lunch} values as they are adjacent on the list sorted by X_{lunch}. For schools in each bucket, we resort them by their X_{enroll} values and further partition them into N_{enroll} bins. Each bin comprises the same number of schools, and the schools within the same bin have similar X_{enroll} values as they are adjacent on the list sorted by X_{enroll}. In total, there are $N_{\text{lunch}} \times N_{\text{enroll}}$ bins, where each bin has the same number of schools, and within each bin, schools exhibit similar values in both X_{lunch} and X_{enroll}. Finally, for the schools in each bin, we partition them into three subgroups based on their X_{white} values, forming the higher-, medium- and lower-X_{white} subgroups. The aggregation of all schools in the higher-X_{white} subgroups across all $N_{\text{lunch}} \times N_{\text{enroll}}$ bins forms the overall higher-X_{white} group. Similarly, the assembly of all schools in the $N_{\text{lunch}} \times N_{\text{Enroll}}$ lower-X_{white} subgroups forms the overall lower-X_{white} group. In our experiment, both N_{lunch} and N_{enroll} are set to 5.

The resulting higher- and lower-X_{white} groups exhibit desired characteristics. Schools in these two groups have comparable X_{enroll} values, averaging 969 and 994 students, respectively, along with comparable X_{lunch} values, averaging 46% and 49%, respectively. However, their X_{white} values differ significantly at 70% and 28%, respectively—meeting our intended criteria. Remarkably, despite substantial X_{white} discrepancies, they have a comparable number of clubs (Y_{club}), averaging 25.4 and 27.5, respectively. Interestingly, the higher-X_{white} group shows a slightly lower number of clubs. The t-test between the Y_{club} values of these two groups yields a p-value of 0.19, insufficient to establish a significant difference between them.

To visualize the pattern, we plot the schools in the higher- and lower-X_{white} groups in Figure 11. The figure shows that despite the notable difference in their X_{white} values, there is no distinct disparity in Y_{club} between the two groups.

Similar t-test results for other racial groups are summarized in Table 3. Overall, when comparing two groups of schools with higher and lower fractions of students from a specific racial group, similar to what is depicted in Figure 11, the marginal difference in Y_{club} and the large p value in the t-test indicate a lack of statistical significance in the difference. An intuitive interpretation of these results is that schools with comparable student enrollments and household incomes do not display significant disparities in the number of clubs due to variations in racial demographics. The lack of direct impact on Y_{club} is a key reason for us to consider excluding the factors representing racial demographics from the final multiple regression model, as described inthe next section.

Multiple Regression Model

After understanding the characteristics of individual independent variables, in this section we design a multiple regression model that incorporates all the factors. Specifically, we model the number of clubs as

$$Y_{\text{club}} = f(X_{\text{enroll}}) \cdot (\beta_0 + \beta_1 \cdot g(X_{\text{lunch}}) + \beta_2 \cdot X_{\text{teacher}} + \sum_{\text{race}} \beta_{\text{race}} \cdot X_{\text{race}}) + \in \quad (3)$$

where β_i are coefficients, ϵ is the model residual, X_{race} such as X_{white} is the fraction of students ofa specific race in a school, $f(X_{\text{enroll}})$ is the nonlinear transformation of X_{enroll} derived from Equation 1, and $g(X_{\text{lunch}})$ is the nonlinear transformation of X_{lunch} obtained from Equation 2.

$$f(\mathrm{X}_{\text{enroll}}) = \sqrt{\mathrm{X}_{\text{enroll}}}$$
$$g(X_{\text{lunch}}) = \frac{1}{1+e^{-13.8\,(X_{\text{lunch}}-0.049)}} \quad (4)$$

A distinctive aspect of this model is the role of $f(X_{\text{enroll}})$ as a multiplicative factor for all other independent variables. This choice is closely tied to the significant role of school size. When $f(X_{\text{enroll}})$ approaches 0, indicating a small student population, Y_{club} should converge to zero, regardless of X_{teacher}, X_{lunch}, and X_{race}. This behavior is effectively captured by utilizing $f(X_{\text{enroll}})$ as a multiplicative term. Furthermore, the impact of other independent variables is amplified by school size. For instance, if higher income levels are assumed to lead to more clubs, this effect should result in a more substantial absolute increase in the number of clubs in larger schools. This amplification finds empirical support in the data, as depicted in Figures 7 and 10.

Also note that this model does not have a bias term in order to achieve the effect that as $f(X_{\text{enroll}})$ approaches 0, Y_{club} converges to zero.

In addition to this model, we have explored numerous others, including those incorporating additional terms related to X_{lunch} and X_{teacher} but without $f(X_{\text{enroll}})$ as their multiplicative factor, or adding a bias term, etc. Moreover, we have also explored introducing independent variables besides school demographics, such as those representing how schools present their club information on their websites, with or without teacher contact information, and with or without detailed club descriptions. Nevertheless, these models added complexity without meaningfully improving data fitting. Consequently, we have excluded their use.

Further Simplifying the Model

Although the model in Equation 3 seems intuitive and comprehensive, we find that the terms representing racial demographics, $\sum_{\text{race}} \beta_{\text{race}} X_{\text{race}}$, do not contribute significantly to enhancing data fitting. Therefore, we eliminate those terms and adopt the simplified model:

$$Y_{\text{club}} = f(X_{\text{enroll}}) \cdot (\beta_0 + \beta_1 \cdot g(X_{\text{lunch}}) + \beta_2 \cdot X_{\text{teacher}}) + \epsilon \tag{5}$$

We use the linear regression implementation in the publicly available statistical analysis software `statsmodels` (Statsmodels, 2023) to compute the coefficients. Information concerning these coefficients is summarized in Table 4. Due to the presence of heteroscedasticity in the residual, as evident in Figures 7 and 10, we employ the HC3 covariance matrix estimator in `statsmodels` to calculate heteroskedasticity-robust standard errors. This estimator implements the algorithm proposed by MacKinnon and White (MacKinnon & White, 1985).

The *uncentered* and adjusted R^2 for the simplified model is 0.843, while the p-value for the F-statistic is less than 10^{-60}, indicating that the model is a reasonable fit for the data. Note that when dealing with a model lacking a bias term, `statsmodels` calculates an *uncentered* R^2 value using the equation below,

$$R^2 = 1 - \frac{\Sigma(y_i - \hat{y}_i)^2}{\Sigma {y_i}^2} \tag{6}$$

where y_i is the observed value of the dependent variable and $\hat{y}_i$ is the predicted value. This is different from the following equation typically used for calculating a *centered* R^2 value,

$$R^2 = 1 - \frac{\Sigma(y_i - \hat{y}_i)^2}{\Sigma(y_i - \bar{y})^2} \tag{7}$$

where $\bar{y}$ is the mean of the observed values of the dependent variable. The reason that `statsmodels` uses Equation 6 instead of Equation 7 for a model without a bias term is because such a model lacks a bias term to help center the residual when all independent variables are removed from the model. To provide a reference for comparison, we independently calculated the *centered* R^2 according to equation 7, whose value is 0.603.

The mean of the model residual, ϵ, is only -0.4, in comparison to the mean of Y_{club} at 26.1. This suggests that the decision to exclude a bias term is justified. Furthermore, empirically, we note that the absence of the bias term enhances the model's stability by preventing the regression from adjusting the bias term to compensate for errors elsewhere in the coefficients.

The signs of the coefficients in Table 4 align with the previous analysis results for individual variables. Specifically, X_{enroll} shows a positive correlation with Y_{club}, while X_{lunch} and X_{teacher} display negative correlations with Y_{club} after excluding the influence of X_{enroll}.
Furthermore, the partial R^2 values for X_{enroll}, X_{lunch}, and X_{teacher} are 0.50, 0.30, and 0.08, respectively. These values reflect the relative magnitude of their impact on Y_{club}, aligning with our prior evaluation of these variables individually.

After establishing the simplified model in Equation 5 as a solid baseline, we delve into the reasoning behind excluding the $\sum_{\text{race}} \beta_{\text{race}} X_{\text{race}}$ terms. When solely introducing the X_{white} variable, without incorporating other X_{race} variables, to the simplified model, the adjusted R^2 regress to 0.840. This indicates that X_{white} does not contribute to enhancing data fit. On the other hand, if all X_{race} variables are added to the model, they cause multicollinearity as the X_{race} variables always sum up to one and have strong correlations. Hence, at least one X_{race} variable should be dropped. Eliminating an X_{race} variable representing a racial group with a small school population inadequately mitigates multicollinearity, as other high-value X_{race} variables still have strong correlations. The most effective resolution is removing the X_{race} variable with the largest value, namely X_{white}. With X_{white} eliminated and multicollinearity resolved, incorporating additional X_{race} variables, regardless of their combination, never raises the adjusted R^2 beyond 0.846, which is hardly an improvement over the simplified model.

These observations indicate that the inclusion of X_{race} variables complicates the model without improving its data fit. Furthermore, the t-test results in Table 3 explicitly confirm that these variables do not have a significant impact on Y_{club} for schools with comparable X_{enroll} and X_{lunch}

values, despite the significant variation in the X_{race} values. Guided by these insights, we choose to exclude the X_{race} terms from the simplified model.

School Initiatives in Improving Club Offerings

While school demographics, such as school size, household income, and pupil/teacher ratio, do impact the number of clubs, we want to understand to what extent school initiatives within these demographic constraints can alter the outcome. For this purpose, we compare the top and bottom-performing schools regarding their club offerings.

For each school, we calculate the ratio, denoted $R_{initiative}$ between its actual club count and the predicted count based on X_{enroll}, X_{lunch}, and $X_{teacher}$ (Equation 5). A higher $R_{initiative}$ indicates superior performance given the constraints of a school's demographics. We rank schools according to $R_{initiative}$, and compare the top group for the best-performing 1/4 of schools and the bottom group for the worst-performing 1/4 of schools. A t-test between these two groups, with $p < 0.001$, shows a significant difference in their $R_{initiative}$ value. Specifically, the median $R_{initiative}$ for the top 1/4 of schools is 163%, while that for the bottom 1/4 of schools is only 51\%. Intuitively, it means that among schools with identical demographics, the top schools have 3.2 times more clubs than the bottom schools. This substantial difference underscores the pivotal role of school initiatives in enhancing club offerings.

Analysis Summary and Lessons Learned

Overall, the simplified model demonstrates a reasonable level of accuracy, indicated by its *uncentered* and adjusted R^2 value of 0.843. Notable features of this model include: (1) addressing the nonlinearity of X_{enroll} and X_{lunch} through the transformations $f(X_{enroll})$ and $g(X_{lunch})$ as defined in Equation 4; (2) utilizing X_{enroll} exclusively as a multiplicative factor for X_{lunch} and $X_{teacher}$; (3) refraining from incorporating a bias term in order to force Y_{club} to approach zero as X_{enroll} approaches zero; and (4) excluding the X_{race} variables from the model, despite the common perception that racial demographics might correlate with X_{enroll} and X_{lunch}, potentially influencing Y_{club}.

A valuable lesson we have learned is that the design of this model greatly benefited from a thorough initial analysis of the characteristics of individual variables, rather than blindly including them in a linear regression model. This aided us in identifying and designing the aforementioned features of the model. Another valuable lesson we have learned is that when validating observations, we have frequently strived to design experiments that directly compare two population groups differing significantly in one independent variable while maintaining similar characteristics across other independent variables. Concrete examples include the comparisons shown in Figures 7, 10, and 11, which are further summarized in Table 3. This direct validation approach has enhanced our confidence in and improved our interpretation of the summaries generated by statistical software.

Discussion and Recommendation

In this section, we discuss issues that may adversely impact the availability of clubs provided by schools, starting with the school size factor, as it has the biggest impact due to its multiplicative role in Equation 3. The challenge is evident in Figure 3, which shows a decrease in club opportunity per student as school size increases. In particular, large schools experience the over-manning effect (Barker & Gump, 1964), resulting in a surplus of students competing for club leadership positions, which limits opportunities for leadership skill development. Moreover, as club growth lags student enrollment, increased student-to-club ratios discourage participation. These observations align with prior research indicating lower student engagement in larger schools (Morgan & Alwin, 1980; Schoggen & Schoggen, 1988;Stevens & Peltier, 1994).

What limits club growth in larger schools? One hypothesis is that$_{X}$ since the pupil/teacher ratio tends to be higher in larger schools, as illustrated in Figure 5, the availability of teachers as supervisors for clubs might be a limiting factor. However, Figure 13 contradicts this. As the club opportunity per student decreases with school size, the club support load per teacher similarly decreases, implying teachers are not a bottleneck. In this figure, the moving average curves are computed similarly to those in Figure 2, but individual schools are not plotted to avoid overcrowding the figure. Club support load per teacher is calculated as $Y_{\text{club}} \times X_{\text{teacher}}/X_{\text{enroll}}$.

We believe that the inclination to eliminate redundant clubs is a contributing factor that negatively impacts club offerings, leading to the emergence of large clubs and the subsequent over-manning effect, ultimately discouraging participation. Comparing club offerings to courseofferings, we observe that in large schools, popular courses such as algebra often offer multiple parallel classes to reduce class size and promote engagement. However, this approach is seldomapplied to clubs, even though clubs like chess and Key Club are popular. Despite the theoreticalpossibility of dividing large clubs into smaller subgroups for internal operations, this is rarely practiced. Additionally, the number of club officers rarely increases in proportion to club size. These factors naturally restrict club size and diminish participation rates in larger schools. Furthermore, national organizations like Key Club usually establish one chapter per school, inadvertently causing the chapter to become unwieldy in larger schools, further dissuadingparticipation.

We propose extending the practice applied to courses to clubs. In large schools, it would be advantageous to establish multiple clubs of the same category, such as multiple chess clubs orKey Club chapters, each with independent club officers. This approach would provide leadership opportunities to a larger pool of students, who subsequently can work with the student communityto boost participation rates. Additionally, we recommend encouraging the creation of similar clubs with slight variations in focus. Notably, large schools successful in offering many clubs tend to feature numerous community service clubs, each centered around a slightly distinct theme. Conversely, certain schools enforce policies discouraging the establishment of new clubs similarto existing ones, inadvertently leading to the over-manning effect and reduced participation.

Our recommendation takes a more moderate stance compared to Leithwood and Jantzi's recommendation to cap secondary schools at 1,000 students or fewer (Leithwood & Jantzi, 2009). Fourteen years after their initial proposal, schools with 1,000 or fewer students host only 34% of the total student population (Figure 1), and the trend of school consolidation remains unaltered. We suggest working within the existing school structure and introducing smaller, immediately actionable changes with substantial potential, instead of waiting for major school demographicsto shift, which could take decades to occur.

Besides our more actionable approach to coping with the hard-to-change school size factor, in general we strongly advocate for individual schools taking initiatives to improve club offerings, despite the constraints of school demographics. Specifically, Figure 12 shows that the top 1/4 schools have 3.2 times more clubs than the bottom 1/4 schools after school demographics are taken into account, emphasizing the pivotal role of individual school initiatives. Besides these statistics, there are also concrete examples. One inspiring example is Syracuse Academy of Science Charter School (Syracuse, 2023). Despite having only 286 students, with 75% of them receiving free or reduced-price lunch, the school boasts an impressive 29 clubs, which is several times higher than that of similar schools. The school’s focus on science is reflected in its numerous STEM-related clubs, but it also offers a diverse range of clubs encompassing humanity,charity, arts, and hobbies.

Besides our more actionable approach to coping with the hard-to-change school size factor, in general we strongly advocate for individual schools taking initiatives to improve club offerings. Specifically, Figure 12 shows that the top 1/4 of schools offer 3.2 times more clubs than the bottom 1/4 of schools, even after school demographics are taken into account, emphasizing the pivotal role of individual school initiatives. In addition to these statistics, there are also concrete examples. One inspiring example is Syracuse Academy of Science Charter School (Syracuse, 2023). Despite having only 286 students, with 75% of them receiving free or reduced-price lunch,the school boasts an impressive 29 clubs, which is several times higher than that of similar schools. The school’s focus on science is reflected in its numerous STEM-related clubs, but it also offers a diverse range of clubs encompassing humanities, charity, arts, and hobbies.

The statement from Principal Corey Tafoya of Woodstock High School, which had successfully improved the student participation rate in extracurricular activities by over 400% in five years, encapsulates our recommendation most effectively: “*If we have six or seven students interested in something, we’ll start a new club. We want students to find a reason to get up and come to school. Whatever trips their trigger is what our teachers and administration are willing to do*” (Reeves, 2008).

Limitations and Future Work

This research has a limitation in that it is solely focused on counting the number of clubs, without considering the variety of club activities. To illustrate, let's consider one school that offers three clubs in arts, while another school provides one club in arts, one in STEM, and one in community service. Clearly, the second school presents a more diverse array of options.

To address this limitation, our ongoing study employs both manual classification and machine learning to analyze club variety. Preliminary results suggest that as schools increase their club counts, the added clubs tend to naturally span across various areas, resulting in a high degreeof Furthermore, our analysis shows that a school's club count is very strongly correlated with its club variety. Specifically, the correlation between a school's club variety and the logarithm of its club count has a coefficient of 0.94 and $p < 0.001$. Therefore, by focusing on club count, club variety is also automatically addressed to a large extent. A detailed studyof club variety is a subject of its own and will be deferred to future work due to space limitations.

Another limitation of this research is that it collects samples from school websites. This approach could be potentially biased since it excludes schools that do not publish club data on websites. Despite this limitation, it is considered an acceptable tradeoff given the limitations of alternative methods to gather comprehensive club data. For instance, conducting in-person surveys would likely bias towards schools that are willing to participate in this kind of study, and achieving widespread coverage across hundreds of schools dispersed throughout the United States would be challenging.

Related Work

Past research has presented compelling evidence of a strong association between positive youth development and active involvement in extracurricular activities, as supported by various studies (Busseri et al., 2006; Darling et al., 2005; Eccles et al., 2003; Eccles & Templeton, 2002; Fredricks & Eccles, 2005, 2006; Gardner et al., 2008; Gilman et al., 2004; Lerner et al., 2005; Mahoney et al., 2005; Marsh & Kleitman, 2002; Peck et al., 2008; Reeves, 2008; Zaff et al., 2003). Additionally, several surveys have summarized the effects of participation in extracurricular activities (Farb & Matjasko, 2012; Feldman & Matjasko, 2005; Holland & Andre, 1987; Seow &

Pan, 2014). A prominent taxonomy, known as “the five Cs,” attributes the positive outcomes to the beneficial impact of organized extracurricular activities on five key areas of youth development: competence, confidence, connection, character, and caring (Lerner et al., 2005).

Concerns about the over-scheduled child problem have been raised in some studies (Rosenfeld & Wise, 2010). However, Mahoney et al. conducted an extensive survey and supported promoting participation in extracurricular activities, as they found limited empirical support for the over-scheduling hypothesis and consistent evidence for the positive youth development perspective (Mahoney et al., 2006).

Some research suggests that the benefits of extracurricular activities may depend, in part, on the type of activities in which youth participate (Larson et al., 2006; Marsh & Kleitman, 2002). Fredricks and Eccles (Fredricks & Eccles, 2006) examined the impact of the total number and breadth of participation in activities on youth development. These studies assume that a reasonable number and variety of extracurricular clubs are available to students. Related to this assumption, this research examines factors influencing the availability of high school clubs.

Barker and Gump’s study on school size and available extracurricular activities is relevant to this research (Barker & Gump, 1964). However, their work was limited to data from a small number of schools in a specific region (13 high schools in Eastern Kansas) and was conducted about half a century ago. In contrast, our modern research is more comprehensive, encompassing 229 schools spread across the United States, and considering factors beyond just school size.

McNeal’s study (McNeal Jr, 1999) is also related to this research, as it investigated the impact of school size and pupil/teacher ratio on student participation in high school extracurricular activities. However, in terms of the student-school relationship, this research focuses on the supply side of extracurricular clubs offered by high schools, in contrast to McNeal’s emphasis on the demand side, specifically student participation. Similarly, some work primarily focuses on factors affecting non-participators, such as lower socioeconomic status, lower grades, and larger schools (Feldman & Matjasko, 2007).

Various studies have discussed the effects of large school sizes, including their impact on student indiscipline (Haller, 1992), dropout rates (Alspaugh, 1998), voluntary participation (Schoggen & Schoggen, 1988), social participation (Morgan & Alwin, 1980), and social networks (Schaefer et al., 2011). Stevens and Peltier conducted a literature review and found support for the claim that students in smaller schools are more actively involved in extracurricular activities than students in larger schools (Stevens & Peltier, 1994). Our quantification of the $1/\sqrt{X_{\text{enroll}}}$ pattern of clubs per student helps shed light on the root cause of many observations above.

Conclusion

In the student-school relationship, both student participation and school offerings affect the outcome of extracurricular activities. Previous studies have predominantly focused on the "demand side" of this relationship, specifically on the participation of individual students. In contrast, this study shifts the focus toward the "supply side," specifically examining the availability of extracurricular clubs provided by high schools. By utilizing information from school websites, we compiled complete lists of clubs offered by hundreds of schools and analyzed the factors that influence club availability.

Our primary finding is that, in terms of their impact on the number of clubs offered by high schools, these factors are ranked in the order of school size, household income, and pupil/teacher ratio. Moreover, after accounting for their indirect influence through school size and household income, racial demographics, by themselves, do not significantly affect the number of clubs. Lastly, the notable variation in club offerings among schools with comparable demographics emphasizes the importance of initiatives taken by individual schools and the feasibility for schools to overcome constraints.

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Variable	Explanation
Y_{club}	Number of clubs offered by a school.
X_{enroll}	School size, i.e., student enrollment.
X_{teacher}	Pupil/teacher ratio. A higher X_{teacher} means fewer teachers per student.
X_{lunch}	Fraction of students in a school receiving free or reduced-price lunch. A higher X_{lunch} value indicates a lower household income.
X_{race} (X_{white}, X_{hispanic}, X_{black}, etc.)	Fraction of students of a specific race in a school.

Table 1: *Symbols for dependent and independent variables used in this study.*

Variable	X_{enroll}	X_{lunch}	X_{teacher}	White	Hispanic	Black	Asian/ Pacific Islander	Multi-race	Native American	Hawaiianor Other Pacific Isl.
All schools	666	50%	15.0	45.45%	28.80%	15.03%	5.48%	3.92%	0.88%	0.38%
Sampled schools	966	47%	15.3	41.57%	31.36%	14.10%	7.91%	4.02%	0.56%	0.41%

Table 2: *Average school statistics. For example, the "White" column shows that, among all 21,064 schools, 45.45% of students are White, while among the 229 sampled schools, 41.57% ofstudents are White. This table shows that the sampled schools are representative in terms of racial demographics.*

	X_{teacher}	X_{lunch}	White (X_{white})	Hispanic	Black	Asian/ Pacific Islander	Multi-race	Native American	Hawaiian/ Other Pacific Isl.
Difference in mean	-9.3	-16.7	-2.1	5.4	-1.8	0.1	0.0	-4.7	-1.6
t-statistics	-2.42	-4.77	-0.64	1.59	-0.51	0.03	-0.01	-1.31	-0.49
p-value	< 0.02	< 0.0001	0.5203	0.114	0.6103	0.9792	0.9955	0.1922	0.6271

Table 3: *Results of t-tests that explicitly compare two groups of schools with higher and lower values on a specific independent variable. The $X_{teacher}$ column corresponds to the comparison shown in Figure 7. The X_{lunch} column corresponds to the comparison shown in Figure 10. The X_{white} column corresponds to the comparison shown in Figure 11. The other X_{race} columns are obtained through experiments similar to the one shown in Figure 11.*

Coefficient symbol	Coefficient value	Robust standard error	t-value	p-value	Confidence interval [0.025	0.975]	Partial R^2
β_0 for X_{enroll}	3.2124	0.333	9.66	< 0.001	2.557	3.868	0.50
β_1 for $g(X_{\text{lunch}})$	-1.9507	0.298	-6.535	< 0.001	-2.539	-1.363	0.30
β_2 for X_{teacher}	-0.0273	0.008	-3.563	< 0.001	-0.042	-0.012	0.08

Table 4: *Information about the model coefficients in Equation 5. β_2 is much smaller than β_1 because the scale of $X_{teacher}$ (mean: 15.3) is much larger than that of X_{lunch} (mean: 0.5).*

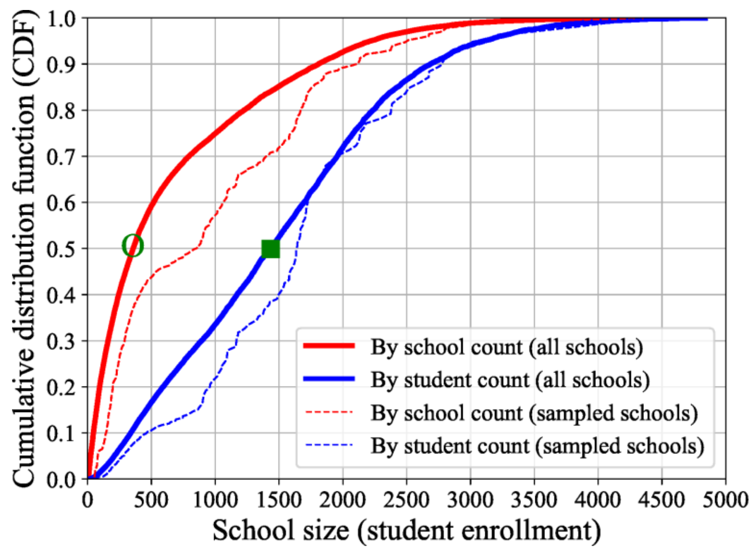

Figure 1: *Cumulative distribution of school count and student count as functions of school size.*

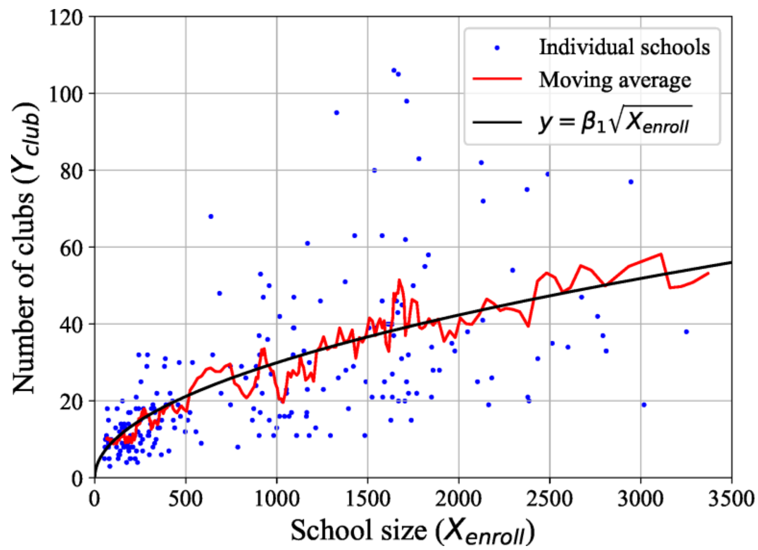

Figure 2: *The number of clubs follows the trend of square root of school size.*

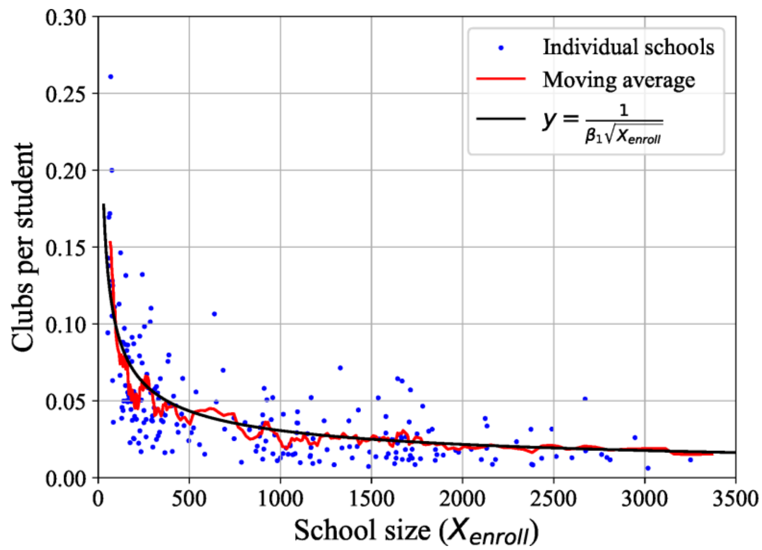

Figure 3: *The number of clubs per student decreases as the school size increases.*

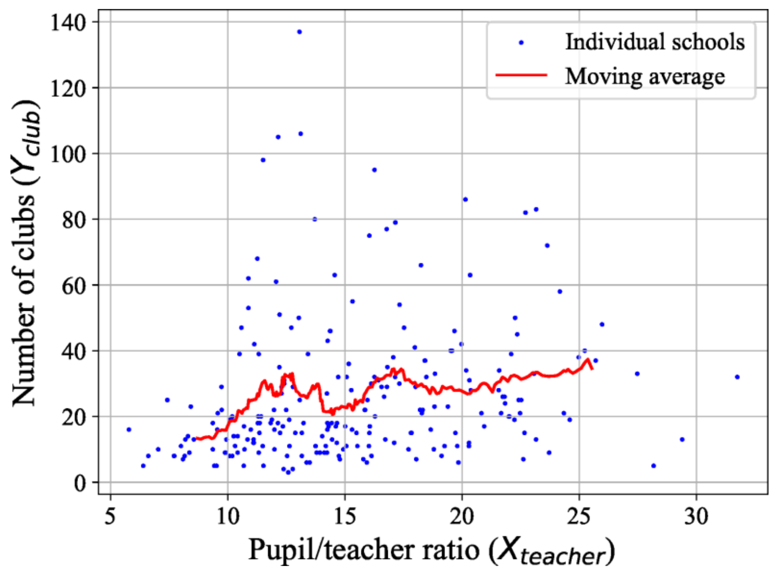

Figure 4: *Schools with higher $X_{teacher}$ values seem to have more clubs, which is counterintuitive.*

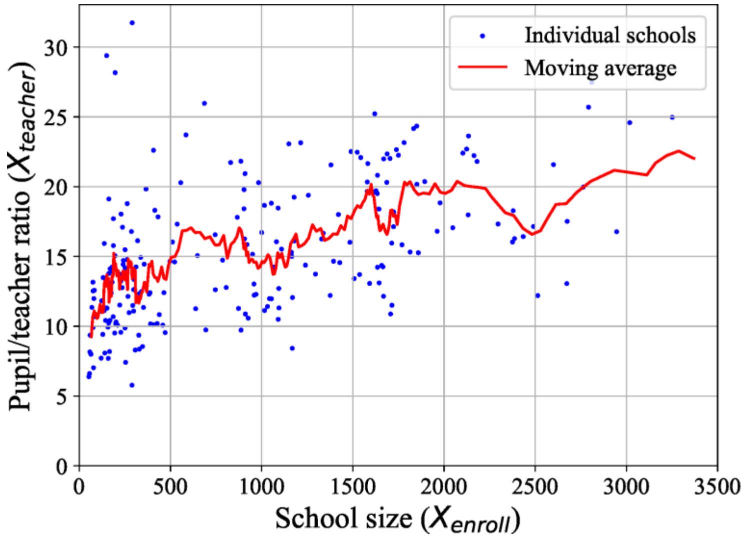

Figure 5: *$X_{teacher}$ is correlated with X_{enroll}. Larger schools tend to have higher $X_{teacher}$ values.*

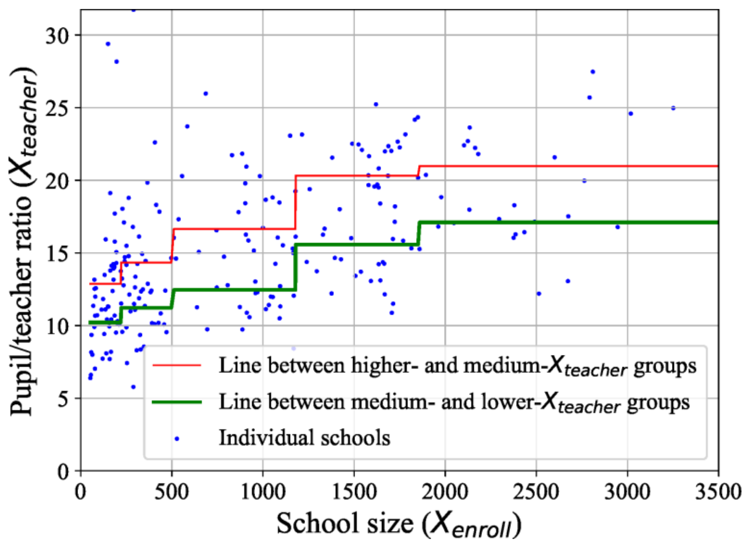

Figure 6: *Partition the 229 sampled schools into three groups based on their $X_{teacher}$ values.*

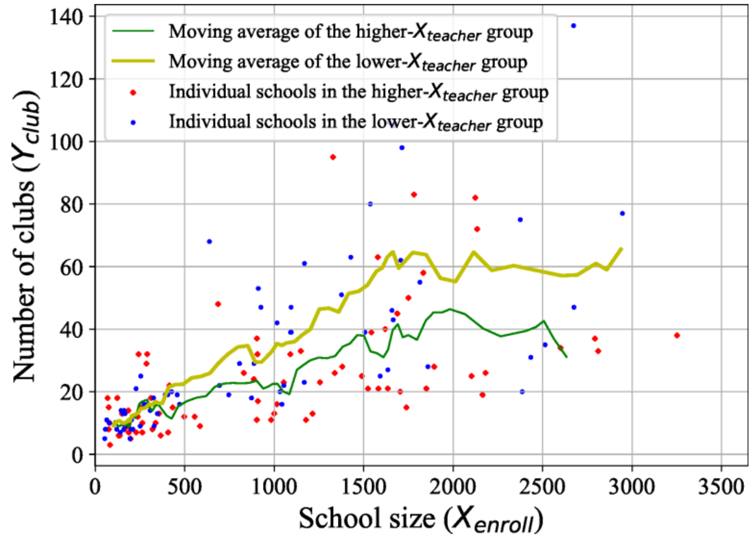

Figure 7: *Schools in the lower-$X_{teacher}$ group tend to have more clubs.*

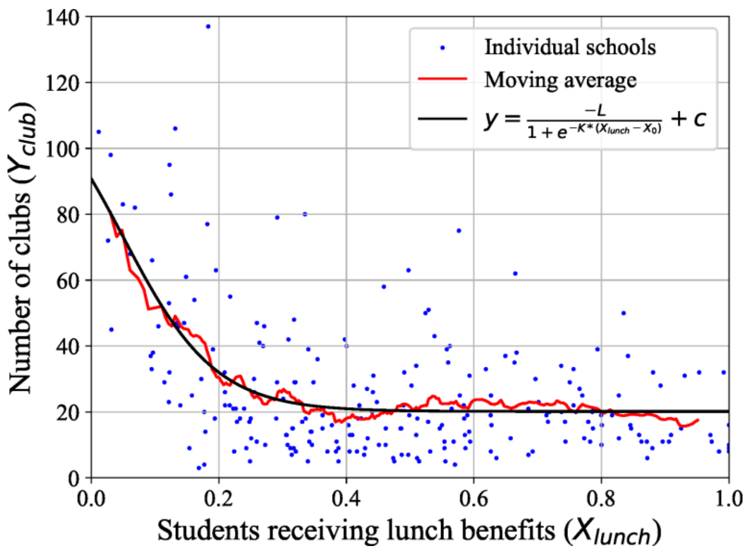

Figure 8: *Only when X_{lunch} < 40%, higher-income schools tend to have more clubs than lower-income schools.*

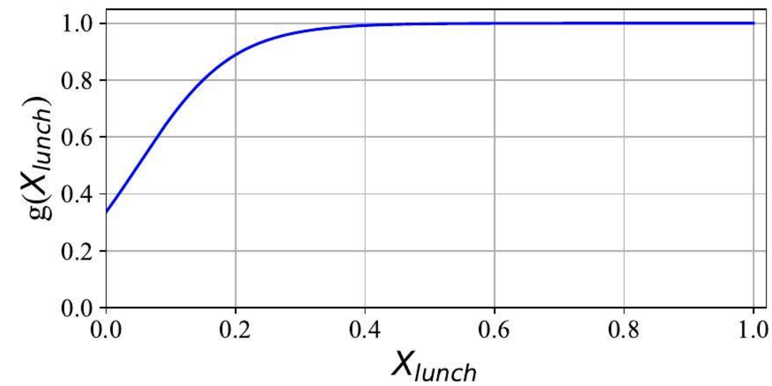

Figure 9: *This logistic function $g(X_{lunch})$ is used to transform X_{lunch} in the final multiple regression model.*

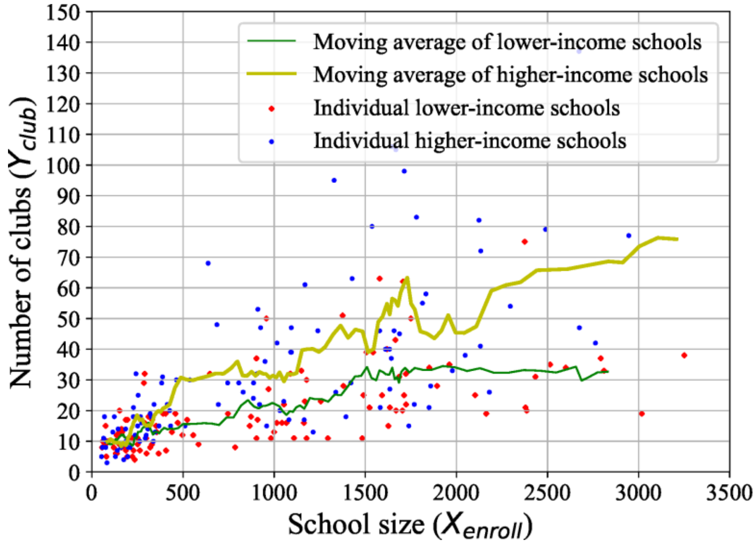

Figure 10: *Higher-income schools tend to have more clubs.*

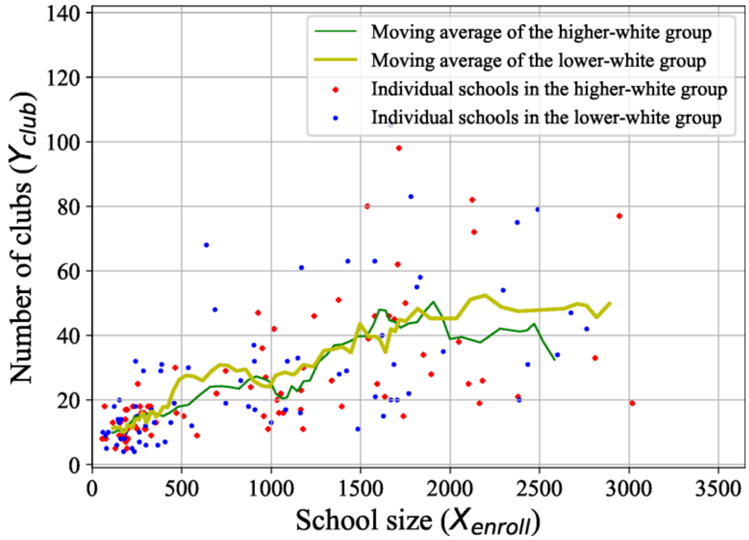

Figure 11: *For two school groups with comparable X_{enroll} and X_{lunch} values but significant differences in their X_{white} values, there is no evidence that X_{white} significantly affects Y_{club}.*

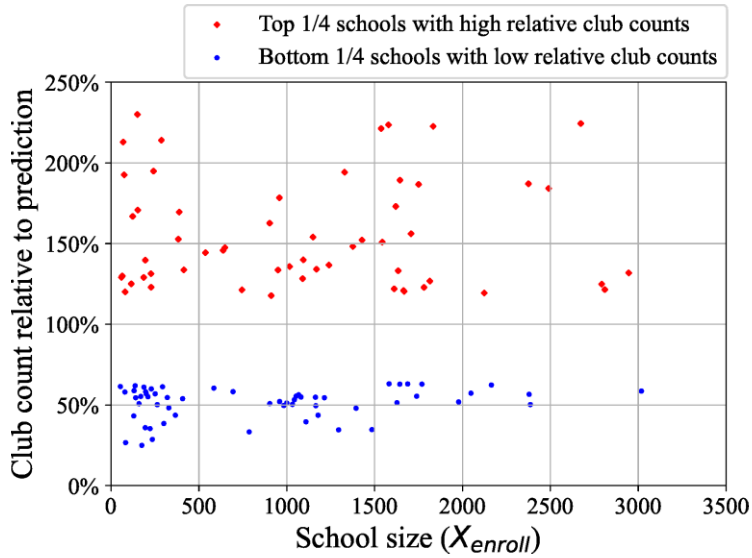

Figure 12: *Out of the 229 sampled schools, this figure compares the relative club counts between the top 58 schools and the bottom 58 schools.*

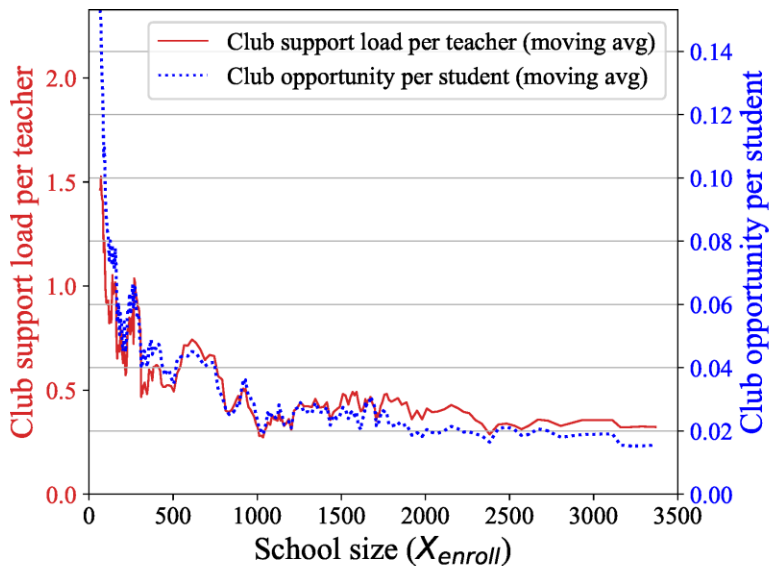

Figure 13: *Club support load per teacher decreases as school size increases. .*