APPLIED QUANTITATIVE ECONOMICS

PROJECT 1

33609001

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Introduction

Secondary school education is necessary for the economic growth of a country, to increase its productivity in a more competitive world, through the investment in human capital to obtain the highest possible levels of education and skill formation. Human capital is positively proportioned to physical capital and technological innovation, which also lead to further economic development. Therefore, education spending is a vital component of the UK's government budget and should not be underestimated because it is a determinant factor of the citizens' career path, which reflects on the level of physical capital (Wobbekind, 2012, p.91). Economics can be applied to examine the spending of England by public secondary schools through microeconomic theory, based on economies and diseconomies of scale, and through macroeconomic theory, important for financial policy making such as the post 2008 economic crisis conservative laissez faire political agenda, consisting of the reduction of governmental spending on schooling, and its unintended consequences on economic growth that are still affecting school funding and spending nowadays, due to inflation problems, causing high levels of regional inequality and lower education standards. Secondary school expenditure per school is based on variables such as the number of pupils in the school and their characteristics, and it is calculated through a formula. In this project, I will elaborate on school expenditure, through statistical analysis, aimed to produce quantitative assessments, implementable across regions, considering their heterogeneity. I will answer three questions, focused on the inequalities of school expenditure, its evolution from 1999 to 2017 and its determinants. 1. What is the extent of regional inequalities in expenditure by secondary schools? 2. What has been the recent evolution of total gross expenditure by secondary schools? 3. What are the determinants of secondary school expenditure?

Dataset Properties

The dataset for this project was obtained from the 'Secondary school performance tables in England in the 2016-2017 academic year, published by the UK Department for Education (DfE). The available sample for the project consists of 758 schools. The project reports the average expenditure of secondary schools and how they are contrasted with each other in their local authority area and in England. The dataset comprises the students' characteristics such as gender (GENDER, DMIXED), eligibility for free school meals (PFSM), special educational needs (PSEN), English as a first language (PENGFL), and the schools' characteristics such as its unique reference number and identifiers (URN, SCHNAME), local authority area (LANAME) and region in England (REGION, DLONDON), as well as the education levels offered (ISSECONDARY, ISPRIMARY, ISPOST16). Furthermore, the dataset has variables relating to school size, in terms of pupils (PUP, PUPKS4), teachers (TEA) and their ratio

(RATPUPTEA); mean compensation to teaching staff (WTEA); school income (INC, INCP), expenditure (EXP, EXPP) and their difference, also called surplus (SUR, SURP), and the self-generated share of school income (SHSELFINC). the variable (LAPAY) captures the median weekly pay of full-time employees in each local authority area, compiled by the Office for National Statistics (ONS), obtained from the Annual survey of hours and earnings for 2017 (Rotta, 2021, p.13-14).

Question 1: Regional Inequalities

To answer this question, I used a one-variable analysis to compare the frequency distributions of regions with the highest and the lowest expenditures, and to examine the differences in school expenditure between and within regions.

Table 1. School Expenditure and School Income in England by Region (2016/17)

	No_Schools	EXP_bar	INC_bar	EXP_bar_rel	INC_bar_rel
07_London	141	7806874.9	7705945.2	131.67%	131.69%
08_South_East	140	5839090.3	5775120.7	98.48%	98.70%
06_East_of_England	34	5768158.7	5772352.8	97.29%	98.65%
03_Yorkshire_Humberside	69	5568986.8	5470961.2	93.93%	93.50%
04_East_Midlands	34	5493168.5	5453623.8	92.65%	93.20%
01_North_East	39	5472154.9	5345178.0	92.30%	91.35%
02_North_West	183	5331773.9	5250956.5	89.93%	89.74%
05_West_Midlands	69	5268098.2	5240642.8	88.85%	89.56%
09_South_West	49	5227006.9	5105389.8	88.16%	87.25%
Grand Total	**758**	**5928941.9**	**5851438.2**	**100.00%**	**100.00%**
References:					
No_Schools: Number of schools in the sample for each region					
EXP_bar: Average regional expenditure (in £/year)					
INC_bar: Average regional school income (in £/year)					
EXP_bar_rel: regional average expressed as a proportion of national average (in %)					
INC_bar_rel: regional average expressed as a proportion of national average (in %)					
Source: Own computation based on Dfe (2018)					

I constructed a pivot table (table 1) based on two variables, from which it can be inferred that London and the South East define a geographical pattern, indeed those areas are the two most over-performing areas in terms of school expenditure and school income/funding, whereas the Western areas, the South West in particular, are underperforming as it is proved by table 2, in which London is 31.67% and 31.69% overperforming in expenditure and funding respectively, whereas the South West is underperforming by -11.84% and -12.75%. There is a notable difference in average school expenditure and average school income between London and the South West, which is respectively £ 2579868.0 and £ 2600555.4. The difference in school expenditure is due to diverse levels of living costs which affects individual income, and population, indeed, according to the Office of National Statistics (ONS), in 2018, London and the South East had a respective GDP per capita of £54686 and £34033, which are above the English average of £32857. On the other hand, the South West was below average (£28231) due to the different sector composition of the regions, indeed London is the base of many more tertiary services companies than the South West, despite the presence of Bristol, which is part of the 'M4 Corridor'. To obtain higher incomes to sustain themselves, Londoners are encouraged to have higher levels of education, necessary in choosing more profitable career paths, and to do so, the government is forced to invest more money in the city. Another factor that causes London to have a

higher school expenditure than the South West is population, indeed London has a population of 8908081, whereas the South west of 5599735, therefore, usually it is obvious that more money for secondary schools would be invested in London than in the South West (Ons.gov.uk, 2019).

Table 2. School Expenditure and School Income in England by Region (2016/17)

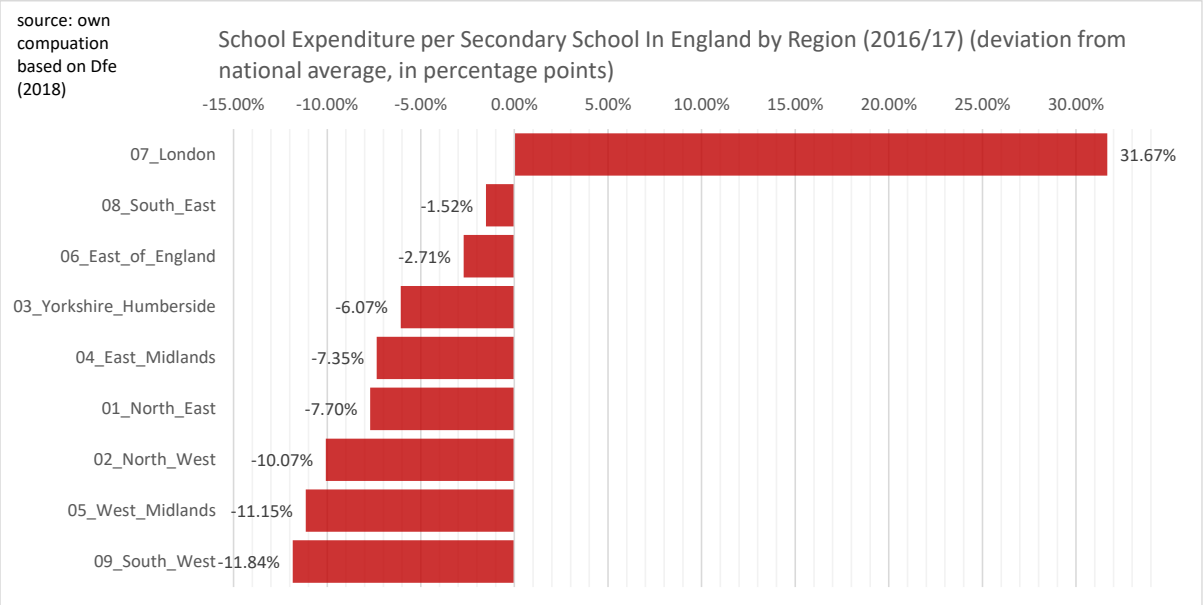
Region	EXP_bar_rel	INC_bar_rel	EXP_bar_rel_dif	INC_bar_rel_dif
07_London	131.67%	131.69%	31.67%	31.69%
08_South_East	98.48%	98.70%	-1.52%	-1.30%
06_East_of_England	97.29%	98.65%	-2.71%	-1.35%
03_Yorkshire_Humberside	93.93%	93.50%	-6.07%	-6.50%
04_East_Midlands	92.65%	93.20%	-7.35%	-6.80%
01_North_East	92.30%	91.35%	-7.70%	-8.65%
02_North_West	89.93%	89.74%	-10.07%	-10.26%
05_West_Midlands	88.85%	89.56%	-11.15%	-10.44%
09_South_West	88.16%	87.25%	-11.84%	-12.75%
Grand Total	**100.00%**	**100.00%**	**0.00%**	**0.00%**

EXP_bar_rel_dif: Regional difference with respect to national average (in percentage points)

INC_bar_rel_dif: Regional difference with respect to national average (in percentage points)

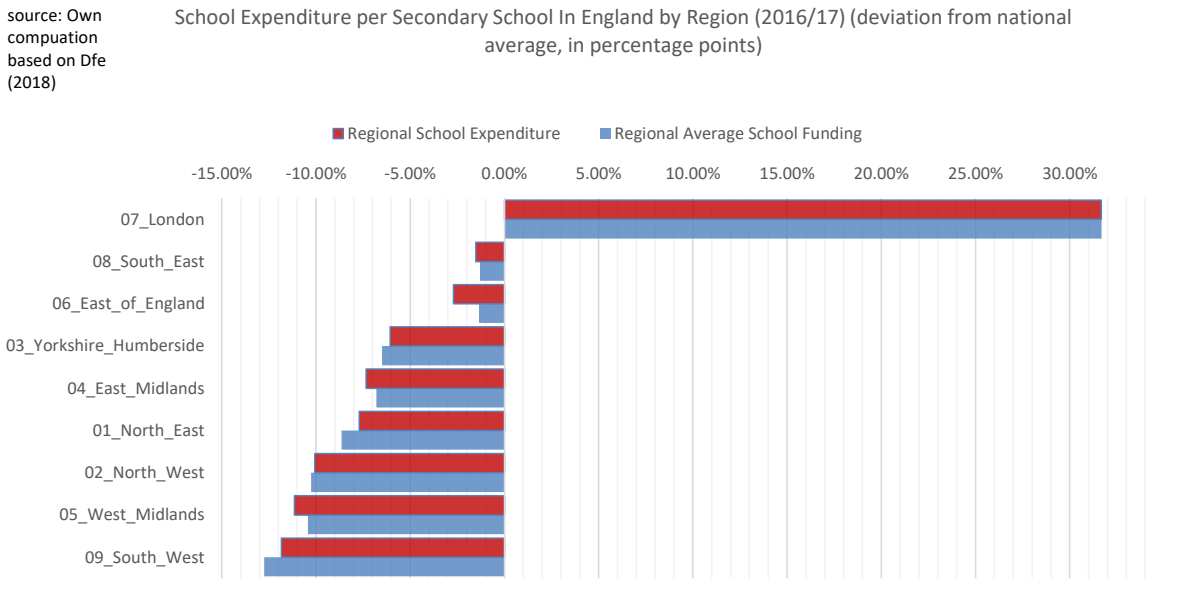
Source: Own compuation based on Dfe (2018)

Subsequently, I used the regional school expenditure difference with respect to national average to represent graphically, through bar charts the school Expenditure per secondary school In England by region in my one-variable analysis (graph 1) and I compared it with the regional school income difference with respect to national average (graph 2). Graph 1 shows clearly that London is the only region in England to spend more than the national average of £ 5928941.9. The other regions are underperforming, and as stated before, the South West in particular.



Graph 1

source: Own compuation based on Dfe (2018)



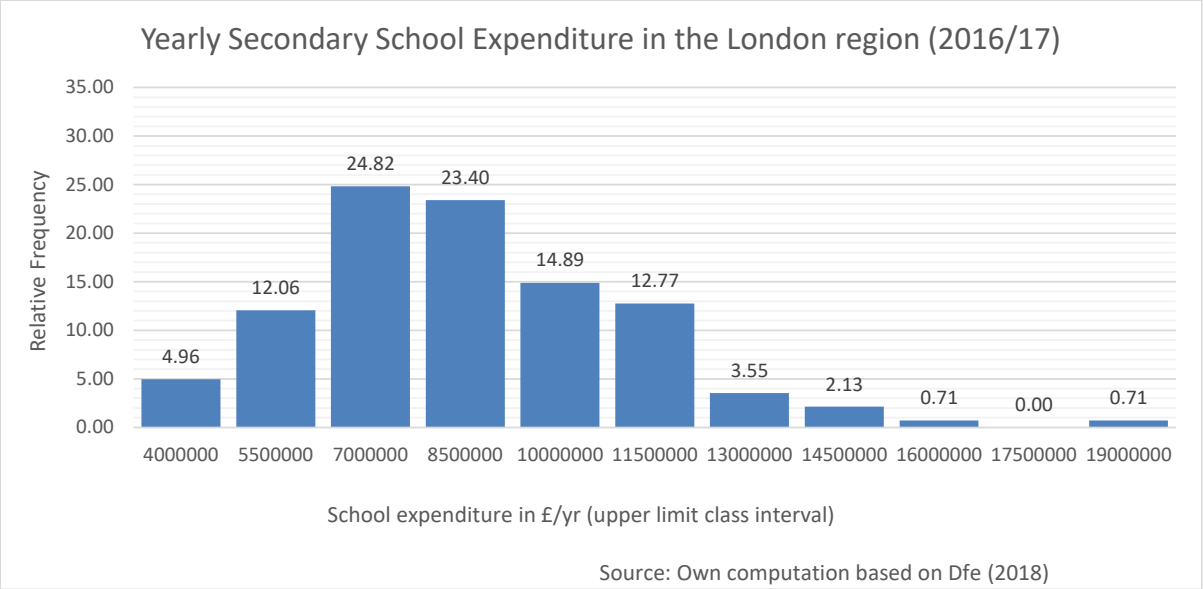
Graph 2

In graph 2, I compared the expenditure with funding, and it is easily noticeable that more funding leads to higher expenditure and vice versa, although in some regions such as the South west, the North West, the North East and Yorkshire Humberside there is a lower school income compared to the national average than school expenditure compared to the national average, proving that the distribution of school income and expenditure is not homogeneous between regions. However, the graph does not demonstrate that some regions spend more than they earn because the figures are related to the national average. To prove that the schools of a certain region spend more than they earn, I would directly look at average income and average expenditure, indeed London has a higher regional difference with respect to national average in income then in expenditure, however it has an average income of £ 7705945.2, which is lower than the average expenditure of £ 7806874.9.

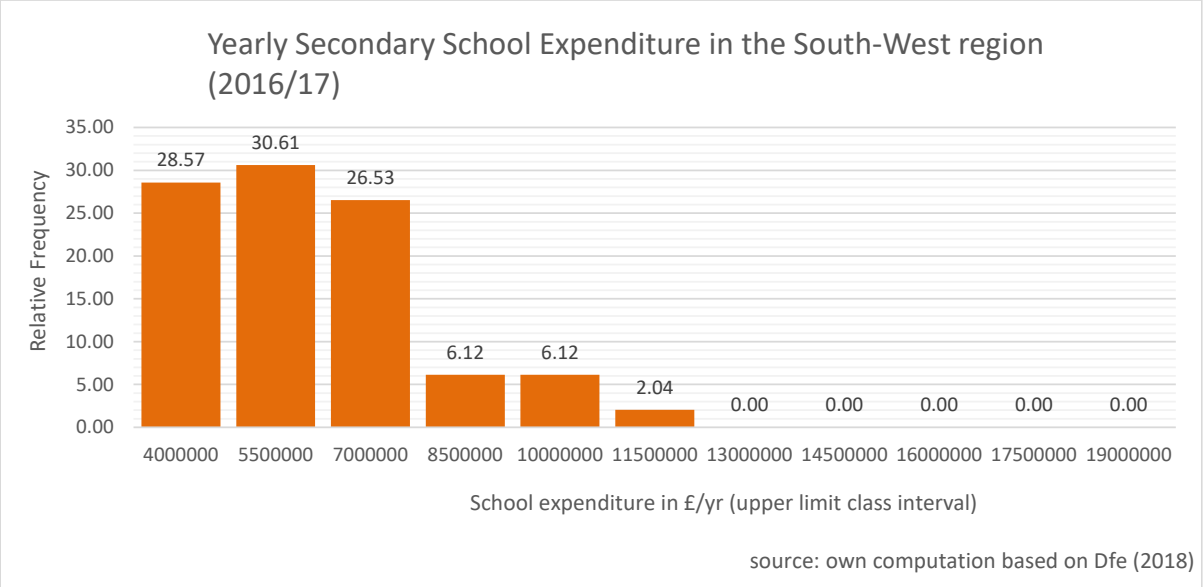
Having compared all regions to the national average, I focused on comparing the two regions with highest and lowest results which are London and the South West. I found the maximum and minimum value for each of them and constructed a frequency distribution table (table 3), which allowed me to find the respective relative frequencies and analyse them. It can be understood from table 3 that in the South West, the data is relatively less spread out and concentrated on a lower location than London which is relatively more evenly spread out and particularly focused on a higher location. I created two histograms to clearly show the distribution of the regions' school expenditure, essential in analysing their respective skewness.

Table3. Frequency distribution for EXP (in £/yr)					
		07_London		09_South_West	
more than	Up to	*Frequency*	*Rel. Freq.*	*Frequency*	Rel. Freq.
0	4000000	7	4.96	14	28.57
4000000	5500000	17	12.06	15	30.61
5500000	7000000	35	24.82	13	26.53
7000000	8500000	33	23.40	3	6.12
8500000	10000000	21	14.89	3	6.12
10000000	11500000	18	12.77	1	2.04
11500000	13000000	5	3.55	0	0.00
13000000	14500000	3	2.13	0	0.00
14500000	16000000	1	0.71	0	0.00
16000000	17500000	0	0.00	0	0.00
17500000	19000000	1	0.71	0	0.00
	More	0	0.00	0	0.00
	n	141	100.00	49	100.00
Source: Own computation based on Dfe (2018)					

As shown in Graph 3 and 4, the secondary school expenditure of London and the South West are both positively skewed because their median (£7500405.0 and £4966744.0 respectively) are below their mean (£7806874.9 and £5227006.9 respectively) as shown in table 4. However, as stated before, London is more evenly distributed and a total 12.77% of secondary schools spends up to £11500000, whereas in the South West, only 2.04% spends the same amount of money, and no school in the region spends more than that. On the other hand, 7.1% of secondary schools in London spends more than £13000000. In London there are more outliers than in the South West and this factor impacts considerably on the mean, increasing the positivity of the skewness, represented by the standard deviation and the Ratio 80_20 that in London are £2530116.2 and 1.76 and in the South West £1794377.2 and 1.74. Furthermore, table 4 has been used to calculate the percentiles, which accentuate London's school expenditure distribution in contrast with the South West, and allowed me to determine the quartiles and the IQR, which have been graphically interpreted in Graph 5 and 6 that give a better comprehension of the difference in distribution and the outliers of both regions, and clearly demonstrate a lower secondary school expenditure in the South West.

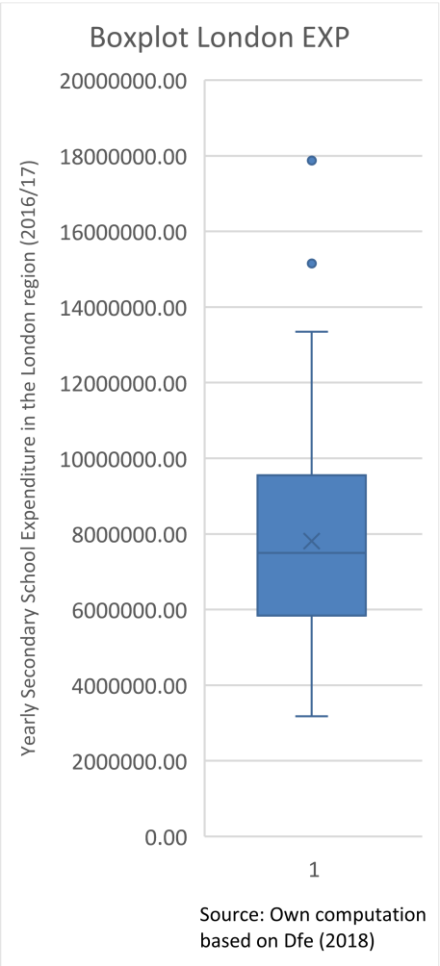


Graph 3

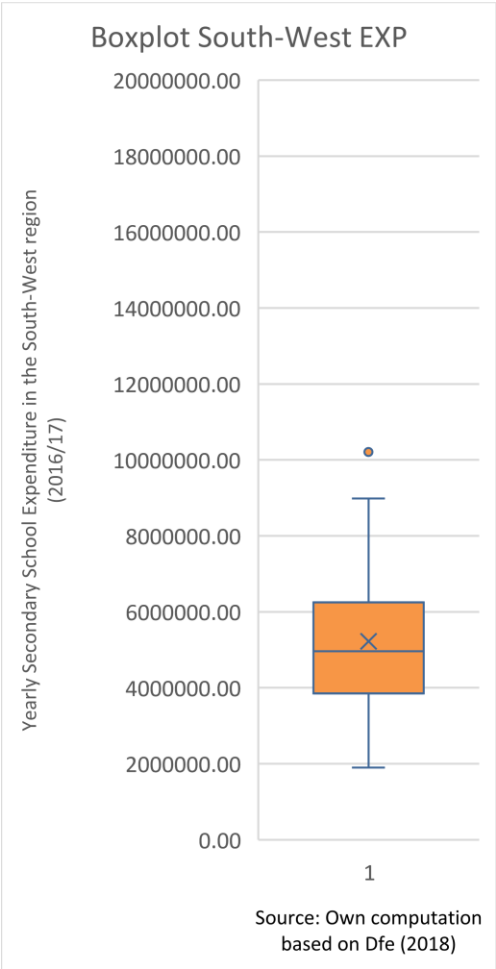


Graph 4

Table 4. Student performance by region 2016/17		
	London EXP	South-West EXP
min	3177200.0	1897983.0
max	17871840.0	10206480.0
mean	7806874.9	5227006.9
Range	14694640.0	8308497.0
Std. Dev.	2530116.2	1794377.2
Bottom 20%	5639670.0	3740643.4
Bottom 25%	5872906.0	3855474.0
Median	7500405.0	4966744.0
Bottom 75%	9540195.0	6142352.0
Bottom 80%	9923392.0	6507211.2
Bottom 99%	14431647.2	9620261.8
IQR	3667289.0	2286878.0
Ratio 80_20	1.76	1.74
Source: Own computation based on Dfe (2018)		



Graph 5



Graph 6

Question 2: Evolution Over Time

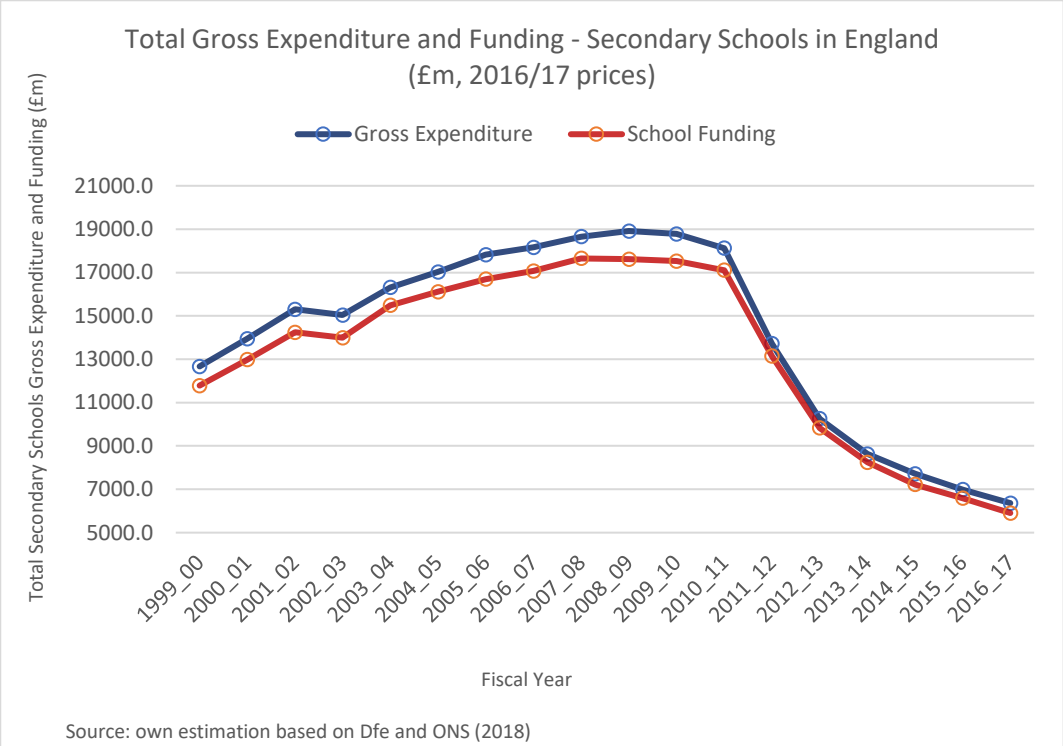
To analyse the recent evolution of total gross expenditure by secondary schools between 1999/00 and 2016/17, I created table 5, containing real total expenditure and funding in constant prices of 2016/17 (labelled REXP and RFUN, respectively). From the results I can infer that real expenditure in English secondary schools has been greater than school funding throughout the all time period and I represented such results in Graph 7, which shows how gross expenditure increases its gap with school funding until 2010/11 when the two begin to converge (from 2011 to 2013, particularly), probably due to the fiscal austerity experienced after the 2008 financial crisis, as funding restrictions coincide with expenditure contractions, until 2013/14, when they commence diverging again until 2016/2017. Real expenditure and funding have declined nearly by half, between 1999 and 2016, indeed since 2008/2009, gross expenditure and school funding started decreasing and plummeted in 2010, continuing to do so, when apparently the effects of the fiscal austerity, induced by the crisis were felt the most, resulting in a notable decrease of both of expenditure and income between 2007, 2008 and 2017.

According to the figures, in 2008/2009 school expenditure was £18915.3 whereas in 2016/2017 it was £6357.2, gross expenditure diminished by 66.4%. In 2007/2008, school funding was £17650.6 and decreased to £5902.5 in 2016/2017, a decrease of 66.6%. Afterwards I computed the approximate average yearly growth rate of real school expenditure in each sub-period. The results (table 6) proved that from 1999/00 to 2008/09 gross school expenditure in real terms has been expanding at 4.46

percentage points per year, whereas from 2008/09 to 2016/17 it has been declining at 13.63 points per year (approximately on average), reinforcing my stand that since 2008, expenditure has decreased notably.

Table 5. Secondary Schools in England					
	Total Gross			Total Gross	
Year	EXP	FUN	GDP deflator	REXP	RFUN
(fiscal)	(£mln, current prices)		(2016_17=100)	(£mln, current prices)	
1999_00	9021.39	8394.53	71.25	12661.5	11781.7
2000_01	10144.32	9439.44	72.73	13948.4	12979.2
2001_02	11267.26	10484.35	73.62	15304.4	14241.0
2002_03	11329.02	10541.82	75.34	15036.5	13991.7
2003_04	12556.79	11924.98	76.99	16309.1	15488.5
2004_05	13476.38	12752.00	79.14	17029.5	16114.1
2005_06	14474.68	13555.58	81.20	17825.6	16693.8
2006_07	15206.80	14295.03	83.74	18158.5	17069.8
2007_08	16008.64	15148.43	85.82	18652.9	17650.6
2008_09	16656.01	15510.54	88.06	18915.3	17614.4
2009_10	16777.74	15660.77	89.34	18780.7	17530.4
2010_11	16485.46	15565.03	90.97	18122.4	17110.5
2011_12	12658.75	12128.44	92.28	13718.1	13143.4
2012_13	9662.38	9257.26	94.19	10257.9	9827.8
2013_14	8266.46	7901.44	95.80	8628.6	8247.6
2014_15	7495.87	7020.86	97.19	7712.4	7223.7
2015_16	6836.26	6445.39	97.85	6986.6	6587.2
2016_17	6357.19	5902.49	100.00	6357.2	5902.5
Source: Own estimation based on Dfe (2018)					

Table 6. School Expenditure Growth Sub-periods between 1999 and 2017			
Initial Year	Final Year	Yearly growth rate	Variance of Growth rate
1999	2008	0.0446	0.0101
2008	2016	-0.1363	0.1574
Source: own estimation based on Dfe and ONS (2018)			



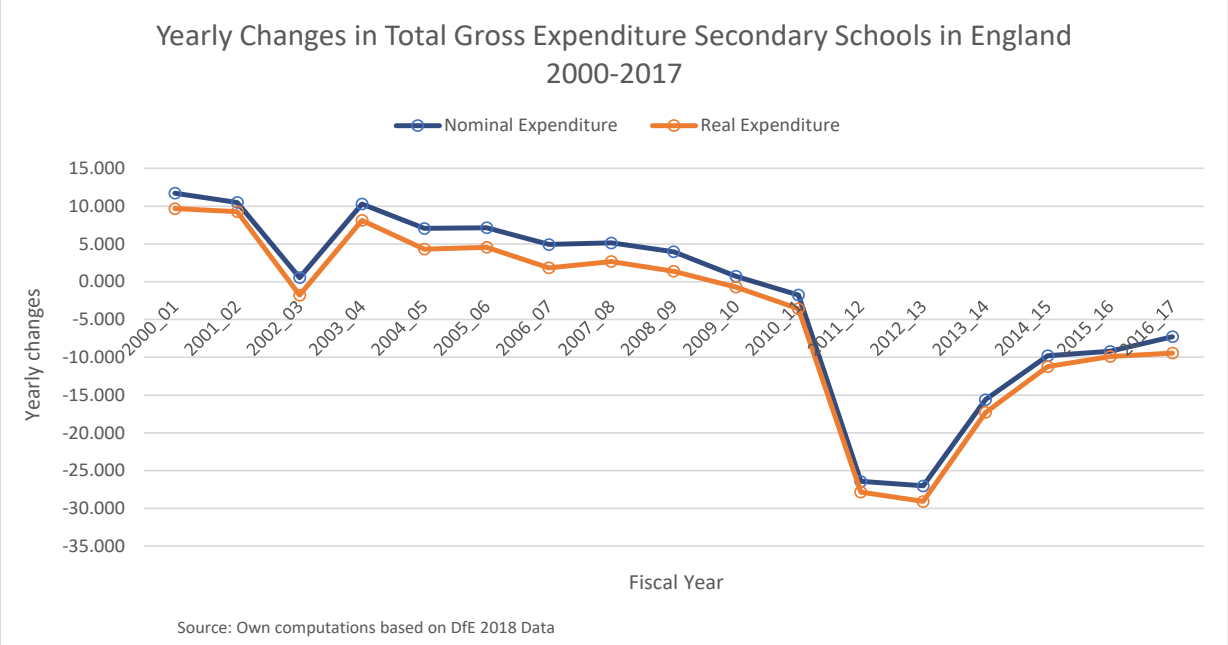
Graph 7

Subsequently, to decompose the quantity and price changes in total gross school expenditure in England between 1999/00 and 2016/17, I found the natural logarithms of the real expenditure, the nominal expenditure and of the GDP deflator in constant prices, which measures the impact of inflation on the GDP of an economy during a period of one specific fiscal year, and I found out their respective differences (table 7). Table 7 shows that nominal and real expenditure have decreased over time, in particular the latter which has always been lower than the former due to changes in inflation, with a constant decrease between 2003/2004 and 2009/2010, in which thanks to government's policies the gap between the two types of expenditure was kept nearly constant. The growth of expenditure worsened in the following years when real contraction started, as shown in graph 8, indeed between 2010/11 and 2012/13, expenditure experienced heteroscedasticity because the standard deviation has been unpredictable in this period, as it did from 2001/02 to 2003/2004, before the constant decline. In 2010 the two types of expenditures converged into an abrupt contraction caused by secondary schooling cuts in government spending that caused real contraction to be at 27 points per year circa and nominal contraction at 29 points per year circa, between 2011/12 and 2012/13. Graph 9 combines with graph 8 in showing that the real contraction in school expenditure started in 2009/10, indeed the graph compares the real expenditure growth rate and the GDP deflator growth rate and shows that due to the 2008 crisis the latter started expanding whereas expenditure contracting. Throughout the following year, the GDP growth rate began stabilizing its expansion levels, contrary to the expenditure growth which continued contracting, due to the consequences of fiscal austerity, until its peak in 2012/2013 when the trend began inverting from a real expenditure contraction level of 30% circa to 9% circa in 2016/2017, thanks to the 2013 Monetary Policy Reform, which implied not to raise a decreased bank Rate from its current level of 0.5% at least until the employment rate had fallen to threshold of 7% (Champroux, 2016).

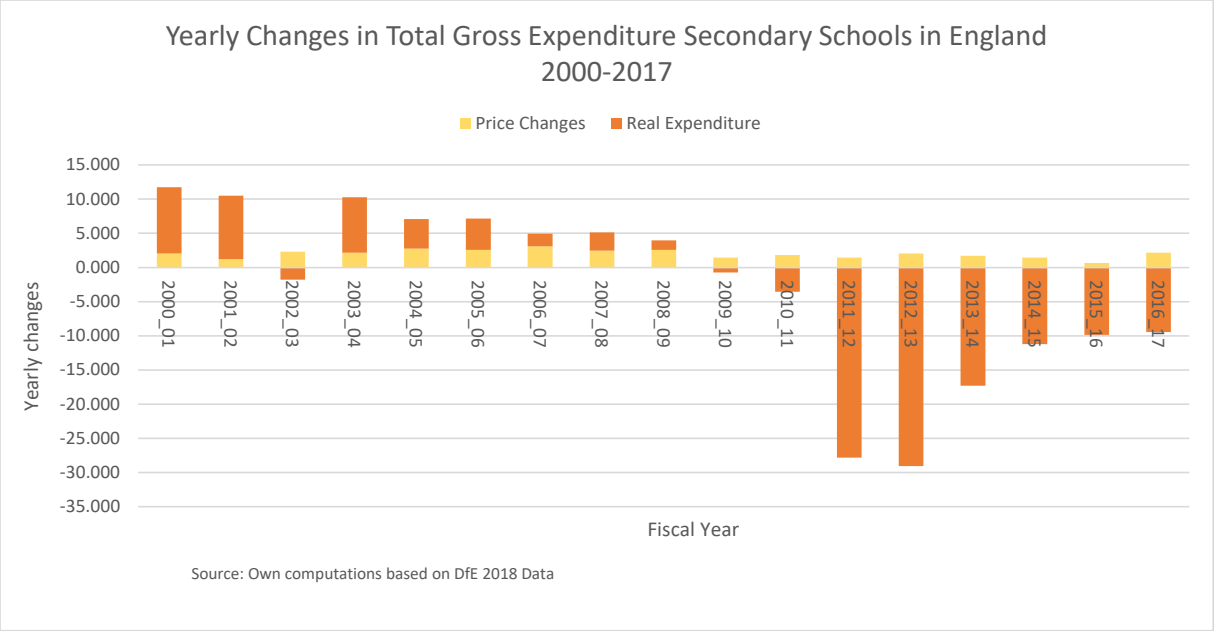
The inflation caused by the financial crisis of 2008, forced the UK to focus on deflationary policies and on cutting the government budget, subsequentially reducing school funding which affected school expenditure as they are proportionally related, as shown in graphs 2 and 7. The government was able to keep inflation constant through fiscal austerity, but at high cost, as shown by the heteroscedasticity that happened between 2010/11 and 2012/2013. Despite still being in a decreasing phase in

2016/2017, expenditure by secondary schools, as shown by graph 8, is experiencing a lower contraction level than in the aftermath of the crisis, hinting to a possible recovery.

Table 7. Secondary Schools in England											
	Total Gross			Total Gross							
Year	EXP	FUN	GDP deflator	REXP	RFUN	ln(REXP)	ln(PI)	ln(NEXP)	ln(REXP)_dif	ln(PI)_dif	ln(NEXP)_dif
(fiscal)	(£mln, current prices)		(2016_17=10	(£mln, current prices)							
1999_00	9021.39	8394.53	71.25	12661.5	11781.7	9.446	4.266	9.107			
2000_01	10144.32	9439.44	72.73	13948.4	12979.2	9.543	4.287	9.225	9.680	2.051	11.732
2001_02	11267.26	10484.35	73.62	15304.4	14241.0	9.636	4.299	9.330	9.278	1.221	10.499
2002_03	11329.02	10541.82	75.34	15036.5	13991.7	9.618	4.322	9.335	-1.766	2.313	0.547
2003_04	12556.79	11924.98	76.99	16309.1	15488.5	9.699	4.344	9.438	8.124	2.165	10.289
2004_05	13476.38	12752.00	79.14	17029.5	16114.1	9.743	4.371	9.509	4.322	2.745	7.068
2005_06	14474.68	13555.58	81.20	17825.6	16693.8	9.788	4.397	9.580	4.569	2.577	7.146
2006_07	15206.80	14295.03	83.74	18158.5	17069.8	9.807	4.428	9.629	1.850	3.084	4.934
2007_08	16008.64	15148.43	85.82	18652.9	17650.6	9.834	4.452	9.681	2.686	2.452	5.139
2008_09	16656.01	15510.54	88.06	18915.3	17614.4	9.848	4.478	9.721	1.397	2.567	3.964
2009_10	16777.74	15660.77	89.34	18780.7	17530.4	9.841	4.492	9.728	-0.714	1.442	0.728
2010_11	16485.46	15565.03	90.97	18122.4	17110.5	9.805	4.511	9.710	-3.568	1.811	-1.757
2011_12	12658.75	12128.44	92.28	13718.1	13143.4	9.526	4.525	9.446	-27.843	1.430	-26.413
2012_13	9662.38	9257.26	94.19	10257.9	9827.8	9.236	4.545	9.176	-29.067	2.056	-27.011
2013_14	8266.46	7901.44	95.80	8628.6	8247.6	9.063	4.562	9.020	-17.297	1.694	-15.603
2014_15	7495.87	7020.86	97.19	7712.4	7223.7	8.951	4.577	8.922	-11.225	1.439	-9.785
2015_16	6836.26	6445.39	97.85	6986.6	6587.2	8.852	4.583	8.830	-9.883	0.672	-9.211
2016_17	6357.19	5902.49	100.00	6357.2	5902.5	8.757	4.605	8.757	-9.441	2.176	-7.265
Source: own estimation based on Dfe and ONS (2018)											



Graph 8



Graph 9

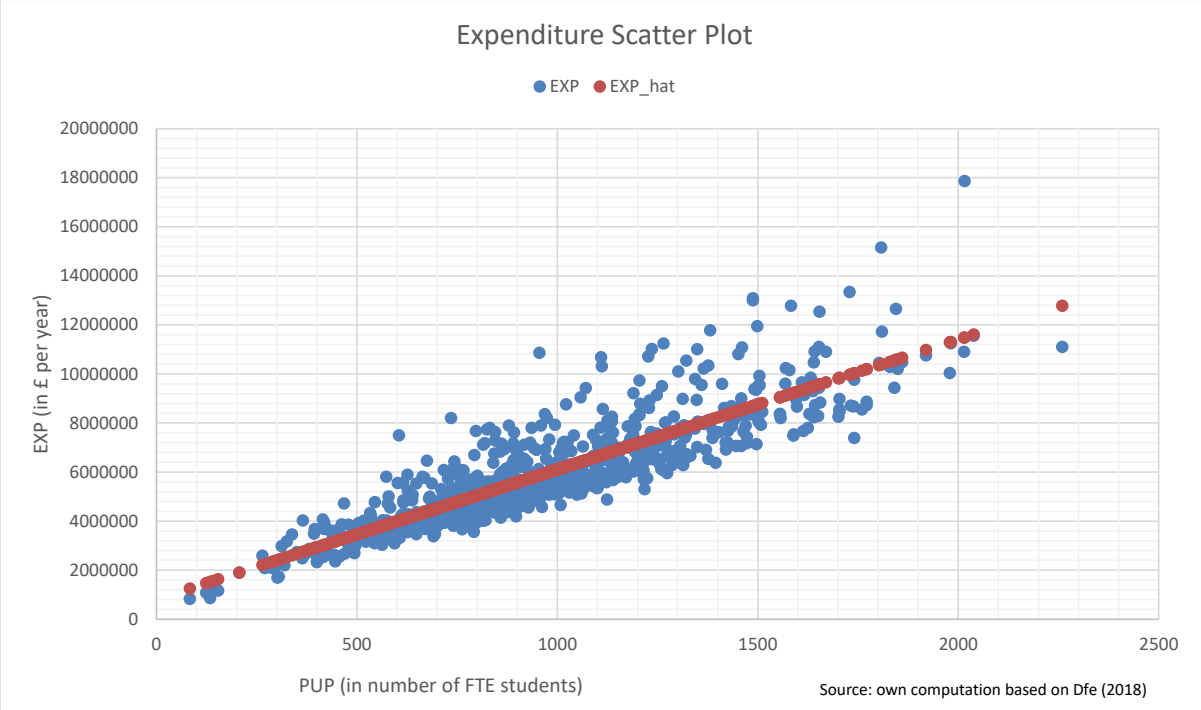
Question 3: Regression Analysis

School expenditure is determined by many factors such as the number of pupils, the number of pupils per teacher and the teachers' compensation. I used correlation and most importantly regression to show how these variables impact on expenditure. It can be inferred from table 8 that there is an outstanding positive linear association of 0.870 between expenditure and the number of pupils, in other words the former increases given an increase of the latter. Oppositely, there is a negative correlation of -0.029 (although weak) between expenditure and the ratio of pupils per teacher, indeed school costs decrease when teachers work with more students, but this would usually cause an increase in the mean compensation to teaching staff, as it is showed by the positive relationship of 0.303 between it and expenditure that leads to an increase of the latter.

Table 8. Correlation analysis				
	PUP	*RATPUPTEA*	*WTEA*	*EXP*
PUP	1.000			
RATPUPTEA	0.238	1.000		
WTEA	0.076	-0.136	1.000	
EXP	0.870	-0.029	0.303	1.000
References:				
PUP: number of full time equivalent (FTE) pupils				
RATPUPTEA: number of pupils per teacher				
WTEA: mean compensation to teaching staff				
Source: own computation based on Dfe (2018				

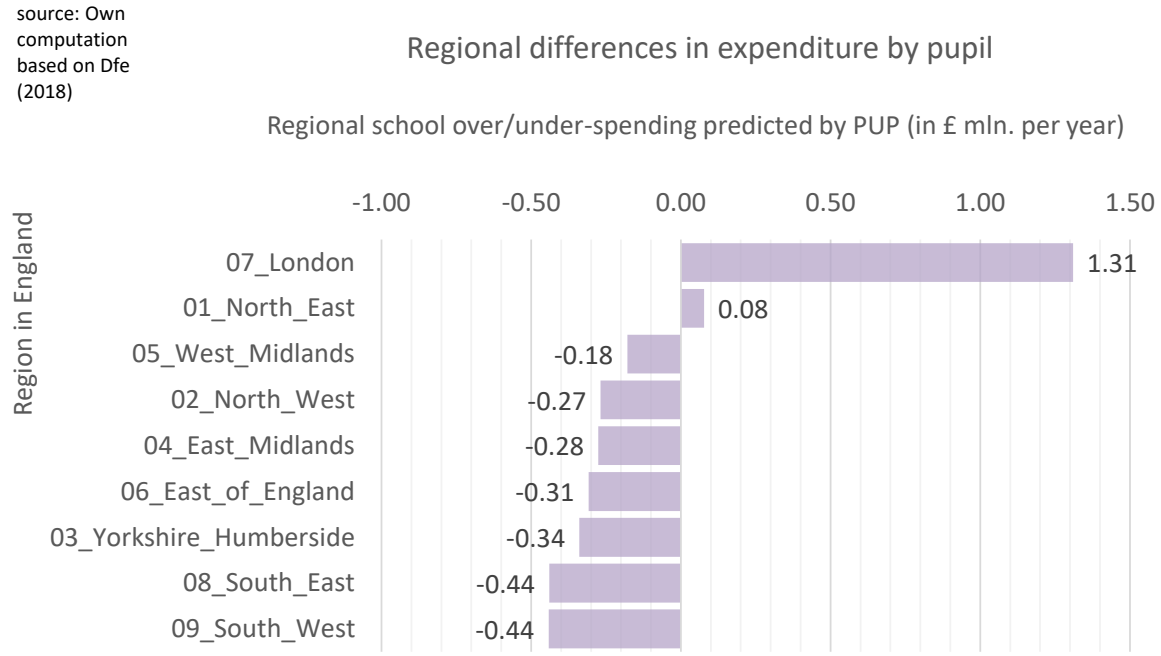
Following my correlation analysis, which quantified the relationship between expenditure and other variables such as the number of fulltime equivalent pupils, in particular. I decided to support the results though a simple linear regression analysis that computed the influence of the number of pupils

on the expenditure to show that when the former increases, several school budget items will be forced to rise as well. Indeed, the mean compensation to teaching staff would rise, as would ultimately, the ratio of pupils per teacher. I applied the OLS method to estimate the regression model and write a fitted model associated to the estimation which is represented by the equation $Yi = b_0 + b_1 Xi + e_i$ that according to my calculations corresponds to $Yi = 815326.11 + 5294.11Xi$. If b_0 represents the expenditure when there are no pupils, b_1 represents how the increase in one pupil corresponds to an increase of £5294.11 per year in school expenditure. I computed the regression analysis and subsequentially constructed graph 10 to show how the positive regression of the original data and the best fit line, made up of predicted expenditure values (EXP_hat) suggest that there is a proportional relation between the number of pupils and expenditure. The differences between the predicted values and the original data are called residuals and show if the predictions were over or under-estimated. As seen in in graph 1, overspending is remarkable in London, and this factor impacts on the results of graph 10. The average of the residuals for London is £1309878, meaning that a school spends on average £1309878 more than it should, as would be predicted by the number of pupils in the school. On the other hand, the South west spends £441615 less than it should, according to the linear regression line, related to the number of pupils. However, as shown in graph 11, even the predicted values would have been different across regions, for example there is a difference of 1.75 £mln in expenditure by pupil between London and the South West. As expenditure is proportionally related to funding, UK's fiscal decentralisation on the levels of taxation across the country might affect the level of school expenditure (Hughes, 1987, p.3).



Graph 10

source: Own computation based on Dfe (2018)



Graph 11

It should be clear by now that the degree of school expenditure depends on the size of the school in number of pupils, the number of teachers per students, the wage of the teachers and the relative school poverty, calculated through the number of free meals. I chose to analyse these variables to understand the factors associated with school expenditure by creating three panels.
I regressed the expenditure on the number of fulltime pupils, and I created panel 1 (table 9), in which I was able to identify the type of relation between the two variables. The fitted model obtained can be written as Yi = 815326.113 + 5294.112Xi. The PUP coefficient is positive, and therefore, there is a direct relationship according to which for an average school an increase in 100 pupils is associated with an increase of £529411.2 in expenditure. I deduced from the p-value (0.0E + 00) that the marginal effect of PUP on EXP is statistically significant at the 1% level since the p-value is smaller than 0.01. The 95% confidence interval conveys that with 95% confidence the increase in school expenditure is at least £5080.028/pupil per year and at most £5508.196/pupil per year.

	Table 9. OLS estimation results of a linear regression of EXP on PUP								
	Observations	758							
	regressors	1							
Y	Dependent variable: EXP								
		Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 99.0%*	*Upper 99.0%*
	Intercept	815326.113	112310.414	7.260	9.66E-13	594848.769	1035803.456	525301.521	1105350.704
X	PUP	5294.112	109.054	48.546	1.58E-234	5080.028	5508.196	5012.497	5575.726
	Source: Own computation based on Dfe (2018)								

	Table 10. OLS estimation results of a linear regression of EXP on PUP and RATPUPTEA								
	Observations	758							
	Regressors	2							
Y	Dependent variable: EXP								
		Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 99.0%*	*Upper 99.0%*
	Intercept	4639992.633	264118.465	17.568	3.48E-58	4121498.764	5158486.503	3957944.516	5322040.750
X_1	PUP	5656.300	97.719	57.883	7.70E-280	5464.467	5848.133	5403.955	5908.645
X_2	RATPUPTEA	-271931.460	17445.208	-15.588	1.06E-47	-306178.341	-237684.579	-316981.213	-226881.707
	Source: Own computation based on Dfe (2018)								

The second panel (table 10) represents the regression of the expenditure on the number of fulltime pupils and the number of teachers per students (personalised teaching). One additional fulltime pupil costs the average school in England £5656.300 per year, ceteris paribus. Increasing class size by 1 student per teacher across all classes, holding fixed the total number of pupils, would save the average school in England £271931.460 per year. The fitted model is Yi = 4639992.633 + 5656.300X1i – 271931.460 X2i, which, through estimations gives that for an average school in England, an additional 100 pupils would require 2 more students per teacher to keep costs approximately constant.

	Table 11. OLS estimation results of a linear regression of EXP on PUP, RATPUPTEA, WTEA and PFSM								
	Observations	758							
	Regressors	4							
Y	Dependent variable: EXP								
		Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 99.0%*	*Upper 99.0%*
	Intercept	-2440123.935	437580.454	-5.576	3.424E-08	-3299146.612	-1581101.258	-3570120.407	-1310127.462
X_1	PUP	5681.333	77.916	72.916	0.000E+00	5528.374	5834.293	5480.124	5882.543
X_2	RATPUPTEA	-147670.686	15141.380	-9.753	3.046E-21	-177395.022	-117946.350	-186771.394	-108569.978
X_3	WTEA	112.171	9.234	12.147	3.934E-31	94.042	130.299	88.324	136.017
X_4	PFSM	45372.599	3163.074	14.344	1.970E-41	39163.108	51582.091	37204.360	53540.839
	PFSM: Provision of Free Meals								
	Source: Own computation based on Dfe (2018)								

Table 11 represents panel 3, which conveys the regression of the expenditure on the number of fulltime pupils, the number of teachers per students, the wage of teachers (unit labour costs) and the number of free meals (relative poverty). £1 increase in teachers' gross yearly salary is associated to an increase of £112.171 in total school expenditure, ceteris paribus. An additional percentage point of students requiring free school meals is associated with an increase school expenditure of £45372.599 per year, ceteris paribus.

Subsequently, I created a consolidated regression output table (table 12) that summarised the results obtained in the three panels. The estimated equations are given in the table, where standard errors are reported in square brackets below the coefficient estimates. The key variable is the number of FTE pupils. It can be inferred from column [1], the OLS coefficient b_1 is £5294.11. the t statistic for testing the null hypothesis β1 = 0 is t = 5294.11/109.05 = 48.55, and so simple regression succeeds in rejecting H_0 at the 0.1% level. OLS coefficient b_1 is an estimate of the marginal cost of a pupil. Column [3] shows that by adding explanatory variables to column [2], the cost of increasing class sizes (RATPUPTEA) is reduced by £124260.77. Finally, the R square shows that the regressors jointly explain 88.76% of the variation in total school expenditure.

Table 12. Regression output: Determinants of School's Annual Expenditure						
Dependent variable: EXP, School Expenditure (all categories) (£ per year)						
(standard errors reported in square brackets under each estimate coefficient)						
Regressors	[1]		[2]		[3]	
	Coefficients		Coefficients		Coefficients	
Intercept (in £ per year)	815326.11	****	4639992.63	****	-2440123.93	
	[112310.41]		[264118.46]		[437580.45]	
PUP (FTE pupils)	5294.11	****	5656.30	****	5681.33	****
	[109.05]		[97.72]		[77.92]	
RATPUPTEA (pupil/teacher)			-271931.46	****	-147670.69	****
			[17445.21]		[15141.38]	
WTEA (£ per year)					112.17	****
					[9.23]	
PFSM (% of pupils)					45372.60	****
					[3163.07]	
R Square	0.7571		0.8163		0.8876	
Observations	758		758		758	
Statistically significant at:	**** 0.1% level					
	*** 1% level					
	** 5% level					
Source: Own computation based on Dfe (2018)						

Afterwards I created table 13, which takes account of all the variables of table 11 and the London effect, a Dummy variable (information not conventionally measured) according to which a school tends to spend £1032152.220 more per year in London than when located elsewhere, controlling for school size, number of teachers per students, teachers' average salary and percentage of students eligible for free school meals. Then I standardised the dependent and explanatory variables apart from DLONDON (Dummy variable) and deployed the results in table 14. It can be deduced from the table that a one standard deviation increase in PUP increases school expenditure by 0.916 standard deviations, whereas a one standard deviation increase in WTEA increases expenditure by 0.074 standard deviations. The variables that have the highest impact on school expenditure are DLONDON, PFSM (measure of relative poverty) and PUP.

	Table 13. OLS estimation results of a linear regression of EXP on PUP, RATPUPTEA, WTEA, PFSM and DLONDON								
	Observations	758							
	Regressors	5							
Y	Dependent variable: EXP								
		Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
	Intercept	443336.888	473427.065	0.936	3.49E-01	-486058.955	1372732.731	-486058.955	1372732.731
X_1	PUP	5528.033	72.992	75.735	0.00E+00	5384.740	5671.325	5384.740	5671.325
X_2	RATPUPTEA	-115079.459	14229.992	-8.087	2.44E-15	-143014.692	-87144.226	-143014.692	-87144.226
X_3	WTEA	26.661	11.249	2.370	1.80E-02	4.577	48.746	4.577	48.746
X_4	PFSM	44762.773	2914.833	15.357	1.70E-46	39040.597	50484.950	39040.597	50484.950
X_5	DLONDON	1032151.220	88831.044	11.619	8.07E-29	857764.902	1206537.538	857764.902	1206537.538
	DLONDON: London effect								
	Source: own computation based on Dfe (2018)								

	Table 14. Standardisation of the regression varaibles PUP, RATPUPTEA, WTEA and PFSM								
Y	Dependent variable: Standarised School Expenditure (all categories) (z_EXP)								
		Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 99.0%*	*Upper 99.0%*
z_1	z_PUP	0.916	0.012	74.764	0.00E+00	0.892	0.941	0.885	0.948
z_2	z_RATPUPTEA	-0.115	0.013	-8.625	3.77E-17	-0.142	-0.089	-0.150	-0.081
z_3	z_WTEA	0.074	0.015	4.970	8.30E-07	0.045	0.104	0.036	0.113
z_4	z_PFSM	0.204	0.014	15.017	8.81E-45	0.177	0.230	0.169	0.239
D	DLONDON	0.326	0.035	9.376	7.81E-20	0.258	0.394	0.236	0.416
	Source: Own computation based on Dfe (2018)								

Subsequently, I created table 15, adding the multiplicative term DLONDON*(PUP-<PUP>) to the model to check if the London effect is also changing the marginal cost of a pupil. DLONDON*(PUP-<PUP>) represents the deviation from the average number of pupils. As DLONDON is statistically significant in both table 13 and 15, there is evidence of higher average expenditure for London schools, indeed a school located in London with an average number of pupils is usually linked with a higher expenditure of £931365.731 ceteris paribus.

	Table 15. OLS estimation results of a linear regression of EXP on PUP, RATPUPTEA, WTEA, PFSM, DLONDON and DLONDON*(PUP-<PUP>)								
	Observations	758							
	regressors	6							
Y	Dependent variable: EXP, School Expenditure (all categories) (£ per year)								
		Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
	Intercept	723454.736	458868.391	1.577	1.15E-01	-177362.565	1624272.037	-177362.565	1624272.037
X_1	PUP	5291.735	77.379	68.387	0.00E+00	5139.830	5443.640	5139.830	5443.640
X_2	RATPUPTEA	-116188.111	13746.355	-8.452	1.48E-16	-143173.963	-89202.260	-143173.963	-89202.260
X_3	WTEA	25.670	10.867	2.362	1.84E-02	4.336	47.004	4.336	47.004
X_4	PFSM	44632.826	2815.654	15.852	4.95E-49	39105.339	50160.314	39105.339	50160.314
X_5	DLONDON	931365.731	86877.488	10.720	4.76E-25	760814.117	1101917.345	760814.117	1101917.345
X_6	DLONDON*(PUP-<PUP>)	1274.011	171.879	7.412	3.35E-13	936.590	1611.432	936.590	1611.432
	Source: own computation based on Dfe (2018)								

To conclude, I created a consolidated regression output table to summaries, as I did before, three estimated regression models (table 16). Column [1] represents Model [1] (table 12) which is the regression of EXP on PUP, reporting marginal costs of a pupil (£5292) complemented by an analysis of regional differences in predicted expenditure, based on school size. Column 2 represents model [2] (table 13) which is based on the regression of EXP on PUP and on RATPUPTEA and analyses how to increase the number of pupils without raising costs. Column [3] depicts model [3] (table 15), which is basically table 15 that reports the effects of multiple variables, necessary for policy implications, and accounts for 91.12% of the variation in total secondary school expenditure.

Table 16. Regression output: Determinants of School's Annual Expenditure (2)						
Dependent variable: EXP, School Expenditure (all categories) (£ per year)						
(standard errors reported in square brackets under each estimate coefficient)						
Regressors	[1]		[2]		[3]	
	Coefficients		Coefficients		Coefficients	
Intercept (in £ per year)	815326.11	****	4639992.63	****	723454.74	
	[112310.41]		[264118.46]		[458868.39]	
PUP (FTE pupils)	5294.11	****	5656.30	****	5291.74	****
	[109.05]		[97.72]		[77.38]	
RATPUPTEA (pupil/teacher)			-271931.46	****	-116188.11	****
			[17445.21]		[13746.35]	
WTEA (£ per year)					25.67	***
					[10.87]	
PFSM (% of pupils)					44632.83	****
					[2815.65]	
DLONDON 1=yes					931365.73	****
					[86877.49]	
DLONDON*(PUP-<PUP>)					1274.01	****
					[171.87]	
R Square	0.7571		0.8163		0.9112	
Observations	758		758		758	
Statistically significant at:	**** 0.1% level					
	*** 1% level					
	** 5% level					
Source: Own computation based on Dfe (2018)						

Policy Implications

From 2009/10 to 2017/2018 the number of pupils has gone up by 9% (700000) and despite the government has funded schools more than ever in 2017/2018 (£49bln), due to inflation the education system is strained because it is funded as much it was in 2009/2010 but with more students. According to the Local Government Association, by 2023 more than half of councils will be unable to provide a secondary school place to an expected 134000 students (the Guardian, 2018). Schools are underfunded in comparison to their expenditure, and they are raising funds through extracurricular activities such as non-uniform days and by cutting reducing hours at both at the start and end of the day to save money. The education system is experiencing a funding crisis caused by the fiscal austerity that the tory cuts have brought upon after the 2008 economic crisis, to tackle an increasing debt to GDP ratio. The schools are forced to cut staff expenses by firing teachers but according to table 14, cost-savings by a one standard deviation increase in RATPUPTEA amount to only 11.5% of the extra expenditure by a one standard deviation rise in PUP, therefore reducing the number of teachers and increasing class sizes will not solve the funding crisis experienced by secondary schools in England. If teaching staff is going to be fired, a one standard deviation increase in WTEA is more cost-efficient and appropriate as the cost savings of a one standard deviation increase in RATPUPTEA would compensate the fact that the teachers will earn more. Child poverty (PFSM) is the second most important variable influencing total secondary school expenditure; indeed, a one standard deviation rise in PFSM would affect school expenditure by 31.9% more than the cost of savings of a one standard

deviation increase in RATPUPTEA. As I mentioned before, for an average school in England, and additional 100 pupils would require 2 more students per teacher to keep costs approximately constant. Furthermore, as we saw in question 1 there is a great inequality in funding and expenditure across England, which might require reforms on poverty, which deeply affect school expenditure and funding, worsening poverty itself as a defective education system would discourage pupils from achieving desired results or even attending school, forcing them on undesired less economically rewarding career paths or none in the worst-case scenario. Given the inequality across regions, issues can be risen against the government's formula used to estimate the amount of funding each school is entitled to, and consequential modifications should be made to it.

Conclusion

This project focused on the school expenditure of secondary schools in England though three sections relating to three questions: 1. What is the extent of regional inequalities in expenditure by secondary schools? 2. What has been the recent evolution of total gross expenditure by secondary schools? 3. What are the determinants of secondary school expenditure? In question 1, the project covered regional inequalities through spatial disaggregation, determining school expenditure geographical patterns and its relation to funding through bar charts. I determined that London's total school expenditure is the biggest and the South west's school expenditure is the smallest and I proceeded in comparing the two regions through histograms, percentiles, and box plots. In question 2, I analysed secondary school expenditure throughout 1999/2000 and 2016/2017, through time-series, finding out that due to the 2008 financial crisis, despite real school expenditure has increased, due to inflation gross funding and therefore expenditure have diminished, but they are hinting to a possible recovery as show by the histogram I created in graph 9. Question 3 focused on the determinants of secondary school expenditure and I identified them to be, in order of importance based on the results of correlation and regression analysis, the total number of fulltime pupils, the London effect, the provision of free meals, the ratio between teachers and students and the wage of teachers. Policy reforms are needed to contrast the increasing inequality and poverty that is straining the education system in England and the only plausible solution to an increasing class size threat, from my project view, it is to increase the number of students per teacher, indeed an additional 100 pupils would require 2 more students per teacher to keep costs approximately constant. Teachers should be compensated through wage rises for the extra work as it does not affect costs by a large margin, if it is done consciously. However, this is possible only through a greater deployment of the public budget to secondary school funding because the financial necessities of schools need to be met as education is a determinant of economic activity and it lowers the rate of poverty, which is also a variable affecting school expenditure itself.

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