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Is there a Link between Teacher Salary and Educational Achievement? An Analysis in OECD Countries

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This paper uses data from the Organization for Economic Co-operation and Development (OECD) and employs multiple regression models to investigate the relationship between teacher salary and educational achievement in mathematics and science across 30 countries. After controlling for alternative wage opportunities and two macroeconomic factors (GDP per capita and educational expenditure as percentage of GDP), the results reveal no significant relationship between teacher salary and educational achievement in mathematics and science. These findings imply the need to look beyond a single policy, such as higher salaries, in favor of policy strategies that address working conditions and other challenges facing new teachers.

Keywords: teacher salary, educational achievement, OECD, PISA data

Introduction

The main purpose of this study is to investigate the relationship between teacher salary and student achievement using the most recent available data from OECD countries.

Teacher salaries represent the largest single cost in formal education and have an important impact on the attractiveness of the teaching profession. They influence decisions to enroll in teacher education, to become a teacher after graduation, to return to the teaching profession after a career interruption (OECD, 2005). Many countries are looking to increase the supply of teachers, particularly those with an ageing teacher workforce by offering more attractive salaries and career prospects. These countries are also trying to retain the most competent and qualified teachers to ensure a well-qualified teaching workforce with the view to increase school performance and student achievement. This paper contributes to the debates by using teacher salary data unavailable in previous studies to account for alternative labor market opportunities that affect the opportunity cost of choosing to teach and explores the relation between teacher salary and educational achievement in OECD countries. It also accounts for two macroeconomic factors (GDP per capita and educational expenditure as percentage of GDP). We find no significant relationship between average teacher salary and national achievement in mathematics and science for both new and experienced teachers.

Over the past decades, discussions about education policy have in part focused on how to improve educational achievement both within and across schools. In this context, several issues such as reducing class sizes, providing more school inputs, incentive-based policies, or increasing the quality of teachers have been largely discussed (Azam & Kingdon, 2015).

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In order to ensure both quality teaching and sustainable education budgets, educators, policy makers and researchers are increasingly interested in understanding the relationship between school resources and student performance.

The interest in examining the relationship between teacher salary and student achievement comes from several sources. First, from an economic perspective, investing in teacher quality and generally in education is perceived as way that can potentially increase economic growth, promote income equality, and reduce poverty (Barro, 1991; Gupta, Verhoeven, & Tiongson, 2002). Education is also considered as a pathway to generate various externalities, related for example to its effect on economic growth or its value for a well-functioning democracy, thus justifying an important component of public intervention (Hanushek, 1996). In this vein, recent empirical research has shown that teacher quality in school is positively associated with social outcomes such as reduced teenage pregnancy and improved quality of neighbourhood lived in (Azam and Kingdon, 2015).

Second, in most countries, an important part of the state budget is devoted to education and teacher salary accounts for between half and three fourth of education expenditure (OECD, 2019). Given the magnitude of the financial investment involved, policymakers are naturally inclined to pay attention to the link between these funds and educational outcomes. Furthermore, examining the level of teacher salary and its potential impact on student learning might provide useful information for school leaders and policymakers to improve students' chances of success and to implement policies aimed at the recruitment and retention of high- quality teachers

During the last two decades, the importance of teacher salary has been the focus of debate for many countries, particularly in the context of teacher accountability promoted by the implementation of performance-related pay schemes. The concept of linking pay to an assessment of individual performance has been adopted in many countries including, for example, England and Wales (Tomlinson, 2000), Australia and India (Kingdom & Teal, 2010). However, existing studies do not provide a clear picture of the relationship between teacher pay and student performance. Several empirical studies have demonstrated some difficulties of implementation concerning this system and the lack of support from teachers (see for example Farrell & Morris, 2004). As a result, most countries still use a standardized compensation system that determines salary level based on education level and teaching experience.

The debate about teacher salary stems also from the situation of the teacher labor market, particularly the teacher shortage and the high attrition rates reported in many OECD countries (OECD, 2005; OECD, 2013). It is generally believed that lower salaries relative to alternative occupations are responsible for teacher shortages and that higher salaries will therefore help to reduce shortages. However, there exists little empirical works devoted to the relationship between teacher shortages and teacher salary differentials.

Furthermore, an increasing number of studies have shown that low teacher salary often leads to teacher dissatisfaction and higher attrition rates. For instance, Figlio (1997) found that U.S. districts with higher teacher salaries tend to attract more teachers from selective colleges and with subject matter qualifications. The

OECD (2014) reports that disadvantaged schools tend to be more likely to suffer from teacher shortages and experience greater difficulties in attracting qualified teachers. Studies in different national contexts show that working conditions are consistently the strongest predictors of teacher turnover (see for example, Ingersoll & May, 2012; Ladd, 2011). More work in this vein could produce a better understanding of the determinants of teacher turnover and retention. The rest of the paper is organized as follows. Section 2 gives an overview of the literature. Section 3 introduce the method and discusses the data and variables. Section 4 presents and discusses the results. Section 5 concludes the paper.

Teacher Salary and Educational Achievement: What do we know?

In the present study, teachers refer to professional personnel directly involved in teaching to students. The definition includes classroom teachers, special-education teachers and other teachers who work with a whole class of students in a classroom, in small groups in a resource room, or in one-to-one teaching situations inside or outside a regular class (OECD, 2018).

Empirical assessments of teacher wage effects have mostly failed to provide any consistent relationship between teacher salary and student performance. For example, only nine of the sixty teacher salary studies cited in Hanushek (1986), in the tradition of education production functions, produced wage coefficient estimates that were both positive and statistically significant. In the same vein, Hanushek (1997) finds that student outcomes are not consistently related to either teacher salaries or per pupil expenditures. Using longitudinal data sets (the High School and Beyond Survey and the National Longitudinal Survey of Youth), Grogger (1996) and Betts (1995) have also produced similar results. Ballou and Podgursky (1997) also find that relative salaries have no effect on the SAT scores of teachers.

In contrast with the cited above studies, Card and Krueger (1995) used variation in teaching salaries across states and found that a 10% rise in teachers' salaries led to a 0.1 percentage point increase in the rate of return to schooling for white males born between 1920 and 1949. Loeb and Page (2000) used state-level variation in relative teachers's wages from the 1960 to 90 censuses and found that a 10% rise in the teaching wage reduced the high school dropout rate a decade later by 3-4%. A study by Kingdon and Teal (2010), in India found that higher salary was associated with higher student achievement in private schools but not in public schools. Their results showed that, after controlling for student ability, parental background and the resources available, higher salary in private schools led to improved achievement through increased teacher efforts measured by minutes of academic instruction per week, rather than through improved overall teacher quality measured by experience and training.

To the best of our knowledge, only few studies adopting a cross-national framework have examined the relationship between national average salary and national achievement level using aggregated data at a country level with different samples of countries participating in international tests such as PISA or TIMSS

(Trends in International Mathematics and Science Study). Ladd (2007) analyzed the relationship between the ratio of teacher salary to GDP per capita and national average mathematics scores in 24 countries using the 2003 PISA data and the OECD teacher salary data. Using correlation analysis, Ladd found no statistically significant relationship between these two national factors. Nir and Naphcha (2007) examined the relationship between privatization measured by private school enrollment and teacher salary level using the 2004 OECD salary data from 29 countries. They also analyzed science scores from the 2003 PISA data and found that the countries with a higher level of privatization had a higher average teacher salary, but national achievement in science was not significantly associated with teacher salary level, controlling for GDP per capita.

Akiba, Chiu, Shimizu, and Liang (2012) used national teacher salary data from OCDE and student achievement data from PISA 2006 in order to examine the relationship between average teacher salary and national achievement in mathematics and science in OECD countries. Their results showed that the countries with higher average salary for experienced teachers are more likely to have higher national achievement. However, the national average salary for new teachers was not significantly associated with national achievement level.

More recently, García and Han (2022) investigated the relationship between teacher pay and student test scores in US districts using nationally representative data. They employed state fixed effects and multilevel mixed effects models and found that both mathematics and English test scores are significantly higher in districts that offer higher base salaries to teachers, compared with those in districts with a lower teacher base salary. They also found that higher teacher base salaries reduce achievement gap between white and black students, as well as between white and Hispanic students, by raising test scores more for those minority students.

Tincani (2021) estimated an equilibrium model to simulate a reform that is planned to be implemented in Chile in 2023. Tying public school teacher wages to teacher skills and introducing minimum competency requirements for teaching is predicted to increase student test scores by 0.30 standard deviations and decrease the achievement gap between the poorest and richest 25% of students by a third.

Marchand and Weber (2020) studied how local labor market conditions for teachers affect teacher quality and, in turn, student achievement.

In this paper, we use recent available data from 30 OECD countries participating in PISA 2018 and teacher salary data from the OECD "Education at a Glance" to examine the relationship between teacher salary and student achievement.

The following research questions were addressed for our purpose:

1. How does average salary of lower secondary school teachers compare across the 30 OECD countries?
2. How did average teacher change from 2005 to 2018 in the 30 OECD countries?
3. How are average teacher salary in 2017 associated with national average student achievement in mathematics and science in 2018?

It was hypothesized that higher pay would attract the most qualified workers in the education sector, assuring a supply of high-quality teachers that improve the student achievement. The rationale for this expectation is that, as noted in Dolton and Marcenaro-Gutierrez (2011, p. 8), in most countries, medical doctors and lawyers are paid high up in the earnings distribution and as a result, these professions attract the most able young people in each cohort. There is no reason, in principle, why teaching could not be added to this list of elite profession. In other words, the propensity of young people to enter or stay in the profession is influenced by the salaries of teachers relative to those of other occupations requiring similar levels of qualification. Specifically, in OECD countries, a tertiary degree is generally required to become a teacher, at all levels of education, meaning the likely alternative to teacher education is a similar tertiary education programme. Thus, to interpret salary levels in different countries and reflect comparative labor-market conditions, actual salaries are compared to earnings of other tertiary-educated professionals (OECD, 2019). The next section will present the data and the method.

Materials and Methods

The traditional approach to specify the link between teacher salary and educational outcomes is based on the theorical framework of an educational production function model in which the outcome or achievement of student *i* who attends school system *s* as measured by test scores *is* related to environmental and school resources input. The history of this model of achievement is generally traced back to the "Coleman Report" (Coleman et al. 1966). Most of the empirical models to estimate teacher salary effects are based on permutations of the following equation:

$$Y_{\text{is}} = \propto + \beta 1 \boldsymbol{W} s + \boldsymbol{Z} s \beta 2 + \boldsymbol{X} is \beta 3 + \in is \quad (1)$$

Where Y_{is} is an outcome measured for student i who attends school s (usually the student's test score), **W**s is related to the average wage paid to teachers at school s, Zs is a vector of factors common to all students attending school system s (such as the average socioeconomic composition of enrollees), and **X**is is a vecteur of other factors that are specific to student I (such as family background). Considering that teacher salaries impact student outcomes because of their effect on teacher quality, $\beta 1$ can be interpreted as an estimate of the slope of the supply curve for teachers in quality-wage space.

Equation (1) is typically estimated using cross-sectional data so that $\beta 1$ is identified from variation in both outcomes and salaries across schools at a point in time. Our discussion and the results presented in section 4 focus on the OLS results.

Data

This study is limited to the OECD group because these industrialized countries constitute a reasonable comparison group despite some differences in their histories and cultures. To examine the link between teacher salary and national achievement, the focus will be on two main OECD sets of data. The first one represents 2017 teacher salary data from "Education at a Glance" reports (OECD, 2019). This is the most comprehensive source of comparative information about teacher salaries in different countries around the world.

It provides data on the structure, finances and performance of education systems in the 35 OECD and a number of partner countries. The second data set used is related to the national mathematics and science achievement data from the PISA (*Programme for International Student Assessment*) 2018. The survey takes place every three years, starting in 2000, thus PISA 2018 represents the seventh wave of this study. Pisa uses a two-stage stratified design sampling. In the first stage of sampling, schools having age-eligible students are sampled systematically with probabilities proportional to the school size. A minimum of 150 schools is selected in each county. Some 600 000 students completed the assessment in 2018, representing about 32 million 15-year-olds in the schools of the 79 participating countries and economies.

Variables

Teacher Salary

Teachers' salaries are the average gross salaries of educational personnel according to official pay scales, before the deduction of taxes, including the employee's contributions for retirement or health care plans, and other contributions or premiums for social insurance or other purposes, but less the employer's contribution to social security and pension.

Teacher salary data in 20017 are from the 2019 OECD "Education at a Glance" report. Two types of teacher salary variables were analyzed: (1) average salary for new teachers, (2) average salary for teachers with 15 years of experience. The salary levels for new teachers and teachers with 15 years of experience were reported in equivalent US dollars converted using purchasing power parities (PPPs). Furthermore, to interpret salary levels in different countries and reflect comparative labour-market conditions, actual salaries are compared to earnings of other tertiary-educated professionals aged 25–64-year-old, full-time workers with similar tertiary education (ISCED 5 to 8). This third (relative) measure of teachers' salaries comes from "Education at a Glance" 2018 report. Note that GDP per capita is defined as the total market value of all final goods and services produced in a given country in a calendar year divided by the population, and it is an indicator of a country's economic wealth per capita. These three variables were analyzed for lower secondary school teachers.

Educational Achievement

National achievement levels in mathematics and science were measured using national mean student scores in mathematics literacy and science literacy in the PISA evaluation administered to 15-year-olds in 2018. These students were enrolled in grade seven or higher and include students from both lower secondary and upper secondary schools in most countries (OECD, 2019). The PISA data were chosen to match the secondary school teacher salary data in 2018 in the OECD reports. National achievement level in mathematics literacy ranged from 409 in Mexico to 527 in Japan with the mean of 489. For science literacy, it ranged from 410 in Mexico to 563 in Finland with the mean of 489.

Control Variables

GDP per capita was analyzed as a control variable as it is a strong predictor of national achievement. GDP per capita in 2017 for 30 countries ranged from $20,022 in Mexico to $112,701 in Luxembourg with the mean of $43,513. Another control variable was educational expenditure as percentage of GDP. By controlling for this variable, we can assess if the country that invested more in teacher salary produced higher national student achievement or not when the educational funding level is held constant. Educational expenditure as percentage of GDP in 2017 from 30 countries ranged from 3.2 in Luxembourg to 6.6 in Norway with the OECD mean of 4.9 (see OECD, 2020, table C2.1). Finally, the study accounts for alternative wage opportunities by using as a control variable teacher salaries to earnings for tertiary educated workers.

Empirical Strategy

For the first and second research questions, teachers' average salary levels in lower secondary schools in 2017 were compared across OECD countries. For the last research question, we conducted multiple regression analyses with country as the unit of analysis. The dependent variables are national average student achievement levels in mathematics literacy and science literacy in the 2018 PISA test. Each teacher salary variable was entered into the model separately as the independent variable with three control variables: GDP per capita, education expenditure as percentage of GDP and teacher salaries to earnings for tertiary educated workers. The multiple regression analyses were conducted separately for mathematics and science achievement levels.

Results

How does Average Salary of Lower Secondary School Teachers Compare across the 30 OECD Countries?

Generally, Statutory salaries of teachers can vary according several factors, including the level of education taught, the qualification level of teachers, and the

level of experience or the stage of the career of teachers. Figure 1 shows Lower secondary teachers' statutory salaries at different points in teachers' careers for OECD member countries and partners. Specifically, it presents the average starting salary with the minimum qualification, the salary after 15 years of experience with the most prevalent qualification and the salary at top scale with maximum qualifications. As can be seen in this figure, teachers' salaries vary widely across countries. The average salary for starting teacher ranges from USD 24 893 in Costa Rica to USD 79 551 in Luxemburg, the OECD average is USD 33 498.

The salaries of teacher with 15 years of experience range from less than USD 25 000 in the Czech Republic, Hungary, Lithuania and the Slovak Republic to more than USD 60 000 in Canada, Germany, Ireland, the Netherlands and the United States, and they exceed USD 100000 in Luxemburg.

In most countries and economies with available information, teachers' salaries increase with the level of education they teach. In the Flemish and French communities of Belgium, Denmark, Lithuania and Norway, upper secondary teachers with 15 years of experience and the most prevalent qualifications earn between 25% and 30% more than pre-primary teachers with the same experience, while in Finland and the Slovak Republic they earn 36-50% more, and in Mexico, 88% more. In Finland and the Slovak Republic, the difference is mainly due to the gap between pre-primary and primary teachers' salaries. In the Flemish and French communities of Belgium, teachers' salaries at upper secondary level are significantly higher than at other levels of education (OECD, 2020, Table D3.1).

In addition to pay scales, the number of years needed to reach the top of scale is an indication of the speed of career progression and prospects. In general, the wider the range between minimum and maximum salaries, the more years it takes for teachers to reach the top of the scale. For example, although it only takes 6-8 years to start earning the maximum salary in Australia, New Zealand and Scotland (United Kingdom), the top of the scale is only about 33-53% higher than starting salaries, compared to 66% on average across OECD countries and economies with data on salaries at both points of the scale. However, this is not true of all countries. For example, while teachers with the most prevalent qualifications in both the Czech Republic and Israel will reach the top of their scale within approximately 32-36 years, maximum statutory salaries in the Czech Republic are only 32% higher than starting statutory salaries, compared to 104% higher in Israel.

Figure 2 presents teachers' salaries relative to earnings for tertiary-educated workers to account for alternative employment opportunities that are important factors in the attractiveness of teaching. Among the countries with available data, actual salaries of teachers amount to 61% and 65% of earnings of similarly educated workers in the Czech Republics and the United States. Few countries have actual salaries of teachers that reach or exceed those of similarly educated workers. However, in some countries, teachers earn more than tertiary-educated workers, for example, in Luxembourg and Portugal, teachers earn at least 30% more that tertiary-educated workers. However, some caution is warranted when interpreting the ratio. For example, in Greece the proportion of overqualified

people in their job may lead to lower average earning compared to workers with similar proficiency but who are well-matched with their jobs. This may explain that teachers' salaries are higher than those of similarly educated (OECD, 2018).

Figure 1. Lower Secondary Teachers' Statutory Salaries at Different Points in Teachers' Careers (2017) Annual Salaries of Teachers in Public Institutions, in Equivalent USD Converted Using PPPs

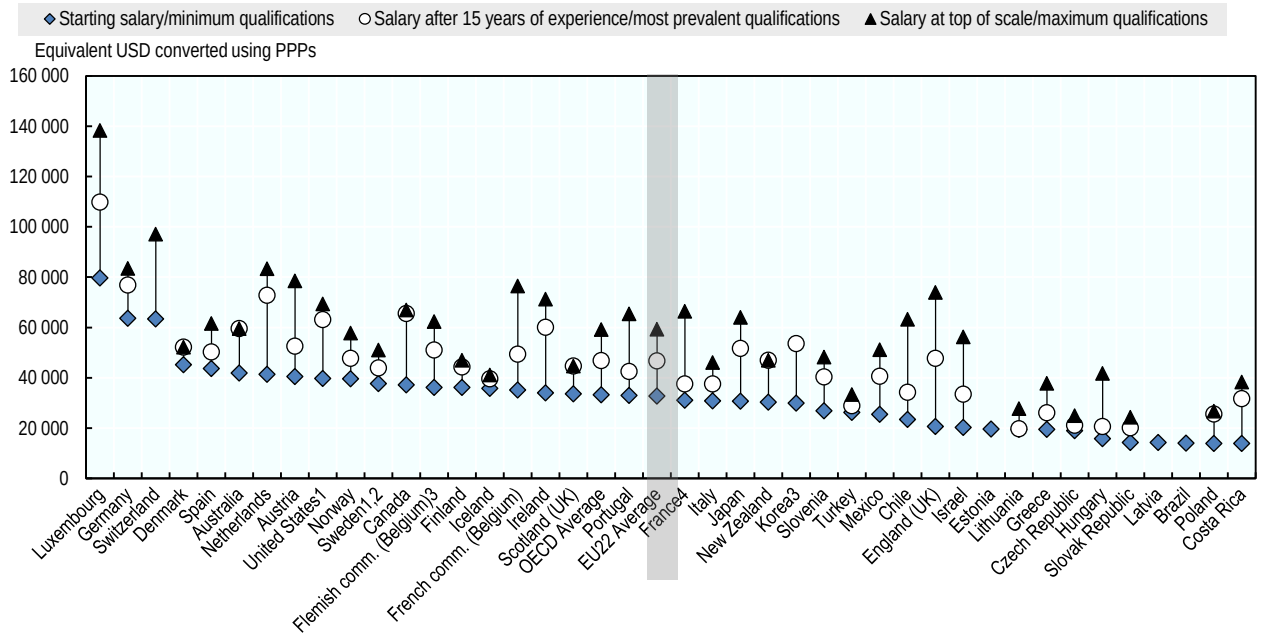
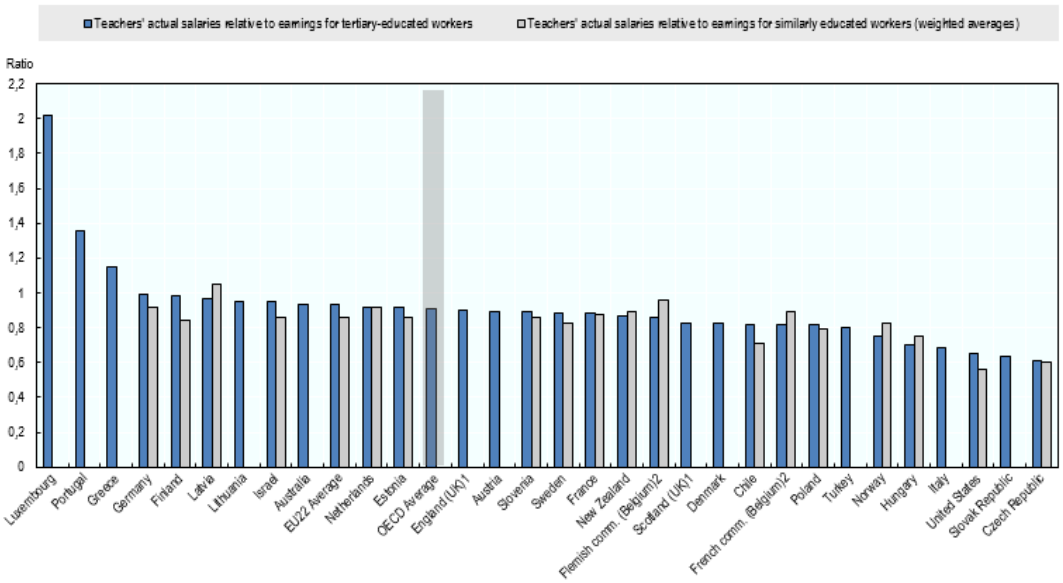


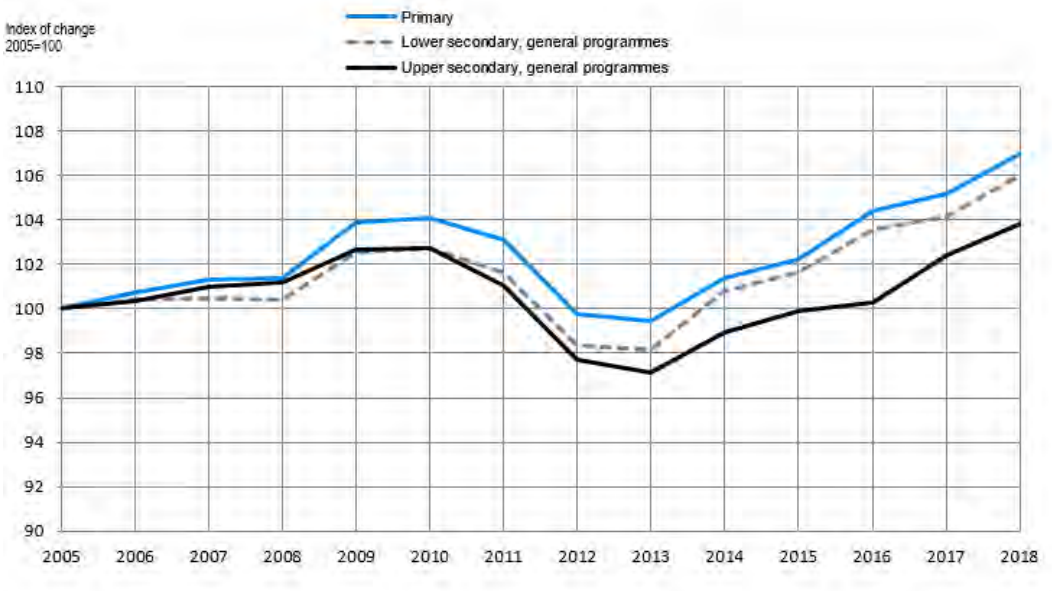
Figure 2. Lower Secondary Teachers' Salaries Relative to Earnings for Tertiary-Educated Workers (2017) Annual Actual salaries of Lower Secondary Teachers Teaching General Programmes in Public Institutions



How did Average Teacher Salary Change from 2005 to 2018 in OECD Countries?

Figure 3 shows the change in teachers' salaries in OECD countries from 2005 to 2018. Over this period for which three-quarters of OECD countries and economies have comparable data, more than half showed an increase in real terms in the statutory salaries of teachers with 15 years of experience and most prevalent qualifications. In most countries, the salary increases were similar across primary, lower secondary and upper secondary levels between 2005 and 2018. However, these overall changes in teachers' salaries in OECD countries between 2005 and 2018 mask different periods of change in teachers' salaries due to the impact of the economic downturn in 2008. On average across OECD countries and economies with available data for all years over the period, salaries were either frozen or cut between 2009 and 2013, before starting to increase again. This is so since national debt, caused by governments' responses to the financial crisis of late 2008 has put pressure on policy makers to reduce government expenditure particularly on public payrolls (OECD, 2017). As a result, teachers' salaries were either frozen or cut in some countries. Between 2005 and 2015 teachers' statutory salaries decreased in real terms in one third of the OECD countries and economies with available data. For instance, the decrease at pre-primary, primary and secondary levels reached about 10% in England and Portugal, and up to 28% in Greece (OECD, 2017).

Figure 3. Change in Teachers' Salaries in OECD Countries (2005 to 2018) Average Index of Change, Among OECD Countries with Data on Statutory Salaries for All Reference Years, for Teachers with 15 Years of Experience and Minimum Qualifications (2005 = 100, Constant Prices)



Source: OECD, Education at a Glance (Paris, 2018).

How is Average Teacher Salary in 2017 Associated with National Average Student Achievement in Mathematics and Science in 2018?

Table 2 presents the multiple regression results on the relationship between teacher salary and national achievement in mathematics after controlling for educational expenditure as percentage of GDP, GDP per capita and salary relative to earnings for tertiary education. Table 3 presents the same set of results for national achievement in science. Overall, the proportion of variation explained in national achievement by four independent variables varied from 0.14 to 0.24 for mathematics and 0.21 to 0.22 for science. In summary, we found no significant relationship between average teacher salary and national achievement in mathematics and science in 2017. Thus, we cannot conclude that investing in the salary of teachers will improve national achievement. The individual coefficients derived from the regression reveal that the variable related to earnings for tertiary-educated workers has the expected negative sign in all regressions but is not statistically significant at the conventional levels. Note also that the average salary for new teachers has the expected positive sign in all regressions but the salary for experienced teachers has a positive sign only in the science regression. We also examined the effect of omitting to account for alternative employment opportunities in the regressions. In doing this, the salary for experienced teachers become positive in the mathematics regression but remains not statistically significant. Our results are generally consistent with the evidence presented by Ladd (2007) who find no clear relationship between teacher salaries and student achievement using data from PISA 2003 test scores for OECD countries. She added that data from the Trends in International Mathematics and Sciences Study (TIMSS) present a similar picture. In the same vein, Nir and Naphcha (2007) analyzed science scores from the 2003 PISA data across 29 OECD countries and found that national achievement in science was not significantly associated with teacher salary level, controlling for GDP per capita.

Table 1. Association between Teacher Salary and National Achievement in Math in 2017

	B	(SE)	Beta
New teacher salary	**0.00**	**(0.01)**	**0.11**
Educational Expenditure	5.67	(4.64)	0.27
GDP per Capita	0.00	(0.01)	0.32
Salary relative to earnings for tertiary education	-23.3	(22.8)	0.29
R^2	0.24		
15th-year teacher salary	-3.31	(0.01)	0.03
Educational Expenditure	5.68	(4.67)	0.27
GDP per Capita	0.00	(0.00)	0.43
Salary relative to earnings for tertiary education	-21.73	(23.04)	0.27
R^2	0.14		

Note: We found no significant relationship between average teacher salary and national achievement in mathematics in 2017.

Table 2. Association between Teacher Salary and National Achievement in Science in 2017

	B	(SE)	Beta
New teacher salary	**0.00**	**(0.01)**	**0.42**
Educational Expenditure	3.48	(4.04)	0.19
GDP per Capita	2.33	(0.01)	0.02
Salary relative to earnings for tertiary education	-22.1	(19.9)	0.32
R^2	0.21		
15th-year teacher salary	**0.00**	**(0.00)**	**0.55**
Educational Expenditure	4.03	(4.02)	0.23
GDP per Capita	0.00	(0.00)	0.10
Salary relative to earnings for tertiary education	-23.28	(19.89)	0.27
R^2	0.22		

Note: We found no significant relationship between average teacher salary and national achievement in science in 2017.

Conclusion

This paper used data from OECD and employed multiple regression analysis to investigate the link between average teacher salary and national achievement in mathematics and science across 30 OECD countries. Several control variables were included in the research namely educational expenditure as percentage of GDP, GDP per capita and alternative employment opportunities as proxied by salary relative to earnings for tertiary education workers. The study revealed an important variation in the level of teacher salary between countries. It also showed that teachers' statutory salaries decreased in real terms in one third of the OECD countries between 2005 and 2015 due to the financial crisis of late 2008. Furthermore, we found no significant relationship between average teacher salary and national achievement in mathematics and science in 2017. Thus, we cannot conclude that investing in the salary of teachers will improve national achievement. We must remember that our results are generally consistent with the evidence presented by Ladd (2007) who find no clear relationship between teacher salaries and student achievement for OECD countries. Nir and Naphcha (2007) also found that national achievement in science was not significantly associated with teacher salary level, controlling for GDP per capita. The policy implication that flows from this study is perhaps the need to look beyond a single policy such as higher salaries in favor of policy strategies that address, for example, teacher preparation and certification, working conditions and other challenges facing new teachers. Research has shown that these policy strategies are important for attracting and retaining skilled and high-quality teachers that have the potential to improve student achievement.

Finally, the results should be interpreted with caution because statutory salaries are just one component of teachers' compensation system and because of the presence of potential comparability issues related to data collected.

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