

The Effects of Teacher Experience on Budget Allocation and Student-Teacher Ratios:

An analysis of the affects of teacher experience on student teacher ratios and budget allocation in Oregon School Districts

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Abstract

The economic literature exploring the potential negative externalities of teacher experience is minimal. To improve on that end we analyze the relationship between teacher experience and both its effect on marginalized categories of the school budget and on student-teacher ratios at the district level. In our analysis, we use a panel data set provided by the Oregon Department of Education spanning the years 2000-2014 across approximately 200 Oregon public school districts. We utilize logarithmic variations of the Ordinary Least Squares empirical models that control for socioeconomic and demographic differences, and include district and year fixed

effects. Our estimates suggest that an increase in teacher experience leads to a decrease in the percentage of the budget allocated to athletics, the arts, physical education, and extracurricular activities. The effects of the average level of teacher experience on physical education, athletics, and extracurricular activity spending are significant at the five-percent level, while the effect on the arts is significant at the ten-percent level. Furthermore, our results indicate that there is a positive relationship between years of teacher experience and student-teacher ratios, an effect that is statistically significant at the one-percent level.

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I. Executive Summary

Many current concerns facing public schools in Oregon include low on-time graduation rates, the slow growth in average spending per student, and large class sizes. In the wake of these concerns, a great interest has developed among education researchers and economic analysts to provide better information on these subjects for future policy recommendations. One avenue in economic research is to focus on teacher experience as the variable of interest because it has great policy implications for education researchers, school officials, the general public, and teachers themselves. Teacher experience has many direct positive effects on student achievement. Additionally, teacher experience has potential negative effects on both the allocation to marginalized categories of the school budget and the size of student-teacher ratios, due to the increased costs associated with employing teachers with a greater amount of experience. The current research looking at the potential externalities of teacher experience is very minimal. To improve upon this, we analyze the relationship between teacher experience on the marginalized budget categories specifically athletics, physical education, the arts, and extracurricular activities, as well as its effect on student-teacher ratios, all conducted at the district level.

To accomplish this, we utilize a panel data set provided by the Oregon Department of Education, which spans the years 2000-2014, across approximately 200 Oregon public school districts. We employ a logarithmic variation of the Ordinary Least Squares Regression approach that utilizes integrated fixed effects to control for year and district differences, as well as a vector of variables that control for both the socioeconomic and demographic differences among the various districts. Our estimates suggest that an increase in teacher experience leads to a decrease

in the percentage of the total district budget allocated to athletics, the arts, physical education, and extracurricular activities. The effects of the average level of teacher experience on physical education, athletics, and extracurricular activity spending are significant at the five-percent level, while the effect on the arts is significant at the ten-percent level. Furthermore, our results indicate that there is a positive relationship between years of teacher experience and student-teacher ratios, an effect that is statistically significant at the one-percent level.

Based on the findings we believe that changes to teacher experience have a strong impact on marginalized categories of the budget and also on district level student-teacher ratios. However, further research is needed to understand the cost tradeoffs and mechanisms associated with increases to years of teaching experience. Future avenues of research could analyze more deeply the mechanisms of student-teacher ratios at the district level, specifically how an increase to the student-teacher ratio changes the composition of the faculty and administrative staff. Additionally, researchers could trace the path of cost effects from teacher experience to salary, pensions, and number of employed teachers and how these same costs and tradeoffs affect student achievement outcomes. These approaches may yield greater understanding of the mechanisms of which these externalities work and also more awareness of how funding decisions are made.

II. Introduction

Public Education in Oregon is of interest to policy makers, social scientists, and the general public in order to increase opportunities and outcomes for students and because it greatly impacts the state economy. However, there are many present concerns in Oregon public school districts. For example the U.S. Department of Education showed that Oregon's class of 2013 graduation rate ranked worst among the 49 states measured, while it ranked 5th worst for the class of 2013 under the new definition of on-time graduation rate.¹ Notably, the on-time graduation rate reached a historic level of 72 percent for the class of 2014, but this can be attributed due to the new definition.² Another concern for education officials in Oregon are the implications of large class sizes on students, because Oregon's public school system has some of the largest class sizes in the nation.³ In this paper we look specifically at student-teacher ratios, which are mathematically related, but distinctly different from class size.⁴ Regarding student-teacher ratios, in 2011-2012 Oregon had 21.2 students for every teacher, compared with 16 students per teacher nationwide. This ultimately means that the average Oregon teacher shouldered 33 percent more students than the average U.S. teacher, which has been a growing trend since the 1990s (Hammond 2014a).⁵ Furthermore, policy makers are concerned with the implications of teacher cutbacks and shorter school years, in addition to slow growth in average spending levels per student. For example, the first time the Census Bureau recorded how much states were spending per student, in 1957, Oregon was found to be the highest spender in the

¹ The definition of on-time graduation now includes special education students who earn modified diplomas, as well as students who delay graduation to remain in high school to attend community college at public expense

² See Hammond 2015 for more information recent graduation rates in Oregon

³ No agency requires Oregon middle schools or high schools to report the number of students in every class, so there is no uniform definition or specific mechanism of how schools should define a class or the number of students in it.

⁴ Student-teacher ratios are defined as the number of students per full-time equivalent teacher

⁵ The ratio is often used as a proxy for class size. In most cases, the student-teacher ratio will be significantly lower than the average class size, with class sizes commonly being 30% or more than student-teacher ratios

nation, however Oregon's ranking has greatly changed over the last 50 years. Unadjusted spending per student in the years 2011-12 was 11 percent lower than the national average, which is the biggest gap that Oregon has ever trailed the national average.⁶ In the wake of these concerns there is great interest by education researchers to provide better information for future policy recommendations and to better understand the long-term trends. One avenue in economic literature on education is looking at the relationship between budget composition and student outcomes. This track of research is often limited to studying student achievement based on the allocation of the budget to certain programs that affect their educational outcomes. Another avenue for research is exploring the role of class size, or student-teacher ratios and their impact on student achievement, test scores, and educational outcomes.

Few studies have looked at budget allocation or student-teacher ratios from a perspective other than their relationships with student achievement. In recent years policy makers and the general public have debated the effects of teacher quality and experience and its role in shaping student outcomes. This leaves teacher experience as an important variable of interest with policy implications for education researchers, school officials, teachers and the general public. Teacher experience has many direct and indirect effects on both budget composition and student achievement. For example, more experienced teachers have positive direct effects on student achievement in the classroom, due to the fact more experienced teachers are better equipped to deal with and educate students. This is especially true when teaching students that come from socially disadvantaged backgrounds. More experienced teachers also typically have more knowledge and expertise than less experienced educators. Teacher experience also has potential negative indirect effects on particular elements of the budget, such as music, arts, drama, and

⁶ For more information about average spending per student in Oregon see Hammond 2012 and 2014b

sports, because less money can be allocated to those categories when incurring higher costs associated with more experienced teachers.

Our main estimates find that teacher experience has a negative effect on many different categories of school district budgets. The effect of average teacher experience on athletics (sports), physical education and extracurricular activities are all statistically significant at the five percent level. Further, teacher experience negatively effects the allocation of the budget to the arts, an effect which is significant at the ten-percent level.

In our principal findings concerning the effect of teacher experience on student-teacher ratios we find that the coefficient for average teacher experience is positive and is approximately 0.102. Due to the logarithmic specification of our model, this means that for every ten percent increase in average teacher experience in a school district, there is an increase in the student-teacher ratio in by 1.02 percent.⁷ This effect is significant at the one-percent significance level after controlling for heteroskedasticity by employing robust standard errors. These results indicate that school districts that employ teachers with a higher average level of teacher experience ultimately have higher student-teacher ratios. This is because they must allocate a larger portion of their budget to salary and pensions costs and consequently are unable to afford as many teachers as school districts that employ teachers with lower levels of experience.

The paper proceeds as follows. Section III reviews relevant economic literature concerning school budget composition, teacher experience, student-teacher ratios and education. Section IV reviews the data sources used in the estimation and section V reviews the hypothesis and methodology of our paper. Section VI presents the main estimates, Section VII discusses the results, and Section VIII concludes.

⁷ Our model uses logged independent variables as well as logged dependent variables. For more information see the Hypothesis & Methodology section, as well as the Results section

III. Literature Review

Although few economic papers have explored the relationship between district budget composition and academic achievement, many have explored the links between class size and student outcomes. Additionally any relevant research utilizing teacher experience as the key variable of interest is minimal.⁸ Though existing research focusing on teacher experience is minimal, it is important to note that prior literature regarding education policy analysis has provided some basis for the work that follows in the rest of the paper.

Theoretically, allocation to specific categories of the budget can potentially be affected by the average level of teaching experience in a district because more experienced teachers earn higher salaries and larger pensions, which decreases the amount of the budget that is available to allocate to other areas. Prior economics literature concerning school budgets has concentrated on the effectiveness of the various different inputs on student performance. Many studies have looked at the link between school funding and student performance, but these papers did not look at the relationship between teacher experience and how school funding is allocated.⁹ However, a previous study by Stephen M. Barro and Stephen J. Carroll finds that the level of budget spending on teachers can affect the budget allocation in variety of different aspects. First, an increase in budget spending on teachers, either by hiring more teachers or increasing the overall pay schedule for teachers, is generally a high priority for education officials and policy makers when extra funding becomes available. Barro and Carroll (1975) find that budget spending on teachers will increase by approximately 0.75 percent when the total budget available for the district increases by 1 percent. Essentially, when additional funds are available, teachers benefit

⁸ We look at student-teacher ratios in our paper, but most economic papers look at or use the term class size

⁹ To find papers examining the effects of school funding on student performance see Hanushek (1981, 1986, and 1989)

by having more of the budget allocated towards employment costs such as salary and pensions. However, the role of experience is not explicitly mentioned in this paper and we explore the potential relationship of teaching experience to improve this previous analysis.

Further, the research involving student-teacher ratios, class sizes and the research on teachers is robust, but it has often focused on its effects on student achievement. Traditionally, the research on student-teacher ratios or class size has analyzed large datasets containing information on a variety of educational inputs and student outcomes (Rockoff 2009).¹⁰ Recently, economists from the past few decades have used experimental and quasi-experimental variation to build stronger casual relationships and account for unobservable factors.¹¹ However, there is not any literature that directly looks at the role of teacher experience in increasing class sizes.

Additionally, the literature on teachers is also vast and covers a wide range of topics such as looking at the effects of teacher effectiveness and other teacher characteristics on student achievement.¹² Yet, this literature mostly looks at teacher quality, certifications (see Kane, Rockoff, and Staiger 2008), and other related qualifications, and whether or not these additional qualifications are correlated with stronger student performance and more effective teaching.¹³ Essentially, the studies that we are aware of only looked at different attributes of teachers as a measure of their effectiveness rather than looking at potential effects on student-teacher ratios or different categories of the budget.

¹⁰ See Hanusek (1998) and Krueger (2003) for two different overview and analyses of the vast amount of literature on class size

¹¹ For information see Angrist and Lavy (1999), Krueger (1999), Hoxby (2000). See Rockoff (2009) for an overview of field experiments on class size in the early 20th century

¹² See Hanushek (1971), Murnane (1975), Ferguson and Ladd (1996), Rockoff (2004), Rivkin, Hanushek, and Kain (2005), and Angrist and Guryan (2008).

¹³ Murane (1975), Summers and Wolfe (1977), Ehrenberg and Brewer (1994), Clotfelter, Ladd, and Vigdor (2006) and Aaronson, Barrow, and Sander (2007) have failed to consistently find that teachers holding master's degrees are more effective

However, a literature outside of economics finds that state decision makers tend to use additional local funds to employ teachers with more professional teaching experience (Macphail-Wilcox and King, 1986). Both of the observations imply the budget composition will be affected by teacher salary and pension costs, which is determined primarily by years of teaching experience. In terms of the second track of our paper, which is to analyze the relationship between teacher experience and student-teacher ratios, Macphail-Wilcox and King find that teachers with higher salaries are mainly employed in districts that receive higher funds and have lower levels of minority students. Furthermore the authors find that student-teacher ratios are lower in schools where the percentage of minority student in enrolled is higher. This implies that the schools with more minority students hire more teachers. Since teaching salary is tied to experience these results imply that teachers experience is leading to higher teacher costs and potentially larger student-teacher ratios and class sizes. In our paper we attempt to examine this mechanism directly to draw stronger conclusions about the relationship between experience and student-teacher ratios. Drawing from the previously stated literature, we assume that the student-teacher ratio will be lower in the school districts that have more minority students enrolled. Additionally, to control for the effects of minority students on budget allocation and student-teacher ratios we include race dummy variables and a variable for the percentage of students in free and reduced lunch programs in our regression models.¹⁴

Although there is research that explores mechanisms of education funding and budget composition in addition to papers on student-teacher ratios no study that we are aware of has attempted to measure the effect of teacher experience on either budget allocation or student-teacher ratios. Much of the role of teaching experience is implied in these studies, but relatively

¹⁴ For more details about these control variables see the regression equations in the Hypothesis & Methodology section of the paper

little is known about it as a key indicator variable and its resulting magnitude of effect. By measuring the average level of teacher experience in school districts, we hope to capture the casual effect of teacher experience on both budget allocation in our first track of research and its impact on student-teacher ratios in the second track of our study.

IV. Data Description

The data sources we use in our analysis are from the Oregon Department of Education's annual reports on teachers, student demographics, and school district budgets.¹⁵ There over three million observations collected by the Oregon Department of Education (ODE) which are organized into a panel dataset and comprise observations from around 200 Oregon public school districts across a time period of 15 years. Based on this we hypothetically have around 3000 observations on the dependent variables, which are the different categories of the school district budget and student-teacher ratio respectively, with the unit of analysis at the school district-level.¹⁶ The teacher data includes observational variables such as the number of employed teachers and average years of teaching experience within a district. Examples of student level variables include the total student enrollment, demographic characteristics of the students and percentage of students in free and reduced lunch programs.¹⁷ Furthermore, the data on school district budgets has observations for various budget categories such as spending on general classroom instruction, social studies, and health education. However, in our paper we restrict our analysis to specifically the following budget categories: the arts, athletics, physical education (P.E.), and extracurricular activities.

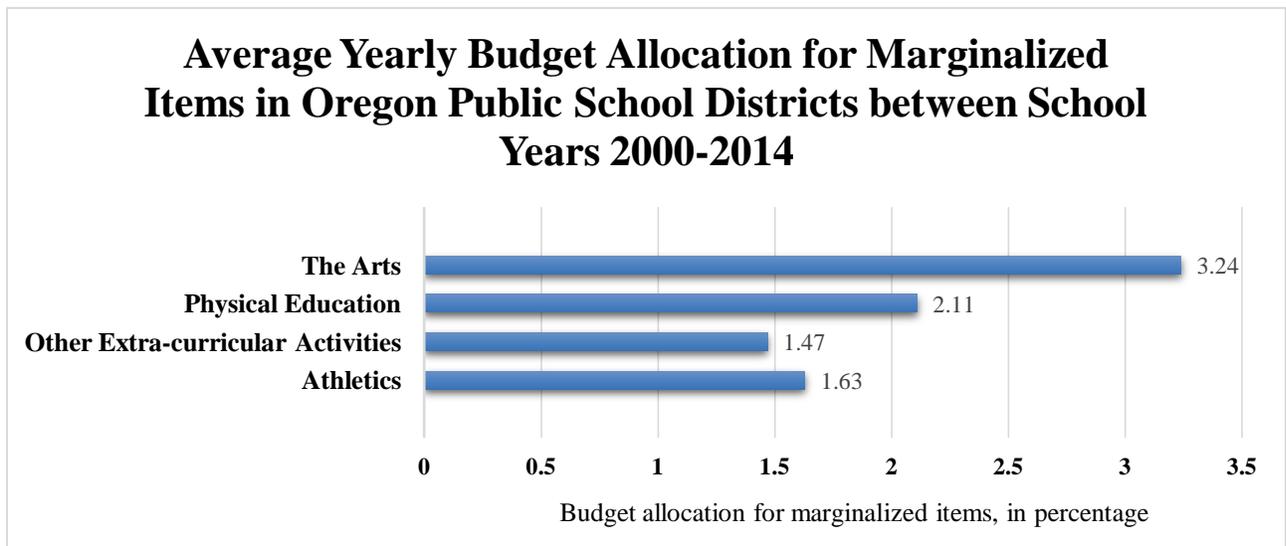
¹⁵ To see the variables we use in our regressions see Table 1 in the appendix

¹⁶ These categories are athletics, physical education, the arts, and extracurricular activities

¹⁷ See Table 1 to see other student characteristics we use in our regressions

Figure 1 below illustrates the average percentage of budget allocation for the marginalized categories, specifically the arts, athletics, physical education and extracurricular activities across the 15 school years. Even though the marginalized items, as shown below, only occupy small portion of the total school budget, we determine based on our methodology that teacher experience has statistically significant effect on the percentage change of budget allocations for these marginalized items.¹⁸

FIGURE 1:



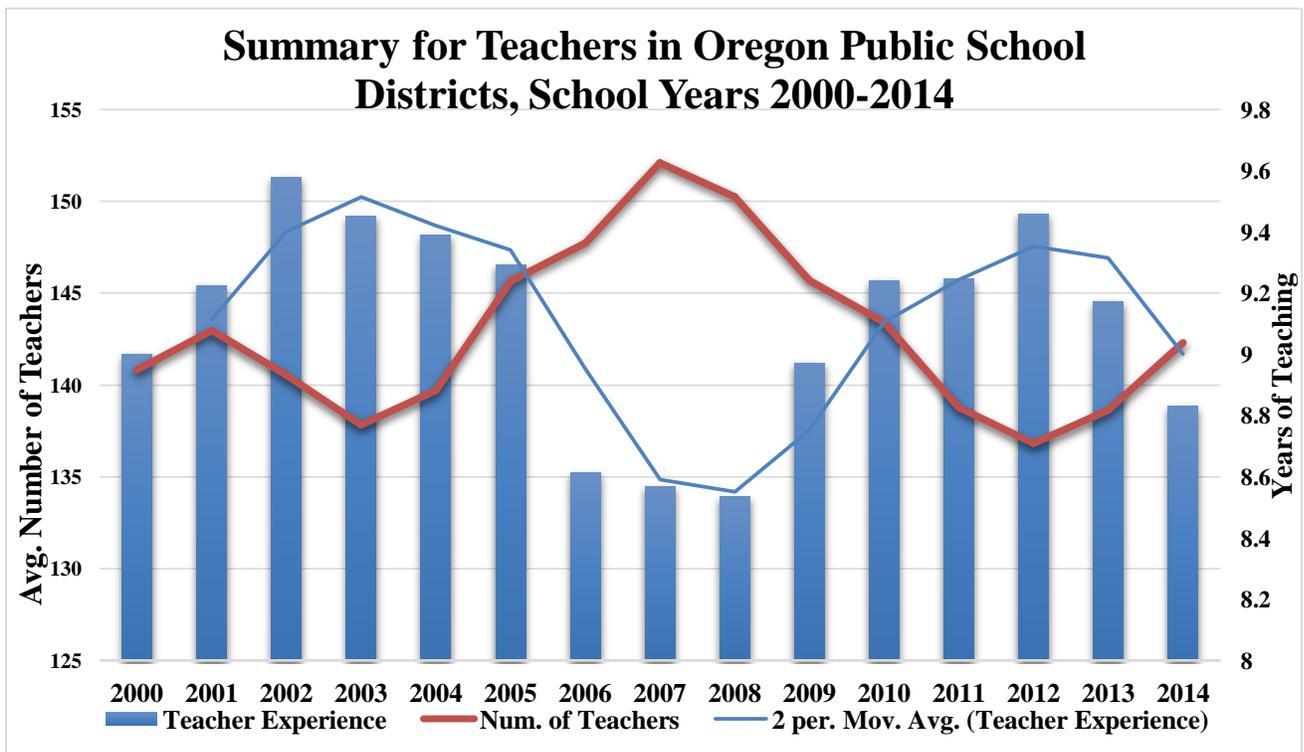
For teacher statistics, the data collected by Oregon Department of Education shows that the average number of teachers reached a peak in the 2007 school year and was followed by a large decrease until the 2012 school year, as indicated by Figure 2 on the following page.¹⁹ When evaluating the trend of average teacher experience across the 15 school years, shown in Figure 2, we notice that teaching experience surprisingly increased while many teachers left school and pursued other career options. Between school years 2005 and 2006, the average

¹⁸ See Results section for further information about our findings and significance levels and see Table 2 in the appendix for our Final Regression Results

¹⁹ We utilize years of teaching to represent teacher experience, our key variable of interest.

number of teachers employed by school districts in Oregon increased by only two whereas teacher experience reduced by over eight months on average. Further, the inverse correlation stopped and briefly became a positive correlation when both teacher experience and net number of teachers decreased between school years 2007 and 2008. Based on the data, we believe that many experienced teachers left districts or were laid off during the Great Recession and an increasing amount of less experienced teachers were employed by the Oregon public school system around the 2008 academic school year. Additionally, beginning with the 2009 school year the inverse correlation between teacher experience and number of teachers in district returned and continued for the following years in our data.

FIGURE 2:

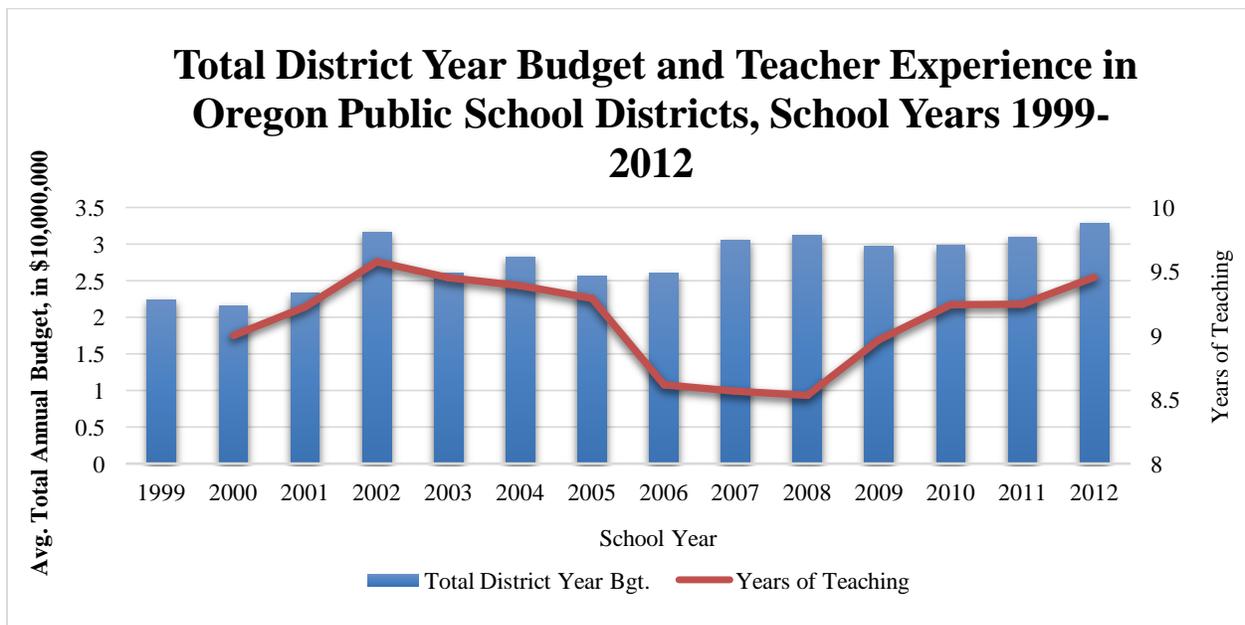


Notably, in 2012 the average number of teachers was the lowest across Oregon public school districts in the 15 years of data that was analyzed. Further, the average teacher experience

at the school district level was at its second highest in this same year, and we believe this may correlated with the low number of employed teachers for that specific year.²⁰ Starting from school year 2012, on average the net number of employed teachers increased yearly by three in Oregon public school districts while the average years of teaching experience decreased annually by more than three months.

As for the total yearly budget assigned to Oregon school districts, it follows an overall smooth trend as the blue bars indicate in Figure 3 below. To find the effect that teacher experience has on budget allocation, we evaluate the trend of teacher experience versus total district yearly budget across the past school years. The total budget fluctuated overall throughout the data, whereas average years of teaching continued to decrease until school year 2008. After that, average years of teaching in districts experienced an increase until school year 2010. In addition, the total district yearly budget rose between school years 2010 and 2012, while the average teacher experience was stable before it increased.

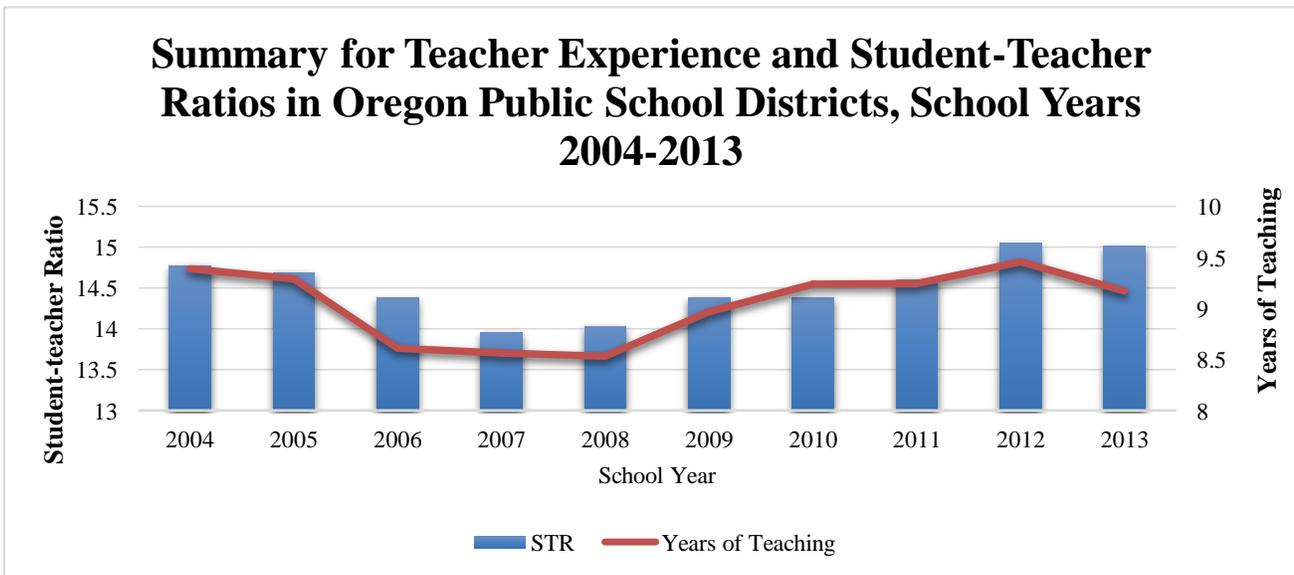
FIGURE 3:



²⁰ The highest level of average teacher experience was in 2002.

The graph in Figure 4 exhibits the trend of student-teacher ratios in Oregon public school districts and shows the average teacher experience across 10 school years. Overall, there is a positive correlation between the variables shown below. As student-teacher ratios decreased and reached its lowest level in the 2007 school year, years of teaching also consistently decreased over the same period. Moreover, both average years of teaching and average teacher experience started to increase after the 2008 school year until the 2012 school year. The most recent data in the figure shows a decrease in average teaching experience while student-teacher ratios remained stable.

FIGURE 4:



V. Hypothesis & Methodology

The premise for our paper is to measure the potential negative externalities resulting from increases to the average level of teacher experience. Teaching experience has positive direct effects on student achievement within the classroom, but at the same time has indirect negative

effects. Our hypothesis is that these indirect negative effects are specifically seen in two different areas, first in the decreasing allocation of funding to budget categories like the arts, and athletic spending due to the increasing pension and salary costs in the budget and secondly in the increasing student-teacher ratios due to the higher costs associated with more experienced teachers. A public school teacher's salary is comprised of two components that are directly affected by experience; their pension and their yearly salary. Each component of a teacher's salary increases in tiers as their years of experience increase. This ultimately results in more experienced teachers costing more to employ both from a pension and salary standpoint. The additional costs associated with these teachers causes funding to be drawn from other budget items. Essentially, it is our expectation that the additional budget expenditures associated with the increases in teacher's salaries and pensions will result in lower allocation to marginalized budget items such as the arts and athletic spending in addition to larger student-teacher ratios.²¹

In an attempt to measure the outcomes of our key independent variable, years of teaching experience, we split our methodology into two distinct paths. The first path is to examine the relationship between teaching experience and allocation to specific marginalized categories of the budget, while the second path is an examination of the casual relationship between increases in teaching experience and student-teacher ratios. To do this we use a panel data set provided by the Oregon Department of Education which consists of around 200 public school districts in Oregon covering a 15 year period. We employ a logarithmic specification of the Ordinary Least Squares Regression approach in our analysis as well as integrated fixed effects in order to control for year-to-year and district-to-district fluctuations. In addition, we add controls to take into account the different socioeconomic status of individual school districts. Examples of variables that are controlled for include total budget, total school enrollment, and percentage of students on

²¹ Since student-teacher ratios are mathematically related to class sizes this will also result in larger class sizes

free and reduced lunch programs. Here, the enrollment and free lunch program variables are used as controls for the effects of student population and low-income status respectively.

Presented below is further analysis of the methodology employed in our analysis of the potential externalities of teacher experience.

4.1- Effect of Teacher Experience on Budget Categories

Controlling for the differences across years and across individual school districts that may affect a district's overall level of budget allocations, we isolate the effect that teacher experience has on budget allocations by using an integrated fixed effect model for the marginalized items of the school district budget. The marginalized budget areas focused upon are funding to physical education, athletics, the arts (i.e. drama, music, and theater), and extracurricular activity programs.

To test our primary hypothesis that teacher experience is associated with a reduction in funding allocation to marginalized items of the budget because of the increased costs of employing more experienced teachers, we utilized the presented regression specification below.

$$Y_{ijt} = \alpha_{it} + \beta_1 E_{it} + \beta_2 C_{it} + \varepsilon_{it}$$

Here, we use an integrated fixed effect model to control for the differences across years and across districts and evaluate the effects of teacher experience on budget allocations (i.e. the arts, athletic spending, P.E., and extracurricular activities). The intercept term, α_{it} is a vector of fixed effects that will be controlled for in the model. The variable Y_{ijt} is the logarithm of budget category j for district i in year t . The fixed effects that are being controlled for are the differences across years and across individual school districts. The variable E_{it} is the logarithm of the average teacher experience in district i for year t . The measure of teacher experience is the average years of teaching experience across teachers at the school district level. Finally, the

variable C_{it} in the regression is a vector of all the control variables that are utilized in the regression for a given year and school district. We have the expectation that the coefficient on teacher experience will have a negative value for marginalized categories of the budget such as the arts because we expect to be the increased costs associated with employing teachers with more experience will cause funding to be taken away from budget items that are susceptible to budget cuts. The full equation used in one of our regressions is as follows:

4.1.1. The effect of Teacher Experience on the Budget Allocation for Physical Education:

$$\begin{aligned}
 LOGPE_{it} = & \beta_0 + \beta_1 LOGyrsindistcnt_{it} + \beta_2 LOGTotalDitYearBgt_{it} \\
 & + \beta_3 LOGTotalStudentsINDistrict_{it} + \beta_4 UnknownRace_{it} \\
 & + \beta_5 PacificIslander_{it} + \beta_6 Black_{it} + \beta_7 Asian_{it} + \beta_8 NativeAerican_{it} \\
 & + \beta_9 Hispanic_{it} + \beta_{10} distfreeredlnchpct_{it} + e_{it}
 \end{aligned}$$

Our endogenous variable, $LOGPE_{it}$, is the logarithm of budget allocation for physical education for district i in year t . $LOGyrsindistcnt_{it}$ is the logarithm of average teacher experience in district i in year t . $LOGTotalDitYearBgt_{it}$ is the logarithm of the total district budget for district i in year t . Here, $distfreeredlnchpct_{it}$ and $LOGTotalStudentsINDistrict_{it}$ are controls for student population, income and poverty. As mentioned above, the variables of race, such as $UnknownRace_{it}$, $PacificIslander_{it}$, $Black_{it}$, $NativeAerican_{it}$, $Asian_{it}$, and $Hispanic_{it}$, are the controls for the demographic characteristics of the students in the school

districts. β_0 is the constant term and e_{it} is the error term. The coefficient β_1 estimates the effect that teacher experience has on the percentage change of budget allocation for P.E.²²

4.2- Effect of Teacher Experience on Student Teacher Ratios

In our second track of research we look at the effect of years of teacher experience on student-teacher ratios at the school district level, and our regression takes the following form:

$$Y_{it} = \alpha_{it} + \beta_1 E_{it} + \beta_2 C_{it} + \varepsilon_{it}$$

In this regression model all independent variables are specified in the same manner as the previous path, but here the dependent variable is now the logarithm of the student-teacher ratio for district i in year t .²³ Our belief is that districts that have teachers with higher experience will be forced to allocate a larger portion of their budget to salaries and pensions and thus will not be able to afford as many teachers as other schools with lower experienced teachers, resulting in larger student-teacher ratios for the former types of school districts. Furthermore, our expectation is that the coefficient of the variable for the average years of teaching experience will have a positive sign, because school districts that employ more experienced teachers will have less money to employ additional teachers.

VI. Results

In our first track of research we examine the relationship between teacher experience and budget allocation to physical education spending, athletics spending, spending on the arts and

²² See the appendix for the other specific equation that look utilize the categories of the budget as the dependent variable

²³ See the appendix for the specific equation used in our student-teacher ratio regression

extracurricular activities spending.²⁴ Our regression results suggest that at the five-percent significance level, teacher experience has a negative effect on physical education, athletics and extracurricular activities spending. Furthermore, at the ten-percent level teacher experience has a negative effect on spending on the arts. In our regression we use logged dependent variables for each budget category and logged independent variables. The coefficients for the log of average level of teacher's experience are -0.404, -0.271, -0.276 and -0.431 for budget allocated to physical education, athletics, art and extracurricular activities respectively. In terms of interpreting our regression results, the coefficient of the log of average level of teacher's experience for example is -0.404 in regression for the log of physical education spending. This result is an elasticity meaning that a one-percent increase in average teacher experience leads to 0.404 percent decrease in the total budget being allocated to physical education spending. To control for demographic characteristics we use control variables for race, which vary in whether they have either positive or negative effects on categories of the budget and in their significance levels, with some being significant and most being highly insignificant.²⁵ We also use another socioeconomic status control variable, the variable for percentage of students on free and reduced lunch at the school district level; this variable is highly insignificant in all regressions except in the regression looking at spending on extracurricular activities where it is significant at the five-percent level.²⁶

We also include controls for total yearly district budget and total number of students at the school district level, both of which are in logarithmic form. Interestingly, the total yearly district budget is highly significant in only two of our regressions when looking at the effects of

²⁴ All these dependent variables are in logged form, see Table 1 for more information about the variables and see the Table 2 for R^2 values and standard errors, as well as significance levels and coefficients

²⁵ See Table 2 for more information, note the coefficients on these variables vary based on the regression. White is the control group and is left out of the regression equations

²⁶ See Table 2 in the appendix for more information

teacher experience on allocation to specific categories of the budget. The total yearly budget is significant in the regressions for physical education spending and for athletic spending, while it is highly insignificant in the two other regressions.

In our second track of research we find that a higher level of average teacher experience at the school district level will result in an increase in student-teacher ratios.²⁷ The regression results indicate that the coefficient of the logged average years in school district, which represents the level of average years of teaching experience, is 0.102 and the p-value is 0.006, which shows that increasing a teacher experiences has a significant effect on the student-teacher-ratio at the one-percent significance level. This result implies that a ten-percent increase in average years of teaching experience will result in approximately a one-percent increase in student-teacher ratios. A ten-percent increase in average years of teaching experience is roughly comparable to an increase of one year in teaching experience which would lead to an increase in student-teacher ratios from 20 to 20.2 students on average.²⁸ This supports our original hypothesis that more experienced teachers will contribute towards an increasing student-teacher ratios at the school district level. Essentially, school districts are forced to allocate a larger portion of their budget to salaries and pensions and consequently will not be able to afford as many teachers as other school districts that employ teachers with lower levels of experience. However, further mechanisms may be needed to examine this result, particularly at the individual school level in order to determine more information about the causal effect of teacher experience on student-teacher ratios.

²⁷ For R^2 values, standard errors, or coefficient values not discussed in the Results section see Table 2 in the appendix

²⁸ See Figure 5 to see the effect of 10% increase of average level of teacher experience at the school district level

We examine further results concerning the control variables used in our empirical model.²⁹ We find that the coefficient of log total students in districts is 0.861, which is significant at the one-percent level meaning that school districts with a higher number of total students will have larger student-teacher ratio than districts with less total students. This positive effect may be attributable to the fact that the number of teacher in a district does not increase at the same rate as the number of students. Furthermore, the coefficient of log total district yearly budget is -0.138 which is significant at the one-percent significance level with a t-statistic of -4.58, meaning that a 10 percent increase in the total annual budget in districts will lower the student-teacher ratio by approximately 1.4 percent. This supports our assumption that larger increases in the total yearly budget will allow schools to hire more teachers and reduce the student-teacher ratios. Our race control variables show differing results with some variables having negative effects on student-teacher ratios and others having positive effects on them.³⁰ However, only the Native American control variable is significant at the ten-percent level, which has a positive effect on student-teacher ratios. In addition, the variable for percentage of student on free and reduced lunch, which is a control for low-income status, is highly insignificant and is not significant at the ten-percent level depending on the individual regression.³¹ It is important to note that variables such as the race control variables and the variable for free and reduced lunch programs are merely being used as controls variables to isolate the effect of teacher experience, and that more investigation must be done in order to determine why these variables are statistically significant or insignificant.

²⁹ See Table 2 for results not discussed in the Results section

³⁰ White is the control group for the race dummy variables

³¹ Has p-value of 0.729 and a t-statistic of -0.35

VII. Discussion of Results

This paper aims to analyze this subject to provide educational departments with more information to construct their budgets in order to maximize programs that benefit student achievement while also providing satisfactory financial support to educators. We are not aware of any previous studies that examine the effects the tracks of research we pursue which leaves our study contributing to this type of analysis. Our results establish that there is a significant relationship between teacher experience and both budget allocation and student-teacher ratios, but there are important caveats to our study. This study looks at budget compositions and student-teacher ratios at the school district level, potentially future literature could examine the effects of average level of teacher experience at the individual school level, possibly resulting in stronger implications due to a greater number of observations. Further, due to time and data constraints we are not able to trace out the path of cost effects from teacher experience to salary, pensions, and number of teachers. Potentially both of these approaches may yield greater understanding of the mechanisms of which these externalities work and also more awareness of how funding decisions are made.

Additionally future papers could purpose a third track of research, which looks more deeply at the mechanisms of student-teacher ratios at the district level. It could examine how increased student-teacher ratios change the composition of teachers at the school district level. This track of analysis could explore whether increases in student-teacher ratios leads to less special education teachers employed district wide, less music and arts teachers, or decreases in library personnel. Future work could also explore more aspects of the budget in addition to categories that we look at in this paper. Furthermore, there are also some limitations to our

findings, for example due to Oregon's biennium education budget structure; these results may not necessarily be externally valid for other public school districts nationwide.³²

In terms of interpreting our findings, previous economic literature has mixed findings regarding the effect student teacher ratios and class sizes on classroom achievement.³³ Many researchers have found that there are positive gains from reducing class sizes, particularly for minority students (Finn and Achilles 1990, Krueger 1999, and Krueger and Whitmore 2001). While recent field experiments have shown there are positive gains from reduced classroom sizes (Bain and Achilles 1986, Word et al. 1990, Krueger 1999, and Krueger and Whitmore 2001). On the other hand, other literature from educational economics suggests that class size has minimal effects on student achievement (Hanushek 1986, 1998).

Concerning teachers, research has consistently found that teachers are important for student learning and achievement, but the findings concerning the effectiveness of teachers are mixed (see Rockoff 2004, Rivkin, Hanushek, and Kain 2005, Aaronson, Barrow and Sander 2007, and Kane, Rockoff, and Staiger 2008).³⁴ Additionally, economics literature examining the relationship between salaries and measures of teacher quality or performance has a lot of variation in its findings (see Murnane et al. 1991, Hanushek, Kain, and Rivkin 1999, and Figlio 2002).

However, our research is not to suggest that teachers should be compensated less or that they are the main cause of increased student-teacher ratios and reduced allocation to marginalized categories of the budget. Rather our findings suggest that there are externalities

³² Biennial budgeting typically works on an odd-even system. Lawmakers submit and approve a budget that includes 24-month appropriations on an odd year and focuses on budget oversight in even years. Essentially, school districts on a biennium education budget may make certain adjustments that districts on a single year budget structure would not due to the type of budget.

³³ See Cohn and Millman (1975), Glass and Smith (1978), Hanushek (1986), and Hedges, Laine, and Greenwald (1994) for more information on the effects of class size on student achievement

³⁴ For a few examples of overviews of the literature discussing teacher effectiveness see Hanushek and Rivkin (2012) and Jackson, Rockoff, and Staiger (2014)

associated with teacher experience that are less understood. They suggest that budgets and student-teacher ratios are very sensitive to changes in the level of teacher experience and propose that teacher costs are one of many mechanisms that are resulting in these types of funding decisions being made. Broadly, our results suggest that further attention by education officials and policy makers is needed to explore these negative externalities associated with increases in teacher experience.

VIII. Conclusion

Increasing student-teacher ratios and shrinking budgets continue to be a major concern for public school systems nationwide. Despite strong public interest, the effects of school budgets have received little attention from education policy researchers. Outside of examining the impact of budget composition on student achievement little is known about their impact on outcomes of interest to policy makers, social scientists, and the general public. The education literature on student-teacher ratios is narrowly tailored towards exploring its effect on student achievement and other student outcomes. This study attempts to alleviate those concerns by using teacher experience as our variable of interest and look at its effect on both specific categories of school district budgets and student-teacher ratios. Theoretically we expect teacher experience to have negative effects on particular elements of the budget, such as music, arts, drama, and sports, while also increasing student-teacher ratios because more experienced teachers are typically more expensive in terms of salary and pension costs.

Our regression findings suggest that an increase in teacher experience leads to a decrease in the funding allocated to athletics, arts, physical education, and extracurricular activities. The

effect of the average level of teacher experience on athletics, physical education and extracurricular activities spending are significant at the five-percent level and the effect on spending on the arts is significant at ten-percent level.

In addition, we also explore the relationship between teacher experience and student-teacher ratios. We find that an increase in the teacher experience is associated with an increase in student-teacher ratios, an effect significant at the one-percent significance level. Our findings are robust to a wide set of specifications, including district and year fixed effects, district-specific linear time trends, and controls for time-varying factors such as the percentage of students on free and reduced lunch, total budget, and student enrollment.

With respect to policymakers and education officials, our findings suggest that any informed debate over budgeting will need to weigh the benefits of increases in teacher experience against the potential negative externalities that may result.

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X. Appendix

TABLE 1 – Variable Description

Variable	Description	Duration
STR_{i,t}	Student-teacher Ratio for school district i at year t	Annually data from school year 2004 to school year 2013
TotalStudentsINDistrict_{i,t}	School enrollment for school district i at year t	Annually data from school year 2004 to school year 2013
TotalDistYearBgt_{i,t}	Total Amount of budget for school district i at year t	Annually data from school year 1999 to school year 2013
UnknownRace_{i,t}	% of unknown race for school district i at year t	Annually data from school year 2000 to school year 2014
PacificIslander_{i,t}	% change of Pacific Islands Americans for school district i at year t	Annually data from school year 2000 to school year 2014
Black_{i,t}	% of African Americans for school district i at year t	Annually data from school year 2000 to school year 2014
Asian_{i,t}	% of Asian Americans for school district i at year t	Annually data from school year 2000 to school year 2014
NativeAmerican_{i,t}	% of Native Americans for school district i at year t	Annually data from school year 2000 to school year 2014
Hispanic_{i,t}	% of Hispanic Americans for school district i at year t	Annually data from school year 2000 to school year 2014
TeacherINDistrict_{i,t}	Amount of teachers in school district i at year t	Annually data from school year 2000 to school year 2014
yrsindistcnt_{i,t}	Average years of teaching experience for school district i at year t	Annually data from school year 2000 to school year 2014
distfreeredlnchpct_{i,t}	% of students receiving free and reduced lunch for school district i at year t	Annually data from school year 2000 to school year 2014

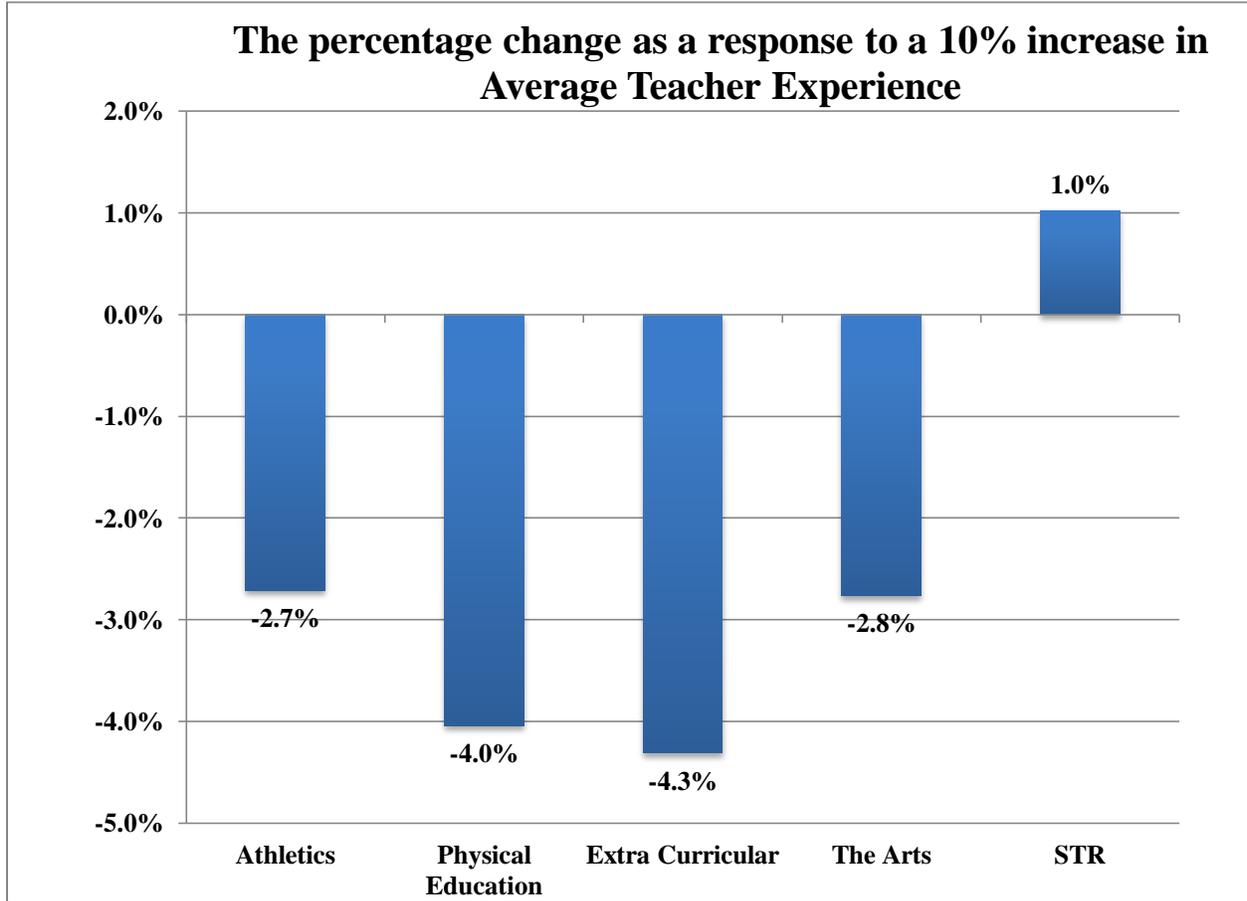
Table 2 – Final Ordinary Least Squares Regression Results

VARIABLES	(1) Log (The Arts)	(2) Log (Athletics)	(3) Log (PE)	(4) Log (Extra)	(5) Log (STR)
Log (Years in District)	-0.276* (0.141)	-0.271*** (0.0687)	-0.404** (0.198)	-0.431** (0.177)	0.102*** (0.0370)
Log (District Yearly Budget)	0.124 (0.0916)	0.296** (0.126)	0.524*** (0.154)	0.214 (0.209)	-0.138*** (0.0301)
Log (Students In District)	0.113 (0.149)	0.0688 (0.0696)	0.519 (0.429)	0.250 (0.278)	0.861*** (0.0585)
Unknown Race	0.00704 (0.164)	0.111 (0.0711)	0.323 (0.208)	-0.104 (0.200)	-0.00609 (0.0368)
Pacific Islander	-2.186 (2.817)	4.151 (3.953)	1.522 (6.774)	9.825 (8.781)	-0.0140 (0.621)
Black	1.325 (2.237)	3.940 (4.056)	4.726 (5.888)	-0.581 (6.829)	0.490 (0.536)
Asian	0.725 (1.379)	-3.060** (1.191)	-6.193* (3.335)	8.014* (4.468)	-0.571 (0.424)
Native American	1.223 (0.940)	-1.640* (0.880)	-2.262* (1.167)	-2.091 (1.588)	0.121* (0.0690)
Hispanic	0.629 (0.582)	-0.0465 (0.223)	-0.550 (0.544)	0.637 (0.430)	-0.0383 (0.0960)
District Free Lunch %	-0.00140 (0.00360)	0.00175 (0.00261)	-0.00279 (0.00405)	0.00779** (0.00354)	-0.000190 (0.000549)
Constant	10.90*** (2.141)	7.910*** (2.264)	0.637 (4.380)	5.808** (2.785)	-1.578*** (0.554)
Observations	1,525	1,226	1,403	1,021	1,740
R-squared	0.923	0.896	0.884	0.853	0.932

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

FIGURE 5:



Hypothesis & Methodology Equations:

Continued from Hypothesis & Methodology section, the specific equations used in our empirical analysis are as follows.

4.1.1. The effect of Teacher Experience on the Budget Allocation for Physical Education:

$$\begin{aligned}
 LOGPE_{it} = & \beta_0 + \beta_1 LOGyrsindistcnt_{it} + \beta_2 LOGTotalDitYearBgt_{it} \\
 & + \beta_3 LOGTotalStudentsINDistrict_{it} + \beta_4 UnknownRace_{it} \\
 & + \beta_5 PacificIslander_{it} + \beta_6 Black_{it} + \beta_7 Asian_{it} + \beta_8 NativeAerican_{it} \\
 & + \beta_9 Hispanic_{it} + \beta_{10} distfreeredlnchpct_{it} + e_{it}
 \end{aligned}$$

4.1.2. The effect of Teacher Experience on the Budget Allocation for Athletics:

$$\begin{aligned} \text{LOGAthletics}_{it} &= \beta_0 + \beta_1 \text{LOGyrsindistcnt}_{it} + \beta_2 \text{LOGTotalDitYearBgt}_{it} \\ &+ \beta_3 \text{LOGTotalStudentsINDistrict}_{it} + \beta_4 \text{UnknownRace}_{it} \\ &+ \beta_5 \text{PacificIslander}_{it} + \beta_6 \text{Black}_{it} + \beta_7 \text{Asian}_{it} + \beta_8 \text{NativeAerican}_{it} \\ &+ \beta_9 \text{Hispanic}_{it} + \beta_{10} \text{distfreeredlnchpct}_{it} + e_{it} \end{aligned}$$

4.1.3. The effect of Teacher Experience on Budget Allocation for the Arts:

$$\begin{aligned} \text{LOGTheArts}_{it} &= \beta_0 + \beta_1 \text{LOGyrsindistcnt}_{it} + \beta_2 \text{LOGTotalDitYearBgt}_{it} \\ &+ \beta_3 \text{LOGTotalStudentsINDistrict}_{it} + \beta_4 \text{UnknownRace}_{it} \\ &+ \beta_5 \text{PacificIslander}_{it} + \beta_6 \text{Black}_{it} + \beta_7 \text{Asian}_{it} + \beta_8 \text{NativeAerican}_{it} \\ &+ \beta_9 \text{Hispanic}_{it} + \beta_{10} \text{distfreeredlnchpct}_{it} + e_{it} \end{aligned}$$

4.1.4. The effect of Teacher Experience on the Budget Allocation for Extracurricular

Activities:

$$\begin{aligned} \text{LOGExtracurricular}_{it} &= \beta_0 + \beta_1 \text{LOGyrsindistcnt}_{it} + \beta_2 \text{LOGTotalDitYearBgt}_{it} \\ &+ \beta_3 \text{LOGTotalStudentsINDistrict}_{it} + \beta_4 \text{UnknownRace}_{it} \\ &+ \beta_5 \text{PacificIslander}_{it} + \beta_6 \text{Black}_{it} + \beta_7 \text{Asian}_{it} + \beta_8 \text{NativeAerican}_{it} \\ &+ \beta_9 \text{Hispanic}_{it} + \beta_{10} \text{distfreeredlnchpct}_{it} + e_{it} \end{aligned}$$

4.2.1. The effect of Teacher Experience on Student-Teacher Ratios:

$$\begin{aligned} \text{LOGSTR}_{it} = & \beta_0 + \beta_1 \text{LOGyrsindistcnt}_{it} + \beta_2 \text{LOGTotalDitYearBgt}_{it} \\ & + \beta_3 \text{LOGTotalStudentsINDistrict}_{it} + \beta_4 \text{UnknownRace}_{it} \\ & + \beta_5 \text{PacificIslander}_{it} + \beta_6 \text{Black}_{it} + \beta_7 \text{Asian}_{it} + \beta_8 \text{NativeAerican}_{it} \\ & + \beta_9 \text{Hispanic}_{it} + \beta_{10} \text{distfreeredlnchpct}_{it} + e_{it} \end{aligned}$$