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Measuring the Impact of Universal Pre-School Education and Care on Literacy Performance Scores

Tarek Mostafa and Andy Green

LLAKES Research Paper 36

Centre for Learning and Life Chances in Knowledge Economies and Societies

LLAKES is an ESRC-funded Research Centre - grant reference RES-594-28-0001.

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The authors would like to thank Francis Green for his valuable comments.

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Abstract

The objective of this paper is to simulate the effects of universal pre-school education and care (PSEC) on reading performance scores and educational inequalities in the UK and Sweden. We utilize the PISA 2009 data and start by estimating a fixed effects multilevel model for each country in order to determine the returns to PSEC attendance. Then we simulate the effects of universal PSEC provision using counterfactual data. More precisely, after estimating the multilevel model, we progressively universalize PSEC participation starting with the lowest economic, cultural and social status (ESCS) decile and moving up to reach the top decile. At each stage of the universalisation process we compute the average predicted performance scores for each ESCS decile and for each country as well as their dispersions. This allows us to measure the change in average predicted literacy scores and the change in the level of inequality.

Our findings show that all social groups benefit from universalizing PSEC with the lowest groups getting the highest additional benefits from universalisation. Further, the international rankings of both Sweden and the UK improve after the universalisation of PSEC. The UK moves 12 positions up the OECD league table and Sweden moves up seven positions. We also find that inequalities in test scores drop until reaching a minimum when the lower seven ESCS deciles are attending PSEC and then starts to increase again. In conclusion, our findings clearly show that universalising PSEC would be an effective policy instrument that boosts educational performances while reducing inequalities in their distribution.[2]

EL Classification: I20, I24, I28.

Keywords: Pre-school education and care, reading achievements, PISA 2009, multilevel models.

[2] In an earlier research paper (Green and Mostafa, 2011) we argued that the provision PSEC does not necessarily equalise education outcomes later because individuals from each social group tend to benefit by the same amount from PSEC. So, hypothetically the distribution of skills at 15 would be likely to be the same in a situation where there is no PSEC at all as in a situation where there is universal PSEC provision. The logic of this still holds true. However, in reality, a policy to universalise PSEC is not starting from a position where there is no PSEC provision. All countries have some PSEC provision and participation tends to be skewed in most cases towards higher social groups. In these cases universalising PSEC from the current uneven provision would equalise outcomes. This is the proposition we test in this paper.

Introduction

In his Autumn Statement on 29th November 2011, the UK Chancellor of the Exchequer, George Osborne, announced that free pre-school education and care (PSEC) will be extended to up to 260,000 two year-olds from the most disadvantaged families. Osborne's plan, which will be piloted in 2013, aims to provide fifteen hours of free nursery care to 40% of all two-year-olds at a cost of around £380m.

The thinking which informs this policy is not difficult to understand. The importance of early learning for children's cognitive development and future learning has been emphasized in many recent studies and the research that demonstrates this has been taken very seriously by policy-makers in a number of countries (Waldfogel, 2004). Recent studies based on the analysis of longitudinal data in the UK suggest that up to half of the gap in children's cognitive abilities is already established by the age of 11 years (Gregg, 2011) or earlier. This does not, of course, mean that formal schooling at primary or secondary level makes no difference to the distribution of educational outcomes. Up to half of the gap in cognitive development appears during that period and will be in part due to the schooling process. Moreover, inequalities in the broader educational outcomes, over and above those of tested cognitive ability, will emerge, and they are also important. However, it remains the case that learning during the early years is highly important to a child's cognitive and broader educational development and that different experiences of parenting and early years education and care do appear to contribute substantially to social inequalities in educational performance. As Esping-Andersen (2009) writes: 'If the race is already half run before the child begins school, then we clearly need to examine what happens in the early years.' These early years affect much that happens in the child's schooling later on. 'Like it or not, says Esping-Andersen, 'the most important mental and behavioural patterns, once established, are difficult to change once children enter school.' (p. 81).

The aim of this paper is to answer the following questions:

1- What are the returns to PSEC, and do these returns vary according to economic, social and cultural status?

2- Does PSEC universalisation contribute to equalizing educational outcomes within a country?

3- When PSEC is progressively universalized starting with the lowest social groups, what are the average gains in terms of educational outcomes for each group?
4- Does the universalisation of PSEC participation increase the average educational outcomes of a country and enhance its international ranking?
5- Can the universalisation of PSEC be used as a policy instrument for boosting educational performances and reducing inequalities in all countries or is it country specific?

Before proceeding with our analyses, it is useful to start with a review of the literature and of the key issues at stake. Waldfogel (2004) provides a review of recent international research on early cognitive development. She acknowledges that the research shows that there are multiple influences on development in the early years, and classifies these into three types which include child endowments, parenting and home environment and pre-school education and care. She says that what parents do generally matters more than what early schooling does, but that the latter can be effective. Research in the UK and the US, based both on experimental PSEC programs and using data from large-scale longitudinal surveys, generally suggests that there are significant cognitive gains to children over the age of one from receiving high quality PSEC. In some studies the benefits are particularly marked for children from more disadvantaged homes. OECD studies (2010, p. 98) also suggest that PSEC improves performance in skills measured at 15 years. About 72% of those tested at 15 years in the PISA 2009 study had received more than one year of pre-primary education. After controlling for social background, attending more than one year of PSEC was associated, on average across the OECD, with a 33 point gain in test scores at 15 years. In all countries, children who participated for more than a year in PSEC got, on average, higher scores at 15 than those who did not.

There is a fairly widespread consensus that high quality PSEC brings educational advantages to children after the first year. However, what is not so clear is whether high levels of participation tend to lead to the equalization of educational outcomes. More equal distributions of skills and qualifications amongst adults are associated cross-nationally with more equal income distributions and these, in turn, are associated with a wide range of social goods, including better public health, lower rates of crime, and higher levels of trust (see Green, Preston and Janmaat, 2006; Green and Janmaat, 2011; Wilkinson, 1996; Wilkinson and Pickett, 2009).

Esping-Andersen (2009) has recently argued that universalizing PSEC does contribute to equalizing educational outcomes. In particular, he argues, that where there is near universal participation in consistently high quality PSEC for young children, as in the Scandinavian countries, this is contributing towards reducing social gaps in educational achievements at the end of compulsory schooling. In much of Europe, attendance at Kindergarten for children aged 3-6 is near universal already, but attendance amongst 1-3 year olds is often much less so – at about 30% in Belgium, the Netherlands and the US, and at only around 10% in Austria, Germany and southern European countries (p. 93). What distinguishes the Scandinavian countries – and what most contributes towards their relatively equal educational outcomes at 15 – says Esping-Andersen, is that PSEC for 1-3 year olds is also very widespread and of consistently good quality. What is the evidence that Scandinavian PSEC contributes towards equalizing educational outcomes. Esping-Andersen provides two main arguments:

First, he argues that the over-time evidence for Scandinavia suggests that PSEC has contributed to the amelioration of educational inequality. According to his figures, the decline in social inheritance effects in Nordic countries between the 1960s and 1990s coincided with increases in participation in PSEC and rising levels of maternal employment. 'Indirectly,' he writes, 'there is evidence to suggest that the arrival of universal pre-school attendance is associated with a significant equalization of school attainment and, one can argue, also links with the comparably quite homogenous performance in PISA … tests.' The decline is most evident, he says, amongst the younger cohorts, who were the first to enjoy near universal participation in PSEC (p. 135). By contrast, in countries which have done less to universalize PSEC, such as Germany, the UK, and the USA, there was no equivalent decline in social inheritance effects over the last half century.

Secondly, Esping-Andersen cites the evidence from some studies that PSEC is particularly beneficial for children from disadvantaged families who benefit disproportionally from attendance. Since PSEC is near-universal in Scandinavian countries he claims that this would mean that a larger proportion of those most prone to educational under-achievement were receiving benefits which will serve to close the social gaps in attainment generally. His general argument is made as follows: ‘If early child care were to compensate for unequal cultural capital, we would expect that the latter’s explanatory importance would be systematically weaker in the Nordic countries than elsewhere. The reasoning is that participation in child centres that are similar in quality across the board, so to speak, help cancel out the stimulus gap that children from low-educated and culturally weak homes suffer. Utilizing again the PISA data this is in fact what we find. The influence of parents’ cultural capital (and socio-economic status) is systematically lower in Scandinavia than elsewhere.’ (p. 136)

The logic of Esping-Andersen’s case is certainly very compelling. However, the evidence for it is rather somewhat speculative, as his tentative tone implies. It is certainly the case that educational outcomes in Nordic countries are relatively equal, and that this is borne out by the relatively low social gradients for PISA scores in these countries. However, Esping-Andersen is not able to prove that this is due to the effects of near-universal PSEC rather than, say, the relatively egalitarian nature of the compulsory school systems (Green, Preston and Janmaat, 2006). The associational evidence he provides comes some way short of proving causality. OECD analyses of the PISA 2009 data show that children from different social groups benefit more or less equally from PSEC attendance in most countries (with the exception of Mexico, Norway and the USA) (OECD, 2010, volume II, pp. 193). Whether PSEC provision is equalizing education outcomes in any given country will therefore depend on how it is distributed. In fact, as the OECD shows (2010), participation is PSEC in most countries is skewed towards children of higher social class families. This is even true in Scandinavia, despite near-universal provision, since, as Esping-Andersen admits, non-attendance in PSEC, particularly during the crucial earliest years, is most common amongst immigrant and poorer families.

In this paper we utilize a simulation approach using PISA 2009 data to shed light on how PSEC attendance affects literacy performance scores and educational inequalities. We retain two countries: the UK and Sweden. The UK is known for its liberal approach in the management of the education system while Sweden is an example of comprehensive education. The objective behind our choice is to ascertain whether PSEC is a viable policy instrument for improving educational performance and reducing inequalities under different education systems. We start by estimating a fixed effects multilevel model for each country in order to determine the returns to PSEC attendance. Then we simulate the effects of universal PSEC provision using counterfactual data. More precisely, after estimating the multilevel model, we progressively universalize PSEC participation starting with the lowest economic, cultural and social status (ESCS) decile and moving up to reach the top decile. At each stage of the universalisation process we compute the average predicted performance scores for each ESCS decile and by country and their dispersions. This allows us to measure the change in average predicted literacy scores and the change in the level of inequality. Our findings show that all social groups benefit from the universalisation of PSEC (i.e. everyone attending for more than one year) with the lowest groups getting the highest average additional benefits because they previously had the lowest attendance rates. In the UK, the effect of PSEC on literacy performance scores is stronger than in Sweden and hence PSEC is more effective in reducing inequalities in the former. The international rankings of both Sweden and the UK improve after the universalisation of PSEC. The UK moves 12 positions up the OECD league table and Sweden moves seven positions. We also found that inequalities in test scores drop until reaching a minimum when students in the lower seven deciles of ESCS are universally attending PSEC and then start to increase again when the 70% threshold is crossed. Our findings also show that under certain conditions related to the initial distribution of PSEC attendance and its impact on performance scores, PSEC can be seen as a policy instrument that boosts educational performances while reducing inequalities in their distribution.

One should note that since the sampled PISA students are 15 years of age in 2009, they must have attended PSEC in the second part of the 1990s. Hence, in this analysis we are answering the question of what could have happened to literacy attainments in 2009 if these students had universal PSEC provision back then. The time lag between the two events (i.e. PSEC attendance and standardized testing) is inevitable, since they are separated by more than ten years. However, this time lag is essential to justify the causal relation between PSEC attendance and improved literacy scores. Of course, PSEC participation has increased over the last ten years in both the UK and Sweden. However, it is too early to know the full effects since the relevant students are still young and have not undertaken standardized tests.

Moreover, the political debate has shifted over the years. In the late 1990s, the net participation rate in PSEC in the UK and Sweden was about 72% (UNESCO data).[3] Hence, the political debate was about providing more PSEC to those not attending at all. Over the years, attendance grew and the debate shifted to younger children (ie 2 year-olds). Putting it differently, the debate was about whether children are getting more than one year of PSEC or no PSEC at all, and it shifted to whether they are getting two, three or four years of PSEC. Since PISA 2009 data measures PSEC attendance in the late 1990s it is concerned with whether students attended PSEC for one year or less, more than one year, or did not attend at all. Our findings confirm that more PSEC is beneficial, and this finding is very likely to hold even though the debate shifted in the last 10 years. One should also note that even if the duration of PSEC differs between the two countries, this will not have any consequences on our analysis since we are estimating the models separately for each country. In other words, we are not modelling between-country variations.

The paper is organized as follows: section one presents the model and relevant descriptive statistics. Section Two presents the regression results and the predicted changes in performance scores, and the last section concludes.

The Model

A. Data.

In this paper, the OECD Program for International Student Assessment (PISA 2009) dataset is used. The major advantages of using it are the following. First, a wide array of student and school characteristics are accounted for, including PSEC participation. Secondly, PISA 2009 measures students' performance in reading in a consistent comparative way. Thirdly, PISA uses an innovative concept of literacy which stresses the importance of certain skills for adult life instead of assessing the mastery of a particular curriculum. Fourthly, assessed students are aged between 15 years and three months and 16 years and two months, regardless of the grade in which they are enrolled. This coverage helps measuring the extent to which knowledge is acquired independently of the structure of national school systems (e.g. entry ages, grade repetition rules, etc). Fifthly, the multilevel structure of the PISA data allows for

[3] The net enrolment rate is defined by UNESCO as 'enrolment of the official age group 'for a given level of education (ISCED 0 in this case) expressed as a percentage of the corresponding population.' For both countries the entrance age is 3, however the official duration is different. For Sweden it is of 4 years while for the UK it is of 2 years.

the use of multilevel modelling techniques.[4] The data for the UK contains 12 179 students and 482 schools, while the data for Sweden has 4 567 students and 189 schools.

B. Variables.

The independent variables can be grouped in two categories[5]:

The main variables of interest.

ESCS: is the economic, social, and cultural status of the student.

PSEC: is a binary variable taking the value of 1 if a student attended pre-school education and care for more than one year. Otherwise, PSEC is equal to zero (one year or less).

*ESCS*PSEC*: is an interaction term between ESCS and PSEC. It measures the additional returns from attending PSEC for higher ESCS students.

Student and School characteristics used as controls.

Male: is a binary variable taking the value of 1 if the student is a male. *Non-native:* is a binary variable taking the value of 1 if a student is a first or second generation immigrant. It takes the value of 0 if the student is a native. *Grade:* is a variable that controls the grade in which a student is enrolled. *Enjoyment of reading:* is a composite indicator measuring students' enjoyment of reading. Higher values indicate higher enjoyment of reading. *Ratio computers /web:* is the proportion of computers connected to the web in a school. *Discipline in a school:* is a composite indicator for disciplinary climate in a school. Higher values indicate better disciplinary climate. *Quality of educational resources:* is a composite indicator measuring the quality of educational resources within a school. Higher values indicate higher quality. *Student teacher ratio:* is the ratio obtained by dividing the number of students in a school by the number of teachers. *School average ESCS:* is the average ESCS in a school. This variable controls for a school's social composition. *Private school:* is a binary variable taking the value of 1 if a school is private dependent or independent school. *Academic Selection:* is a binary variable taking the value of 1 if a school uses academic selection.

The dependent variable of our models is reading performance scores which is computed as the arithmetic average of the five plausible values of literacy scores provided in PISA 2009.

[4] Before undertaking any analyses, the dataset was imputed using multiple imputations with a *Marcov Chain Monte Carlo* procedure. However, one should note that the data contains very few missing values.

[5] The selected control variables are the same as those used in Mostafa (2011). They cover different aspects such as student, school and peer characteristics.

C. Estimation procedure.

In this paper, we utilize a multilevel modelling technique with two levels (school and student). The general model is the following:

$$Y_{ij} = \beta_{0j} + \beta_1 X_{ij} + \beta_2 Z_j + \varepsilon_{ij}$$

$$\beta_{0j} = C + V_j$$

When the intercept is replaced by its value, the equation becomes:

$$Y_{ij} = C + \beta_1 X_{ij} + \beta_2 Z_j + V_j + \varepsilon_{ij}$$

Y_{ij}: The performance scores of student in school j.

X_{ij}: A vector of student level variables for student i in school j.

Z_j : A vector of school level variables.

ε_{ij}: The residuals of the model, they follow a normal distribution, with zero mean and a constant variance of $\sigma^2, \varepsilon_{ij} \sim \mathrm{N}(0,\sigma^2)$.

β_1 and β_2: are vectors of regression coefficients.

Note that the intercept is divided into two parts: C is the overall intercept which is constant for all schools, and V_j which measures a school's specific effect (Raudenbush and Bryk, 2002). Note that V_j can be treated as random or as fixed. If it is considered to be random then it has to follow a normal distribution with zero mean and a constant variance τ_0^2. With $V_j \sim \mathrm{N}(0,\tau_0^2)$. If it is considered to be fixed then we have to compute j values of V_j. In other words, we have to compute an intercept component for each school.

The model we are estimating relies on the following properties.

1- The independent variables are not correlated with the residuals of the model. $\mathrm{cov}(X_{ij}, \varepsilon_{ij}) = 0$ and $\mathrm{cov}(Z_j, \varepsilon_{ij}) = 0$. In other words, $\varepsilon_{ij} \sim \mathrm{N}(0,\sigma^2)$.

   If V_j is considered to be random then two additional properties have to be respected:

2- The residuals and the school level random effects are independent. $\mathrm{cov}(\varepsilon_{ij}, V_j) = 0$.

3- The independent variables are not correlated with the school level random effects. $\mathrm{cov}(X_{ij}, V_j) = 0$ and $\mathrm{cov}(Z_j, V_j) = 0$.

We estimate three different models for each country. Model 1 is univariate and only takes into account PSEC attendance as an explanatory variable. Model 2 considers PSEC, ESCS and ESCS*PSEC, in addition to male and non-native. Model 3 considers all the explanatory variables.

Before estimating the models, two decisions have to be made. First, we need to decide whether to use random or fixed effects multilevel estimation. In a previous study, Hanchane and Mostafa (2011) assessed the existence of endogeneity bias (violation of property n° 3) in multilevel estimation of education production functions. They found that when random effects are used and school level variables are not controlled for, endogeneity bias arises and estimates are neither consistent nor efficient. Hence, if one needs to use random effect multilevel models, one must consider the full array of controls. In our case, if random effects are to be used then model 3 is best as models 1 and 2 are likely to suffer from endogeneity bias. Secondly, we need to decide on how many controls to include. One should note that school level variables are unlikely to be fully exogenous as they might be correlated with PSEC. In other words, students who have attended PSEC in the late 1990s could have developed better cognitive abilities that allowed them to get into better quality schools (e.g. better social composition, better infrastructure, etc). Chronologically speaking, the variables that are completely exogenous are male, non-native and ESCS, as these came into being before PSEC participation. On the other hand, all other school level variables might have been affected by whether the student participated in PSEC or not. Hence, we estimate three models, the first solely considers PSEC as an independent variable, the second considers PSEC in addition to the variables that came prior to it, and the third considers the full range of independent variables. One should note that model 2 measures the gross effects of PSEC on literacy performance scores, while model 3 measures the net effects of PSEC after controlling for other variables that might absorb some of PSEC's effects. In our paper, we are trying to simulate the effects of universalising PSEC provision in the late 1990s on performance scores of 15 year-old students in 2009. Thus, we are not interested in the net effect of PSEC (everything else held fixed). What we are interested in is the gross effect which includes possible externalities and spill-overs.

In conclusion, given these two considerations, we decided to use model 2 to compute predicted performance scores since it measures the gross effect of PSEC. However, since such a minimal model might suffer from endogeneity bias if school heterogeneity is treated as a random effect, we decided to use fixed effects modelling. This allows us to avoid imposing properties 2 and 3. Fixed effects models can be estimated by including a dummy variable for each school. Even though this might consume more degrees of freedom than random effects models, the large number of observations we have for both countries means that this is not a matter of concern.

The only remaining issue is to test whether property 1 holds. For this we estimate the models using OLS with school-fixed-effects, then we test for heteroscedasticity using the Breusch-Pagan-Cook-Weisberg test. The failure of the test (i.e. heteroscedasticity is present) means that the variance of the residuals is not constant and this suggests the existence of correlations between the explanatory variables and the residuals. Note that 'fixed effects estimation' will partially solve the heteroscedasticity bias as it controls for a fraction of the models global error term $V_j + \varepsilon_{ij}$. But it does not completely solve the heteroscedasticity problem as ε_{ij} might still be heteroscedastic.

Table 1: The Breusch-Pagan-Cook-Weisberg test for heteroscedasticity.

	UK			Sweden		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Chi 2	132	134	103	35	60	41
P value	0	0	0	0	0	0

Table 1 presents the results on this test. A large chi-square (small p value) indicates that heteroscedasticity is present. This is true for all models, which means that OLS is not the best estimation method as it generates inconsistent estimates even when using fixed effects. This finding is expected as OLS regressions do not take into account the nested structure of error terms and that students within the same school bear some arbitrary resemblance because of educational stratification. In Schaffer's and Nichols's (2007, p.2) words: 'In the presence of clustered errors, OLS estimates are still unbiased but standard errors may be quite wrong, leading to incorrect inference in a surprisingly high proportion of finite samples.' As the authors suggested (ibid, p.6), we partial-out the fixed effects while using robust-clustered standard errors to address any remaining heteroscedasticity. The authors also noted (ibid, p.7) that 'the cluster-robust standard error (CRSE) estimator converges to the true standard error as the number of clusters M approaches infinity, not the number of observations N. Kezdi (2004) shows that 50 clusters (with roughly equal cluster sizes) is often close enough to infinity for accurate inference.' This is true in our case as the UK has 482 schools and Sweden has 189, with roughly 30 students in each school. Hence, by estimating the models using this technique, we generate unbiased and consistent estimators. In what follows, we present some descriptive statistics before presenting the regression results.

Table 2: PSEC participation before universalisation in the UK and Sweden by ESCS groups (deciles).

ESCS groups	UK	Sweden
Group 1	54.0	54.0
Group 2	58.5	58.2
Group 3	61.5	57.7
Group 4	62.5	63.9
Group 5	64.4	64.6
Group 6	66.0	69.2
Group 7	67.2	66.7
Group 8	67.6	71.4
Group 9	70.8	68.6
Group 10	72.6	75.5
Total	64.7	64.9

Table 3: Average PSEC participation after universalisation for different ESCS groups in the UK and Sweden.

Universal PSEC	UK	Sweden
Before universalisation	64.7	64.9
Group 1	69.1	69.6
Group 2	73.1	73.8
Group 3	76.8	78.0
Group 4	80.3	81.6
Group 5	84.0	85.2
Group 6	87.3	88.3
Group 7	90.6	91.6
Group 8	94.0	94.4
Group 9	97.2	97.5
Group 10	100	100

Table 2 gives PSEC participation rates for each social group before it is progressively universalised. As expected, PSEC participation rates are strictly increasing in ESCS for each of the groups in the UK while in Sweden this is also the case but with some slight variations. In general, we can say that PSEC attendance for more than one year, in both countries, is skewed towards the upper social groups. The average participation rate for more than one year of PSEC is 64.7% in the UK, and 64.9% in Sweden. Note that our definition of PSEC participation (more than one year) may hide some major differences between the UK and Sweden since children in the UK are likely to attend PSEC for 2 years while those in Sweden may attend up to four years of PSEC. However, this does not have any consequences on our models since we are not explicitly modelling between-country variations. In other words, we are estimating the models by country separately.

Table 3 gives the average participation rates by country when PSEC is universalised (i.e. all children participating for more than one year), starting with the bottom ESCS decile and progressively moving to the 10^{th}. PSEC Participation starts at 64.7% and 64.9% for the UK and Sweden respectively and increases progressively until reaching 100% when PSEC is provided to all students for more than one year. One should note that universalizing PSEC attendance in such a way is similar to providing PSEC free of charge; since we are not imposing any new constraints on the students (i.e. we universalize PSEC attendance while everything else is held equal).

Findings

A. Regression results.

In this section, we present the different findings from our analyses starting with the regression results.

Table 4: The regression results.[6]

	UK			Sweden		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
PSEC	24.988	20.029	19.816	27.515	16.898	14.088
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ESCS		21.049	13.043		33.840	24.351
		(0.000)	(0.000)		(0.000)	(0.000)
ESCS*PSEC		5.3661	3.7344		-3.3423	-1.7636
		(0.046)	(0.153)		(0.307)	(0.577)
Male		-23.172	-4.2995		-45.556	-19.867
		(0.000)	(0.080)		(0.000)	(0.000)
Non-native		1.7961	-6.9575		-34.875	-33.771
		(0.712)	(0.104)		(0.000)	(0.000)
Grade			41.462			84.969
			(0.000)			(0.000)
Enjoyment of reading			33.768			34.364
			(0.000)			(0.000)
Ratio computers /web			11.625			7.3633
			(0.383)			(0.565)
Discipline in a school			10.346			2.2056
			(0.000)			(0.103)
Quality ed resources			-1.2147			1.3330
			(0.749)			(0.881)
Student teacher ratio			0.1632			0.1236
			(0.239)			(0.551)
School Average ESCS			154.38			-101.79
			(0.001)			(0.000)
Private School			16.251			42.039
			(0.327)			(0.000)
Academic Selection			17.385			-8.0940
			(0.224)			(0.453)
Constant	445.16	465.38	13.491	440.99	459.87	-259.48
	(0.000)	(0.000)	(0.856)	(0.000)	(0.000)	(0.000)
M	482	482	482	189	189	189
N	12179	12179	12179	4567	4567	4567

p-values in parentheses

Table 4 presents the regression results on the 3 models for the UK and Sweden. In both countries, model 1 generates the strongest effects of PSEC on performance scores. This is not surprising as model 1 does not control for any other explanatory variables. Hence, the model is underspecified and the effect of PSEC is likely to be over estimated. Model 2 measures the gross effects of PSEC on literacy performance scores after controlling for the variables that came into existence prior to PSEC participation. As we can see, the effect of PSEC drops by

[6] School fixed effects are not included in table 4 since there are hundreds of them.

4 points in the UK and by 10 points in Sweden. Model 3 controls for the full array of school level variables. In this model, the effect of PSEC drops by a slight amount indicating that, as expected, model 3 measures the net effects of PSEC after factoring out possible externalities that transit through school characteristics. Since we are interested in the gross effects of PSEC we are only interpreting the results on model 2. Further, model 2 is used to generate the predicted performance scores when PSEC participation is universalised.

In the UK, students attending PSEC for more than one year benefit from 20 additional points on their literacy performance scores on average in comparison with pupils experiencing one or less years of PSEC attendance. In Sweden, they receive about 17 additional points on their literacy performance scores. In both countries, an increase in ESCS of 1 unit leads to a substantial increase in test scores. In the UK the increase is of 21 points and in Sweden it is of 33 points. In contrast, the interaction term between PSEC attendance and ESCS has an insignificant effect in Sweden while it is positive and significant in the UK. In the UK, students with 1 additional unit of ESCS are expected to have 5 additional points on their test scores if they are attending PSEC for more than one year. However, one should note that this finding is only significant at the level of 5% and loses significance when the rest of the school level variables are added (model 3). This loss of significance indicates that the interaction term might have absorbed some effects that transit through school characteristics. In other words, higher ESCS students attending PSEC for more than one year are likely to be in better quality schools.[7] The interaction term measures the additional returns on PSEC attendance for higher ESCS students. In model 3, these additional returns are insignificant. This means that all students within the same country benefit similarly from PSEC irrespective of their ESCS. This finding should not be confused with the fact that lower ESCS students benefit more on average when PSEC attendance is universalised. In this case, PSEC is increased for the lower ESCS groups (i.e. PSEC is not held equal). Hence, one should not confuse the marginal effect of PSEC which is identical for all students and the average effect of increased PSEC provision for the lowest ESCS groups. It is also worth noting that in the UK, attending PSEC for more than one year does compensate the lack of 1 unit of ESCS as

[7] Our regression results differ from those published in the PISA 2010 report (volume II, p. 193) for two reasons. First, in the PISA report the two categories of PSEC attendance, 'one or less years' and 'more than one year' were merged, and the reference group was 'no PSEC at all'. In our analysis, given the fact that most students were already attending one or less years of PSEC in the UK and Sweden, it made more sense from a policy point of view to model PSEC attendance for 'more than one year' against 'one year or less' and 'no PSEC at all' combined. Secondly, the PISA report used a number of school variables as controls since it is interested in measuring the net effect of PSEC on literacy performance scores. This is not the case is this paper, since we are interested in the gross effect.

the effects of both variables are almost of the same magnitude. On the other hand, in Sweden, attending PSEC for more than one year does compensate half a point of ESCS. Hence, providing free PSEC for one or more years to a lower ESCS student will help bridge the performance gap between him and his upper ESCS counterparts. Further, universalizing PSEC is more effective in reducing inequalities in achievements in the UK than in Sweden because the effect of PSEC on literacy performance scores is stronger in the former.

B. Predicted performance scores.

In the following two tables we present the predicted performance scores for the UK and Sweden.

In tables 5 and 6, we present the average predicted performance scores for each ESCS group at each stage of the universalisation process. As noted in the introduction, after estimating the multilevel model we compute the average and the dispersion of predicted performance scores using counterfactual data which simulates the progressive universalisation of PSEC. Thus, in both tables, the columns represent the ESCS deciles for which PSEC was universalised (i.e. all children attending for more than one year). Column (0%) presents the results with the data as it is, the following column (10%) presents the results when PSEC was provided universally to the lowest ESCS decile (group 1), and henceforth until reaching (100%) where PSEC is provided universally to all ESCS groups. The last column presents the changes between columns (0%) and (100%).

Table 5: Average predicted performance scores for each ESCS group before and after universalisation in the UK.

ESCS groups	0 %	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	100 %	Change
Group 1	436.3	445.5	445.5	445.5	445.5	445.5	445.5	445.5	445.5	445.5	445.5	9.2
Group 2	458.1	458.1	466.4	466.4	466.4	466.4	466.4	466.4	466.4	466.4	466.4	8.3
Group 3	467.2	467.2	467.2	475.0	475.0	475.0	475.0	475.0	475.0	475.0	475.0	7.7
Group 4	477.6	477.6	477.6	477.6	485.1	485.1	485.1	485.1	485.1	485.1	485.1	7.5
Group 5	487.2	487.2	487.2	487.2	487.2	494.4	494.4	494.4	494.4	494.4	494.4	7.1
Group 6	496.5	496.5	496.5	496.5	496.5	496.5	503.3	503.3	503.3	503.3	503.3	6.8
Group 7	502.7	502.7	502.7	502.7	502.7	502.7	502.7	509.3	509.3	509.3	509.3	6.6
Group 8	518.6	518.6	518.6	518.6	518.6	518.6	518.6	518.6	525.1	525.1	525.1	6.5
Group 9	532.1	532.1	532.1	532.1	532.1	532.1	532.1	532.1	532.1	537.9	537.9	5.8
Group 10	553.2	553.2	553.2	553.2	553.2	553.2	553.2	553.2	553.2	553.2	558.7	5.5
UK average	494.2	495.1	495.9	496.6	497.3	498.0	498.7	499.4	500.0	500.7	501.3	7.1
UK std	53.6	52.6	52.0	51.5	51.1	50.9	50.8	50.7	50.8	51.1	51.5	-2.1
UK variance	2871	2768	2704	2651	2616	2590	2577	2570	2583	2607	2647	-224
Coef of variation	0.1084	0.1063	0.1049	0.1037	0.1028	0.1022	0.1018	0.1015	0.1016	0.1020	0.1026	-0.0058

Table 6: Average predicted performance scores for each ESCS group before and after universalisation in Sweden.

ESCS groups	0 %	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	100 %	Change
Group 1	430.3	438.1	438.1	438.1	438.1	438.1	438.1	438.1	438.1	438.1	438.1	7.8
Group 2	458.4	458.4	465.5	465.5	465.5	465.5	465.5	465.5	465.5	465.5	465.5	7.1
Group 3	473.2	473.2	473.2	480.3	480.3	480.3	480.3	480.3	480.3	480.3	480.3	7.2
Group 4	486.1	486.1	486.1	486.1	492.2	492.2	492.2	492.2	492.2	492.2	492.2	6.1
Group 5	493.8	493.8	493.8	493.8	493.8	499.8	499.8	499.8	499.8	499.8	499.8	6.0
Group 6	503.5	503.5	503.5	503.5	503.5	503.5	508.7	508.7	508.7	508.7	508.7	5.2
Group 7	513.0	513.0	513.0	513.0	513.0	513.0	513.0	518.6	518.6	518.6	518.6	5.6
Group 8	526.5	526.5	526.5	526.5	526.5	526.5	526.5	526.5	531.3	531.3	531.3	4.8
Group 9	538.0	538.0	538.0	538.0	538.0	538.0	538.0	538.0	538.0	543.3	543.3	5.3
Group 10	553.7	553.7	553.7	553.7	553.7	553.7	553.7	553.7	553.7	553.7	557.8	4.1
Sweden average	497.4	498.2	498.9	499.7	500.3	500.9	501.4	502.0	502.4	503.0	503.4	5.9
Sweden std	56.1	54.9	54.3	53.9	53.6	53.5	53.5	53.6	53.7	54.0	54.4	-1.7
Sweden variance	3142	3017	2952	2903	2876	2866	2864	2869	2888	2921	2957	-186
Coef of variation	0.1127	0.1102	0.1089	0.1078	0.1072	0.1069	0.1067	0.1067	0.1070	0.1075	0.1080	-0.0047

The cells highlighted in dark grey present the average of predicted performance scores for each ESCS group before they have been given universal PSEC. The cells highlighted in light grey present the average of predicted performance scores for each ESCS group after they have been given universal PSEC (e.g. for group 1, in the (0%) column the PSEC participation rate was 53.5%, in column (10%) it was increased to 100%). The findings can be summarized as follows.

In the UK and Sweden, all groups benefit from universalising PSEC provision with the lowest groups benefiting the most. In the UK, students in the lowest decile benefit on average by an increase of 9.2 points while those in the top decile benefit by 5.5 points. Similarly, in Sweden, individuals in the lowest decile benefit by an increase of 7.8 points while those in the top decile benefit on average by 4.1 points. This hierarchy of gains reflects the hierarchy of participation in PSEC before the universalisation process. In other words, students in the lowest ESCS deciles are the most affected by non-attendance in PSEC. Therefore, they benefit the most from universalisation. Further, the universalisation of PSEC allows each ESCS decile to catch up with the next ESCS decile in terms of average performance scores (knowing that students in the next decile are not getting universal PSEC). However, in general the gain of each group is not enough to equalize average performances of two consecutive ESCS deciles.

After universalising PSEC, the national average PISA score of the UK increases by seven points and that of Sweden increases by six points. These changes are statistically significant. When comparing these two countries with the rest of the OECD countries using the OECD league table (PISA 2010 report, Volume I, p. 15), we find that the ranking of the UK improves by 12 positions while that of Sweden improves by seven.

Table 7: The OECD national averages before PSEC universalisation.

Country	Average
Belgium	506
Norway	503
Estonia	501
Switzerland	501
Poland	500
Iceland	500
USA	500
Liechtenstein	499
Sweden	**497**

Germany	497
Ireland	496
France	496
Chinese Taipei	495
Denmark	495
UK	**494**

When it comes to the dispersion of the predicted performance scores, tables 5 and 6 present three measures: the standard deviation, the variance and the coefficient of variation. For the interpretation we use the latter because it is standardised to the mean (i.e. it is the ratio of the standard deviation to the mean).

Figure 1: The coefficient of variation.

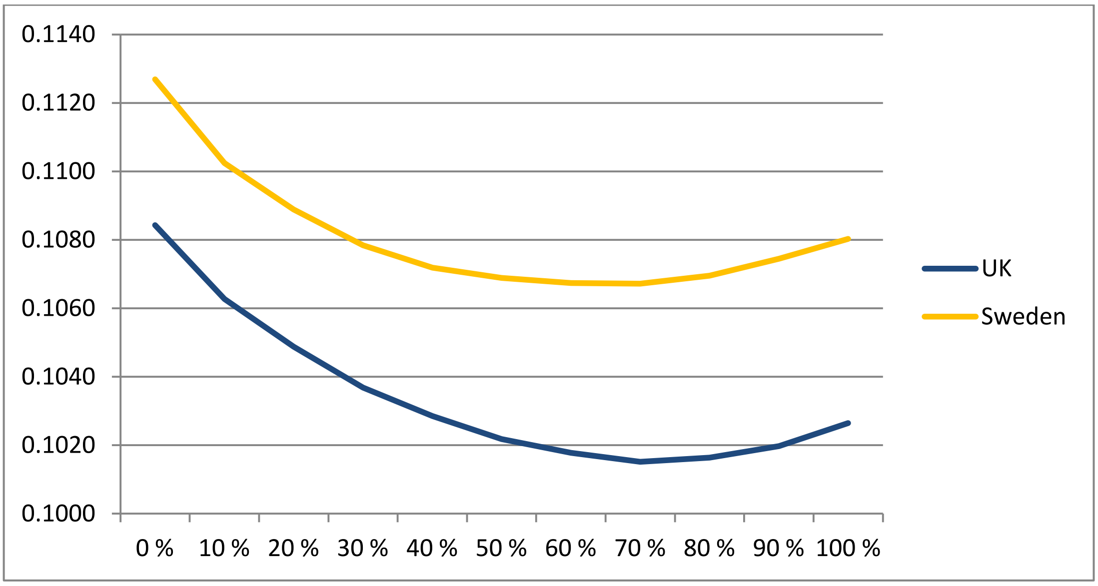

Figure 1 shows that the coefficient of variation of predicted performance scores drops with the universalisation process until reaching a minimum when PSEC is provided to the lowest seven deciles of ESCS (i.e. lowest 70%). After that it starts to increase again. This indicates the existence of a tipping point after which inequalities in literacy performance scores start to expand. This finding reflects the results of the regressions. PSEC participation has a strong positive effect on performance scores irrespective of ESCS. Hence, anyone who gets PSEC is likely to achieve higher test scores. Hence, providing PSEC to the lowest seven deciles of ESCS pushes their test scores up while those of the top three deciles are still the same. This is why the dispersion of test scores drops. However, if PSEC is provided universally to all ten deciles, the test scores of the upper three ESCS deciles will increase and the dispersion will expand. It is worth noting that even though the dispersion increases after the threshold of 70% it never reaches its initial level. Hence, we can conclude that universalising PSEC does equalise literacy performance scores relative to the existing distribution while increasing their average levels for each social group and for the UK and Sweden as a whole.

This finding provides a nuance to Esping-Andersen's (2009) theory that educational inequality in PISA test scores is strictly decreasing when PSEC is progressively universalised. In fact, inequality decreases as PSEC provision is universalised for the lowest seven deciles and then increases thereafter. Nevertheless, universalisation for all ten deciles produces a more equal outcome than the existing skewed participation rates.

The maximal policy for decreasing inequality might therefore be to target PSEC incentives for the lowest seven deciles. However, one can still argue, as Esping-Andersen does, that PSEC should be universally provided to everyone irrespective of their ESCS. First, universal provision helps maintain a sense of solidarity among the different social groups and gives more legitimacy to such policy. Secondly, even though the coefficient of variation is convex and it increases after the tipping point of 70%, it never reaches its initial level. Further, the national average is strictly increasing which justifies universal PSEC provision.

One last concern is to determine whether PSEC is beneficial in countries other than the UK and Sweden. As we have seen in our analyses, despite all the differences between the British and Swedish education systems, the universalisation of PSEC generated almost the same benefits: higher average literacy performance scores and diminished educational inequalities. These similar findings are caused by two structural similarities between the two countries. First, PSEC attendance for more than one year has a positive and significant impact on performance scores. Secondly, PSEC participation is skewed towards the upper social groups in both countries.

Is universalising PSEC, therefore, always is a 'win-win' policy which both boosts average performance and reduces inequalities? The answer to this would seem to be a qualified 'yes'. In countries where PSEC has, on average, a positive impact on individual test scores and where existing participation in PSEC is skewed towards higher social groups, universalising PSEC is going to increase national performance scores at the same time as reducing the distribution of scores. This appears to be true for most of the countries for which we have data. In the following table, we present the regression coefficient of PSEC on performance scores for a selection of OECD countries, and PSEC participation rates for each of the ESCS deciles. Table 8 shows that the two aforementioned properties hold in various countries which belong to different educational traditions (i.e. liberal, social market, Mediterranean, and East Asian systems).

Table 8: The impact and distribution of PSEC in a selection of OECD countries.[8]

	Australia	Canada	Denmark	Germany	Finland	Norway	Spain	Italy	Japan
PSEC regression coef	5.3	10.3	20.6	10.5	10.1	10.5	31.3	16.1	14.2
Group 1	0.35	0.33	0.57	0.51	0.50	0.72	0.76	0.79	0.93
Group 2	0.40	0.37	0.61	0.65	0.55	0.73	0.82	0.84	0.96
Group 3	0.45	0.42	0.66	0.73	0.57	0.81	0.83	0.84	0.95
Group 4	0.45	0.45	0.62	0.75	0.64	0.82	0.83	0.85	0.96
Group 5	0.49	0.47	0.68	0.77	0.68	0.86	0.85	0.85	0.97
Group 6	0.51	0.47	0.66	0.81	0.70	0.86	0.86	0.89	0.97
Group 7	0.55	0.49	0.70	0.80	0.69	0.88	0.86	0.87	0.99
Group 8	0.54	0.49	0.73	0.83	0.73	0.89	0.90	0.87	0.98
Group 9	0.59	0.57	0.74	0.86	0.76	0.89	0.90	0.87	0.97
Group 10	0.60	0.60	0.75	0.86	0.76	0.90	0.91	0.88	0.97

Conclusion

In this paper, we estimated the effects of universalising pre-school education and care on literacy performance scores and educational inequalities in the UK and Sweden. Our findings show that all social groups would benefit from universalising PSEC with the lowest groups getting the highest benefits. The international rankings of both Sweden and the UK improve after the universalisation of PSEC. The UK moves 12 positions up the OECD league table and Sweden moves seven positions. We also found that inequalities in test scores drop until reaching a minimum when students in the lower seven deciles of ESCS are all attending PSEC for more than one year and then start to increase again when the 70% threshold is crossed. Our findings also show that under most conditions related to the initial distribution of PSEC attendance and its impact on performance scores, PSEC can be seen as a policy instrument that boosts educational performances while reducing inequalities in their distribution.

[8] All regression coefficients are significant at the level of 1% and they were generated using the same technique as in model 2.

Our findings do support the policy proposed by the British Coalition Government. As announced by Chancellor George Osborne in his autumn speech, PSEC provision will be extended to 260,000 two year-olds from the most disadvantaged families. This number represents about 30% of the entire cohort of two year-olds. Given our findings, we expect that this rise in free PSEC provision to the most disadvantaged 30% will increase their literacy attainments at the age of 15 and will reduce inequalities in educational performance scores while boosting the national average.

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