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Child Care and Child Outcomes: A Comparison Across European Countries

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Abstract:
Using data from OECD's PISA, Eurostat and World Bank's WDI, we explore how child cognitive outcomes at the aggregate country level are affected by macroeconomic conditions, specifically government education expenditures. We also investigate how investments received in early life are linked to child educational outcomes when children are adolescents. We find that higher shares of the sample with pre-primary education in early years are associated with better later outcomes.

Keywords: early child care and education, investments, PISA, trend, fiscal crisis

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Contents

1. Introduction

Education is crucial for building a nation's human capital, as it serves as the building block for a productive society. In economic studies, individual education outcomes are seen as the result of inputs received especially in the early years, which prove to be particularly important for (static and dynamic) complementarity and self-productivity (e.g., Cunha et al., 2006). Evidence also points to the relative importance of family inputs at early years (Del Boca et al., 2014). As children grow up and experience more social interactions, inputs from other sources (such as school, peers, as well as children's investments in themselves) become more important (Del Boca et al., 2016).

In a macroeconomic context, the government's investments in education reflect its importance and priority in promoting human capital development. The role of government intervention also becomes increasingly important in case of market and family failures (Mukherjee, 2007). In the first case, a fiscal shock such as an economic recession or financial crisis dampens economic growth as inflation and unemployment rates increase, reducing the opportunities for work. In the second case, when households face budget constraints, governments can step in to provide additional coverage through financial and non-financial transfers.

The 2008-09 financial crisis led to significant contractions in the economies of European countries. During this period, inflation and unemployment rates increased, which overall put a higher demand and value for education and training. There are a few studies that looked into how macroeconomic conditions can affect education (for reviews, see Behrman and Deolalikar, 1991; Duryea et al., 2007; Fallon and Luas, 2002; Dellas and Sakellaris, 2003; McIntyre and Pencavel, 2004; McKenzie, 2004; Schady, 2004; for long-run effects, see Irons, 2009). Generally, these studies have concluded that decreasing government expenditures on education tends to decrease the quality of education (Campos and Jolliffe, 2004), and lead to poorer outcomes. Kisswani (2008) found that the Great Depression affected white individuals. Similar negative effects of macroeconomic shocks were concluded by Flug et al. (1998) using cross-country analyses, as well as by Behrman et al. (2000) with Latin America.

Poor macroeconomic conditions have implications for education and human capital, especially for vulnerable or disadvantaged groups such as the youth (Shafiq, 2010). Consequently, there is a pressing need for social protection (Jolly and Cornia, 1984; Reimers, 1994): "educated individuals become workers who are better at coping with crises and protecting their families from poverty. Furthermore, there are ethical and social justifications for protecting educational outcomes for the general population." (Lange and Topel, 2006). One important intervention as

protection against negative shocks is investments made at the early stages (e.g., Chetty et al., 2016).

The aim of this research is to explore how child education outcomes aggregated at the country level are affected by macroeconomic conditions, specifically government education expenditures. We also analyse the role of investments received in early life. We use data from OECD's PISA and Eurostat and World Bank's WDI focusing on 25 European[1] countries.

Our results show positive associations between education outcomes and the shares of the student population who received pre-primary education. Comparing the magnitudes indicate a non-linear hump-shaped pattern with respect to the duration of enrolment pre-primary education, wherein emphasis is put on pre-primary education of up to 1 year.

The paper will proceed as follows: Section 2 describes the data and variables used. Section 3 reports the descriptive statistics and describes the trends of macroeconomic conditions and PISA assessments. Section 4 discusses the multivariate analysis, and Section 5 concludes.

2. Data and Variables

The analyses use aggregated data for 25 countries sourced from the OECD's PISA and Eurostat database, and World Bank's World Development Indicators. The test outcomes of students between ages 15 years 3 months and 16 years 2 months are from the PISA database, which currently has waves 2000, 2003, 2006, 2009, and 2012. Students who are in grade 7 or higher are assessed at the period approaching the end of the compulsory schooling, from countries with enrolment that sees almost universal participation. Assessments include reading (2000-2012), mathematics (2003-2012), and science (2006-2012).

Each wave also assesses a major domain, providing an in-depth analysis. For instance, reading literacy was the major domain in 2000 and 2009, while mathematics was the major domain in 2012. This last cycle then contains more information in assessment of mathematics skills and interests, and less on reading skills. A trend analysis of the overall performance is made possible through an equating procedure that aligns performance scales because of common link items[2] across the different assessments that make them comparable.

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[1] Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Iceland, Italy, Liechtenstein, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom

[2] "Common items are a subset of the total items (84/110 in 2012 math linked to 2003 math, 48/110 linked to 2006, 35/110 linked to 2009; the differences are also attributable to varying domains of the waves; 44/110 in 2012 reading linked to 2009, 3/110 linked to 2000, 2003, 2006 "Only three items are needed to link PISA 2012 to PISA 2006 because equating is done in two steps: PISA 2012 reading scores are equated to PISA 2009, which in turn is equated to PISA 2006 through 26 link items."; 53/110 2012 Science linked to 2006, 2009.)" (OECD, 2013)

For our analyses, we take the annualised changes of the (unadjusted and adjusted) test assessments in reading, mathematics, and science, which are "the average yearly changes in performance observed throughout a country's or economy's participation in PISA." (OECD, 2013). Adjusted scores account for the demographic or socio-economic changes that may affect a country's overall performance, and give an indication to changes in performance scores that are not attributable to the socio-economic and demographic characteristics of the student sample, including the students' ages, proportion of girls, immigration background, and language spoken at home. Adjustment is made, assuming that these socio-economic factors remain the same across the different PISA waves using the latest available cycle (i.e., PISA 2012) as the reference point. To illustrate, observed trends that are lower with respect to adjusted trends imply that the negative patterns on the assessment outcomes can be attributed to the student population, and the observed trends are capturing the quality of education in a school system. (Refer to Annex A5 of OECD (2013) for a detailed discussion regarding the calculation of adjusted trends.)

In addition to the unadjusted and adjusted assessment scores that allow for a general cross-country comparison, we also look at the shares of low and high performers, which can give an indication regarding the variability of student performance that may not be evident with average scores. For instance, these statistics can show which countries with the highest-performing students have improved, or where lowest-performing students have decreased.

To classify low- and high-performing students, assessment scores are divided into 6 proficiency levels that correspond to different levels of difficulty. The trends in low- and high-performing students are based on the changes in the share of students at each proficiency level. Students are considered low performers if their scores are level 2 or below, which correspond to below 480 for reading, below 482.4 for mathematics, and below 484 for science. High performers are those who have at least level 5 or above, which correspond to at least 626 for reading, 607 for mathematics, and 633.3 for science. Details of the proficiency levels and the description of each are detailed here (http://www.oecd.org/pisa/aboutpisa/PISA%20scales%20for%20pisa-based%20test%20for%20schools.pdf).

Information on macroeconomic conditions and government expenditures on education and early investments are from OECD Eurostat and World Bank's World Development Indicators. For consistency with the PISA waves (2000, 2003, 2006, 2009, and 2012) and to avoid cyclical variations, the macroeconomic variables used in the analyses take the average three years referenced from the PISA waves, i.e., corresponding to the assessment scores from PISA 2000, government expenditures on education refer to the average between 1998 and 2000. Meanwhile,

variables on early investments are cohort-specific, i.e., corresponding to the assessment scores from PISA 2000 with cohort born between 1983-1985, early investments refer to the average of the years 1983 to 1985. The table below shows a summary of these correspondences:

Table 1. Summary of data sources

PISA test scores Source: OECD PISA	Actual birth cohorts	Macroeconomic variables Source: WDI	Early investments Source: OECD
2000	1983-1985	1998-2000	1983-1985
2003	1986-1988	2001-2003	1986-1988
2006	1990-1991	2004-2006	1989-1991
2009	1993-1995	2007-2009	1992-1994
2012	1996-1997	2010-2012	1995-1997

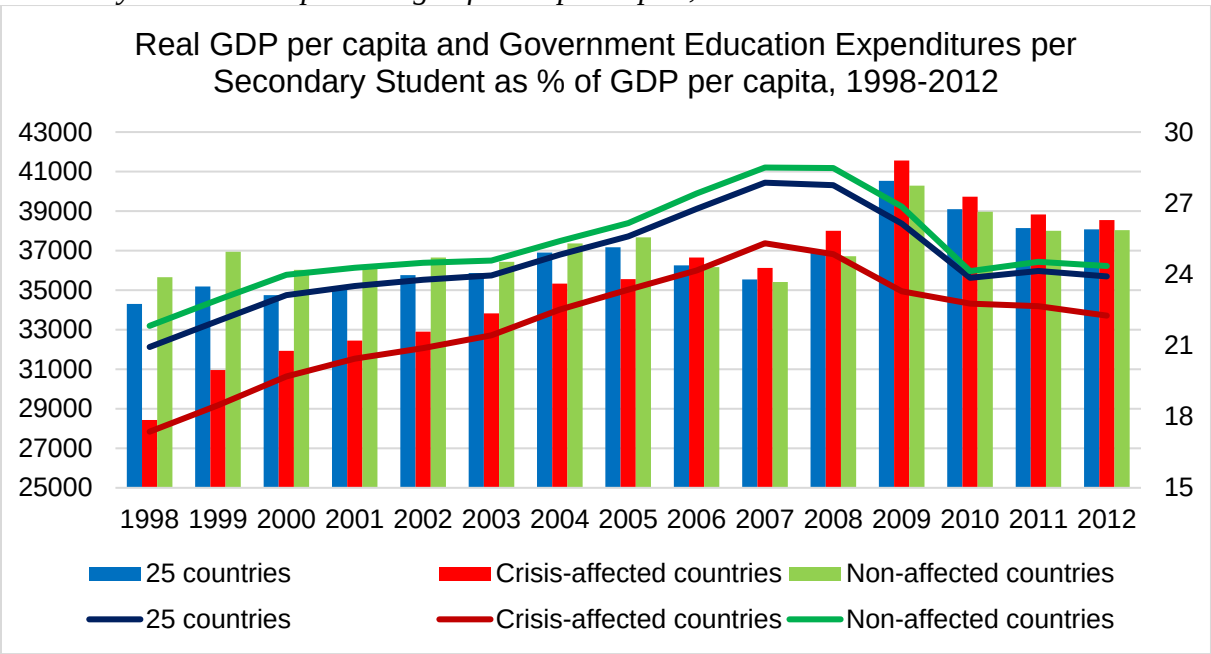
3. Descriptive Statistics and Trend Analyses

A preliminary comparison of the macroeconomic indicators of the 25 countries showed the existence of varying economies. We identified a pattern that is consistent with the countries' experience with the European debt crisis in 2008-09, and for the sake of simplicity, split the countries into two groups accordingly: Greece, Iceland, Ireland, Spain, and Portugal were forced to seek external help due to the sovereign debt and are classified here as the "crisis-affected countries," while the rest are the "non-affected countries."

3.1 Macroeconomic conditions and education expenditures

We look at two macroeconomic indicators to capture the overall economy and the government's investment to education and training. Gross domestic product gives an indication of the overall income of the economy. We specifically look at GDP per capita in real terms (constant 2005 US dollars) to take into account both inflation and population. Meanwhile, public education expenditures reflect the government's commitment to economic growth and to improve human capital. Having a workforce with high education and skills allows for a labour market that drives the economy to be productive. We specifically look at government education expenditures per secondary student as a percent of GDP per capita to take into account the population composition. Figure 1 shows the time trend of both variables. On the primary axis (left) is the line graph of real GDP per capita, while the secondary axis (right) shows the bar graphs of the education expenditure shares.

Figure 1. Time trend of real GDP per capita and government education expenditures per secondary student as a percentage of GDP per capita, 1998-2012



Source: World Development Indicators.

Looking at the yearly averages of real GDP per capita shows peaks in year 2007, followed by a steep decreasing trend most prominent between 2008 to 2010, corresponding to the fiscal crisis. This pattern is true regardless of the country groups' experience with the fiscal crisis, with the crisis-affected countries exhibiting significantly lower GDP per capita compared to the non-affected group.

As mentioned, government expenditures on education reflect its commitment to human capital investment. A fiscal recession can push the government to invest more on its human capital to reverse the detrimental effects of a macroeconomic shock or can trigger a realignment of government priorities in terms of allocating budgets, giving priority to social services such as pension and unemployment benefits.

Across the years, the 25-country average government expenditures on education per secondary student as a percent of GDP per capita was at its lowest in year 2007. The period from 2008 onwards shows significantly higher shares of education expenditures compared to pre-crisis. In fact, during the height of the fiscal crisis between 2008 and 2009, the shares of education expenditures were at its highest.

Distinguishing the countries according to their experience with the fiscal crisis shows an interesting pattern. Up until 2005, the group severely affected by the fiscal crisis devoted a

smaller share of its expenditures on education per secondary student, as compared to the group that was not (or were less) affected by the crisis. However, from 2006 onwards, the reverse pattern holds – the crisis-affected crisis were investing more compared to their non-affected counterparts, particularly between 2008 and 2009, when the differences are at their highest. This might suggest the government's attempt to compensate or protect its youth against the potential adverse effects of the crisis, similar to findings by Zeehandelaar and Clemens (2010). In summary, crisis-affected and non-affected countries exhibit differences in macroeconomic conditions and education expenditures. Real GDP per capita is lower in crisis-affected countries, especially during the height of the crisis between 2008 and 2009. However, this period also saw the biggest shares of public education investment per secondary student, implying the government's precautionary attempt to protect the youth against potential negative effects from the fiscal shock.

3.2 Test assessment scores

Across the years, the average scores for the 25 countries show an increasing trend in the overall performance, from 496.74 in 2000 to 500.85 unadjusted score points in 2012.

Motivated by the difference in macroeconomic and education expenditures according to the countries' experience with the fiscal crisis, we look at the assessment performances of the two groups as well and find that the pattern above is largely driven by the non-affected countries, which has a 6.28 unadjusted score point difference in the same period. The average for the crisis-affected countries, instead, experiences a 5.60 score point decrease.

Table 2. Average assessment scores and shares of low and high performers in PISA: 2000, 2003, 2006, 2009, 2012

Year	2000	2003	2006	2009	2012	5-Year Average
25-country average						
Unadjusted scores	496.74	499.55	499.01	500.36	500.85	499.77
Reading, unadjusted	496.7	495.5	491.7	494.7	498	495.3
Mathematics, unadjusted		503.6	501.2	501.6	499.6	501.5
Science, unadjusted			504.1	504.8	505	504.6
Adjusted scores	509.16	506.73	504.08	500.25	500.91	503.02
Reading, adjusted	509.2	502.1	496.9	494.6	498.1	500.2
Mathematics, adjusted		511.4	506.2	501.5	499.6	504.7
Science, adjusted			509.1	504.7	505	506.3
Share of low performers	18.34	18.79	18.67	17.78	17.93	18.25
Share of high performers	8.43	11.31	10.04	9.53	9.89	9.96
Crisis-affected countries						
Unadjusted scores	494.2	485.2	482.67	488.93	488.6	487.1
Reading, unadjusted	494.2	487.6	478.8	489.8	491.8	488.4
Mathematics, unadjusted		482.8	482.4	486	483.6	483.7
Science, unadjusted			486.8	491	490.4	489.4
Adjusted scores	506.4	493.4	489.33	488.93	488.67	491.17
Reading, adjusted	506.4	494.8	485	489.6	491.8	493.5
Mathematics, adjusted		492	489.4	486.2	483.8	487.9
Science, adjusted			493.6	491	490.4	491.7
Share of low performers	18.5	22.16	22.4	20.07	20.55	20.99
Share of high performers	7.34	7.51	6.37	6.65	7.05	6.88
Non-affected countries						
Unadjusted score	497.64	503.76	503.1	503.37	503.92	503.15
Reading, unadjusted	497.6	497.8	495	496	500	497.3
Mathematics, unadjusted		509.7	505.9	505.7	503.6	506.2
Science, unadjusted			508.5	508.4	508.6	508.5
Adjusted score	510.14	510.65	507.77	503.23	503.97	506.19
Reading, adjusted	510.1	504.2	499.9	495.9	499.7	502
Mathematics, adjusted		517.1	510.4	505.5	503.6	509.1
Science, adjusted			513	508.3	508.7	510
Share of low performers	18.28	17.8	17.74	17.18	17.27	17.52
Share of high performers	8.81	12.42	10.96	10.29	10.6	10.78

Source: OECD PISA

Once accounting for the sampling demographic and socio-economic factors, the trend for the 25-country adjusted values actually shows a negative pattern, with an 8.25 decrease, from 509.16 adjusted score points in 2000 to 500.91 score points in 2012. This pattern is true regardless of the experience with the fiscal crisis.

The share of low performers shows a hump-shaped pattern, which is also reflected in crisis-affected countries. That for the non-affected countries instead exhibits an inverted J-shaped pattern. The share of high performers also shows a hump-shaped pattern, regardless of the experience with the fiscal crisis.

Specific to subjects, overall averages of the 25 selected European countries across the years for reading, mathematics, and science performance are 495.3, 501.5, and 504.6, respectively. When comparing the crisis-affected and non-affected countries, the averages for the latter are also notably higher compared to the crisis-affected countries, at 497.3 (vs. 488.4) for reading, 506.2 (vs. 483.7) for mathematics, and 508.5 (vs. 489.4) for science.

Across the years, the mean reading performance of the 25 European countries has seen a dip in the middle, but shows a subsequent trend of improvement, specifically for the period immediately before and after the 2008 fiscal crisis. Between 2006 and 2009, reading has improved by 3.0 points, from 491.7 to 494.7, improving further by 6.3 points between 2006 and 2012. Meanwhile, overall mathematics and science performances remained relatively stable, both with improvements of less than 1 point from 2006 to 2009.

Again, there is a strong evident difference in the averages of countries affected by the crisis and those that were not. Not only are averages higher for non-affected countries with respect to those that were severely affected, but all three assessments also had significant improvements for crisis-affected countries, most especially for the reading assessment, with 11.0 points increase for the years 2006 and 2009, and 13.0 points for years 2006 to 2012. Mathematics improved by 3.6 for the short-run time period between 2006 and 2009, and 1.2 points for the medium-run time period between 2006 and 2012, while science improved by 4.2 and 3.6 points for the short-run and medium-run periods, respectively.

Reading also improved for non-affected countries, though at a more conservative range of 1.0 to 5.0 points for the short- and medium-run periods, respectively. Meanwhile, mathematics remained stable between the period 2006 to 2009, decreasing only by 0.2 points from 505.9 to 505.7 score points. However, the figure slides to 503.6 in 2012. Science assessments stayed constant across from 2006 to 2012, at an average of 508.5 points.

Averages for adjusted assessment scores are generally bigger in magnitudes as compared to the unadjusted scores, with overall averages of 500.2 (vs. 495.3) for reading, 504.7 (vs. 501.5) for mathematics, and 506.3 (vs. 504.6) for science. The averages for countries that were not affected by the crisis also show bigger magnitudes with respect to the averages of crisis-affected countries, similar to the pattern with adjusted scores: 502.0 (vs. 493.5) for reading, 509.1 (vs. 487.9) for mathematics, and 510.0 (vs. 491.7) for science.

After accounting for socio-economic and demographic compositions of each country, the change between 2006 and 2009 show decreases, except for reading among crisis-affected countries which shows an improvement of 4.6 points, from 485.0 to 489.6. Medium-run change

between 2006 and 2012 also show decreases overall, again except for reading that improves by 1.2 points from an average of 496.9 in 2006 to an average of 498.1 in 2012. This is largely driven by crisis-affected countries with a positive difference of 6.8 score points.

To summarize, we observe a stark difference in the assessment scores and measurements among countries that were significantly affected by the fiscal crisis and among those that were not or were less affected. While the latter had higher average test scores, lower shares of low performers, and higher shares of top performers across all test scores, the average scores (particularly for unadjusted scores) for the crisis-affected countries showed improvements pre- and post-fiscal crisis. That for the non-affected countries instead shows relatively stable patterns.

Because individual outcomes are a result of cumulative inputs, early investments can also factor in as a determinant of the assessment test outcomes and measures. The next section looks at the pre-school expenditures and the average number of years of pre-primary education that can serve as a protection mechanism against future negative shocks.

3.3 Early investments as a potential protection mechanism

Looking at pre-school expenditures during the period when the sample cohorts were in their early years, the averages among the countries show a relatively constant pattern, ranging from 0.36 to 0.40 percent of GDP. However, there is a strong heterogeneity between crisis-affected and non-affected countries, with the latter showing considerably bigger magnitudes of approximately 0.45 to 0.50 percent of GDP. It is also interesting to point out the stark growth between the 2003 and 2006 cohorts for the crisis-affected countries, from 0.03 to 0.14 percent of GDP.

Table 3. Government expenditures in ECEC as percentage of GDP, PISA cohorts 2000-2012

PISA Years	Birth Cohorts	25-country average	Crisis-affected countries	Non-affected countries
2000	1983-1985	0.3575	0.0243	0.4408
2003	1986-1988	0.3806	0.0256	0.4774
2006	1989-1991	0.3759	0.1360	0.4559
2009	1992-1994	0.4107	0.1465	0.4988
2012	1995-1997	0.3918	0.1671	0.4509
5-period average	1983-1997	0.3852	0.1142	0.4643

Source: OECD Social Expenditure Database

PISA 2003 and 2012 includes information regarding the percentage of sampled students who received ISCED 0, or pre-primary level of education, which “is defined as the initial stage of organised instruction, designed primarily to introduced very young children to a school-type

environment, that is, to provide a bridge between the home a school-based atmosphere." (http://www.oecd.org/edu/1841854.pdf). Because of differences in each country's definitions of pre-primary or early childhood education, "comparability depends on each country's willingness to report data for this level according to a standard international definition, even if that definition diverges from the one that the country uses in compiling its own national statistics. Programs should be centre- or school-based (may come under the jurisdiction of a public or private school or other education service provider), designed to meet the educational and developmental needs of children at least 3 years of age, and have staff that are adequately trained (i.e., qualified) to provide an educational programme for the children" (http://www.oecd.org/edu/1841854.pdf)

Table 4. Percentage of students reporting that they had attended pre-primary education (ISCED 0), 2003 and 2012

	No ISCED-0		Up to 1 year		More than 1 year	
	2003	2012	2003	2012	2003	2012
25-country average	**7.28**	**4.96**	**17.81**	**15.78**	**74.89**	**79.26**
Crisis-affected countries	**14.56**	**8.24**	**20.92**	**20.64**	**64.54**	**71.14**
Greece	5.40	4.60	32.70	27.40	62.00	68.00
Iceland	6.60	2.10	4.50	3.20	88.90	94.70
Ireland	27.70	13.60	39.80	43.60	32.50	42.80
Portugal	27.70	15.00	17.40	20.70	54.90	64.40
Spain	5.40	5.90	10.20	8.30	84.40	85.80
Non-affected countries	**5.26**	**4.14**	**16.95**	**14.57**	**77.76**	**81.29**
Austria	4.30	1.80	15.50	10.50	80.20	87.70
Belgium	2.40	2.40	3.80	4.60	93.80	93.00
Czech Republic	7.30	3.20	13.90	8.80	78.80	88.00
Denmark	2.30	1.10	32.00	20.10	65.70	78.90
Estonia		7.30		8.70		83.90
Finland	7.90	2.50	25.30	34.80	66.80	62.70
France	1.60	1.80	4.50	6.40	93.90	91.80
Germany	4.40	3.30	13.00	11.50	82.60	85.20
Great Britain	6.00	5.00	26.00	26.10	68.00	68.90
Hungary	1.00	0.50	4.70	4.00	94.20	95.50
Italy	4.80	4.30	8.40	8.00	86.70	87.70
Liechtenstein	3.30	0.70	6.10	8.80	90.60	90.50
Luxembourg	11.90	4.60	8.70	12.80	79.30	82.60
Netherlands	2.90	2.30	3.10	2.70	93.90	95.00
Norway	7.60	7.90	14.00	5.80	78.30	86.30
Poland	3.90	2.50	51.70	46.40	44.40	51.10
Slovak Republic	8.10	6.80	15.60	13.20	76.30	80.00
Slovenia		14.70		12.80		72.50
Sweden	11.80	8.20	28.60	20.40	59.50	71.40
Switzerland	3.10	1.80	30.20	25.00	66.70	73.10

Source: Table IV.3.50 in PISA 2012

Table 4 shows the percentages of students reporting their attendance to pre-primary education (ISCED 0). A comparison of the PISA cohorts 2003 and 2012 shows about a 2% and a 5% increase in the share of students who received pre-primary education of up to 1 year and of more than 1 year, respectively. This pattern, particularly that for pre-primary education of more than 1 year, is true for both country groups, with the crisis-affected countries showing a significant difference of about 6%, twice the increase in the group that were not or were less affected by the crisis.

Ireland and Portugal, two of the countries severely affected by the crisis, have the largest share of students with no pre-primary education and the highest shares of students with more than 1 year of pre-primary education.

The figures also indicate a polarization. The crisis-affected countries see a larger share of the students without pre-primary education compared to the non-affected, with a difference of almost 3 times in magnitude in year 2003, and 2 times in magnitude in year 2012. Meanwhile, the non-affected countries show a larger share of students with more than 1 year of pre-primary education compared to the crisis-affected countries, pointing to higher early investments among these countries.

4. PISA Assessments Scores, Government Expenditures on Education, and Pre-primary Education

To understand how the various outcome measures are related with the macroeconomic, education, and ECEC characteristics[3], we look at how outcomes are determined by early investments and government expenditures on secondary education, controlling for real GDP per capita. We estimate the model:

$$Outcome_{ijt} = \beta_0 + \beta_1 ISCED0_{it_0} + \beta_2 \overline{EducExp}_{it-2} + \beta_3 \overline{GDP}_{it-2} + \delta_j + \theta_t + \varepsilon_{ijt}$$

Where $Outcome_{ijt}$ refers to the four outcome measures for country i on subject j reported at time t; $ISCED0$ is a vector of variables on the share of the cohort who did not receive pre-primary education, who received up to 1 year of pre-primary education, and who received more than 1 year of pre-primary education; $EducExp$ is the three-year average of government spending on education of a secondary student as a percentage of GDP per capita; GDP is GDP

[3] We also estimated a specification using the variable ECEC expenditures (cohort-specific) instead of shares of students who received pre-primary education, but did not find significant results.

per capita in 2005 US dollars; δ_j are subject fixed effects; θ_t is time fixed effect; and ε_{ijt} is the idiosyncratic error term. Our estimated coefficients of interest are β_1 and β_2 in the model.

Tables 5a and 5b show the estimated coefficients of the relevant variables from a multivariate analysis on four outcome variables – unadjusted score, adjusted score, share of low performers, and share of high performers.

Table 5a. Multivariate analysis results, 25 countries

VARIABLES	Unadjusted Score	Adjusted Score	Share of Low Performers	Share of High Performers
Share of students who received up to 1 year of ISCED-0 education	1.001**	1.053**	-0.261*	0.213**
	(0.350)	(0.368)	(0.100)	(0.074)
Share of students who received more than 1 year of ISCED-0	0.671*	0.671*	-0.148	0.171**
	(0.289)	(0.304)	(0.082)	(0.061)
Government education expenditures per secondary student as % of GDP per capita	0.316	0.271	-0.093	0.035
	(0.320)	(0.336)	(0.091)	(0.068)
Real GDP per capita in billions	0.204*	0.235**	-0.043	0.050**
	(0.079)	(0.083)	(0.023)	(0.017)
Constant	413.569***	418.497***	37.208***	-11.037
	(29.190)	(30.667)	(8.302)	(6.167)
Observations	130	130	130	130
R-squared	0.130	0.145	0.154	0.374

Specification include subject and year fixed effects. Standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05

Results from the multivariate analysis indicate that a higher share of the student population who received pre-primary education improves test score outcomes, increases the share of high performers, and decreases the share of low performers. Comparing the magnitudes indicate a non-linear hump-shaped pattern with respect to the duration of enrolment to pre-primary education. Emphasis is put on pre-primary education of up to 1 year, not only in terms of statistical significance but also with respect to magnitude.

Higher GDP per capita is also positively related with assessment outcomes and share of top performers. Though not statistically significant, devoting higher shares of public expenditures on secondary education improves outcomes as well.

Countries that were severely affected by the fiscal crisis may be different with respect to those marginally or not affected by the crisis. For instance, the first group may have been more vulnerable, with different government spending priorities. As such, government spending on education and early investments may affect outcomes differently for these two groups. We look at this by doing a similar analysis as before, subset to the group of countries that were not or were moderately affected by the fiscal shock to allow for heterogeneity according to the experience with the fiscal crisis.

We find that the results above are driven by the group of countries that were not or were less affected by the 2008-09 crisis. Table 5b shows the regression estimates for the subset of countries not affected by the crisis. The previous pattern holds, especially regarding the share of students who received pre-primary education in their early childhood.

Table 6b. Multivariate analysis results, Non-crisis affected countries

VARIABLES	Unadjusted Score	Adjusted Score	Share of low Performers	Share of High Performers
Share of students who received up to 1 year of ISCED-0 education	1.182*	1.684**	-0.330*	0.199
	(0.565)	(0.600)	(0.158)	(0.123)
Share of students who received more than 1 year of ISCED-0 education	0.899	1.351*	-0.224	0.169
	(0.535)	(0.568)	(0.149)	(0.116)
Government education expenditures per secondary student as % of GDP per capita	0.169	0.128	-0.063	-0.002
	(0.350)	(0.372)	(0.098)	(0.076)
Real GDP per capita	0.130	0.172	-0.021	0.038*
	(0.083)	(0.089)	(0.023)	(0.018)
Constant	400.807***	362.069***	42.329**	-9.009
	(51.900)	(55.105)	(14.511)	(11.255)
Observations	103	103	103	103
R-squared	0.112	0.163	0.131	0.391

Specifications include subject and year fixed effects. Standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05

5. Conclusions

This research aims to explore how child education outcomes at the macroeconomic level are affected by government education expenditures. We also explore how early investments factor in determining education outcomes. We use data from OECD's PISA and Eurostat and World Bank's WDI, looking at 25 European countries. Because of country differences that were consistent with the occurrence of the European fiscal crisis, we performed the trend and multivariate analyses categorizing the countries accordingly

The trend analysis shows a stark difference in the assessment scores and measurements among countries that were significantly affected by the fiscal crisis and among those that were not or were less affected. While the latter had higher average test scores, lower shares of low performers and higher shares of top performers across all test scores, the average scores (particularly for unadjusted scores) for the crisis-affected countries showed improvements pre- and post-fiscal crisis. That for the non-affected countries instead shows relatively stable patterns.

Similarly, the two groups exhibit differences in macroeconomic conditions and education expenditures. The trend analyses show a difference in shares of education expenditures immediately before and after the fiscal crisis.

Because individual outcomes are results of cumulative inputs, we use a multivariate analysis to investigate how government expenditures and early investments can determine the test assessment outcomes and measures. Overall results indicate that higher shares of children who received pre-primary education improve outcomes, with the estimated coefficients on years of pre-primary education received showing a non-linear pattern of duration of pre-primary education, indicating the importance of looking at duration of ECEC as well. This pattern is driven by the group of countries that were not affected by the fiscal crisis.

Our results have some policy implications. First of all, the positive link between macroeconomic conditions and students' cognitive performance should advise policies aimed to prioritise and stabilise expenditures in education. Moreover, as we have shown in the empirical analysis, early education has a significant positive impact on child outcomes which implies that governments should focus on educational investments in early years. These results are supported by a large a growing literature which has shown the importance of early investments in child care especially for children from disadvantaged households who are more exposed to economic adversities. The intervention made at the early stages are crucial protection against negative economic shocks is investments.

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