APPLIED QUANTITATIVE ECONOMICS

PROJECT 1

Student ID# 33636339

26/03/2021

Word count: 4339

1. Introduction

Education up to the age of 16 is a key learning period for pupils in term of determination of their future career paths, and because of that it is of crucial importance for governments to shape correct educational policies to fight inequality across regions and to provide the correct level of funding. School expenditure includes different budget categories and may be directly related to school income, size, personalised teaching and its location. Nowadays local public authorities in England are facing increasing pressure for constraint expenditure in areas relating to schooling, health and social policy, and restrictive policies may trigger a process of fragmentation of social cohesion in the country. For this reason, it is the purpose of this paper to conduct a statistical analysis of the overall national evolution and uneven regional dimension of school expenditure, and to understand what the key determinants of expenditure are. To conduct the research, I will use a large sample from Department for Education's dataset 'Revised key stage 4 results' for the (academic and fiscal) year 2016-2017. After describing the dataset characteristics, I will proceed to conduct a statistical analysis in order to answer to the following 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 order to answer to the question of the project, I will make use of descriptive statistics and regression models, and the data obtained will then be used in the last section in which the policy implications of the results of the analysis will be addressed.

2. Dataset Properties

The Dataset used in this project is drawn by the UK Department of Education (DfE) databases, and it contains data regarding the educational attainment of pupils at the Key Stage 4 level for the (academic and fiscal) year 2016-2017 (published in January 2018). The sample includes the following variables, for individual schools in England:

Table 1 *. List of variables for each school:*			*(continued…)*	
Variable	**Description**	**Variable**	**Description**	
URN	School Unique Reference Number	INC	School Income (grant funding and self generated) (£)	
SCHNAME	School Name	EXP	School Expenditure (all categories) (£)	
LANAME	School Local Authority	SUR	School Surplus (£ per year)	
REGION	School region in England	INCP	School Income per Pupil (£ per pupil)	
GENDER	Gender of student body (Mixed, Boys, Girls)	EXPP	School Expenditure per Pupil (£ per pupil)	
ISSECONDARY	Whether the school is offering secondary education (1 = Yes)	SURP	School Surplus per Pupil (£ per pupil)	
PUP	Number of full-time equivalent (FTE) pupils	EXPLRESP	School Expenditure in Learning Resources per Pupil (£ per pupil)	
PUPKS4	Number of pupils at the end of key stage 4	SHEXPLRES	Share of School Expenditure in Learning Resources (% of Total)	
PSEN	Percentage of Special Education Needs pupils (% of pupils)	SHSELFINC	Share of Self-generated School Income (% of Total)	
PFSM	Percentage of pupils eligible for Free School Meals (% of pupils)	ATT8SCR	Average Attainment 8 Score per Pupil	
PENGFL	Percentage pupils with English as first language (% of pupils)	DMIXED	Whether it is a mixed-gender school (1 = Yes)	
RATPUPTEA	Pupil:Teacher Ratio (number of pupils per teacher)	ISPRIMARY	Whether the school is offering primary education (1 = Yes)	
TEA	Number of full-time equivalent (FTE) teachers	ISPOST16	Whether the school is offering 16-18 education (1 = Yes)	
WTEA	Mean gross FTE salary of a teacher (£ per year)	DLONDON	Whether the School is located in the London region (1 = Yes)	
LAPAY	Median gross weekly pay in the Local Authority (£ per week)			
Source: Author's elaboration based on DfE (2018) databases				

The variables contained in Table 1 are utilised in this project to measure regional inequalities in average spending of secondary schools between and within regions in England. The sample employed contains data of 758 schools and covers the academic year 2016-2017. The data are broken down by categories, in particular there are data related to schools such as: school unique reference number (URN), school name (SCHNAME), school region in England (REGION, DLONDON), school income (grant funding, self-generated, share of self-generated) (£) (INC, INCP, SHSELFINC), school expenditure (EXP, EXPP), data regarding their difference

(surplus) (SUR, SURP), and school size, in terms of pupils (PUP, PUPKS4). Moreover, the dataset presents data that describe pupil characteristics and variables concerning teachers: for the former, pupil gender (GENDER, DMIXED), pupil eligibility for free school meals (PFSM), special educational needs (PSEN), English as a first language, their average attainment 8 score (ATT8SCR), while for the latter, number of full-time teachers (TEA), their pupil:teacher ratio (RATPUPTEA) and the mean compensation to teaching staff (WTEA).

***Table 2** : Secondary Schools in England*							
Year	Total Gross Expenditure	Total Funding	GDP deflator				
(fiscal)	(£mln, current prices)	(£mln, current prices)	(2016_17=100)				
1999_00	9021.39	8394.53	71.25				
2000_01	10144.32	9439.44	72.73				
2001_02	11267.26	10484.35	73.62				
2002_03	11329.02	10541.82	75.34				
2003_04	12556.79	11924.98	76.99				
2004_05	13476.38	12752.00	79.14				
2005_06	14474.68	13555.58	81.20				
2006_07	15206.80	14295.03	83.74				
2007_08	16008.64	15148.43	85.82				
2008_09	16656.01	15510.54	88.06				
2009_10	16777.74	15660.77	89.34				
2010_11	16485.46	15565.03	90.97				
2011_12	12658.75	12128.44	92.28				
2012_13	9662.38	9257.26	94.19				
2013_14	8266.46	7901.44	95.80				
2014_15	7495.87	7020.86	97.19				
2015_16	6836.26	6445.39	97.85				
2016_17	6357.19	5902.49	100.00				
Sources: Own estimation based on:							
Detailed school income and expenditure statistics for local authority maintained schools in England by phase of education (DfE)							
Quarterly National Accounts (ONS)							

Furthermore, in order to analyse the evolution over time of gross expenditure by secondary school in England through a period that range from 1999_00 to 2016_17, the data contained in table 2 are used. Table 2 contained detailed school income and expenditure statistics for local authority maintained of secondary schools in England by the phase of education (DfE) which are taken from the Quarterly National Accounts of the Office for National Statistics (ONS). I will now proceed to start the analysis of Regional Inequalities in expenditure by secondary schools in England.

3. Regional Inequalities in expenditure by secondary schools in England

To analyse and draw conclusions regarding the level of regional inequalities in expenditure by secondary school in England, I use descriptive statistics tools to identify concentration tendencies and regional differences. First of all, let us have a look at the distributions of average school expenditure in England by Region (2016/2017) depicted in table 3: the data are sorted in base of average expenditure (expressed in £/year) from the highest to the lowest. The first thing that can be noted is the difference between London and the rest of the country: there is a difference of £1,967,785 between London and the second region with the highest average expenditure (South East), while the difference between South East and the region with the lowest average expenditure (South West) is equal to £612,083. The difference in average expenditure between London and the South East is indeed 3.22 times the difference between the South East and the South West.

***Table 3**: Average school expenditure in England by Region (2016/2017)*

Region	Num_of_Schools	Average of EXP	Rel_Avg_EXP	Rel_Dif_EXP
07_London	141	7806875	131.67%	31.67%
08_South_East	140	5839090	98.48%	-1.52%
06_East_of_England	34	5768159	97.29%	-2.71%
03_Yorkshire_Humberside	69	5568987	93.93%	-6.07%
04_East_Midlands	34	5493169	92.65%	-7.35%
01_North_East	39	5472155	92.30%	-7.70%
02_North_West	183	5331774	89.93%	-10.07%
05_West_Midlands	69	5268098	88.85%	-11.15%
09_South_West	49	5227007	88.16%	-11.84%
Grand Total	**758**	**5928942**	**100.00%**	**0**

References:

Num_of_Schools: number of schools in the sample per region

Average of EXP: average regional school expenditure (in £/year)

Rel_Avg_EXP: regional average expressed as a proportion of national average (in %)

Rel_Dif_EXP: regional difference with respect to national average (in percentage points)

Source: own computation based on DfE (2018)

The average national average school expenditure amounts to £5,928,942, placing London well above the national average. It ought to be mentioned that London itself drags the national average up of quite a significant amount and to prove this point I built a pivot table that does not include London data:

***Table 4**: Average school expenditure in England by Region excluding London (2016/2017)*

Row Labels	Count of URN	Average of EXP	Rel_Avg_EXP	Rel_Dif_EXP
08_South_East	140	5839090	106.17%	6.17%
06_East_of_England	34	5768159	104.88%	4.88%
03_Yorkshire_Humberside	69	5568987	101.26%	1.26%
04_East_Midlands	34	5493169	99.88%	-0.12%
01_North_East	39	5472155	99.50%	-0.50%
02_North_West	183	5331774	96.95%	-3.05%
05_West_Midlands	69	5268098	95.79%	-4.21%
09_South_West	49	5227007	95.04%	-4.96%
Grand Total	**617**	**5499787**	**100.00%**	**0.00%**
References:				
Num_of_Schools: number of schools in the sample per region				
Average of EXP: average regional school expenditure (in £/year)				
Rel_Avg_EXP: regional average expressed as a proportion of national average (in %)				
Rel_Dif_EXP: regional difference with respect to national average (in percentage points)				
Source: own computation based on DfE (2018)				

As shown in Table 4, without considering London the national average would sit at £5,449,787, and the relative difference between the regions and the national average decrease, making the average school expenditure more concentrated around the national average.

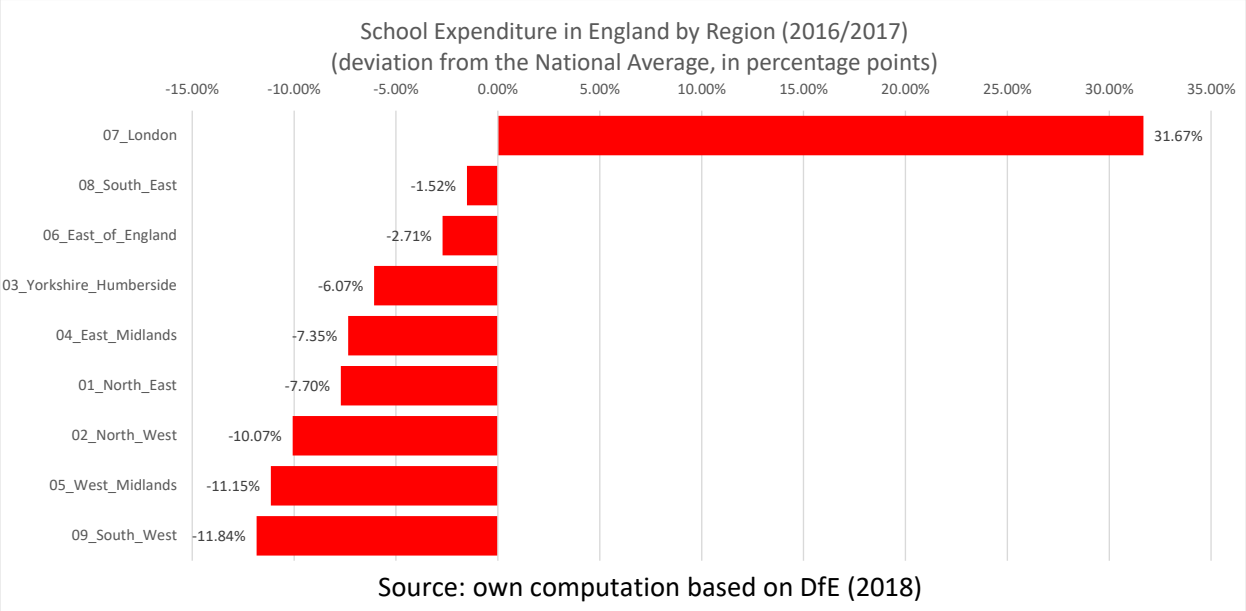


Figure 1

Figure 1 depicts the deviation from the National Average in percentage points of school expenditure in England by Region and helps us to visualize the huge disparity between London, which is placed 31.67% above the national average, and the rest of the country which is placed mostly below the national average, with exception of the South east and the East of England which are close to the national average, while the worst performing regions (in term of spending) are the West Midlands and the South West (respectively -11.15% and -11.84%).

Table 5: Average school expenditure and funding in England by Region (2016/2017)

Row Labels	Num_of_Schools	Average of EXP	Average of INC	Rel_Avg_EXP	Rel_Avg_INC	Rel_Dif_EXP	Rel_Dif_INC
07_London	141	7806874.887	7705945.177	131.67%	131.69%	31.67%	31.69%
08_South_East	140	5839090.321	5775120.679	98.48%	98.70%	-1.52%	-1.30%
06_East_of_England	34	5768158.706	5772352.794	97.29%	98.65%	-2.71%	-1.35%
03_Yorkshire_Humberside	69	5568986.768	5470961.203	93.93%	93.50%	-6.07%	-6.50%
04_East_Midlands	34	5493168.529	5453623.794	92.65%	93.20%	-7.35%	-6.80%
01_North_East	39	5472154.949	5345178	92.30%	91.35%	-7.70%	-8.65%
02_North_West	183	5331773.885	5250956.53	89.93%	89.74%	-10.07%	-10.26%
05_West_Midlands	69	5268098.232	5240642.812	88.85%	89.56%	-11.15%	-10.44%
09_South_West	49	5227006.878	5105389.816	88.16%	87.25%	-11.84%	-12.75%
Grand Total	**758**	**5928941.947**	**5851438.172**	**100.00%**	**100.00%**	**0**	**0**

References:

Num_of_Schools: number of schools in the sample per region

Average of EXP: average regional school expenditure (in £/year)

Average of INC: average regional School Income (grant funding and self generated) (in £/year)

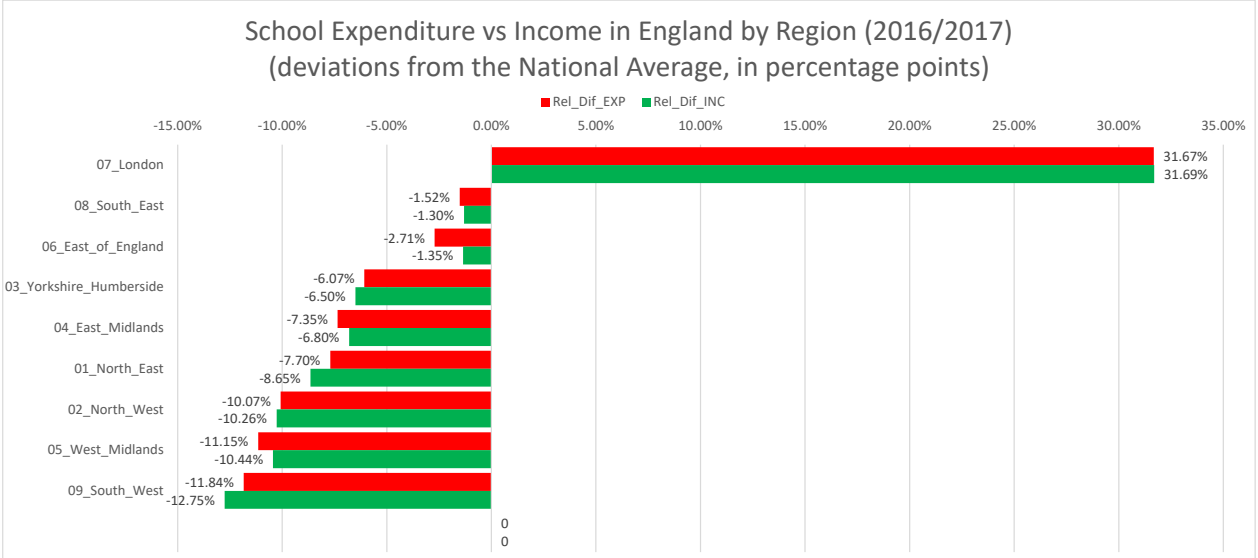
Rel_Avg_EXP: regional spending average expressed as a proportion of national average (in %)

Rel_Avg_INC: regional income average expressed as a proportion of national average (in %)

Rel_Dif_EXP: regional difference in spending with respect to national average (in percentage points)

Rel_Dif_INC: regional difference in income with respect to national average (in percentage points)

Source: own computation based on DfE (2018)



Source: own computation based on DfE (2018)

Figure 2

***Table 6**: school EXP Statistical analysis 2016/2017*		
	London	**South West**
Count	141	49
Min	3177200	1897983
Max	17871840	10206480
Mean	7806875	5227007
Median	7500405	4966744
Range	14694640	8308497
Standard dev.	2530116	1794377
20 Percentile	5639670	3740643.4
25 Percentile	5872906	3855474
50 Percentile	7500405	4966744
75 Percentile	9540195	6142352
80 Percentile	9923392	6507211
99 Percentile	14431647	9620262
IQR	3667289	2286878
80/20 Ratio	1.76	1.74
Source: own computation based on DfE (2018)		

By looking at table 5 and figure 3 above, I can infer that the pattern of school income follows strictly the same pattern of school expenditure: London is placed well above the national average in term of school funding too, while the rest of the country is placed below the national average, with the south west performing worst. In order to understand the level of inequality between and within regions, let us now proceed to analyse measures of dispersion and location. For the purpose of this project, only two regions will be compared, respectively the best and the worst in term of school expenditure and school income: London and the South West.

Table 6 provides us of a summary of the main numerical measures of dispersion and location, providing us of value of the quartiles. Starting with measures of dispersion, by looking at the Inter Quartile Range (IQR) it can be noticed that London presents a higher value compared to the South West: £3667289 for London while £2286878 for the South West, suggesting a higher degree of inequality within the London region. A second sneak peek is the significant difference in the mean and the median between the two regions, with higher values for London that confirm the high degree of inequality between London and the rest of England.

***Table 7**: EXP Frequency distribution 2016/2017*

			07_London		09_South_West
From	***Up to***	***Frequency***	***Rel. Frequency***	***Frequency***	***Rel. Frequency***
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%
	Tot.	141	100.00%	49	100.00%

Source: own computation based on DfE (2018)

To better visualize the difference between the two regions and the degree of inequality within regions, I built the Exp frequency distribution table (table 7) for the year 2016/2017 and the correspondent relative frequencies histograms for the two regions object of analysis.

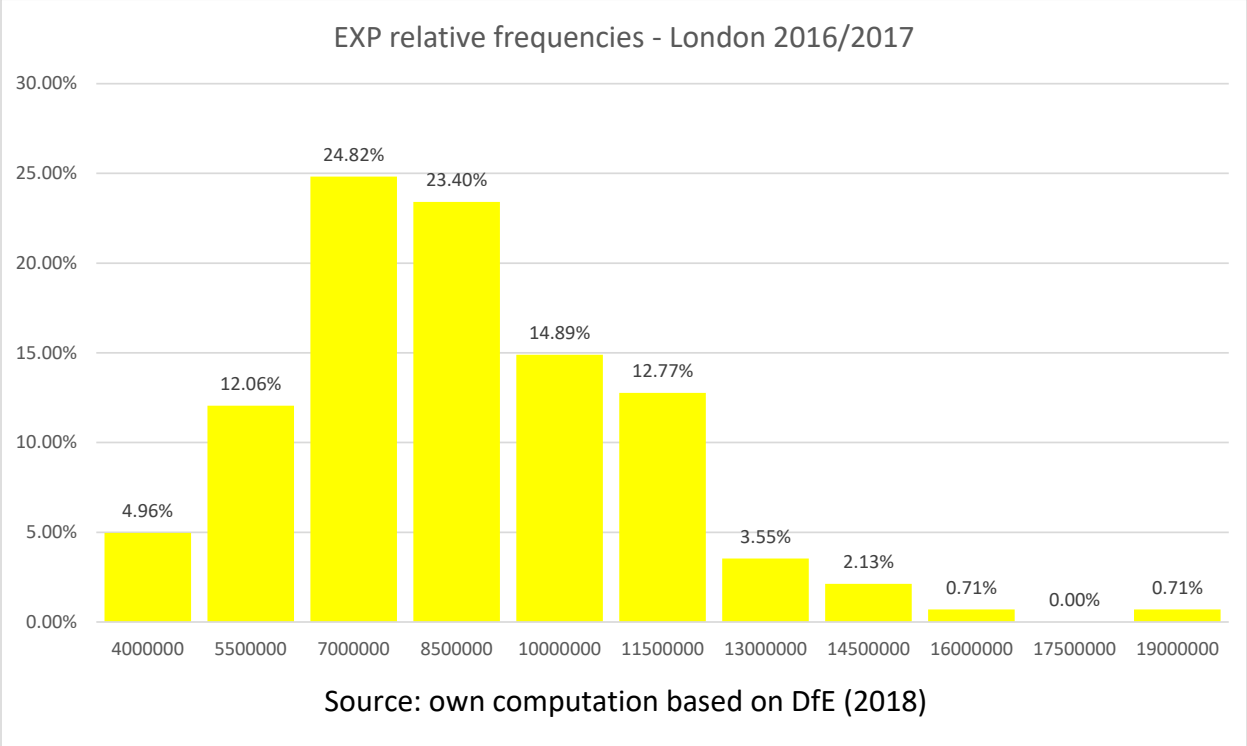


Figure 3

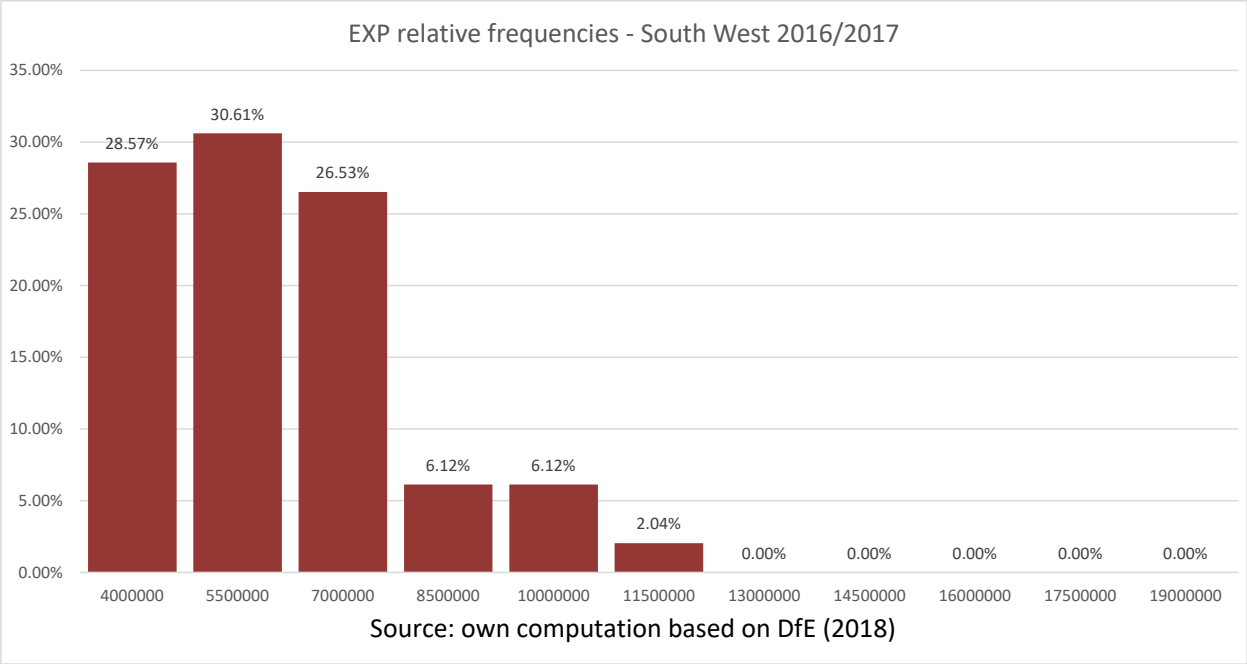


Figure 4

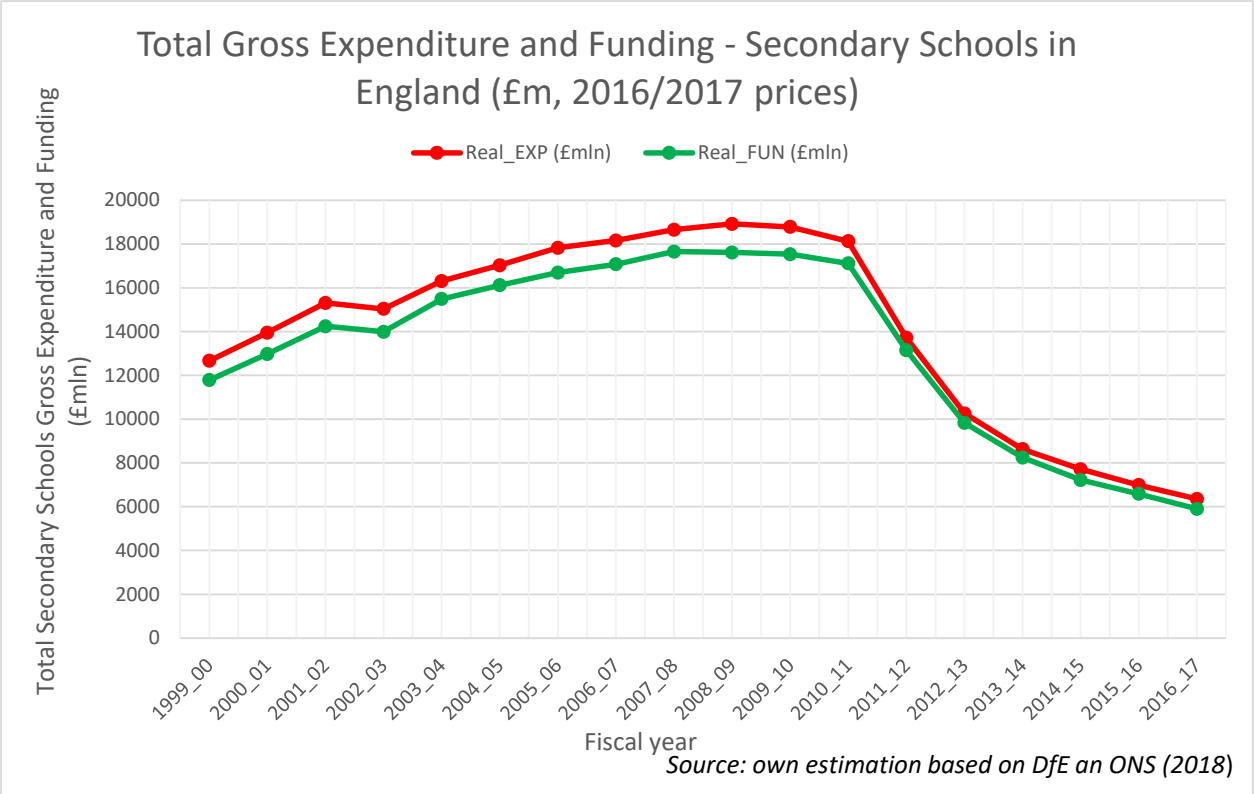
By comparing the two histograms (figure 4 and figure 5), we can notice how the level of relative expenditure in London schools are more spread out suggesting higher degree of inequality, although it presents a certain degree of right-skewness (48.22% of schools are placed around the mean - £7,806,875 - and spend between £7,000,000 to £8,500,000). Different story for the South West (figure 5): with the mean being £5,227,007 (£2,579,868 less than London), 85.71% of the schools spend between £4,000,000 and £7,000,000. Put it in another way, 85.71% of the schools in South West spend less than the average spending in London.

Figure 5

These differences can be easily visualized in the box plot below (figure 6). From figure 6, it can be noticed the presence of a significant number of outliners for London and of a higher degree of dispersion (box more stretched) with a light level of skewness, while the South West box results less stretched. Moreover, the bulk of South West schools (1st to 3rd quartiles) are place well below the ones in London.

4. Evolution Over Time of total gross expenditure by secondary school in England

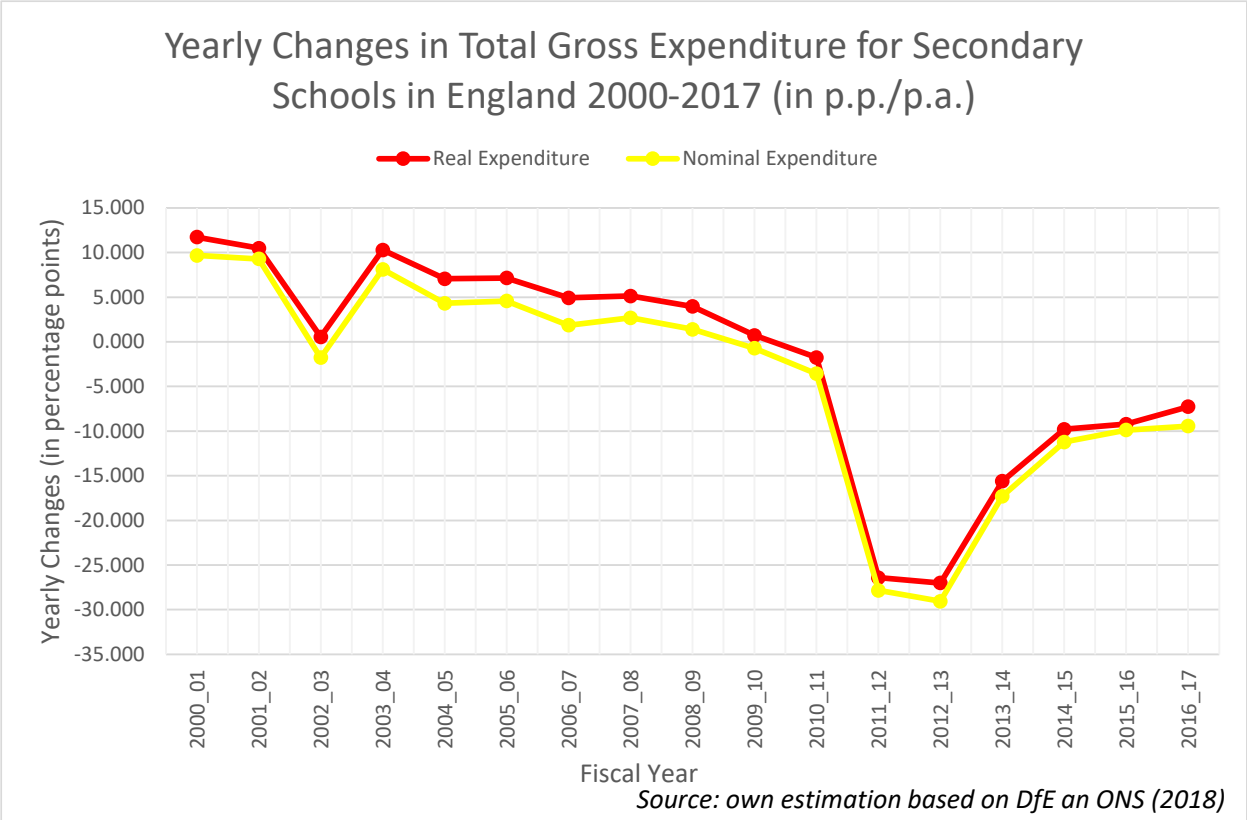
I will now move into analysing the evolution over time of total gross expenditure by secondary school in England by employing time series techniques. The period object of analysis runs from year 1999/2000 until year 2016/2017.



Source: own estimation based on DfE an ONS (2018)

Figure 6

The first inference that can be effectuated regards the trend of both variables, shown in figure 7: between the fiscal year 1999_00 and 2008_09 there was a positive constant trend (with exception of year 2002_03), while in 2008_09 the trend assumed a negative shape experiencing a slump from year 2010_11 inwards. If we compute the average yearly growth rate for the period 1999_00/2008_09, it amounted to 4.46%, while the year 2008_09/2016_17 registered a negative growth rate of -13.63%. The decline originated after the 2008 Financial Crisis and has been persistent until the year 2016_17, not showing any signal of improvement. Moreover, it can be mentioned the fact that the two curves resemble each other, meaning that the level of funding contracted along with the contraction in total gross expenditure. Nevertheless, the school budget has been running a constant deficit as shown by the higher real expenditure curve in comparison to the real funding curve, especially between 1999_00 and 2010_11, while from 2010_11 until 2016_17 the two lines converged, which can mean that either the level of expenditure decreased to adapt to the level of funding or the level of funding increased to match the level of expenditure of secondary schools.

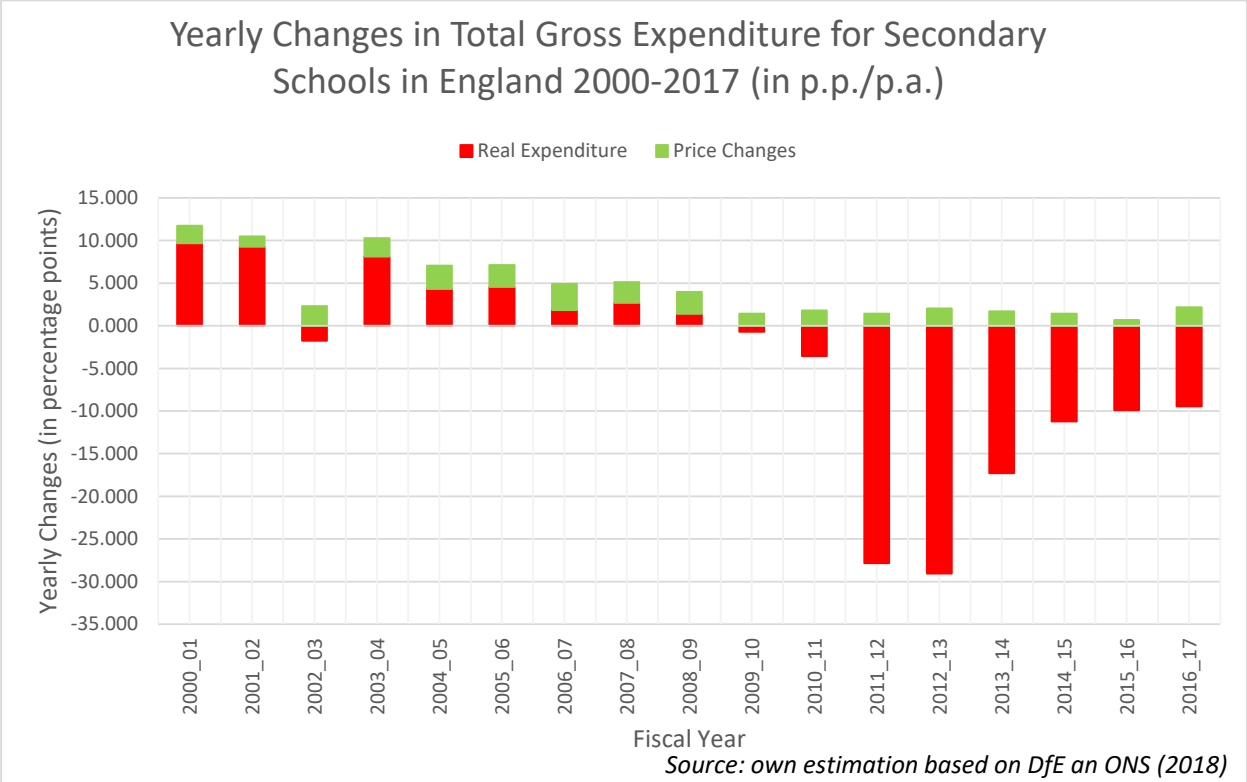


Source: own estimation based on DfE an ONS (2018)

Figure 7

We may gain further insights into how expenditure evolved over time by focusing on the change in expenditure from year to year between the period from 2000_01 until 2016_2017. As we can see from figure 8, between 2000_01 and 2009_10, expenditure experienced declining rates of yearly growth (with exception of the year 2002_03 where the real rate of growth was null), and the year 2009_10 defined the change in the trend, with the change in yearly real growth rate experienced a negative change of -27.84% in year 2011_12 and -29.07% the following year. In 2012_13 the amount of total real expenditure was £10,258mln while in 2008_09 before the financial crisis was £18,915mln. Between 2012_13 and year 2016_17, the yearly changes in expenditure has kept a negative trend, but it shows that the level of expenditure is dropping at a slower rate: in 2016_17 the yearly change in real expenditure registered -9.44%, suggesting that within the trend of the yearly changes is converging toward 0% and might in the short run go back to registered positive trends. The total real expenditure of 2016_17 amounted to £6,357mln, which is £12,558mln less than the level of real expenditure before the financial crisis occurred. The negative trend depicted in figure 8 might suggest that the convergence of the level of expenditure and level

of funding is mainly a consequence of the decrease in the level of expenditure rather than an increase in the level of funding which also experienced a contraction between 2009_10 and 2016_17.



Source: own estimation based on DfE an ONS (2018)

Figure 8

Finally, figure 9 gives us insights on the rate of inflation that occurred between 2000_01 and 2016_17. Firstly, figure 9 confirms the trend in changes in expenditure highlighted before, with a declining yearly growth rate from year 2003_04 until 2009_10 when it assumed a negative growth. Moreover, the graph shows us the rate of inflation expressed as Price Changes by the green boxes. The inflation was at his highest in year 2006_07 (3.08%) and 2008_09 (2.57%), while it reached its lowest in year 2015_16 (0.67%). Overall, prices kept increasing over the timeframe between 2000_01 and 2016_17, and the average inflation rate of the period registered 1.99% in line with the Bank of England inflation target.

5. Correlation and Regression Analysis: the determinants of secondary school expenditure in England

This project aims to postulate, estimate and test relationships between variables in the dataset in order to find out what are the determinants of secondary school expenditure in England. Linear regression techniques will be employed, and after conducting a statistical analysis, I will proceed with an economic analysis of the results obtained. Firstly, let us start by defining the null hypothesis in order to analyse the correlation between the first two variables PUP for EXP:

$$H_0: school\ expenditure\ does\ not\ depend\ on\ number\ of\ pupils$$

My hypothesis claims that:

$$H_1: school\ expenditure\ depends\ on\ number\ of\ pupils$$

To test whether the null hypothesis can be rejected, I proceed to compute a simple linear regression analysis. The starting population regression equation is the following:

$$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i$$

Yi=School Expenditure (£/year)(EXP)

Xi=Number of pupils (PUP)

Having defined our regression equation, I proceed to compute the relevant calculations by making use of the OLS method.

***Table 7**: OLS estimation results of a linear regression of EXP on PUP*

SUMMARY OUTPUT								
Regression Statistics			Dependent variable: EXP					
Multiple R	0.870129062				*Coefficients*			
R Square	0.757124584		b_0	Intercept	815326.11			
Adjusted R Sq	0.756803321		b_1	PUP	5294.11			
Standard Erro	1072692.692							
Observations	758							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	2.71179E+15	2.71E+15	2356.707	1.5767E-234			
Residual	756	8.69906E+14	1.15E+12					
Total	757	3.5817E+15						
	Dependent variable: EXP							
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	815326.1127	112310.4141	7.259577	9.66E-13	594848.7689	1035803.456	594848.7689	1035803.456
PUP	5294.111512	109.0536715	48.54593	1.6E-234	5080.027503	5508.195522	5080.027503	5508.195522
Reference:								
PUP: Number of full-time equivalent (FTE) pupils								
Source: own computation based on DfE(2018)								

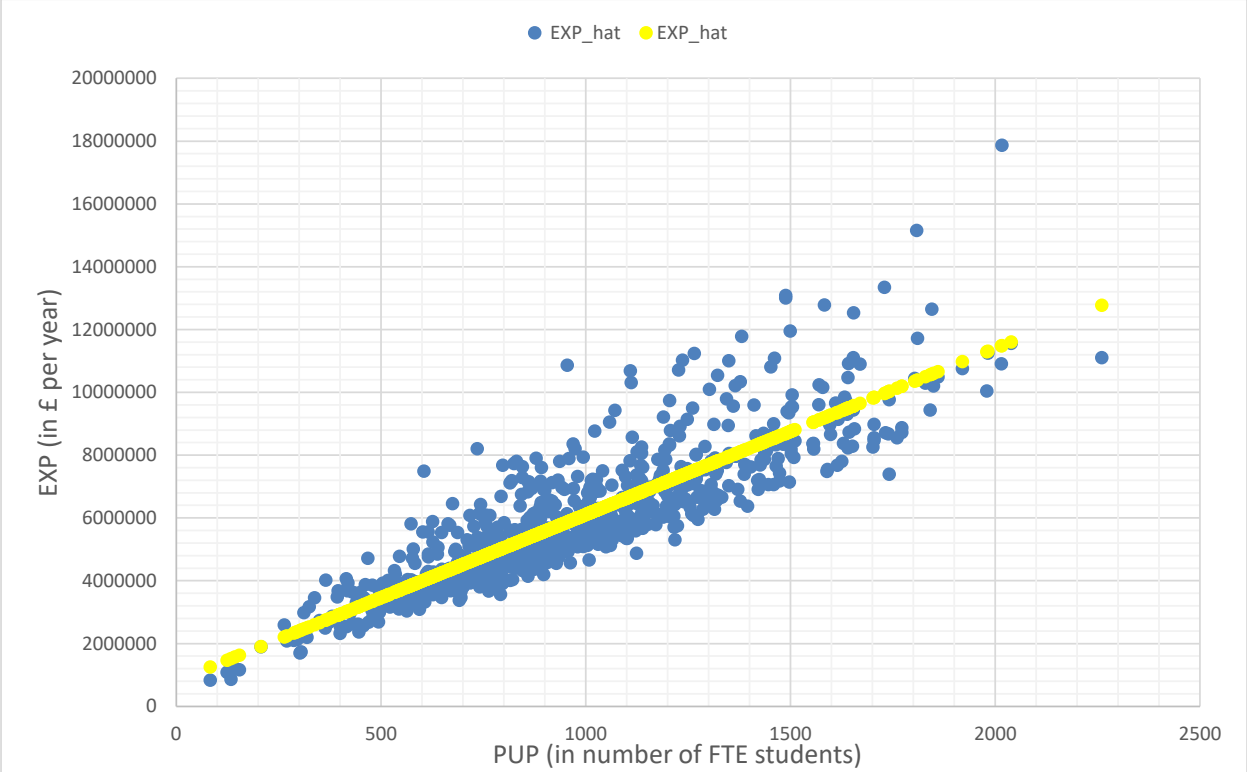
After having obtained the estimation results of a linear regression of EXP on PUP, I can build the fitted model:

$$\hat{Y}_i = 815{,}326.11 + 5{,}294.11X_i$$

B_0 (intercept) represents the average school cost per year assuming no pupils and equal to £815,326. B_1 represents the point estimate of the regression and it measures the average yearly increase of school expenditure: for an average school, an increase in one pupil tends to be associated with an increase of £5,294 in total expenditure. We can safely claim that the result obtained is statistically significant at a 1% confidence interval, since the P-value (1.6E-234) is smaller than 0.01. Furthermore, the R square is close enough to 1 to allows us to believe that the regression is a good fit. The graph that results out of the calculations is attached below (figure 10). Moreover, by examining the 95% confidence interval, we can claim with 95% confidence that the increase in average school expenditure related to an increase of one pupil is at least £5,080 and at most £5,508 per year. To make an example, I multiply the average costs of one pupil at 95% confidence interval by 100 to quantify the average increase in total expenditure per school:

Lower 95%×100=£5,080.03×100=£508,003
Upper 95%×100=£5,508.19×100=£550,819

Therefore, if an average school increases its size of 100 pupils, its total yearly expenditure will grow of at least £508,003 per year and at most £550,819 per year with a confidence of 95%.



Source: own computation based on DfE (2018)

Figure 9

Following the results obtained, I can reject the null hypothesis 'H_0: *school expenditure does not depend on number of pupils*' and I do not reject the hypothesis 'H_1: *school expenditure depends on number of pupils*', which means that the school size in terms of number of pupils is a variables that directly affect the total spending of schools: an increase in pupils is associated with an increase in total spending of a predicted average value of £5,294.

Another important factor that can be analysed is the inequality in total school spending that has been highlighted in section 1. and section 2. Between the London region and the rest of England. We can compute the residuals of total expenditure of all the regions and compare them to individuate which regions are overspending and which ones are underspending. The data regarding the residuals are computed in table 9 below.

***Table 9**: Regional school over/underspending as predicted by PUP*

	PUP_bar	EXP_bar	EXP_hat_bar	Residuals_bar
07_London	1073.21	7806874.89	6496996.63	1309878
01_North_East	865.00	5472154.95	5394732.57	77422
05_West_Midlands	874.84	5268098.23	5446829.70	-178731
02_North_West	903.72	5331773.89	5599698.58	-267925
04_East_Midlands	935.74	5493168.53	5769213.11	-276045
06_East_of_England	993.71	5768158.71	6076115.86	-307957
03_Yorkshire_Humberside	961.91	5568986.77	5907801.03	-338814
08_South_East	1031.88	5839090.32	6278206.34	-439116
09_South_West	916.73	5227006.88	5668621.81	-441615
Grand Total	**965.91**	**5928941.95**	**5928941.95**	**0.00**

References:

PUP_bar: average number of pupils in schools of the region (in number of FTE students)

EXP_bar: average regional school expenditure (in £/year)

EXP_hat_bar: average regional predicted school expenditure (in £/year)

Residuals: regional average of differences between observed and predicted values of EXP (in £/year)

Source: own computation based on DfE(2018)

As we can see from table 9, London and the North East have a positive residual, which can be interpretated as an overspending of the schools within those region in relation to the average regional predicted school expenditure: if we pick a random school in London, the institutions will spend in average £7,806,874 a year against the predicted value of £6,496,996 of our fitted model, with a yearly average overspending of £1,309,878. All others region with except of the North East are assumed to underspending in relation to the average predicted school expenditure, with South East and South West performing worst: the two regions underspending amount to -£439,116 and -£441,615 respectively. These differences in average

regional school over/underspending predicted by PUP (in £/year) is depicted by figure 11.

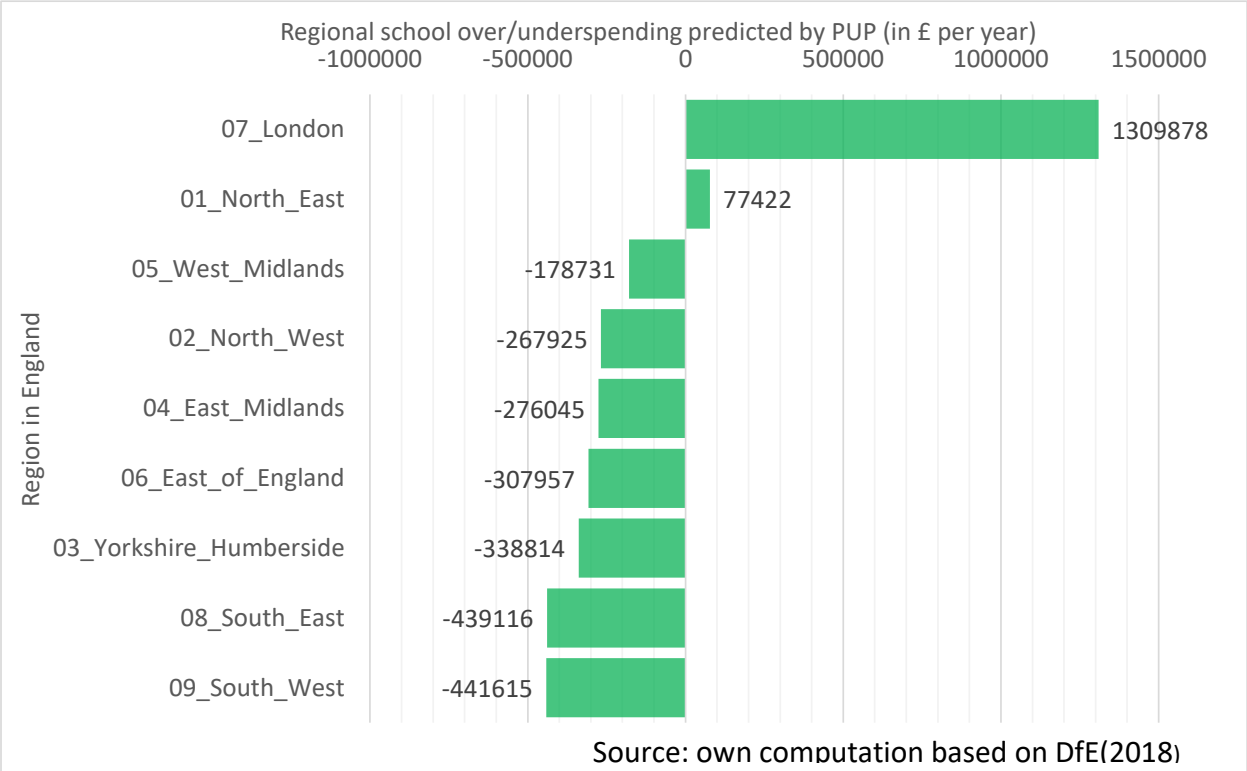


Figure 10

The difference between the region that overspend the most (London) and the region the underspend the most (South West) amounts to £868,263, which is almost 15% of the average national spending.

Nevertheless, the determinants of school expenditure are numerous, and a single regression will not provide enough information about the factors that affect total expenditure. For the purpose of this paper, I will compute multiple regression analysis by integrating variables that measure the number of pupils per teacher (RATPUPTEA), the cost per teacher calculated as the Mean gross FTE salary of a teacher in £ per year (WTEA), and the level of poverty in the school expressed as the percentage of pupils eligible for Free School Meals (PFSM). By adding these variables into the regression models, I expect that by increasing the numbers of pupils in class per teacher (by holding the school size constant), the average

marginal expenditure per pupil will decrease allowing schools to save as the number of teachers to be hired will decrease; by increasing the salary of teachers, the average total yearly spending per school will increase significantly; by having a larger number of pupils eligible for Free School Meals the average total yearly expenditure will be greater.

Table 10: dependent variable EXP, RATPUPTEA added

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.903469698							
R Square	0.816257496							
Adjusted R Square	0.815770761							
Standard Error	933632.1126							
Observations	758							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	2	2.92359E+15	1.46179E+15	1677.00558	1.7343E-278			
Residual	755	6.5811E+14	8.71669E+11					
Total	757	3.5817E+15						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	4639992.633	264118.4647	17.56784646	3.48142E-58	4121498.764	5158486.503	4121498.764	5158486.503
PUP	5656.299989	97.71892697	57.88336164	7.7049E-280	5464.466887	5848.133092	5464.466887	5848.133092
RATPUPTEA	-271931.4603	17445.20845	-15.58774497	1.05847E-47	-306178.3413	-237684.5793	-306178.3413	-237684.5793

Source: own computation based on DfE (2018)

Let us start first by addressing the case when RATPUPTEA is computed in the model. Table 10 above shows how the determinants of school expenditure impact on the average total yearly school expenditure: one additional pupil per school will now increase the yearly average school spending by £5,656, holding all the other variables constant. Moreover, the RATPUPTEA coefficient shows that by increasing the class sizes by one pupil per teacher across all classes, ceteris paribus, will allow the school to save in average £271,931 per year. With a confidence of 95%, the cost per extra pupil amounts to at least £5,465 and t most £5,848, while regarding the average savings it will range between £237,684 and £306,178 per year. In this case school will be incentivised to increase the class size maintaining the total number of pupils in the school constant as it will allows it to save from cutting the number of teachers.

Table 11: dependent variable EXP, WTEA and PFSM added								
ANOVA							*Regression Statistics*	
	df	*SS*	*MS*	*F*	*Significance F*		R Square	0.88755522
Regression	4	3.17895E+15	7.94739E+14	1485.905082	0		Observations	758
Residual	753	4.02743E+14	5.34851E+11					
Total	757	3.5817E+15						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 99.0%*	*Upper 99.0%*
Intercept	-2440123.935	437580.454	-5.576	3.42E-08	-3299146.612	-1581101.258	-3570120.407	-1310127.462
PUP	5681.333	77.916	72.916	0.00E+00	5528.374	5834.293	5480.124	5882.543
PFSM	45372.599	3163.074	14.344	1.97E-41	39163.108	51582.091	37204.360	53540.839
RATPUPTEA	-147670.686	15141.380	-9.753	3.05E-21	-177395.022	-117946.350	-186771.394	-108569.978
WTEA	112.171	9.234	12.147	3.93E-31	94.042	130.299	88.324	136.017
Source: own computation based on DfE (2018)								

I now add into the regression model the variables WTEA and PSFM to analyse how teachers' salary and number of students eligible for free school meals will affect expected yearly average school spending. In this case, the average cost per extra pupil will increase to £5,681, while the average savings due to an increase the ratio pupil:teacher will decrease to -£147,671 (£124,261 average loss of savings compared to the previous model). The increase in expenditure depends now by two important variables: the WTEA and the PFSM. Now, for every increase of £1 for every teacher's salary will cause in average an increase in expenditure of £112.17, all other factors constant. The significant increase in expenditure depends now from the Percentage of pupils eligible for Free School Meals (% of pupils): an expansion of 1% of pupils eligible for Free School Meals will cause in average an increase of £45,372 in total expenditure. Schools will be biased to constrain teachers' pay rises, and either to avoid accepting pupils from poorer backgrounds or to cut the quality of the meals offered.

As previously highlighted, the average difference in spending between schools located in London and schools in other regions is huge. To understand whether being in London is a factor itself affecting school expenditure, I now add in the model the dummy variable DLONDON, which represents whether the School is located in the London region.

Table 12: dependent variable EXP, DLONDON added								
Regression Statistics								
Multiple R	0.951141377							
R Square	0.904669919							
Adjusted R Square	0.904036075							
Standard Error	673830.2491							
Observations	758							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	5	3.24025E+15	6.48051E+14	1427.276193	0			
Residual	752	3.41443E+14	4.54047E+11					
Total	757	3.5817E+15						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	443336.888	473427.065	0.93644179	0.349346399	-486058.9551	1372732.731	-486058.9551	1372732.731
PUP	5528.032657	72.99210749	75.73466293	0	5384.740128	5671.325185	5384.740128	5671.325185
RATPUPTEA	-115079.4592	14229.99185	-8.087106471	2.44316E-15	-143014.692	-87144.2264	-143014.692	-87144.2264
WTEA	26.66142328	11.24949316	2.370011067	0.01803896	4.577277798	48.74556876	4.577277798	48.74556876
PFSM	44762.77344	2914.832529	15.35689375	1.69673E-46	39040.59692	50484.94996	39040.59692	50484.94996
DLONDON	1032151.22	88831.04361	11.61926257	8.06511E-29	857764.9023	1206537.538	857764.9023	1206537.538
Source: own computation based on DfE (2018)								

By adding the DLONDON, we can observe that a school located in London tends to spend in average £1,032,151 more per year than any other schools located in England, controlling for the other variables.

To be able to compare and analyse the marginal effects on the other variables, we need to standardise the dependent and explanatory variables with except o DLONDON. After the required computation, we obtain the estimation output in term of standard deviation, contained in table 13:

Table 13: 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_PUP	0.9165	0.0123	74.7645	0.00000	0.8924	0.9405	0.8848	0.9481
z_RATPUPTEA	-0.1153	0.0134	-8.6250	0.00000	-0.1416	-0.0891	-0.1499	-0.0808
z_WTEA	0.0744	0.0150	4.9699	0.00000	0.0450	0.1038	0.0358	0.1131
z_PFSM	0.2038	0.0136	15.0171	0.00000	0.1772	0.2305	0.1688	0.2389
DLONDON	0.3259	0.0348	9.3764	0.00000	0.2577	0.3942	0.2362	0.4157
Source: own computation based on DfE (2018)								

From table 13, we can infer that the highest marginal effect on EXP is given by the size of the school (PUP) with a value of 0.92 coefficient, by whether the school is located in London (DLONDON) that amounts to 0.33 coefficient, and by the poverty level of the school (PFSM) with a 0.2 coefficient. The coefficients are expressed in

number of standard deviations, which means for example that an increase of one point of standard deviation in PUP will cause the EXP to increase of 0.92 standard deviations.

Finally, we can add an extra variable to our model, the variable DLONDON*(PUP-<PUP>) which measures the marginal cost per pupil for a school located in London. I produced a consolidated regression table, after doing the required computation to address the problem of multicollinearity between the two highly correlated dummy variables, which provides a broad overview on the various regression models included in this paper.

Table 14: Regression ouput: Determinants of School's Annual Expenditure							
Dependent variable: EXP, School Expenditure (all categories) (£ per year)							
(standard errors reported in square brackets under each estimated coefficient)							
Regressors		[1]		[2]		[3]	
		Coefficients		Coefficients		Coefficients	
Intercept (in £ per year)		815326.11	****	4639992.633	****	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	****	-116188.111	****
				[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	****
						[171.88]	
R Square		0.757124584		0.816257496		0.911168614	
Observations		758		758		758	
Statistically significant at:	**** 0.1% level						
	*** 1% level						
	** 5% level						
Source: Own computation based on DfE (2018)							

The consolidated table above (table 14) contains the regression models analysed in this paper. Conclusions on model [1] and [2] have been already made, while model [3] deserves a further analysis. By looking at the variable, model [3] contains five variables which are statistically significant at 0.1% level and one variable statistically significant at the 1% level, which along with the R square value of 0.91 leads me to claim that the model is a good fit and can provide reliable estimations. Furthermore, it can be inferred that the main determinants of school expenditure that should be taken into account when shaping policies regarding education in England are: size of the school in terms of pupils (PUP), the poverty level given by PFSM, the ratio pupil/teacher (RATPUPTEA), and teacher salary (WTEA). Furthermore, the dummy variables DLONDON and DLONDON*(PUP-<PUP>) (which represents the average yearly marginal cost per pupil in London) are good indicators of the ''London effect'' confirming that schools in London face higher costs compared to the rest of the country.

6. Policy Implications

In section 1., I pointed out the level of inequality in funding and expenditure between London and the other Regions in England. For example, the difference in average expenditure between London and the South East is indeed 3.22 times the difference between the South East and the South West. Moreover, I highlighted how the level of expenditure has always been above the level of funding, meaning that secondary schools have been running budgets in deficit for the past 20 years. In section 2., I shown that between the fiscal year 1990_00 and 2009_10 there was a yearly positive growth in expenditure which took place ''under Tony Blair's Labour government, until its peak in 2009-10'' when school funding and expenditure both slumped marking a ''decline that began after the Conservative-led coalition government [which] took office in 2010'' (Richard Adams, 2020). In facts, ''State schools in England have suffered their worst decline in funding since the 1980s, with secondary schools and those in the most deprived areas the worst affected by the era of austerity'' (Richard Adams, 2020). A first implication involves a better reallocation of schools funding across regions, with the aim of levelling up those poorer disadvantaged regions, such as South West and South East, in order to close the gap with schools in London. The aim of the government should be developing better Macroeconomic policies in regard to school funding, so that school will be able to increase their expenditure. In this way, drastic microeconomic choices

made within the institutions can be avoided: it has been seen in table 14 that, for example, increasing the class sizes by 1 pupil per teacher, maintaining the total number of pupils unchanged, will allow a school to save in average £116,188 per year, which combined with the fact that by increasing of 1% the salary of teachers will result in an increase of £25.67 per year per teacher in school expenditure. In this way, having the funding cut, school will tend to lay off staff and increase class size, affecting the quality of education. Furthermore, the lack of funding could have drastic consequences on the benefits offered to students from poorer backgrounds: by increasing of 1% the number of pupils eligible for free school meals, in average the total spending per school would increase of £44,632, putting a heavy burden on the finances of those schools characterised by a higher percentage of lower-class pupils. A proper school budget levelling up plan must take into consideration the observations made above, in order to guarantee a higher and fairer level of education for all regions across England.

7. Conclusion

To summarise, this paper aimed to answer to three main 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?* and *3. What are the determinants of secondary school expenditure?* By the use of statistical tools, I conducted an analysis which allowed me to obtain important empirical findings: from section 1, I found that there is a huge disparity between London and the other regions as the difference in average expenditure between London and the South East (2nd region with highest expenditure) is indeed 3.22 times the difference between the South East and the South West (region with smallest expenditure) and that 85.71% of the schools in South West spend less than the average spending in London. In section 2 I highlighted the fact that between the fiscal year 1999_00 and 2008_09 there was a positive constant trend (with exception of year 2002_03), while in 2008_09 the trend assumed a negative shape experiencing a slump from year 2010_11 inwards. The average yearly growth rate for the period 1999_00/2008_09 amounted to 4.46%, while the year 2008_09/2016_17 registered a negative growth rate of -13.63%. In section 3, I established that the main determinants of school expenditure are: size of the school in terms of pupils (PUP), the poverty level given by PFSM, the ratio pupil/teacher (RATPUPTEA), and teacher salary (WTEA), and I confirmed that, through analysing the dummy variables DLONDON and DLONDON*(PUP-<PUP>) that schools in London face higher costs compared to the rest of the country.

Finally, I suggest that the aim of the government should be developing better Macroeconomic policies regarding school funding, so that school will be able to increase their expenditure. In this way, drastic microeconomic choices made within the institutions that undermine the quality of education and trigger further fragmentation of social cohesion can be avoided.

References

- Adams, R. (Fri 18 Sep 2020 00.01 BST) *England's state schools suffering biggest fall in funding since 1980s, says IFS.* Available at: https://www.theguardian.com/education/2020/sep/18/englands-state-schools-suffering-biggest-fall-in-funding-since-1980s-says-ifs#:~:text=Schools%20funding%20in%20England%20has%20declined%20since%202015&text=A%20Department%20for%20Education%20spokesperson,more%20money%20for%20every%20child. (Accessed: 20 March 2021)

- DfE (2018) Educational attainment of pupils at the Key Stage 4 level, UK Department for Education, January [Online]. Available at: https://www.compare-school-performance.service.gov.uk/download-data (Accessed: 20 March 2021)

- ONS (2018) Annual survey of hours and earnings Database, Office for National Statistics [Online]. Available at:https://www.nomisweb.co.uk (Accessed: 20 March 2021)