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Long-run effects of public expenditure on poverty

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Abstract Household characteristics may have long-run effects on individual outcomes in adulthood. For instance, individuals who lived when young in households experiencing financial problems are more likely to be poor when adults. Governments try to reduce these effects and to promote equality of opportunity. The objective of this paper is to check whether public expenditure has a long-run effect in reducing the probability of being poor when adult, and to what extent. Our main finding is that public expenditure on education has a strong long-run effect on reducing incidence of poverty in adulthood. We also find that this effect is concentrated mainly among individuals who have parents with a low level of education.

Keywords Public expenditure on education · Poverty rate · Intergenerational transmission of poverty

1 Introduction

There is a growing literature documenting how inequality has increased during the last decades in many developed countries (see Piketty (2014) or Atkinson (2010) for the EU;

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Atkinson et al. (2011) or Jenkins et al. (2013) for the US). For instance, in most OECD countries the gap between the rich and the poor has widened continuously prior to 2008 (OECD 2011). In addition, recent OECD data (OECD 2013) show that the global economic crisis has reduced incomes in most countries. However, this reduction is not shared evenly across the two extremes of the income distribution as there are larger reductions at the bottom part of the distribution. This fact suggests further increases in inequality and poverty. It is also well-known that living in poverty during childhood has long-run negative effects. Children from poor families are more likely to be poor when adults, are also more prone to suffer health problems, and are less likely to stay in school after the end of compulsory education (see Corak (2006) or Jenkins and Siedler (2007) and references therein). These long-run effects reflect the degree of intergenerational mobility in a society. In countries where social mobility is low, being poor when young is a good predictor of the probability of being poor when adult.

There are at least two plausible mechanisms underlying the intergenerational transmission of poverty. First, there may be genetic differences in ability that are transmitted from parents to children, leading to intergenerational persistence in poverty. Second, rich parents invest more in the human capital of their children, who end up with more education. This second mechanism suggests a role for government intervention to equalize opportunities. In particular, public intervention at early stages is seen as one of the most important tools to reduce the long-run effects of poverty and to promote equality of opportunity.

Our objective is to estimate the effects of public expenditure on poverty status in adulthood in Europe. The notion of poverty used is income-based, reflecting the main approach in the literature.[1] In order to do so, we combine individual and aggregate variables by merging data from the 2005 and 2011 cross sections of the European Union Statistics on Income and Living Conditions (EU-SILC) with data on public expenditure that we retrieve from the United Nations Educational, Scientific and Cultural Organization (UNESCO) database. The 2005 and 2011 cross sections of EU-SILC include a special module on "Intergenerational transmission of poverty." The database we construct allows us to analyze which factors contribute to cross-country and cohort differences in the probability of falling below the poverty line.

Ideally, we would like to have data on all categories of public expenditure, in particular those items that can be categorized as expenditure on children. We would also need data on public expenditure covering a period of time as long as possible. These two requirements lead us to use data on public spending dedicated to education. In particular, we have data on public education spending since 1971 that are disaggregated at three levels (primary, secondary, tertiary) for a number of European countries. This could be seen as a potential drawback of our approach, since any effect that we may find of public expenditure on adult poverty status could be attributable not to spending in education per se, but to public spending in general. However, in previous work Mayer and Lopoo (2008) study the long run effect of public spending on intergenerational income mobility in the USA. They find that intergenerational mobility is greater in high-spending states, compared to low-spending states. Interestingly, when they disaggregate by categories of spending they find that spending on primary and secondary education is the public spending that has the largest impact on low-

[1] As measures of social exclusion, material deprivation and material hardship are becoming more and more available, the concept of multidimensional poverty is increasingly used. For instance, Figari (2012) analyzes the relationship between deprivation, income and other individual dimensions over time, in eleven European countries. For an overview of this literature see Morelli et al. (2015) or Nolan and Marx (2009).

income children's future income. Regarding the period of time for which we have available data on spending, the oldest data go back to 1971, allowing us to consider individuals born from 1954 and later. We follow an approach similar to that of Mayer and Lopoo (2008) and try several definitions of per capita expenditure to capture the level of public investment per individual. First, we assign to each individual average expenditure per pupil at the three levels when the individual was between the ages of 15 and 17. Next, we consider other more restrictive definitions as the sum of expenditure per pupil only in primary and secondary education, and the expenditure at each level separately.

The first result we get is that expenditure on primary and secondary education seem to have a strong long-run effect on reducing the incidence of poverty in adulthood. As an illustration, an increase of one standard deviation in expenditure on secondary education is associated with a reduction of 0.61 percentage points in adult poverty, which is an important reduction as it represents 5% of the mean poverty rate (12.11). This association between public expenditure and poverty vanishes when we consider expenditure in tertiary education. Next, we compute the effects of expenditure for different sub-groups of individuals according to the characteristics of the family in which they were raised. In particular, we divide individuals into two groups depending on the level of education of their parents. Our second result is that the beneficial effect of public expenditure on education is concentrated mostly among individuals with low-educated parents. This result holds for most of the models we estimate. For instance, an increase in expenditure in secondary education of the size of one standard deviation is associated with a reduction of 1.24 percentage points in the incidence of poverty in adulthood for children from low-educated families. At the same time, we find that expenditure is positively associated with adult poverty for individuals from educated families. This result underscores that the effects of public expenditure are coming through individuals whose parents had low levels of education. A likely implication is that public expenditure helps to increase intergenerational mobility.

The effects we have obtained can be explained by a simple human capital model in which individuals' outcomes today are a function of both their own endowments and of human capital investments received while young. For instance, an increase in public expenditure may push some individuals to undertake post-compulsory education. This, in turn, may reduce the probability of being below the poverty line in adulthood. There are several works documenting a positive effect of education spending on later outcomes. Some studies find a positive effect on test scores (see Hedges et al. (1992)) whereas others do not find a significant impact (see Hanushek (1996, 2001)). Grogger (1996) finds that state per-pupil spending on compulsory education is associated with higher post-schooling wages. Within this literature, there are other authors who use alternative identification strategies. For example, Meghir and Palme (2005) evaluate the impact of a school reform that took place in the 1950s in Sweden on educational attainment and earnings. This reform consisted of increasing compulsory schooling, among other aspects, and thus can be seen as an increase in per-capita public expenditure on education. They find that this reform increased both educational attainment and earnings of those individuals whose fathers had only compulsory education.

Our identification strategy to assess the impact of government spending on individual's poverty status consists of exploiting country and time variation in expenditure. We identify the effect of public intervention by exploiting changes in spending across countries from the initial period in our sample. As different countries experience different economic situations that might have different effects on different cohorts, we also control for other country-cohort variables, such as per capita GDP and income inequality during childhood. However, there are many other factors that may have changed within particular countries between the

time the individual was a teenager and the expenditure was made and the moment when poverty status is determined. To address this problem, we include the *change* in per capita GDP and the *change* in our measure of inequality from the time the individual was 15-17 until the year of survey response, respectively. These two additional variables capture country-specific time trends. Finally, we perform a number of robustness checks. In particular, we check the validity of our results to alternative measures of parental circumstances and current poverty status and to alternative specifications of the model. We also implemented a falsification exercise for the exposure to public expenditure.

The paper is related to the literature that studies the long-run effects of government spending on adult outcomes as income or poverty. The most closely related papers to ours are Mayer and Lopoo (2008), mentioned above, and Jackson et al. (2016). The former assesses the relationship between government spending and intergenerational economic mobility using PSID data together with data on state spending from the U.S. Census of Governments. The latter also uses U.S. data and finds a significant effect of increased school spending on children from poor families. In particular, they find that an increase of 10% in expenditure for all years of K-12 education reduces the incidence of adult poverty by 3.2 percentage points.

In addition to public expenditure, the previous literature has shown that individuals' socioeconomic background is also a crucial determinant of adult poverty. There is substantial evidence that poverty is to a large extent inherited across generations. Recently, Bellani and Bia (2016) using also data from EU-SILC 2005 and 2011 find that exposure to poverty in childhood reduces equivalized income in adulthood by about 5% and increases the probability of falling below the poverty threshold by about 6 percentage points. For a review of this literature, see Jäntti and Jenkins (2014). While experiencing financial problems during childhood is shown to have a strong impact on poverty in adulthood, other dimensions of family background, as parental education, are associated with future poverty. For example, Corcoran and Adams (1997) were among the first who attempted to separate the impact of poverty during childhood from other family background characteristics (such as parental schooling). Blanden and Gregg (2004) perform a similar study. Both studies found that individuals with better educated parents are less likely to be poor themselves. Hertz et al. (2007) report strong correlations between schooling of parents and children for many countries. Holmlund et al. (2011) provide a survey on the different methodologies used to study the causal effect of parent's schooling on children's schooling. Recently, Piopiunik (2014) suggests that the channel for this relationship could be that parents with more education value good school performance of their children more highly and are more likely to believe that schooling is good for them. Finally, see Marx et al. (2014) for a recent survey of these types of studies. In this paper, we control for the role of parental background while studying the long-run effect of public expenditure on adult poverty.

Our paper contributes to the literature in several respects. First, we focus on intergenerational poverty transmission rather than on transmission of income, as most of this literature does. Surprisingly, there is almost no evidence on the potential mitigating effect of public expenditure on poverty, despite the recent trends in poverty and income inequality. Second, we focus on a group of European countries using data from the EU-SILC. Finally, we also add to this debate by using a more narrowly defined measure of expenditure on children's schooling.

The paper is organized as follows. Section 2 describes the data used in the paper. Section 3 presents the empirical model. We discuss our empirical results in Section 4. Finally, Section 5 concludes.

2 Data and descriptive statistics

Estimating whether government expenditure has a long-term effect on reducing poverty requires individual-level data on adult's income together with information on the characteristics of the household where that adult grew up. It also requires a source of variation in government expenditure. In this study, we merge data drawn from both the 2005 and 2011 cross sections of the EU-SILC database with data from the UNESCO database for Education. We build a database comprising 16 European countries. These are the countries in the EU-SILC database for which we have enough historical data on public expenditure.[2]

The reason for using the 2005 and 2011 cross sections of the EU-SILC database is that they include special modules on intergenerational transmission of poverty.[3] Using these modules requires one to exclude from the 2005 and 2011 cross sections all individuals who are not in the age range of the module (25-65) and are not the selected respondent. These modules contain retrospective information on parental background and childhood circumstances including, in particular, family composition, year of birth of parents, occupation, and level of education of parents. To assess the long-run effect of household characteristics, we exclude all individuals who lived in a collective house or in some institution when young. Individuals also provide retrospective information about the socio-economic situation of the household they lived in when teenagers. All these variables give us valuable information on individual circumstances that prevailed before the end of compulsory education. Individuals report the highest level of education attained by their mother and their father. We summarize this information by building a dummy variable called "*educated_family*" that takes value one when either the mother or the father has at least secondary education.[4] We have also explored the possibility of introducing parental education in several other ways (see the Online Appendix, Section A). As can be observed there, our main results do not depend on how parental education is defined. In addition to parental education, we consider a set of household characteristics when the individual was young (unemployed father, number of siblings, single mother family, etc.).[5] See Section F in the Online Appendix where we check the validity of our results to alternative measures of childhood circumstances.

As mentioned above, we obtain data on public expenditure from the UNESCO Database for Education. The UNESCO Database for Education contains country data on annual public expenditure in education per student going back to 1971, although in some countries there are missing data for some years. The original data correspond to percentages of per capita GDP at three levels (primary, secondary, tertiary). We use data on per capita GDP to recover data on expenditure in primary, secondary and tertiary education for each country and year. We also use data on Purchasing Power Parities from the World Bank.[6] Since data

[2]The list of countries is: Austria, Belgium, Denmark, Finland, France, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden and United Kingdom.

[3]For an overview of EU-SILC, see Wolff et al. (2010). To access further information about EU's regulations concerning the SILC, data documentation provided by Eurostat, and SILC variable lists, we recommend the EU-SILC web portal provided by the GESIS research institute at http://www.gesis.org/.

[4]The mean value of educated-family is .355 (st. dev. is .478). Requiring tertiary education would be too restrictive, since only a 11.68% of individuals in the sample have at least one parent with tertiary education.

[5]We do not use information on parents occupation, since these variables contain a large fraction of missing values.

[6]See http://www.uis.unesco.org/Education/Pages/default.aspxandhttp://data.worldbank.org/ for data on public expenditure in education and PPP, respectively.

on per capita GDP are in US dollars of year 2000, all our data on expenditure per individual have the same purchasing power in terms of 2000 US dollars. Our data cover the period from 1971 to 2008, for which we have 608 distinct country-year cells.[7]

We propose different ways of measuring per child expenditure. We follow previous research on the long-run impact of public expenditure on adult circumstances using different combinations of per pupil public education expenditure as proxies of public expenditure.[8] As we do not know whether they attended education in a different country, we exclude from our sample all individuals who were not born in the country of residence at the time of the survey

The first measure we consider aggregates expenditure across the three educational levels and takes the average of these expenditures for the country of residence when the child was of ages 15 to 17. This allows us to study the effect of public expenditure made before the age at which individuals may join the labor market. We think of our measure as a proxy for general public expenditure rather than a measure of public expenditure in education. As an example, consider the case of an individual born in Spain in 1960, who was 16 in 1976. The sum of public spending per capita at the three levels in Spain in 1976 was $3,558.57. The corresponding numbers for 1975 (when 15) and 1977 (when 17) are $3,415.94 and $3,517.64, respectively. We assign to this individual the average of these three numbers, namely $3,497.38. By doing so, we get a smoother measure of expenditure than just considering expenditure at age 16 only, for instance. Our second measure is similar to the first one, but adds only expenditure for primary and secondary education. With this second measure, we try to capture expenditure at the compulsory levels of education, which could be a better measure of the level of public spending from which all individuals have benefitted. We also consider expenditure separately at each one of the three levels. By doing this, we try to see which one of the three components of government exhibits the strongest association with poverty reduction.

Observe that our measure of public expenditure is not the exact amount individuals received while they attended primary, secondary or tertiary education. In that case, and in particular regarding expenditure on tertiary education, the amount of public expenditure assigned to each individual would depend on his (endogenous) decision of college attendance, which is highly correlated with parental education (see, for example, Piopiunik (2014) for recent evidence on the causal link between parents and children's education). Thus, by constructing our measure in this way, we avoid introducing bias on the impact of public expenditure on future poverty status. Since our oldest data on public spending go back to 1971, we have to restrict our sample to individuals born between 1954 and 1980 (for the 2005 cross section) and between 1954 and 1985 (for the 2011 cross section).[9] This means that the age range in our sample varies between 25 and 57. The reason to choose expenditure when individuals were 15-17 is to have the largest possible sample size. An individual born in 1954 was 17 in 1971, so we can assign to him/her some expenditure in that

[7]Since our sample contains 16 countries, in principle we could have data for the three educational levels corresponding to 16*38 = 608 distinct country-year cells. However, we lack data corresponding to 115 of these cells. This can be due to the fact that UNESCO did not collect data every year in every country. We use a simple linear interpolation to smooth expenditure data. We cannot do this when missing data for a given country correspond to the first or the last years of the period considered. As an example, data for Belgium are only from 1975 onwards while for Spain they are from 1972.

[8]See Akin and Garfinkel (1980), Grogger (1996), or Mayer and Lopoo (2008).

[9]With our measure, for those born in 1954 we assign public spending in 1971 (they are 17 in 1971) only, while for those born in 1955 we assign the average of public spending in 1971 and 1972 (they are 16 and 17, respectively).

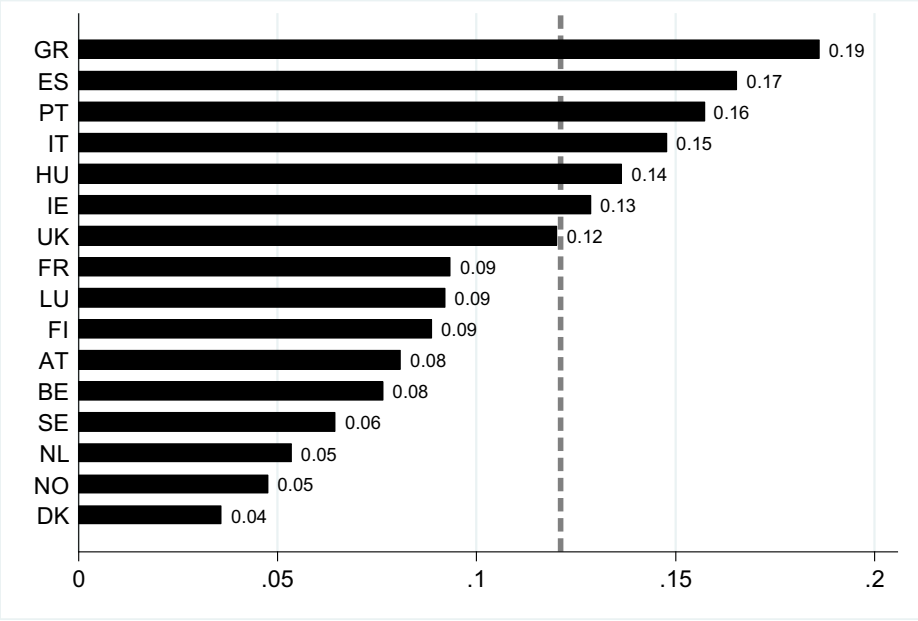

Fig. 1 Poverty rate by country. Notes: Only individuals between ages 25 and 57. We exclude individuals not born in the corresponding country. Source: EU-SILC, waves 2005 and 2011

year. In addition, Mayer and Lopoo (2008) use the same age interval. Nevertheless, we redo the exercise considering public expenditure earlier in life. In particular, we choose expenditure when the individual was aged 10-12. Now the earliest cohort would be that of 1959, which implies we lose five birth cohorts (1954-1958) with a sizable reduction in sample size (see Table 5). Our results remain qualitatively the same, although, as we comment below, we lose significance in some models . Our final sample consists of 163,159 individuals from 16 countries. Of those, 78,183 are in the 2005 wave and 85,021 in the 2011 wave.

Our objective is to study whether public expenditure helps to mitigate the effects on adult circumstances of being raised in a disadvantaged household. In particular, we focus on individual's current poverty status.[10] This is the information contained in the variable HX080, which is an indicator of whether the individual lives in a family with income below the poverty threshold.[11] We define a dummy variable called "*poor* " which is 1 whenever HX080 is 1. This is a standard poverty measure and the official one in the European Union.[12] The mean value of *poor* in our final sample is 12.11%. It takes roughly the same value in both waves. Figure 1 shows the percentage of individuals below the poverty line in each country.

[10] In Online Appendix, Section F, we perfom some robustness checks to alternative definitions of monetary poverty, in particular considering other income sources.

[11] The poverty line corresponds to 60% of equivalized household disposable income and corresponds to the standard measure of poverty in the European Union. Equivalized household disposable income (HX090) is equal to the product of total disposable household income (HY020), multiplied by an inflation factor for within-household non-response (HY025), divided by equivalized household size (HX050). That is, $HX090 = \frac{HY020 * HY025}{HX050}$.

[12] See http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:At-risk-of-poverty_rate

Table 1 Summary Statistics

Variable	Mean	Std.Dev.	Min	Max	Obs
Poor	0.121	0.326	0	1	163,133
Female	0.508	0.500	0	1	163,159
Non citizen	0.003	0.059	0	1	162,915
Year 2011	0.521	0.500	0	1	163,159
Educated family	0.355	0.478	0	1	153,517
Single mother family	0.076	0.266	0	1	157,600
Number of siblings	1.791	1.687	0	40	155,908
Father unemployed	0.009	0.095	0	1	147,536
Per pupil exp. education (age 15-17), year 2000 US dollars (PPP)	13,034.6	6,336.4	3,905.5	39,648.3	163,159
Per pupil exp. compulsory education (age 15-17), year 2000 US dollars (PPP)	6,039.3	2,613.2	1,246.6	17,710.6	163,159
Per pupil exp. primary education (age 15-17), year 2000 US dollars (PPP)	2,742.0	1,422.1	441.5	9,034.6	163,159
Per pupil exp. secondary education (age 15-17), year 2000 US dollars (PPP)	3,297.3	1,555.8	604.9	10,517.8	163,159
Per pupil exp. tertiary education (age 15-17), year 2000 US dollars (PPP)	6,995.3	4,492.6	1,857.4	31,475.1	163,159
Per capita GDP (age 15-17), year 2000 US dollars (PPP)	16,324.5	3,971.4	5,742.1	35,686.7	163,159
Income Inequality (age 15-17)	35.94	3.428	27.59	43,49	158,489
Youth unemployment rate (age 16-21)	32.82	19.27	0	92,03	102,476
Country dummies					
AT					8,828
BE					7,051
DK					3,387
ES					23,637
FI					8,106
FR					15,862
GR					9,581
HU					4,781
IE					7,008
IT					32,769
LU					3,265
NL					9,083
NO					4,363
PT					7,820
SE					4,660
UK					12,958
					163,159

Note: Sample: Individuals for which the variable Per pupil expenditure in education is not missing. Source: EU-SILC 2005 and 2011 and UNESCO Database

Table 2 Long-run effects of parental education

	Poor 2005		Poor 2011		Poor All	
	Mean	SE	Mean	SE	Mean	SE
educated_family=0	15.04	0.16	15.37	0.16	15.21	0.11
educated_family=1	6.14	0.15	6.59	0.14	6.40	0.10
Difference test p-value	<0.0001		<0.0001		<0.0001	
All	12.11	0.11	12.11	0.11	12.11	0.08

The maximum value is found in Greece (18.6%) and the minimum in Denmark (3.6%). The dotted line is the mean for the whole sample. It is important to remember that these numbers are not representative of the whole population, since we are considering only those individuals who at the time of the survey were 25-51 in the 2005 wave or 25-57 in the 2011 wave. In particular, the elderly are excluded from our sample. Table 1 shows the main descriptive statistics. A complete description of all the variables we use can be found in the Appendix.

Table 2 below illustrates the correlation between current poverty status and family background, as measured by parental education. We compute probabilities for the current poverty status (variable *poor*), conditional on the two possible values of the variable *educated_family*. We also provide their corresponding standard errors. We do it separately for the two cross sections and also pooling all the data. As Table 2 shows, there is a strong association between these two variables.

In the 2005 cross section (Column 1 in the table), the proportion of individuals who had low-educated parents that are below the poverty line is 15.04%. However, for those individuals with educated parents this probability is just 6.14%. We find similar differences in the 2011 cross section (15.37% vs. 6.59%) and with the two cross sections combined (15.21% vs. 6.40%). So, roughly speaking, the probability of being below the poverty line for individuals with low-educated parents is twice as big as that of individuals with highly educated parents.[13] We illustrate these correlations at the country level in the Online Appendix, Section B.

Finally, we briefly describe the connection at the country level between expenditure and poverty by family type. In order to do so, we compute poverty rates according to the education of parents for each country. We use the average value of one of our measures of spending per individual (in logs), in particular our first measure of public expenditure that aggregates expenditure across the three educational levels (primary, secondary and tertiary) for the country of residence when the child was of ages 15 to 17. As we have already seen in Table 2, poverty rates are typically higher among individuals with low-educated parents. Figure 2 shows poverty rates for these two groups as a function of average public expenditure. We fit a line for each group. We see that higher expenditure is associated with lower poverty rates mostly for individuals whose parents have a low education level.[14]

[13]The t-statistics for the difference in mean poverty between individuals without educated parents and with educated parents are equal to 35.96, 41.13 and 54.54 for the 2005, 2011 and the all sample respectively.

[14]The slope of the line corresponding to individuals with parents with low education is -.085 (p-value 0.004), while the one corresponding to individuals with highly educated parents is -.013 (p-value 0.228).

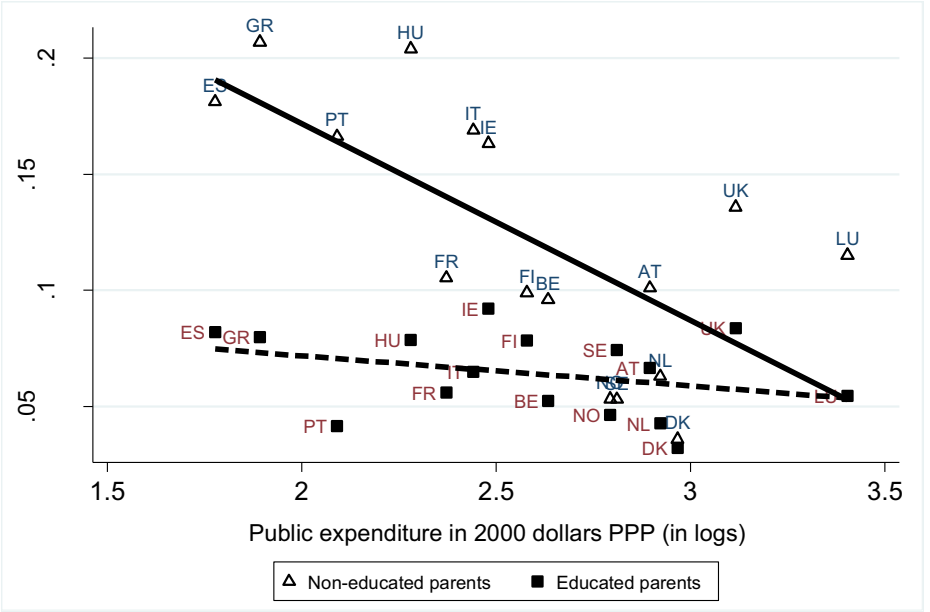

Fig. 2 Public expenditure and poverty rates by parental background

Next, we analyze whether these relationships observed at the country level hold also at the individual level.

3 Empirical model

Our aim is to study the effect that public expenditure has on reducing the long-run negative effects of having a disadvantaged background. The relationship of interest between public expenditure and poverty status is given by the following equation:

$$POOR_i = \beta_0 + \beta_1 PE_{ct} + \beta_2 ED\_FAM_i + \beta_3 (PE_{ct} \times ED\_FAM_i) + X_i\gamma + \beta_c + \beta_t + \varepsilon_i, \quad (1)$$

where $POOR_i$ is an indicator that equals 1 if individual i lives in a household that has disposable income below the poverty line. The variable PE_{ct} is the logarithm of our measure of public spending per capita corresponding to an individual from country c born in year t.[15] We try different measures of public spending, as described above. The variable ED_FAM_i is a dummy variable capturing parental education. We add an interaction term of this dummy variable with public expenditure to test whether individuals who grew

[15] We could alternatively consider the ratio of expenditure over GDP as our main regressor of interest (see Hidalgo-Hidalgo and Iturbe-Ormaetxe (2014) for a similar strategy). However, we choose our approach for two reasons. First, it is a more general specification (observe that using the ratio implies restricting the effect of $\ln(GDP)$ to be the mirror effect of $\ln(PE)$). Second, it provides a more clear interpretation of results (since a large value in this ratio can be due either to high spending or to low per head GDP). Nevertheless we have also estimated a model using the ratio and find results in line with the ones in the paper. We do not show these results here for space reasons but are available upon request.

up in families in which both parents had little education benefit differently from public expenditure, compared to other individuals. We include country fixed effects in the model, captured by the term β_c which contains a set of dummy variables, to control for invariant factors within countries. We include a time trend, captured by the parameter β_t that represents a vector of birth year variables. In particular, it addresses a possible common time trend toward increasing public expenditure. Because of the structure of our data, we cannot include country-specific time trends since these ones would be perfectly correlated with our measures of public expenditure. Recall that we assign the same value of expenditure to all individuals who were born in the same year and country. However, below we include two additional regressors that help to capture country-specific time trends.

The vector X_i contains the remaining explanatory variables, apart from parents' education. First, there are variables describing current circumstances (gender, non-citizen status, date of survey). Second, we include a set of family background variables that were determined well before schooling was completed. We include number of siblings, having been raised in a single-mother family and whether the father was unemployed at that time. Third, we add some country-cohort specific variables. In particular, we control for per capita GDP at the time the individual benefitted from each particular measure of PE. By doing so, we relate education expenditure to the level of living of the country. If we did not do this, the impact of expenditure on education might be biased. Rich countries raise more revenue from taxes and can dedicate more resources to education. At the same time, they have lower poverty rates. Then, the impact of public expenditure in education would be overestimated. In particular, we add a variable called GDP_{ct} that represents the logarithm of average per capita GDP when the individual was of age 15 to 17. Not surprisingly, the two variables PE and GDP are strongly correlated.[16]

Fourth, we also include a measure of "initial inequality" (denoted by $INEQ_{ct}$). The idea is that countries with larger amounts of public expenditure may have unobserved characteristics (for instance, inequality levels) that correlate with both those levels of spending and current individual poverty status. If these inequality levels are positively correlated with current individual poverty, then our results would be overestimating the true impact of public spending (as measured here). For example, more unequal countries may spend more on other long term inequality-reduction policies (not captured in the measured proposed in the paper) which reduces individuals' probability of being poor when adults. However, these inequality levels might also be negatively correlated with individuals' current poverty status. For example, if some forms of expenditure are entitlements, those countries that are initially more unequal might need to spend more than countries with fewer poor families. In that case, our results would be underestimating the true impact of public spending on poverty reduction. Thus, it is very difficult to establish a priori the sign and magnitude of the bias if we do not account for this effect.[17] Similarly to the case of GDP,we assign to each individual the average value of the Gini indexes in her country at the time she benefited from each particular measure of PE. Note that both GDP_{ct} and $INEQ_{ct}$ take a different

[16]The correlation coefficient is 0.66 when we consider our first measure of expenditure per capita, the one that adds expenditure at the three levels.

[17]There is some evidence in the related literature on that. For example, Sylwester (2000), in a cross-country analysis finds that higher levels of initial income inequality are associated with higher public education expenditure. See also, Corak (2006) or Marx et al. (2014) for additional discussion on the relationship between inequality and social policies.

value for every combination of year of birth and country. They reflect initial circumstances that may have a long-run effect later in life.[18]

The crucial issue for identification is the assumption regarding exogeneity of public expenditure. Variation in this measure arises because of differences in expenditure across countries at the same point in time and differences in country expenditure over time. Either difference could be partly endogenous with respect to the poverty rate and related to both country expenditure and children's eventual income. The inclusion of GDP and $INEQ$ as regressors helps to partially correct this endogeneity problem. However, there are many other factors that may have changed within particular countries between the time the individual was a teenager and the time of the survey. The inclusion of a time trend can capture a common trend, but cannot capture differences across countries over time. To address this problem we include two additional regressors that help to control for country-specific trends. These are the *change* in per capita GDP and the *change* in our measure of inequality from the time the individual was 15-17 until the year of survey response, respectively. Since we have two cross sections, these two regressors take different values for each combination of year of birth, country, and cross section. They control for possible changes that are happening within countries between the moment when expenditure was made and the moment when poverty status is determined.[19]

Another concern is that the place in which people end up living may also play a role in determining poverty status (at least in the US there is wide variation in rates intergenerational mobility across regions within counties, see Chetty et al. (2014)) and therefore we include some region-cohort-specific controls. In particular, we include as controls both the unemployment level in the region of residence when the individual was 15-17, together with the change in the unemployment level between that time and the year of survey response. We decided not to do so in our main specification because there are many missing data in the unemployment variable. In fact, sample size reduces by almost one half. In Section 4, we comment on this.

Finally, since we combine individual-level data with group-level data in our explanatory variable of interest (PE_{ct}), errors are clustered at the country and year of birth level. Since our dependent variable is a binary variable, we also estimate a probit model and obtain similar results. Thus, for the sake of brevity, we only report results from the OLS specification in the main text.[20]

Note that, according to the specification in Eq. 1, if public expenditure during teen years reduces the probability of being poor as an adult, the estimated coefficient of β_1 should be negative. Moreover, if that effect works mainly through those individuals who come from families with a low level of education, the estimated coefficient of β_3 should be positive.

[18] In the Online Appendix, Section F, we check whether public expenditure has a similar impact on poverty reduction regardless of some contextual variables as country GDP or inequality. Results are very similar to the ones found for the main specification.

[19] An additional way to account for unobserved factors consists of interacting the cohort trends with the initial GDP and Inequality to allow separate trends for countries that have initially low or high productivity and inequality. We considered this possibility and obtained very similar qualitative results. See Online Appendix, Section C.

[20] We show the results of estimating Eq. 1 with a Probit specification (see Online Appendix, Section D).

4 Results

We begin by estimating seven alternative models using the different measures of public expenditure per capita presented in Section 2. In Model 1, we use the sum of public expenditure at the three educational levels. In Model 2, we only add expenditure in primary and secondary education. Models 3 to 5 consider only expenditure on primary, secondary, and tertiary education, respectively. In Model 6, we include expenditure on primary and secondary education, included separately. Finally, in Model 7 we include expenditure at the three levels, again separately. In the seven models, each spending category is interacted with the dummy variable ED_FAM_i. All seven models include the full set of controls, with the exception of the rate of unemployment and its change. Later on, we include these additional controls to see if they affect our results. Since we want to concentrate on the effects of our main variables of interest, we present in Tables 3 and 4 the marginal effects corresponding to the different measures of government spending and to the dummy variable that describes the level of education in the family (ED_FAM_i).[21] Table 3 calculates the overall effects of these variables, while in Table 4 we compute marginal effects of government expenditure, for each one of the two family types. [22] Recall that the estimation we get for the parameter β_1 captures the effect of PE on individuals from families with a low level of education, while the effect on those coming from families with a high education level is captured by the sum $\beta_1 + \beta_3$. The overall marginal effect is simply a weighted sum of these two effects, where the weights correspond to the fraction of individuals in each group.

The upper part of Table 3 shows a pattern that is consistent with the idea that higher public expenditure on primary and on secondary education is associated with lower poverty rates in adulthood. This association vanishes when we consider expenditure on tertiary education. The estimated marginal effects of total expenditure (Model 1), expenditure on compulsory education (Model 2), on primary education (Model 3), and on secondary education (Model 4) are all negative and significant at the 1% level except for total expenditure, which is significant only at the 5% level. The marginal effect of expenditure on tertiary education (Model 5) is not statistically different from zero. When we include separately expenditure at different levels (Models 6 and 7), we find that higher expenditure on primary and secondary education is again associated with lower adult poverty rates. Interestingly, in Model 7 we find that more expenditure on tertiary education is associated with a higher incidence of adult poverty. A possible explanation could be that expenditure on primary and, in particular, secondary education helps to redistribute income. Notice that this is a type of expenditure that benefits most individuals, since attendance at these levels is compulsory in most countries. On the contrary, since attendance in tertiary education is not compulsory, expenditure at this level concentrates on the richest segment of the society. Another explanation could be that, since public expenditure is computed when individuals are in their teens, they are most likely to be affected by expenditure on secondary education since this is the level of education they are currently attending.

To illustrate the size of the effects we obtain, we focus on Model 4 in which we only consider expenditure on secondary education. The estimated marginal effect is $-.0158$.

[21] Results remain unchanged after excluding observations with number of siblings above 19 and observations with youth unemployment rate above 75 (see Table 1). Results available upon request.

[22] In Section E of the Online Appendix we present a table with the estimated coefficients corresponding to Models 1 to 7.

Table 3 Overall marginal effects of public expenditure (15-17 years old)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
I. Baseline							
Total exp.	−0.0128**						
	(0.0065)						
Exp. in compulsory educ		−0.0322***					
		(0.0073)					
Exp. in primary educ			−0.0139***			−0.0126**	−0.0157***
			(0.0053)			(0.0054)	(0.0057)
Exp. in secondary educ				−0.0158***		−0.0159***	−0.0204***
				(0.0041)		(0.0040)	(0.0042)
Exp. in tertiary educ					0.0034		0.0096**
					(0.0046)		(0.0048)
Family educated	−0.0688***	−0.0684***	−0.0657***	−0.0688***	−0.0675***	−0.0687***	−0.0694***
	(0.0028)	(0.0028)	(0.0029)	(0.0028)	(0.0027)	(0.0028)	(0.0027)
Observations	138,512	139,807	141,701	140,053	144,349	139,807	138,512
II. Adding unemployment and its change							
Total exp.	−0.0185						
	(0.0114)						
Exp. in compulsory educ		−0.0399***					
		(0.0091)					
Exp. in primary educ			−0.0126			−0.0062	−0.0156
			(0.0102)			(0.0083)	(0.0094)

Table 3 (continued)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Exp. in secondary				−0.0250***		−0.0238***	−0.0288***
				(0.0049)		(0.0047)	(0.0050)
Exp. in tertiary educ					0.0039		0.0197**
					(0.0103)		(0.0090)
Family educated	−0.0732***	−0.0729***	−0.0711***	−0.0739***	−0.0724***	−0.0740***	−0.0745***
	(0.0032)	(0.0031)	(0.0033)	(0.0031)	(0.0032)	(0.0031)	(0.0031)
Observations	82,580	83,875	83,875	84,121	82,826	83,875	82,580

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the country-year of birth level. Source: EU-SILC 2005 and 2011, UNESCO Database and EU Labor Force Survey, Eurostat (see the Appendix for the variables definition)

Table 4 Decomposition of the marginal effect of public expenditure (15-17 years old)

	Total	Compulsory	Primary	Secondary	Tertiary
I. Baseline Models 1-5					
Educated family = 0	−0.0347***	−0.0510***	−0.0281***	−0.0322***	−0.0142***
	(0.0066)	(0.0076)	(0.0059)	(0.0041)	(0.0048)
Educated family = 1	0.0255***	0.0002	0.0103*	0.0126**	0.0344***
	(0.0073)	(0.0081)	(0.0059)	(0.0055)	(0.0053)
Observations	138,512	139,807	141,701	140,053	144,349
II. Baseline Model 6					
Educated family=0			−0.0135**	−0.0316***	
			(0.0066)	(0.0045)	
Educated family = 1			−0.0111*	0.0114*	
			(0.0065)	(0.0061)	
Observations			139,807	139,807	
III. Baseline Model 7					
Educated family = 0			−0.0144**	−0.0303***	−0.0021
			(0.0069)	(0.0047)	(0.0050)
Educated family = 1			−0.0181***	−0.0031	0.0300***
			(0.0069)	(0.0077)	(0.0065)
Observations			138,512	138,512	138,512

Note: Sample: Individuals for which the variable Per pupil expenditure in education is not missing. Source: EU-SILC 2005 and 2011 and UNESCO Database

This means that an increase of one standard deviation ($1,556) in expenditure is associated with a reduction of 0.61 percentage points in adult poverty. This is a sizable effect, since it represents a 5% of the mean value of the variable *poor* (the mean of *poor* is 0.1211). Nevertheless, this effect is dwarfed by the effect of having educated parents. In Model 4, we find that having educated parents is associated with a reduction of 6.75 percentage points in the probability of being poor, in line with what we saw in Table 2.[23]

In the bottom part of Table 3, we add two additional regressors. These are the level of unemployment in the region of residence when the individual was 16, together with the change in the unemployment rate since that moment till of survey response. These unemployment rates are computed from the European Labor Force Survey.[24] Data on unemployment rates are not available for all the country-cohorts we have in our sample. Because of this, using unemployment rates reduces our sample size from 140,053 to 84,121 observations in the case of Model 4. This means that the results are not directly comparable to those on the upper part of the table. In particular, we lose more than 50% of the observations from Austria, Finland, Hungary, Ireland, Norway, and Sweden. In terms of cohorts, we lose all observations from 1954 to 1957. In general, the inclusion of the unemployment

[23] Results are also similar if we use alternative definitions of parental education. In Section A of the Online Appendix we examine results by including instead separately two variables capturing both father and mother educational levels and also by defining three category dummies to capture three levels of educated parents instead of just two. We find very similar results.

[24] See the Eurostat website for an overview of the LFS: http://ec.europa.eu/eurostat/web/microdata/european-union-labor-force-survey

rate means that we give more weight to younger cohorts. In any case, we find that the results are very much in line with those in the upper part of the table. In particular, the effect of expenditure on secondary education is even stronger than what we obtained in the upper part of the table. We also find that now expenditure on primary education does not seem to be associated with a reduction in poverty rates.

Since the models we estimate contain an interaction term between expenditure and family type, this allows us to compute marginal effects separately according to family type. This is what Table 4 shows, for the baseline model that does not include unemployment rates. In the upper part of the table, we present the results corresponding to Models 1-5. Below, we present the results corresponding to models 6 and 7. The general pattern is that the effect that public expenditure has on reducing adult poverty concentrates mostly on individuals from families with low education. In models 1-6, we find that the effect of expenditure is associated with a reduction in poverty rates only for individuals with parents with low education. For instance, an increase in expenditure on secondary education of the size of one standard deviation is associated with a reduction of between 1.18 and 1.25 percentage points in the incidence of poverty in adulthood for children from low-educated families depending on the particular model considered.

It is very interesting what happens in Model 5. The marginal effect for individuals from non-educated families is negative and highly significant (-0.0142), while the one corresponding to individuals from educated families is positive and also highly significant (+0.0344). These two effects do not have similar sizes but do have opposite signs. This is the reason why in Table 3 we found no effect of public expenditure on poverty reduction, since the overall marginal effect we obtained (+0.0034) is just the weighted average of the two marginal effects in Table 4.[25] In Model 7, we get mixed results. Similar to Models 4 and 6, expenditure in secondary education has a stronger association with poverty reduction for individuals from low educated families than for individuals from educated families. Expenditure in primary education seems to have a stronger effect on individuals from educated families, in opposition to results in Models 3 and 6.

Finally, expenditure on tertiary education in Model 7 follows a similar pattern to what happens in Model 5. Once we disaggregate by family type, its correlation with poverty status is negative for individuals from non-educated families and positive for the other group. Focusing again on Model 4, an increase of one standard deviation in expenditure in secondary education is associated with a reduction of 1.24 percentage points in adult poverty for individuals from families with low education.

The general conclusion from Tables 3 and 4 is that higher public expenditure seems to be associated with lower adult poverty rates, although the effect seems to work through expenditure in primary and, in particular, secondary education. This finding is in line with previous results in the literature (see Mayer (2002) or Mayer and Lopoo (2008)).[26]

Next we estimate again all Models 1-7, but using expenditure when individuals were of ages 10 to 12. We do this to study whether the strong effect of expenditure on secondary

[25] The weights are the proportion of individuals from educated and non-educated families, in particular 0.3636 and 0.6364, for the observations used in the estimation of Model 5.

[26] As a robustness check, we regress poverty rates in adulthood on public expenditure from a different period than the one we are considering in our main specification. In particular, to each cohort from a given country, we randomly assign public expenditure corresponding to a different cohort from the same country. We find that the effect of public expenditure is not significant in most cases. Therefore, the actual measures of public expenditure are meaningful determinants of the variation of current poverty rates among individuals. See Online Appendix, Section F.

Table 5 Overall marginal effects of public expenditure (10-12 years old)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Total exp.	0.0050						
	(0.0074)						
Exp. in compulsory educ		−0.0085					
		(0.0101)					
Exp. in primary educ			0.0103			0.0146**	0.0115
			(0.0072)			(0.0073)	(0.0079)
Exp. in secondary educ				−0.0232***		−0.0232***	−0.0266***
				(0.0057)		(0.0055)	(0.0058)
Exp. in tertiary educ					0.0061		0.0086
					(0.0048)		(0.0057)
Family educated	−0.0710***	−0.0711***	−0.0679***	−0.0717***	−0.0694***	−0.0717***	−0.0720***
	(0.0028)	(0.0029)	(0.0030)	(0.0029)	(0.0027)	(0.0030)	(0.0029)
Observations	109,560	110,152	111,901	110,152	115,218	110,152	109,560

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the country-year of birth level. Source: EU-SILC 2005 and 2011 and UNESCO Database (see the Appendix for the variables definition)

education found in Tables 3 and 4 is due to the fact that most individuals aged 15-17 must be enrolled in secondary education. If that is the main reason, when using expenditure at ages 10-12 we should find a stronger effect of expenditure in primary education, since that is the level in which most individuals should be enrolled at that age. As mentioned above, results are not exactly comparable for two reasons. First, with this new measure of expenditure, we have fewer observations since now we lose all individuals born before 1959, while with our previous measures we had cohorts going back to 1954. In the case of Model 4, sample size drops from 140,053 to 110,152. Second, the sample we use with this new measure is much younger since we are excluding the five older cohorts. As Table 5 shows, expenditure on secondary education is still the one that has the strongest association with poverty reduction. Expenditure at the other levels does not display any correlation with poverty reduction.[27]

As a further illustration, we have used our results from Model 1 to compute predicted probabilities of being below the poverty line as a function of public expenditure for the two types of families. In particular, here we use our first measure of public expenditure, the one that combines expenditure at the three educational levels when individuals were of age 15-17 (Model 1). Figure 3 contains a plot of these probabilities. As can be seen in the figure, public expenditure seems to reduce the gap between the two types of families. However,

[27] Similar results are obtained while estimating Models 1-7 using expenditure at age 10-12 and age 15-17 on the same smaller set of observations. These results are not shown for conciseness but available from the authors upon request.

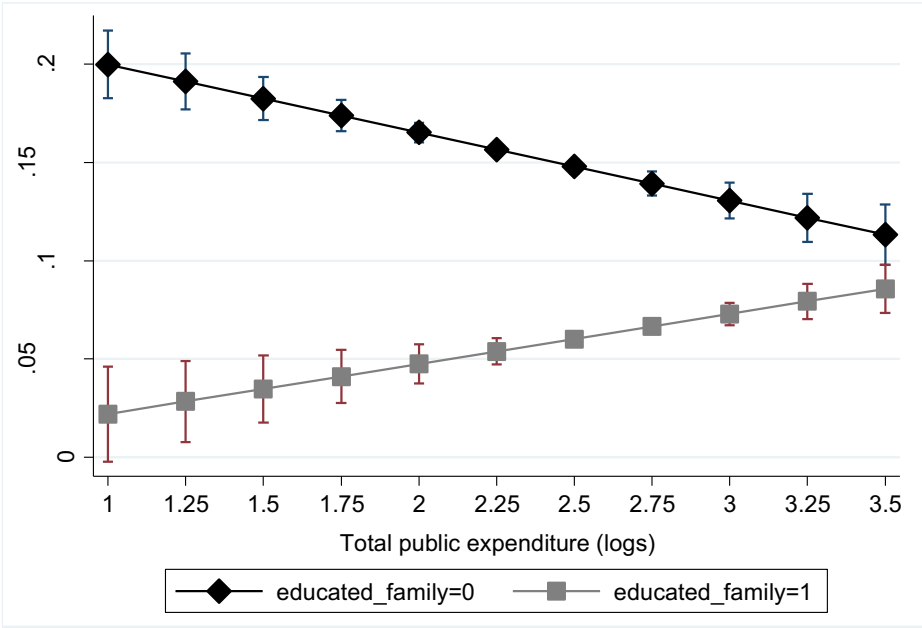

Fig. 3 Predicted effect of PE on poverty by family background

even at the 99th percentile of total expenditure, there is still a gap between the probabilities for the two groups.[28]

We see that the effect of public expenditure on poverty is negative among individuals from low educated families and positive among individuals with high educated parents. Therefore we can conclude that the negative relationship between public expenditure and poverty observed at the country level for individuals with parents with low education (see Fig. 2 above) still holds at the individual level.

Before closing this section, we want to comment briefly on the possible mechanisms behind the effect of public expenditure in adult poverty. There is a recent literature that points to the existence of a positive link between public expenditure on education and academic achievements. One possibility is that when we invest more resources in education, some individuals benefit because they acquire more education. In particular, they may decide not to drop out of school after finishing compulsory education. This, in turn, may reduce the probability of being below the poverty line when adults. Some recent studies provide evidence on the potential mechanisms from which these spending effects arise. For instance, Bhalotra et al. (2015) find that the removal of primary schools fees in developing countries is associated with roughly 0.2 more years of schooling. They also find that this effect is stronger for children of women with less schooling. Bellani and Bia (2016) use data from the 2005 and 2011 EU-SILC and find that exposure to poverty in childhood reduces the probability of completing at least secondary education by 12 percentage points. Finally, Jackson et al. (2016) find that spending increases are associated with sizable

[28]Predicted probabilities of poor at the 99 percentile of public expenditure are .085 for individuals from educated families and .113 for the other group. We reject the hypothesis that these two probabilities are equal (p-value is 0.0001).

improvements in measured school inputs, including reductions in student teacher ratios, increases in teacher salaries, and longer school years, which in turn improve individuals' adult outcomes.

5 Concluding remarks

Being raised in a poor household may have negative long-run effects on individual welfare. Here we study whether and to what extent these long-run effects of poverty are mitigated by public expenditure.

Our main finding is that public expenditure has a strong long-run effect on reducing the incidence of poverty in adulthood. In addition, we find that this effect concentrates mostly on individuals who were raised in families with a low level of education. This result suggests that public expenditure increases intergenerational income mobility.

We believe that our results could be relevant for several recent debates in the literature on the economics of education. In particular, they lend support to policies that promote increasing expenditure on basic education, for example, by reducing the compulsory school entry age, or by improving the quality of the education provided at early stages.

This study has several limitations. The most important one is the lack of a source of plausibly exogenous variation in public expenditure, implying that the estimated coefficients may reflect the effects of other unobserved factors correlated both with expenditure and with adult poverty status. The inclusion of several controls that capture country-specific time trends may help to mitigate this concern. Another relatively minor concern is that we do not have a direct measure of government investment in education and thus we follow previous research in using government spending as a proxy for government investment (see Mayer and Lopoo (2008)). However, public expenditure could be an imperfect measure of actual investment. For example, countries that spend similar amounts might be spending it differently and having different results with the same level of expenditure depending on several other circumstances. Moreover, we lack data on private expenditure on education, although some of the variables describing household characteristics can be seen as proxies of such expenditure.

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Appendix: Variable Description

- *Expenditure per student, primary, secondary and tertiary*: Public expenditure per student is the public current spending on education divided by the total number of students at that level. Public expenditure (current and capital) includes government spending on educational institutions (both public and private), education administration as well as subsidies for private entities (students/households and other privates entities). Data are in constant 2000 U.S. dollars, and are corrected by PPP. Sources: United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics and PPP data are from the World Bank.

- *GDP per capita*: It is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2000 U.S. dollars and are corrected by PPP. Source: World Bank national accounts data, and OECD National Accounts data files.
- *Educated family*: A dummy variable that takes value 1 if either the education the father or mother had attained when the individual was around 14 years old is at least upper secondary education. Source: EU-SILC
- *Father unemployed*: A dummy variable that takes value 1 if the father was unemployed when the individual was 14 years old. Source: EU-SILC.
- *Siblings*: It is the number of siblings the individual's had when he/she was around 14 years old. Source: EU-SILC.
- *Citizenship*: It generally corresponds to the country issuing the passport. It refers to current (at the time of survey) national boundaries. It is a dummy variable that takes value 1 if citizenship corresponds to the country of residence. Source: EU-SILC
- *Inequality*: It is the country average inequality during the previous years (3-5) to the period of individual's primary school attendance. Source: Estimated Household Income Inequality Data Set (EHII), which is a panel of estimated Gini coefficients. The EHII is a global dataset on inequality derived by the University of Texas Inequality Project (UTIP)
- *Unemployment rate*: It is the regional (at the level of NUTS-2) youth unemployment rate in the region of residence when the individual was 15-17. Source: EU Labor Force Survey, Eurostat and US Bureau of Labor Statistics, International Comparisons.
- *Single mother*: It is a dummy variable that takes value 1 if the individual lived with only his mother when he/she was around 14 years old. Source: EU-SILC.
- *CS2011*: It is a dummy variable that takes value 1 if the observation belongs to the 2011 cross section. Source: EU-SILC.

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