Research Paper
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How Does Your Kindergarten Classroom Affect Your Earnings?

I. Introduction

This paper looks into the long-term impacts of early childhood education with the use of data provided by Project STAR. Project STAR is a widely studied educational experiment that consisted over 4 years to measure the effect of reduced class size. The experiment that took place randomly assigned over 11,000 Kindergarten through 3rd-grade students and teachers to various classrooms. The main factor that differed between the classes was that some classes were smaller than others. The designated small classes aimed to have 15 or fewer students, while the larger classes aimed to have at most 22 students. The study links the experimental data to administrative records, allowing for an analysis of outcomes up to age 27, and data about college attendance, home ownership, and retirement savings. Due to some of the privacy restrictions of the data, I was not able to analyze any outcomes beyond the 3rd grade. The group who experimented had a license agreement with the IRS to obtain data on income, though I don't have access to this data, their findings will be used to make predictions based on the analysis I conducted on the grades Kindergarten through 3rd-grade.

The experimenters conducting the Project STAR experiment were able to find strong correlations between kindergarten test scores and numerous adult outcomes. These correlations lead to the plausibility that if classroom environments affect test scores, they could lead to improved adult outcomes. There are 2 strategies used to determine this plausibility. The first option is to analyze the characteristics of the classroom such as class size, teacher experience, and peer characteristics. The second option would be to analyze the variance in

both the observed and unobserved aspects of classrooms. Within the Project STAR research, it is shown that students of smaller class sizes are more likely to enroll in college by age 20. Additionally, students whose teachers have lots of experience and whose peers are of high quality in kindergarten tend to have higher earnings. Overall, the analysis of the class quality indicates significant impacts on both test scores and earnings, despite the fade-out of test score impacts.

The research conducted within this study gave me an outline of what to look for when conducting my analysis. Though my observations on the scope of the effects of class size in primary school impacting long-term outcomes are limited, the evidence I found supports this claim and can be used as supplementation for the analysis of how varying class sizes affect test scores.

II. Data

The experimental design of Project STAR involved approximately 80 schools located in Tennesee. Over the 4 years that the study was conducted, it focused on kindergarten to 3rd-grade students with an emphasis on low-income schools. The first trial began with 6,300 kindergarten students in the year 1985 to be randomly assigned to either small or regular-sized classes. The initial goal was for students to remain in the same type of class up until 3rd grade, but due to factors like grade retention and students moving away, students were reassigned to classes for all grades up to 3rd. Teachers were also randomly assigned to classes in support of the randomization of the experiment. Despite some of the deviations from the experimental protocol, an intent-to-treat approach was implemented. This approach assigned treatment status based on the initial random assignment. To measure the effect on learning of various class sizes all students took the Stanford Achievement Test each year. This test primarily assessed math and reading performance. Based on the results from the tests percentile ranks

were computed based on the distribution of the students in large classes, which were apple to the ranks of students in smaller classes.

The Project STAR study used data from the United States tax records to measure adult outcomes. The experimenters were able to link approximately 95 % of STAR records to tax data. This range of data covered 12 years of data pertaining to federal tax forms and 3rd party reports. The outcome measures included earnings, college attendance, college quality, marital status, retirement savings, home ownership, cross-state mobility, neighborhood quality, and mortality rates. The earrings within the dataset are adjusted for 2009 dollars and is capped at $100,000 to reduce the influence of outliers. College attendance was determined by 1098-T forms and college quality was based on an earnings-based index. All of the other outcomes were based on some form of tax information or data from a 3rd party report. The STAR database also includes personal characteristics such as gender, race, and things like whether a student was eligible for free or reduced lunch.

The validity of the study's casual inferences relies on 2 key assumptions, that the randomization of the students was successful and that there are no differences in match rates across different classrooms. To evaluate whether the randomization occurred successfully the experimenters of Project STAR tested for a balance in predetermined variables within the various classrooms. Through the use of tax data, parental characteristics such as household income, 401(k) savings, home ownership, and marital status were found. The analysis was able to conclude that parental characteristics heavily affected the prediction of a student's outcome. However, through the use of regressions, it was found that no demographic characteristic could predict the likelihood of a student being assigned to a small class. This observation indicates that students of small and large class sizes have similar demographic characteristics due to the randomization of the experiment. To determine whether there were differences in the match rates across classrooms tax data was examined. The objective was to see if tax data varies by classroom assignment within schools. Analysis of this objective was able to conclude that the

match rate does not significantly differ between class sizes, confirmed by F tests. Furthermore, the study found no evidence of a variance in mortality rates between class sizes or classrooms.

III. Test scores and Adult outcomes

My limited access to the data used with the project STAR experiment limited the amount of analysis I could conduct. This limited analysis prevented me from using the data I collected to properly support the claim that primary school class size affects adult outcomes, differing from the analysis conducted within the paper. My analysis aims to showcase the benefits of smaller class sizes in achieving higher test scores. Though my analysis is partial to that of the analysis conducted for the Project STAR experiment, it can be used to partially support their claim.

I began my analysis by cleaning the data and removing any unnecessary variables from the datasets I examined. Within the STAR_Students file, I separated the data into 2 separate data frames. The first data frame contained data for students who participated in STAR from Kindergarten to 3rd grade, belonged to small class sizes for all 4 years, had data present from kindergarten to high school, and have taken either the SAT or ACT. This data frame I named TrueStarStudents and used this as a baseline measure of the benefits that STAR offered. I then created a second data frame containing the data from the STAR_Students file where none of the students belonged to a small class. With these 2 I created a line chart to illustrate the differences in the test scores between students of small and regular class sizes[1]. Additionally, I created 2 regression models to show the effect of class size on math test scores, compared to the effect of teacher experience on test scores [2]. As a result of my analysis, I was to conclude that class size is a bigger determinant of test scores than teacher experience, and students of smaller class sizes perform better on tests than students of regular class sizes.

The Project STAR study produced similar results but went a step further to examine the effect of earnings, college attendance, and other adult outcomes based on kindergarten test scores. The study was able to conclude that a 1 percentile point increase in kindergarten test scores is associated with a $132 increase in earnings between the ages of 25 to 27. Though

kindergarten test scores have a strong correlation with earnings, only explaining about 5% of the variation in adult earnings. The study found that high kindergarten test scores increase the odds of attending college, owning more homes, having larger savings, getting married, and living in affluent neighborhoods when compared to their peers who didn't receive test scores as good as theirs. This correlation between kindergarten test scores and various adult outcomes shows the important role that small class sizes can play in the influence of a child's adult outcomes.

The study also examines the impacts of observable classroom characteristics such as class size and teacher characteristics. Resulting from the research conducted for Project STAR, class size influences better test scores, increases the likelihood of college attendance, and increases average earrings after high school. Teachers with high experience influence higher test scores and higher earnings.

IV. Empirical Results

Various graphics were produced to better support the analysis I conducted. Appendix 1 shows the line graph created to illustrate the difference in test scores for small and regular-sized classes. The red lines represent the average math test scores, while the blue lines represent the average reading test scores. Within the graph, the "N" shaped lines represent the average test scores for small class sizes. The lines for the average test scores for small class sizes are higher than those of the regular-sized classes. This supports the claim that students of smaller classes receive higher test scores than students of regular-sized classes. Appendix 2 references the regressions calculated to support the claim that class size is a larger determinant of test scores, than the number of years of experience a teacher has. Table A shows the relation between the class size of a kindergarten student stated as gkclasssize, and math test scores. Table B shows the relation between years of teacher experience for a kindergarten teacher stated as gktyears, and math test scores. As indicated by the p-values of gktyears and

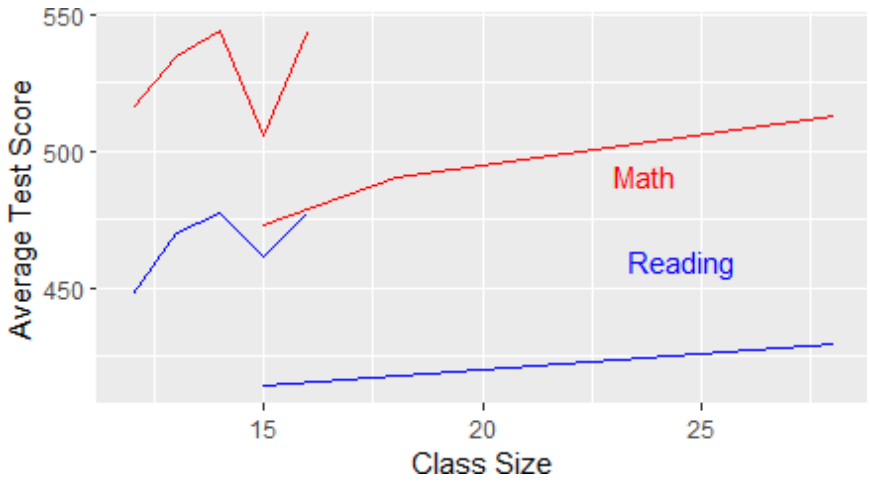
gkclasssize, class size is a better predictor of math test scores than the years of experience a teacher has due to its lower p-value and larger R^2 value.

V. Conclusion

In conclusion, the work done by Project STAR has opened doors for people to begin challenging the traditional measures of education solely through standardized tests. The analysis conducted found that classroom environments play a large role in the long-term outcomes of a child. Students randomly assigned to classes of higher quality in grades kindergarten through 3rd grade were shown to have higher earnings, college rates, larger savings accounts, and a better chance of living in affluent neighborhoods. With this evidence, policymakers should reform how education is measured and use classroom quality as a measure within educational interventions. Emphasizing classroom quality, a reduction in class size, and teacher quality can help children obtain the best outcomes as adults.

Appendix 1.

This appendix shows a line chart created to demonstrate the difference in test scores for small and regular-sized classes. The red lines represent the average math test scores for classes based on their respective class size. The blue lines represent the average reading test scores for classes based on their respective class size. To the left of the graph, the “N” shaped line represents the average test scores for small class sizes. On average the smaller classes score higher on their reading and math tests when compared to their peers.



Appendix 2.

These images represent the regressions between math test scores, class size, and years of teacher experience.

Table A. The effect of kindergarten class size on math test scores

Independent variable	Coefficient	Std.Error	t-stat.	Prob.
Math Test Score	488.804	22.191	22.027	0.000
Class Size	2.850	1.508	1.890	0.1174

Adjusted R^2 : 0.6372

Multiple R^2 : 0.7409

p-value: 0.0342

F-stat: 7.147

A)

```
Call:
lm(formula = average ~ gkclasssize + dataset, data = combined_data)

Residuals:
      1       2       3       4       5       6       7       8
 -3.959   4.965  -1.006  -7.401   8.816  15.453 -25.935   9.067

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)      488.804     22.191  22.027 3.58e-06 ***
gkclasssize        2.850      1.508   1.890   0.1174
datasetplotdata2 -54.591     14.689  -3.717   0.0138 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 15.28 on 5 degrees of freedom
Multiple R-squared:  0.7409,    Adjusted R-squared:  0.6372
F-statistic: 7.147 on 2 and 5 DF,  p-value: 0.03419
```

Regression A) shows the relation between the class size of a kindergarten student (stated as gkclasssize) and math test scores.

Table B. The effect of kindergarten teacher experience (in years) on math test scores

Independent variable	Coefficient	Std.Error	t-stat.	Prob.
Math Test Score	512.844	17.713	28.953	0.000
Teacher Experience	1.253	1.466	0.855	0.405

Adjusted R^2 : 0.009

Multiple R^2 : 0.1137

p-value: 0.3586

F-stat: 1.09

B)

```
Call:
lm(formula = average ~ gktyears + dataset, data = combined_data)

Residuals:
   Min     1Q Median     3Q    Max
-55.10 -22.31  -3.03  11.68  96.86

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)      512.844     17.713  28.953 6.61e-16 ***
gktyears           1.253      1.466   0.855    0.405
datasetplotdata2 -39.625     26.977  -1.469    0.160
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 36.3 on 17 degrees of freedom
  (23 observations deleted due to missingness)
Multiple R-squared:  0.1137,    Adjusted R-squared:  0.009397
F-statistic:  1.09 on 2 and 17 DF,  p-value: 0.3586
```

Regression B) shows the relation between years of teacher experience for a kindergarten teacher (stated as gktyears) and math test scores.