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Public education provision, private schooling and income redistribution

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Abstract Availability of free public education induces a transfer in kind among households with school age children. We provide evidence of the redistributive character of public education provision. We estimate structural quantile treatment effects of household income on the distribution of expected educational transfers in kind. Under the assumption that education quality is a normal good, better services (ancillary to the core education mission) supplied by private schools increase quality therein and reduce the incentives for wealthy households to enroll in public education. Because of these incentives, rich families benefit less from educational transfers in kind and the public education system is redistributive. Using household survey data from Italy, we find that an increase in net income reduces the value of the expected educational in kind transfers for compulsory education.

Keywords Public education provision · Sorting · Structural quantile treatment effects · Redistribution · Inequality

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1 Introduction

In many countries public education provision and free accessibility to compulsory education are fundamental constitutional rights. Public education provision accounts for a substantial share of the public budget in countries with developed welfare states.[1] Several reasons justify this spending: among them, a redistributive motive (Boadway and Marchand 1995; Aaberge et al. 2010, 2013).

A government with redistributive intents could subsidize the education of children from low-income households through a cash transfer. The transfer would allow these households to buy the quantity and quality of educational services they prefer on the market. Alternatively, educational services can be publicly provided at no admission costs, inducing a *transfer in kind* to households with children in school age who decide to benefit from free education availability. The presence of informational asymmetries on household income, however, makes it difficult to establish who is really poor and deserves to be supported, financially or in kind. Granting universal access to free education offers alternatives to the targeting issue. The redistributive implications of universal provision is, nonetheless, unclear.

The objective of this article is to test if universal availability of public education acts as a transfer in kind that redistributes income (i.e. is inequality-reducing) across households with school age children. Following Lambert (2001, p. 269) a transfer (in kind) is redistributive when it is regressive, i.e. when the share of the transfer to household income decreases with household income. Universal take-up of public education would induce a lump-sum transfer in kind across all households, which is inequality-reducing as long as high-income households contribute more (through taxes) to financing eduction compared to low-income households. However, high-income households are generally more likely than low-income households to consume educational services in upper-secondary education, implying a potential positive association between the educational transfers in kind and household income, which harms redistribution. Furthermore, universal coverage can deteriorate the quality of the service (at fixed budget), and hence the size of the transfer. Alternative mechanisms can ensure the redistributive nature of public provision of education in the presence of a market for private schooling.

Consider the case in which there are informational asymmetries about household income, and preferences for educational quality are homogeneous across households, valuing education quality as a normal good. In this situation, redistribution can be always achieved if public education provision is designed in such a way that high-income households with children in education find it optimal to sort out of the public system and purchase the educational services in the private market at their preferred quality. The mechanism formalized by Besley and Coate (1991) produces situations in which universal availability of public education can induce a regressive transfer in kind by imposing costs on households opting for free public education. These costs take the form of restrictions on the quality of education produced by the public sector (Currie and Gahvari 2008). The lower the quality, the higher the incentive for the high-income households to sort out of the public education system, while still contributing to financing education through taxes (Besley and Coate 1991; Blackorby and Donaldson 1988; Gahvari and Mattos 2007).

[1] See, for instance, the 2017 OECD's report "Education at a Glance".

Quality of education is, nonetheless, multidimensional in nature.[2] Private and public sectors may differentiate the quality provision of education along different lines, reflecting underlying heterogeneity in households motives to opt for expensive private schooling in presence of freely available public education.[3] The quality costs advocated by the Besley and Coate mechanism need not to be related to quality of core educational services (especially in compulsory education, where quality standards are set by central governments), but rather can refer to additional services that only private schools offer expensively.

The sorting mechanisms illustrated above implies regressivity: given preferences for education quality, households with higher income prefer to consume less public education and opt for private provision, implying decreasing transfers in kind; given household income, households with higher preferences for education quality are more willing to accept the opportunity costs of foregoing public education and opt out for private education provision. We investigate evidence of this mechanism on the data by quantifying the sign and size of the structural quantile treatment effect (Ma and Koenker 2006; Chernozhukov and Hansen 2006) of an exogenous increment of household income (equivalized by families needs) on the educational transfers in kind accruing to the households with children in education. Identification of the desired effect relies on an instrument for household income, which is related to heterogeneity in expected tax deductions across households. We allow the desired affects to vary along the distribution of transfers in kind (which identifies opportunity costs of foregoing public education, and hence reveals information about preferences for quality) and along the distribution of household income. We are hence able to recover the effect of household income while holding household preferences and income (and their correlation) as fixed.

The analysis is developed for the Italian case. We derive a monetary measure that values the educational transfers in kind accruing to the households who decide to benefit from the inexpensive provision of educational services from the public sector. We make use of a study carried out in 2003 by the Italian National Institute for the Evaluation of Education System (INVALSI) and the Consortium for the Development of the Methodologies and Innovations of the Public Administrations (MIPA), (INVALSI-MIPA 2005), to microsimulate the educational transfers in kind accruing to the household. We also use SHIW database (wave 2004) by the Bank of Italy to collect information on income and other characteristics of a representative sample of Italian households with children in education (either compulsory or post-secondary).

In the largest sample, we find evidence that household income has an effect on transfers in kind. For given preferences for educational quality, an exogenous increment in household income *decreases* the transfers in kind accruing to the household, implying a redistributive impact of public education provision. The size of this effect is smaller, in magnitude,

[2]Cellini et al. (2010) emphasize that evaluation of public education investments should account for academic and non-academic features of education provision, as both dimensions are valuable to household. Their identification strategy relies on the fact that household preferences towards quality of public education are revealed by changes in household residential decisions, which in turn produce general equilibrium effects on housing prices (see also Bayer et al. 2007).

[3]Such motives include: support of common values, such as religion (Sander 2001) and status symbol (Fershtman et al. 1996); regard for social composition of schools and peers' socio-economic conditions (Zimmer and Toma 2000); interest in the long-term implications of education, such as the ability of private schools to produce economic advantages for their students (Green et al. 2012); as well as demand for educational inputs, such as the student-teacher ratio (Checchi and Jappelli 2003).

for households with greater income. For given household income, we also find evidence of negative effects, which increase in magnitude along the distribution of transfers in kind. Consistently, households with larger preferences for education quality (hence facing larger opportunity costs) are also more responsive to changes in income, implying larger likelihood to sort into private education provision and fostering redistribution. These findings hold when estimates are restricted to households with children in compulsory education, as well as across a variety of robustness checks. Results do not hold for the sample of households with children in post-compulsory education, where sorting across private and public provision is sequential to the choice of further investing in education. Furthermore, there is evidence that the quality of upper secondary education in private institutes in Italy might not be larger than the quality in public schools, thus implying that sorting behavior leverages on different incentives.[4]

The rest of the paper is organized as follows. Section 2 illustrates the role of household sorting into private and public education on household income redistribution, and provides a description of the Italian institutional framework. Section 3 describes the empirical strategy: method, data, the microsimulation exercise on the educational transfers in kind, descriptive statistics and our instrument. Results and the discussion are reported in Section 4. Finally, Section 5 concludes.

2 Public education provision as a transfer in kind

The objective of this article is to assess the effect of household income on the transfer in kind accruing to the households with children in education. The sign and size of the effect is informative of the redistributive nature of the transfer in kind. A simple regression of the value of education transfers in kind on household income masks different channels through which income affects transfers. For instance, households are generally not comparable in terms of demand for education. Childless households do not demand educational services, but pay taxes that are used to finance public provision of education. Also, households with many children in school age receive a proportionally larger transfer than households with the same income but fewer children. We control for these differences by focussing on households with children and we use equivalence scales to make households comparable in terms of demographics. Furthermore, households may differ in demand of compulsory and post-compulsory education, depending on parents human capital and expected returns from local labor markets. These channels can be controlled for by including demographic and human capital controls as long as macro-area fixed effects.[5] For a group of otherwise comparable households, the effect of household income on transfers in kind depends on the sorting incentives, which are driven by heterogeneity in income and preferences for education quality. We first show with a simple consumption model how these two sources of heterogeneity interact to determine sorting behaviors, and what implications this has for testing redistributive

[4]We motivate in Section 2.2 that private and public provision of education in Italy differ by the quality of ancillary services they offer, while the quality of core (teaching-related) services is rather homogeneous across provision status, at least at compulsory schooling level. Evidence suggests that demand for upper secondary private education in Italy is mainly driven by a remedial scope for less talented children coming from rich households (Bertola et al. 2007; Bertola and Checchi 2013).

[5]We control for macro-area (North, Center and South) fixed effects rather than regional effects (NUTS2) to be parsimonious in the number of geographical dummies given the limited size of the sample. However, results are robust to the inclusion of regional controls.

effects of educational transfers in kind. Then, we motivate the interest in performing the empirical exercise on Italian data.

2.1 Theoretical background

If the household's income is observable and preferences are homogeneous, a first best allocation of educational resources can be achieved by producing education in the public sector at the quality level that would have been chosen by the poor households if they had to buy the educational good on the market and their income was complemented by a positive cash transfer. This transfer would leave the poor household indifferent between receiving one extra euro in cash and one extra euro worth of the publicly provided educational good (Currie and Gahvari 2008). When households income is not observable, the relevant self-targeting mechanism (see Besley and Coate 1991) can achieve the redistributive goal by imposing some costs, related to quality of education, on the intended recipients. Nevertheless, if households value multiple dimensions of educational quality, it is sufficient that the quality level of public education provision is fixed in such a way to guarantee budget balance and to still offer the quality of core educational services that would be equivalently supplied in the market.

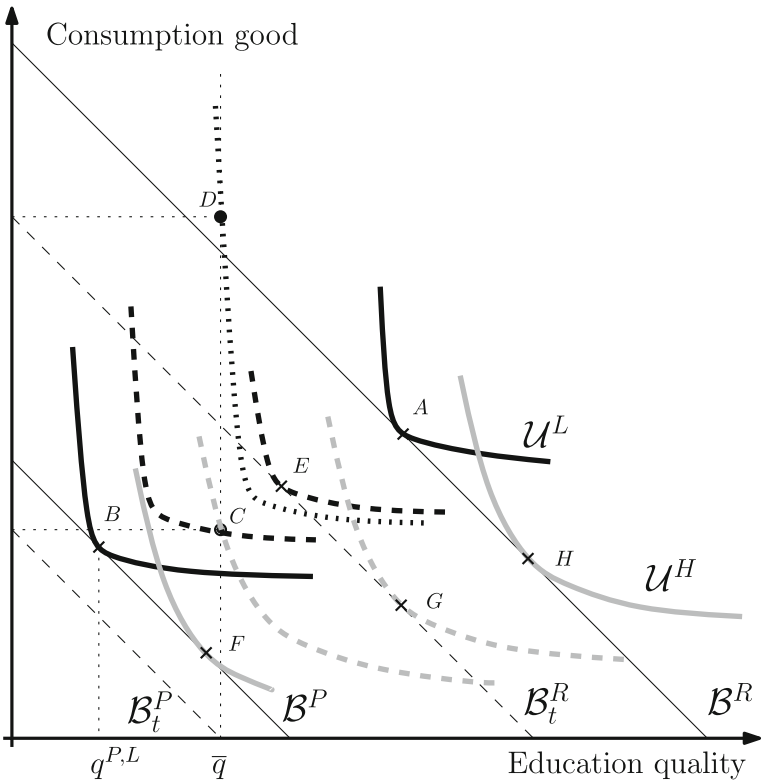


Fig. 1 Sorting and heterogeneity in household preferences (black and gray indifference curves) and in income capacity (solid and dashed budget lines)

Consider first the case with two households with homogeneous preferences over consumption of a composite good and of educational quality for their children in compulsory schooling age.[6] Their preferences are denoted $\mathcal{U}^L$ to indicate that these households display low preferences for education. There is inequality in income capacity: a household has a high income implying budget $\mathcal{B}^R$, while the other household has low income implying budget $\mathcal{B}^P$. Indifference curves and budget sets for these households are represented by bold solid curves and lines in Fig. 1. The budget sets are obtained under the assumption that the relative price of consumption over the price of private education is $p = 1$.

At the optimum, the poor household purchases education quality $q^{P,L}$ (point B). The government can implement a redistributive transfer in kind by providing public education for free at a sufficiently high quality $\overline{q}$ (which is larger than $q^{P,L}$). The provision is financed through a flat-tax regime with rate t, such that $\gamma p\overline{q} = t(\sum Income)$, where γ is the number of people benefitting from public education provision. In the example, we set t below 50%, implying that post-tax budget constraints for private school consumption respectively shift to $\mathcal{B}_t^R$ and $\mathcal{B}_t^P$ (dashed lines in the figure).

The government can redistribute in kind by implementing a public education system that redistributes resources across households. When $\overline{q}$ is produced, the poor household can save a sufficiently large amount of money to consume all her post-taxes income and rise education quality consumption. Education provision induces a welfare gain for this household (which moves from B to C). The level of quality in education guarantees budget balance and is such that the rich household (also with preferences $\mathcal{U}^L$) is better off when buying education from the private sector and foregoing the transfer in kind, while paying taxes to finance public education provision. In fact, welfare in E is larger than in D for these households.

Households may have heterogeneous preferences for education. Consider now a second type of households with high intensity preferences for education quality, denoted $\mathcal{U}^H$ in Fig. 1. For these households, take up and self-selection constraints are not binding: the poor household can enjoy larger quality thanks to public provision, implying a lower opportunity cost for spending on consumption good (C preferred to F), while the rich household is better off in resorting on the market (G preferred to D).

In general, we expect the impact of household income on educational transfers in kind to be negative (since education is a normal good), implying redistribution. The simple model in Fig. 1 shows that the degree of redistribution of household income is determined by heterogeneity in households' preferences for educational quality, by heterogeneity in households' income capacity, and by the correlation between these two forms of heterogeneity. On the one hand, the magnitude of the effect of interest increases with intensity of preference for education quality when holding household income capacity as fixed (which is the case if education is a normal good and opportunity costs for foregoing consumption decrease in household preferences for education quality). On the other hand, the magnitude of the effect declines with household income capacity when holding quality preferences as fixed (which is the case if high income households face lower opportunity costs in foregoing free public education in favor of expensive private provision).

We now motivate that the Italian case is well suited for assessing redistributive effects of education when differences in provision among public and private matter for the quality of educational services that are not at the core of the educational activities.

[6]We assume that each household consumes an indivisible unit of educational services (no top-up option available) that can be purchased on the market or obtained for free through public education provision.

2.2 Institutional framework: public education provision in italy

The Italian education system is organized in five cycles: kindergarten (ISCED 0), primary school (ISCED 1), lower secondary school (ISCED 2), upper secondary school (ISCED 3), and tertiary education (ISCED from 5 to 8). In 2004, the year to which our data refer, Italian children have the right/duty to attend school up to 14 years old (from 2000 to 2003 was up to 15 years old).

The education system has both public and private components of provision. Public education is free (at compulsory schooling level) and centrally financed.[7] Private schools can be either *certified* by the Ministry of Education ("scuole paritarie") or completely independent. Certified schools have to meet specific criteria established by national rules; in return, they are allowed to issue certificates with the same value of public schools. In 2004 around 95% of all Italian students were enrolled in public institutions: the percentage was slightly lower (93%) at primary and tertiary education levels and higher at lower secondary education level (97%). Remaining students generally attend independent private institutions; only at upper secondary education level there is a non-insignificant proportion of students attending government dependent private institutions.[8] Only a small proportion of families opt for private schooling. The evidence based on the Italian case is hence instructive of the lower bound of the redistributive effect of public education provision for those countries where demand for private education is more pervasive.

From the public finance perspective, 96% of all resources spent for schools (from primary to upper secondary) in Italy is publicly funded, and households pay the remaining 4%. Only at tertiary education level, the private component raises up to 30% due to the application of tuition fees which vary across universities and which are related to households income.[9] The central government accounts for more than 80% of public expenditures on education, while the remaining 20% is financed at local level (regions, provinces, municipalities). Expenditures on *core services*, such as teachers' salaries, school buildings, teaching materials, books, administration of schools represent about 96% of all expenditures, slightly more than EU average (94%). Among such services, teachers' and technical/administrative staff salaries are fixed by nationally centralized bargaining procedures, and do not vary across regions (but vary across educational levels). Remaining expenditures are on *ancillary services*. OECD defines ancillary services as "services provided by educational institutions that are *peripheral* to the main educational mission" and distinguishes among two main components: student welfare services and services for the general public.[10] The former include meals, school health services, transportation to and from schools at school level (ISCED 0-3); dormitories, dining halls and health care services at tertiary education level. Services for the general public cover for instance museums, technology projects with computer activities providing beginners with basic knowledge of computer fundamentals, radio and television broadcasting, sports, recreational and cultural program. In public schools day or evening childcare (at pre-primary and primary school level) is not included as an ancillary service while it is generally granted by private institutions.

[7] Article n.34 of the Italian Constitution explicitly states that public schools are open to everybody and compulsory schooling is free.

[8] OECD, Education at a glance, Archive database. An institution is defined as *government-dependent private institution* if either receives 50% or more of its core funding from government agencies or its teaching personnel are paid by government agency.

[9] OECD (2007), Education at a glance, table B3.1, B3.2a, B3.2b

[10] See Education at a Glance, OECD, Paris, 2002, Glossary.

In the Italian public education system ancillary services are mainly supplied (and financed) at local level: by municipalities and provinces at ISCED levels 0-3, by regions at tertiary education level. In the balance sheets of the Italian municipalities, for instance, education expenditures are clustered in 6 types: pre-primary education, schools (ISCED 1-3), tertiary education, technical non tertiary education, financial services to students to guarantee the right to education, and finally auxiliary services which correspond to the "complementary educational services" defined above. Among core services municipalities and provinces are instead responsible of the maintenance, renovation and construction of school buildings respectively for schools at ISCED level 0-2 (municipality) and at ISCED level 3 (provinces).

The so-called *Patto di Stabilita' Interno* (Domestic Stability Pact), implemented since 1999, imposes a severe budget constraint for local governments to be satisfied. Each year municipalities must achieve targets set out by the central government in terms of zero or limited growth of the fiscal gap (in year 2004 the rule was zero growth with respect to its value two years before), consistently with the targets of the European stability pact for Italy.[11] An important implication of this institutional arrangement is that local governments might be constrained in the quantity (and quality) of educational ancillary services but not on the quality of core services (except for school buildings quality) they can offer. Private schools, which are financed by imposing school fees to households and do not depend on public financing, can be hence competitive in terms of the quantity and quality of non-core services offered.

Italy is an interesting case study since budget constraints affecting the public provision should not undermine the educational achievements of students enrolled in public schools, compared to those attending private schools. The survey that aims to test the skills and knowledge of students at primary and lower secondary school (INVALSI) does not evidence differences between public and private schools. Significant differences emerge across localities, with Northern Italy schools performing on average better than Southern schools. Results show a remarkable heterogeneity within the public school system.[12] At upper secondary school level, PISA data show that students enrolled in private schools have, on average, poorer performances compared to students enrolled in public schools, unlike in the most OECD countries.

Altogether, evidence suggests that core educational services coincide in public and private schools in Italy, although the latter differ from the former in the quality and intensity of ancillary services they provide. Households with high preferences for education quality and/or large income capacity may sort across education provision on the basis of quality of ancillary services offered therein. The next section devises an empirical strategy for tackling with these inequalities.

[11] In 2001 the fiscal rules were relaxed for municipalities below 5.000 inhabitants. However, on the one hand, only 17% of the Italian population resides in very small municipalities. On the other hand, as illustrated by Grembi et al. (2016) unconstrained municipalities increased deficits by reducing taxes rather than varying expenditures. Moreover, since 2001 the new article 119 of the Italian Constitution made bailouts unconstitutional by forbidding the central government to help local governments in distress.

[12] If students' performance, especially of those with poor family backgrounds, is positively related to the time spent at school, the lower diffusion of all-day public schools ("scuole a tempo pieno") in Southern Italy can be one of determinants of poor performance in this area. Lower average income of households residing in Southern Italy furthermore prevents families to recover to private schools to compensate for the low diffusion on public schools offering a full-day schedule.

3 Empirical strategy

3.1 Structural quantile treatment effect estimation

We apply the control variate approach by Ma and Koenker (2006) (see also Chesher 2003) to exogenously manipulate the household income distribution and to estimate the structural quantile treatment effects of exogenous variations of income on the distribution of the educational transfers in kind accruing to the households. To identify such effects, we build on the intuition that quantiles of the educational transfers in kind distribution and of the income distribution are informative of the households' preferences for educational quality and income capacity. In this way, we can estimate the desired effects while holding, one at a time, these two dimensions of heterogeneity (and hence their correlation) as fixed.

Consider the quantile functions of the response variable, the educational transfers in kind, denoted Q_K, and of household income, denoted Q_Y.[13] We assume that the two quantile functions are related by the following structural relations:

$$\begin{aligned} Q_K(\tau_K|Y, \mathbf{x}, \nu_Y(\tau_Y)) &= g_K(Y, \mathbf{x}, \nu_Y(\tau_Y); \alpha(\tau_K, \tau_Y)) \\ Q_Y(\tau_Y|z, \mathbf{x}) &= g_Y(z, \mathbf{x}; \beta(\tau_Y)), \end{aligned}$$

where $\mathbf{x}$ are covariates and $\nu_Y(\tau_Y)$ is the control variate, corresponding to the residuals of a set of income quantile regressions. In the equations, τ_Y and τ_K identify the quantiles of the distributions of income, Y, and educational transfers in kind, K, while α and β are the structural parameters. In particular, α depicts the effect of a marginal increase in income on the value of educational transfers in kind accruing to the household, calculated at pre-determined quantiles of both income capacity and preferences for educational quality. The variable z is an *instrument* for income. It induces exogenous variations in income that are independent from the unobserved components that jointly determine incomes and educational transfers in kind accruing to the household.

Conditioning on the estimated control variates $\hat{\nu}_Y$ (whose coefficient can be interpreted as the degree of endogeneity of the income variable) the parameters of the structural equation solve the following minimization problem:

$$\hat{\alpha}(\tau_K, \tau_Y) = argmin_\alpha \sum \sigma_K \cdot \rho_{\tau_K}(K - g_K(Y, \mathbf{x}, \hat{\nu}_Y(\tau_Y); \alpha))$$

where σ_K are strictly positive weights and the function ρ_{τ_K} is the check function as in Koenker and Bassett (1978).

Following Ma and Koenker (2006), we focus on parametric identification of the structural parameters based on a linear model for conditional quantiles of the form:

$$K = \alpha_0 + \alpha_1 Y + \mathbf{x}_h \cdot \alpha_2 + \mathbf{x}_{hh} \cdot \alpha_3 + \mathbf{x}_r \cdot \alpha_4 + u, \tag{1a}$$

$$Y = \beta_0 + \beta_1 z + \mathbf{x}_h \cdot \beta_2 + \mathbf{x}_{hh} \cdot \beta_3 + \mathbf{x}_r \cdot \beta_4 + U. \tag{1b}$$

In the specification we control for the following observables: $\mathbf{x}_h$ are household characteristics including the number of earning recipients, dummies for the area of residence of the household and a trend related to the cohort of birth of the first child; $\mathbf{x}_{hh}$ are characteristics of the head of the household including gender (i.e. if female), age, age squared, years of schooling; $\mathbf{x}_r$ are local market conditions measured by the regional GDP per head and the unemployment rate.

[13] In what follows, we use capital letters to indicate distributions, while bold letters refer to either vectors or matrices.

We assume a general model with a flexible specification of the error term u in Eq. (1a) where income is allowed to influence both the location and scale of the educational transfers in kind distribution. These considerations lead to formulating the error term in Eq. 1a as a linear transformation of income: $u = (\lambda \nu_Y + \nu_K)(Y\psi + 1)$ and $U = \nu_Y$, where ν_K and ν_Y are independent of one another and *i.i.d.* over households.

The model is estimated in two steps. The first step consists in running a set of quantile regressions of Eq. (1b) at given quantiles of Y. The set of estimates $\widehat{\beta}$ identifies the distribution of $\nu_Y(\tau_Y)$, our control variate, for every reference quantile τ_Y. The second step consists in running a set of quantile regressions of Eq. (1a) at finite quantiles of K, controlling for $\widehat{\nu}_Y(\tau_Y)$. The estimated effects $\widehat{\alpha}$ vary therefore in both τ_K and τ_Y dimensions. We produce estimates and run tests at all deciles (from 10% to 90%) of the distributions K and Y.

3.2 SHIW data and sample selection criteria

We use household data from the 2004 wave of the nationally representative Survey on Households Income and Wealth (SHIW), conducted in Italy every two years by the Bank of Italy. SHIW provides information on net incomes, savings and characteristics of a representative sample of Italian households. We use microsimulated gross incomes and personal income taxes to compute household net of taxes income[14], in this way we can limit the saliency of tax evasion[15] among self-employed workers and reduce the role of informational asymmetries on the household income capacity estimated from observed incomes. Individual data are collapsed into household income, providing a sample of 8,004 households with positive incomes. Throughout the paper, we maintain the (rather strong) assumption of classical measurement error for microsimulated incomes.

The working sample is selected to include households with children aged 3 to 23 years old.[16] As a result, the sample is reduced to 2,495 households with children born between 1981 and 2001. Out of the selected sample, we drop only the lower and the upper 1% of the distribution of the age of the head of the household to attenuate the life-cycle effect related to parents' aging. Our estimating sample comprises households whose head is aged 30 to 71 at the time of the survey (i.e. individuals born between 1933 and 1974). This cut shrinks the working sample to 2,435 household, after eliminating 11 observations because of missing information on the educational level of the spouse.

To account for scale economies within the household, we equivalize household income using the EU equivalence scale, which employs different scale factors for children and adults.[17] The equivalent (net) income in the working sample from SHIW ranges from 95 to more than 360,000 euro, with an average of 12,942 euro per household. About 80% of

[14]Microsimulated gross incomes have been kindly provided by Carlo Fiorio. We have also replicated our analysis using the net of taxes income provided by SHIW which relies on households' reported values and do not consider tax evasion. Results are qualitatively similar and can be provided by the authors upon request.

[15]In Italy tax evasion is a relevant issue. According to estimates of the Italian Ministry of Economy and Finance (Annual Report on Fiscal Evasion, 2014), the overall tax gap accounted for around 8% of GDP in the period 2001-2006 (7% in the following five years). Roughly half of the tax evasion concerns direct taxation.

[16]University tracks in the Italian education system have variable lengths, from 3 to 6 years. To avoid selection into achievement, we exclude from our working sample households with children aged more than 23. This age can be conceived, in the majority of cases, the minimum age required to complete a university course degree.

[17]The EU scale assigns a weight equal to 1 to the head of the household; equal to 0.5 to the other household components, including the spouse and children older than 14 years old, and equal to 0.3 to children under 14 years old, (see Aaberge et al. 2013).

Table 1 Descriptive statistics

	Mean	Std. Dev.	Min	Max
Income	12,942	12,311	94.76	360,002
Hh components	3.86	0.92	2.00	9.00
Income recipients	1.77	0.68	1.00	3.00
Prob. enroll. pub. sch.	0.93	0.08	0.51	1.00
Inkind Overall (Euro)	3,726	2,023	0.00	10,214
Inkind Comp. (Euro)	2,241	2,462	0.00	10,214
Inkind Sec. (Euro)	1,021	1,539	0.00	6,747
Inkind Univ. (Euro)	361	831	0.00	6,806
Exp. Max. Tax Deductions	3,927	958	1,318	5,537
Children, tot	1.88	0.79	1.00	7.00
Children studying (Comp.)	0.56	0.72	0.00	3.00
Children studying (Sec.)	0.43	0.61	0.00	4.00
Children studying (Univ.)	0.20	0.44	0.00	2.00
Hh head, female	0.33	0.47	0.00	1.00
Hh education (years)	10.40	3.76	5.00	19.00
Hh head, age	46.25	7.82	30.00	71.00
Sample Size	2,435			

Sources: *SHIW*, Bank of Italy, wave 2004; microsimulated educational transfers in kind using INVALSI-MIPA data, 2003; household gross income and personal income taxes kindly provided by C. Fiorio

observed incomes are between 4,495 and 22,883 euro. Additional descriptive statistics are reported in Table 1.

3.3 Transfers in kind: definition and imputation rules

The evaluation of educational transfers in kind accruing to the household is an empirical demanding exercise, as their data availability is generally limited. We make use of a unique study by INVALSI-MIPA (2005) based on year 2003 data to compute the monetary equivalent of the educational transfers in kind accruing to each child in education. This amount, denoted $AC(r, e)$, is equal to the average cost of producing the public educational services, and is allowed to vary across Italian regions r, and educational levels e. Such monetary value summarizes the information provided by a variety of indicators representing costs of producing educational services in a given region and grade. The most relevant of these indicators is the students-teachers ratio (INVALSI-MIPA 2005).

We merge information on average costs with the data in SHIW. We treat as recipients of the transfers all children in a household who are aged between 3 and 5, and those aged 6 to 23 who classify themselves as *students* in the survey. Unfortunately, we do not observe the type of school (either private or public) attended by the students. We are aware that this data limitation has some implications on the use of our method, which requires that the response variable has to be perfectly observable.[18]

[18] In the Online Appendix we present several robustness checks based on various subsamples, using a different equivalence scale and introducing a measure of family background. In all cases, the significance and direction of the effects is preserved.

We assign to each student the average cost of production of the public educational service. This cost is then weighted by the probability the student has to benefit of public education, denoted by $\omega(g)$, where g refers to a given household group. To calculate $\omega(g)$, we make use of data from the Multiscopo Survey issued by ISTAT in 2005. The survey collects information on the presence of a child enrolled either in a private or in a public school but it does not provide information on households' income. Data and methods are carefully described in the Online Appendix of this article.

The monetary value of the *expected* educational transfer in kind associated to each child c in household h of type g, who lives in region r and who is in educational level e is therefore denoted:

$$k_c := \omega(g) \cdot AC(r, e). \tag{2}$$

According to the imputation rules, two children in education who live in the same region, attend the same educational level and come from households in the same group, receive an equal expected value of educational transfers in kind.[19]

The educational transfer in kind accruing to the household h corresponds to the sum of the transfers received by each of the children in education living in the household. This quantity is denoted:

$$k_h = \sum\nolimits_{c \in h} k_c. \tag{3}$$

To achieve comparability among households with different educational needs, related to the fertility and the timing of fertility of the families, we scale k_h by the needs-adjusted equivalence scale (see Aaberge et al. 2010, 2013), which allows to calculate the amount of educational transfers in kind per equivalent child enrolled at schools.[20] Educational transfers in kind towards children in post-compulsory schooling age that are not in education is set to $k_c = 0$. The average equivalized educational transfer in kind corresponds to 3,726 euro. For compulsory education, the average transfer in kind amounts to 2,241 euro, and its variability is considerably higher than for transfers related to the other educational levels (see Table 1).

3.4 Identification strategy: instrumenting income with expected tax deductions

To assess the impact of household income on educational transfers in kind distribution it is necessary to single out a change in income that is independent from the household income capacity (i.e. the error term of Eq. (1b)) and household preferences for educational quality (i.e. the error term of Eq. (1a)). Our identification strategy does so by controlling for these two components, and for their correlation, in a control variate setting. An instrument is, therefore, needed. We exploit heterogeneity in expected tax deductions accruing to the household h, denoted z_h, to exogenously manipulate the distribution of income in order to disentangle the effect of such manipulation from the co-movements of the errors distribution.

[19] For instance, within a region, the expected educational transfers in kind may take 30 different positive values, 5 educational levels times 6 different probabilities of attending public schools, and a zero value for those in post-compulsory schooling age who choose stop studying.

[20] The Simplified Needs-Adjusted equivalence scale (SNA) calculated by Aaberge et al. (2013) for year 2006, the closest to year 2004, amounts to assign to all household components other than children a weight of 0.5, and to each child different weights according to her age: from 3 to 5 years old, 0.3; from 6 to 13, 0.66; from 14 to 23, 0.93. In the Online Appendix we show that baseline estimates are not sensitive to changes in the equivalence scale.

Description of the instrument For each household member[21] $m = 1, \ldots, M_h$ of the household h, we calculate the expected value of the maximum tax deductions that member m is entitled to as a weighted average of the four maximum tax deductions fixed by the law in 2004 (denoted d_i with $i = 1, \ldots, 4$). There are four levels of tax deductions: 7,500 euro for employed workers, 4,500 euro for self-employed workers, 7,000 euro for retired workers and 3,000 euro for the residual category, comprising, for instance, house owners.[22] We assume that the probability that household h claims any of the four deductions depends on two exogenous characteristics, the age a_m and gender s_m of the household member m, and is denoted $\psi_i(a_m, s_m)$. We compute these probabilities from ISTAT (2003) using the one-year lagged value of the observed frequencies of the distributions of the Italian population of employees, retired persons and self-employed workers given age class and gender.[23] The overall amount of deductions accruing to the household is the sum of the expected benefits that each member of the family is entitled to. These potential deductions at the household level are then scaled by the household size, M_h, thus giving:

$$z_h := \frac{1}{M_h} \sum_{m=1}^{M_h} \sum_{i=1}^{4} \psi_i(a_m, s_m) \cdot d_i. \tag{4}$$

Equation (4) defines the instrument for income. For each household's member, the instrument is exogenous since it combines the four maximum tax deductions, determined by the law, with the exogenous probabilities of claiming these deductions. At household level, the instrument is exogenous under the assumption that the age class and gender composition of the household is independent from the unobservable characteristics that may affect the households sorting process into private/public education. The analysis is always at the level of the household with children in schooling age, so the subscript h is dropped for expositional purposes.

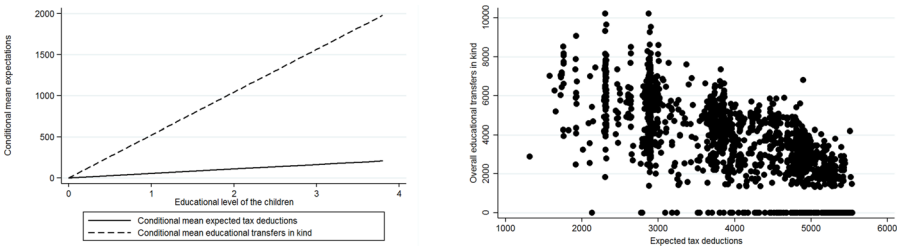
The exclusion restriction The key maintained exclusion restriction for identification is that a manipulation of the distribution of the expected tax deductions affects the quantiles of the distribution of the educational transfers in kind K only through its effect on the household's income distribution Y. We detect two possible threats to such assumption.

Our first concern is the potential association between the instrument z and children's age. The data show that the expected tax deductions do not have a direct impact on the educational transfers in kind received by the household, when conditioned for the age profiles of the children. In fact, children in compulsory schooling age are entitled with a fixed amount of 3,000 euro irrespectively of their age or educational stage. The amount of educational

[21] We consider here only the parents and the offspring as household members. We disregard other relatives living within the family even if they could potentially contribute to generate the income of the household.

[22] According to the 2004 Italian personal income tax system, the effective tax deductions accruing to each taxpayer were related to two parameters: the source of income, and the amount of gross income. The tax deduction system was designed to assure an exemption threshold (heterogeneous across sources of income), and to reinforce the progressivity of the personal income tax. The direct link between the tax deduction and the gross income explains why we do not use the effective tax deductions but rather an expected amount as an instrument for net income. We consider potential income and for this reason we allow children in mandatory education to be entitled to belong to the residual category, as it is prescribed by law.

[23] We consider age classes made of 5 years each with the exception of the lowest (age$\leq$ 14). For instance, this amounts to say that for all children aged less than 15 years old, the expected maximum tax deduction corresponds to 3,000 euro taken with probability equal to one since, for this age class and for both gender, the national frequencies of employees, retired persons and self-employees are equal to zero.



(a) Conditional means given education levels.

(b) Educational transfers in kind on expected tax deductions.

Fig. 2 Exclusion restriction: the instrument and children's age. *Note:* We assign the following ordinal values to the educational levels of the children: the value of zero corresponds to any educational level attended (i.e. households with children in post-compulsory schooling age who are not enrolled in education); to those households who have one or more children in the same educational level, we assign the values of 1 for compulsory, 2 for upper secondary and 3 for tertiary education; we impute to households with more than one child in different educational levels the values of 3.2 if having at least one child in compulsory and one in secondary education, 3.4 if having at least one child in compulsory and tertiary education, 3.6 if having at least one child in secondary and tertiary education and finally 3.8 if having at least one child in all educational levels

transfers in kind these children receive, instead, is always positive and varies according to the educational level they consume (either primary or lower secondary), the region where they live, and the reference group to which their household belongs. The expected tax deductions do not have a direct effect on the educational transfers in kind also for children in post-compulsory schooling age, because deductions are independent of the true working condition of the child, while the amount of the educational transfers in kind is conditioned on being a student.

Panels (a) and (b) of Fig. 2 provide support for these considerations. On the one hand, expected tax deductions are flat across educational levels of the children but slightly increasing for households with at least one child in post compulsory schooling. On the other hand, the positive relationship between the educational level of the children and the educational transfers in kind is more marked. Overall, the weak correlation between these two patterns is positive pointing for a possible violation of the independence assumption of the instrument if and only if the household's unobservable characteristics that drives the household sorting into private schooling depend upon the family composition. This assumption cannot be directly tested.[24] Panel (b) shows, however, that the association between educational transfers in kind and expected tax deductions is possibly negative.

The instrument varies within household size according to the age class and the gender of each household member. The advantage of such a choice is that age and gender are clearly exogenously assigned to individuals. These two sources of variation are independent from the potential income of the family. Although it is far beyond the scope of the paper to discuss gender differences in actual income acquisition, these differences are observed in the data.

[24] In the working paper version of this paper we have included into our main regression model two proxies of the families' unobservable characteristics related to the family background. The estimated effects of interest are independent from either the inclusion or the exclusion of these variables into Eq. (1b) and (1a). We consider this evidence as an indirect test of the independence assumption.

Moreover actual income is correlated with age as long as earnings increase in job seniority. These two stylised facts are independent from the families' schooling choices. Nevertheless, we have to deal with the inevitable consequence of a possible rather mechanical relationship between the amount of the educational transfer in kind and the instrument, generated by the use of an equivalence scale which weights the size of the family according to the age of the household's members. In such a case, the exclusion restriction would be violated leading to an identification problem. To cope with all these concerns, we propose to replicate our analysis using household size as equivalence scale for the response variable[25] and several other robustness checks. Furthermore, we use the Chernozhukov and Hansen (2006)'s estimators which rely in the rank similarity assumption without requiring neither the monotonicity assumption of the $LATE$ approach (Imbens and Angrist 1994) nor the stronger independence assumption of the Ma and Koenker (2006) model. The main message that we take from all these estimates is the same: educational transfers in-kind are redistributive at compulsory schooling level. We conclude that, although a priori we cannot exclude the violation of the exclusion restriction, the corresponding bias is negligible and our baseline estimates can be considered as lower bounds of the effects of interest.

The last concern is about the relevance of the instrument. We produce results from reduced form (first stage) models to bring evidence that the instrument is able to generate sufficiently large exogenous changes in income to affect the educational transfers in kind distribution. Altogether, evidence hints that the effect of an exogenous manipulation of the prevailing distribution of incomes on various quantiles of educational transfers in kind distribution might be negative.

4 Results

4.1 Benchmark

Table 2 illustrates our benchmark results. We first test for the specification of the model. The first column of the table reports estimates from a Box-Cox specification of the baseline model, based on a single shape parameter λ. We find that $\hat{\lambda} = 0.37$ and significantly different from zero at 1% confidence level, hence rejecting the null hypothesis of a log-log specification of the baseline model. In what follows, we produce results for a linear specification of the model, which allows to identify the effect of a one euro change in household equivalent income on the level of educational transfers in kind accruing to the household.

The marginal effect of income on educational transfers in kind estimated by OLS is negligible but statistically significant at 5% level. The small size of the coefficient might be the consequence of averaging the heterogeneity in the income effects along the distribution of the educational transfers in kind.[26] We check this by resorting on quantile regression. The pattern of the coefficients reported in columns (3) to (7) for a selected number of quantiles

[25] Results, reported in the Online Appendix, are statistically robust, indicating that our main conclusions are not severely affected by this issue.

[26] If educational transfers in kind are redistributive, it might be the case that the marginal effect of income is negative in the upper part but positive in the lower part of the educational transfers in kind distribution.

shows that the income effect is generally negative and close to zero, and it turns out to be significant only at the median of the educational transfers in kind distribution.

Similarly to OLS, the quantile regression coefficients do not have a causal interpretation when there are unobservable dimensions that simultaneously affect both income and educational transfers in kind. In the main sample, the direction of the OLS bias is, nevertheless, not clear. On the one hand, parents of children in mandatory schooling age can only choose between private and public provision of education. If education quality is a normal good and if the households sorting process is redistributive in nature, then households with higher income capacity and preferences for education quality would tend to have larger incomes and consume less public education, implying that OLS estimates are upward biased (i.e., the effect is attenuated). On the other hand, the households' choice for post-compulsory education is mainly driven by the decision of whether or not to enroll the child at school. Consequently, parents with higher income capacity and preferences for education would tend to demand more educational services for their children, implying that OLS estimates are downward biased.

We use a control function (denoted CF) approach to cope with the endogeneity of income. The CF estimates account for heterogeneity in income effects by conditioning on residuals of a first stage income regression, where we use expected household tax deductions as an instrument, and the interaction between income and these residuals. The coefficient of the estimated residuals identifies the shift of the intercept of the educational transfers in kind function. The interaction term captures, instead, the slope shift effect of the marginal change of income, which is associated to the unobservable heterogeneity in household characteristics. The interaction term turns out to be statistically insignificant[27] and is omitted from Table 2.

The CF estimated effect of a one euro increase in household income that is unrelated to changes in the unobservable characteristics (preferences for educational quality and income capacity) is of -0.80 euro. The size and significance of the coefficient confirms the substantial bias of the OLS estimates. Under the plausible assumptions described in Section 3.4, the CF coefficient measures the *average marginal treatment effect* of income in the population. In fact, the control function can be conceived as a structural relation that provides the counterfactual conditional expectations of K given Y (and other covariates), if Y could be manipulated independently of the errors and household income capacity would be perfectly observable (Blundell and Powell 2003).

The CF method offers only a conditional mean perspective of the underlying structural relations. In fact, it does not allow one to verify how and whether the marginal effect of income varies over the whole distribution of the outcome. Table 3 illustrates quantile regression estimates based on Chernozhukov and Hansen (2006) estimators applied to the working sample, as well as to two subsamples of households with at least one child in compulsory and upper secondary schooling age. The estimates in Table 3 identify the effect of a change in household equivalent income on transfers in kind for households having equivalent income Y and preferences for educational quality τ_K. Estimates for the overall sample confirm the redistributive nature of these transfers, although the pattern is not strictly monotonically decreasing along the K distribution. In fact, the impact on the educational transfers in kind appears to be different for different levels of τ_K, implying heterogeneous effects of Y on K of families that have different levels of preferences for educational quality.

[27] Given the linear model specification and the insignificance of the interaction term between the first stage residuals and the income variable, IV and control function estimates are here equivalent.

Table 2 Baseline estimates, various estimators

	Box-Cox	OLS	Quantiles educational transfers in kind					CF
			20%	30%	50%	70%	90%	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Income	−0.04**	−0.01**	0.00	−0.01	−0.02**	−0.01	-0.01	−0.80***
	(0.02)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.21)
Residuals							0.80***	
								(0.21)
λ	0.37***							
	(0.05)							

Note: The table reports OLS (model (2)), quantile regression (models (3)-(7)) and control function estimates (model (8)) of the effect of income on educational transfers in kind. The specification also includes an indicator for the number of earning recipients, dummies for the area of residence; cohort of birth of the first child of the household; gender (i.e. if female), age, age squared, years of schooling of the household's head; regional GDP per head and unemployment rate. The control function specification further includes the residuals of the first stage regression and their interaction with income. Model (1) reports estimates from a Box-Cox single parameter (λ) model. Bootstrapped standard errors are reported in parentheses. Significance levels: $***=1\%$, $**=5\%$, $*=10\%$

Table 3 Instrumental variable quantile regression

Quantile of transfers in kind									
	10%	20%	30%	40%	50%	60%	70%	80%	90%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Main sample									
Income	−1.187***	−1.087***	−1.061***	−0.958***	−1.042***	−0.992***	−1.164***	−1.270***	−0.946***
	(0.25)	(0.22)	(0.17)	(0.15)	(0.15)	(0.15)	(0.18)	(0.23)	(0.27)
Compulsory education									
Income	0.085	0.076	0.056	−0.086	−0.316	−0.753	−0.878	−1.169	−1.251
	(0.44)	(0.45)	(0.33)	(0.20)	(0.27)	(0.75)	(1.28)	(1.66)	(1.91)
Upper secondary education									
Income	0.142	0.181	0.186	0.109	0.138	0.144	−0.105	0.119	−0.321
	(7.56)	(6.11)	(2.78)	(4.50)	(4.07)	(4.11)	(0.45)	(8.06)	(3.17)

Note: The table reports the instrumental variable quantile regression estimates (Chernozhukov and Hansen 2006). The specification also includes an indicator for the number of earning recipients, dummies for the area of residence; cohort of birth of the first child of the household; gender (i.e. if female), age, age squared, years of schooling of the household's head; regional GDP per head and unemployment rate. Bootstrapped standard errors are reported in parentheses. Significance levels: $*** = 1\%$, $** = 5\%$, $* = 10\%$

Heterogeneity is even more marked for the sub-sample of families with children either in compulsory education or secondary post-compulsory education. These effects, however, are not precisely estimated and turn out to be strongly insignificant.[28]

4.2 First stage

Table 4 reports the OLS and the quantile estimates of Eq. (1b) for the working sample, and for two subsamples of households with at least one child in compulsory and upper secondary schooling age. We interpret the estimated coefficients as the sum of two effects through which a change in the instrument affects the distribution of income, as outlined below.

Let y_N be the net of taxes income, corresponding to the gross income y_G minus the personal income tax liability $T(y) = T(y_G - d)$, which depends on gross income net of deductions d. We can decompose the overall effect of a change of tax deductions on net of taxes income $y_N = y_G - T(y_G - d)$ as follows:

$$\frac{\partial y_N}{\partial d} = \left(1 - \frac{\partial T(y_G - d)}{\partial y}\right) \frac{\partial y_G}{\partial d} + \frac{\partial T(y_G - d)}{\partial y},$$

where $\frac{\partial T}{\partial y}$ is the marginal tax rate. The variation of (net of taxes) income due to a one euro increase of a tax deduction is the sum of the tax cut (the direct effect, always positive), and of the variation of the gross income net of the average tax rate (the indirect effect). In principle, the latter effect can be either negative or positive depending on the behavioral labour supply response of each household member. It is negative if an income effect prevails, while it is positive if the household members respond to the increase in net income by substituting leisure with labour. At the household level, the effect of expected tax deductions on income corresponds to the sum of the effects estimated for each household member.[29]

The estimates of the first stage regression, reported in Table 4, highlight the pattern of the coefficient of the maximum expected tax deductions at the mean and across the selected quantiles of the income distribution. The OLS mean effect is higher than the corresponding effect at the median of the income distribution for the working sample and the upper secondary education sample, while the opposite holds true for the sample of households with children in compulsory schooling age. These differences support the presence of heterogeneous effects.

The coefficients are always statistically significant at 1% in the working sample and positive, with values always greater than the maximum marginal tax rate accruing to personal income taxes in Italy (45% in 2004). This suggests that the substitution effect dominates the income effect on the household labour supply.

The size of this effect might appear large. Note that, however, the expected tax deductions and incomes net of tax are expressed in different equivalence scales. This implies that if we apply the same equivalence scale to both variables, the coefficients would be smaller in

[28] The model proposed by Chernozhukov and Hansen (2006) is based on assumptions (i.e. rank similarity) that are weaker than those in Ma and Koenker (2006). One limitation is that the model does allow estimating a parameter which is conditioned on different quantiles τ_Y of the income capacity distribution (i.e. the quantiles of the distribution of the first stage quantile regressions). This procedure allows us to offer a complete characterization of the stochastic relationship between income and educational transfers in kind by discussing to what extent the income capacity and the preference for educational quality distributions, along with their interaction, contribute to explain the redistributive impact of the educational transfers in kind.

[29] The Italian taxation system is individualized, hence the effects of a change in tax deductions affect primarily the income of each household member.

Table 4 Structural quantile treatment effect estimation: First stage

	OLS	Quantile of income								
		10%	20%	30%	40%	50%	60%	70%	80%	90%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Main sample										
Exp. tax deductions	1.477***	0.831***	0.906***	0.996***	1.065***	1.245***	1.235***	1.242***	1.118***	1.436***
	(0.33)	(0.17)	(0.15)	(0.15)	(0.14)	(0.15)	(0.19)	(0.21)	(0.26)	(0.43)
Compulsory education										
Exp. tax deductions	1.061**	0.329	0.818***	0.871***	0.988***	1.144***	1.228***	1.174***	1.198**	1.833**
	(0.44)	(0.36)	(0.26)	(0.27)	(0.23)	(0.32)	(0.38)	(0.38)	(0.53)	(0.75)
Upper secondary education										
Exp. tax deductions	1.419***	0.864***	0.956***	1.053***	0.948***	1.133***	1.407***	1.055***	0.908**	0.608
	(0.36)	(0.29)	(0.27)	(0.23)	(0.24)	(0.27)	(0.29)	(0.35)	(0.45)	(0.65)

Note: The table reports the first stage of the structural quantile treatment effect estimates (including benchmark estimates for linear regression model). The specification also includes an indicator for the number of earning recipients, dummies for the area of residence and a polynomial of degree one in the cohort of birth of the first child of the household; gender (i.e. if female), age, age squared, years of schooling of the household's head; regional GDP per head and unemployment rate. Bootstrapped standard errors are reported in parentheses. Significance levels: $***=1\%$, $**=5\%$, $*=10\%$

proportion.[30] Moreover, additional empirical evidence in Eissa and Liebman (1996), Eissa and Hoynes (2004), and Blundell et al. (2005), among others, suggests that major changes occur at the extensive rather than intensive margin of the labour supply. These contributions show that, as long as deductions are conditional on earning income, some individuals may find worth entering the labour force and benefit of the additional after-tax income from the tax deduction. In the case of either unmarried women with children or one earner in the household, such taxation scheme clearly encourages labour market participation, being absent the income effect. The labour supply effect is instead ambiguous among married individuals. On the one hand, the effect of an earned income tax cut on labour force participation of primary earners is positive. On the other hand, the income effect discourages labour market participation of the second earner. However, such negative effect is likely to be weak when the taxation unit is the individual rather than the household as in the Italian case.

4.3 Structural quantile treatment effects on the working sample

Figure 3 plots the marginal quantile treatment effects of income on the quantiles of the educational transfers in kind distribution, at selected income capacity levels. Standard errors for the estimated coefficients are obtained by bootstrapping 200 independent samples with replacement from the working sample, upon which first and second stage regressions are jointly estimated.

Figure 3 shows that an exogenous increase in income is always associated to a decrease in transfers in kind accruing to the household.[31] In order to correctly interpret the figure and to assess the premises of redistributive nature of the educational transfers in kind, it is necessary to fix one of the two dimensions of heterogeneity at a time.

Fixing quantiles τ_Y of the household income capacity. For a given quantile of the income capacity identified by each of the nine panels in Fig. 3, we find that the magnitude of the (negative) effect of household income on the educational transfers in kind increases along the quantiles of the educational transfers in kind reported on the horizontal axes. Table 5, panel (a), reports the statistical test for the difference between the impact of income on the lowest quantile ($\tau_K = 10\%$), and the same effect at highest quantile ($\tau_K = 90\%$), respectively for each panel in Fig. 3. These differences are generally positive and always statistically significant at 5% level for households with high income. We conclude that the drop in transfers in kind that is due to an increase in household equivalent income is larger for households with high preferences for education (those that would be more likely to demand for higher education quality), implying that transfers in kind are regressive in nature. The magnitude of the effect is stable across the distribution of income. In the main sample, the mechanism related to preferences for educational quality is weakened by the presence of children opting out of education (public or private) after reaching mandatory education age.

[30] It is easy to show that for a one euro increase of the per-capita (expected) tax deduction, the corresponding increase of the overall (non equivalized) income is equal to the estimated coefficient multiplied by the EU equivalence scale applied to the household. For instance, consider a family with two parents and two children, one over and one under 14 years old. In such a case, our instrument is scaled by 4, the size of the family, while income is scaled by 2.3 according to the EU equivalence scale. Consequently, only when the estimated coefficient is greater than $4/2.3 = 1.74$, income increases proportionally more than our instrument.

[31] In the Online Appendix we also report elasticity estimates for the same coefficients.

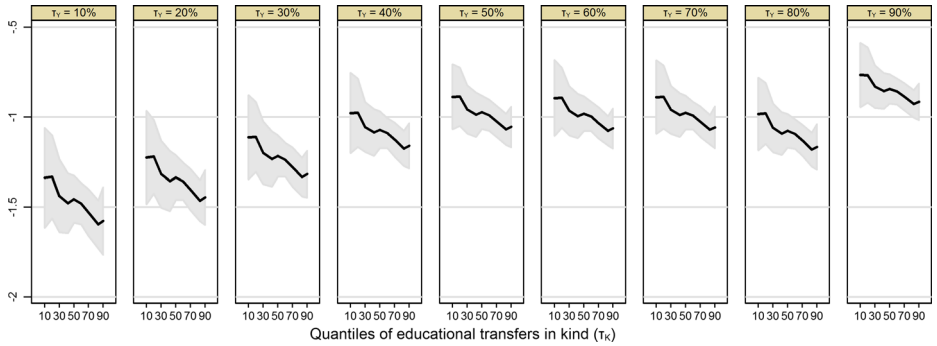


Fig. 3 Marginal quantile treatment effects of income. *Note:* The figure plots the marginal quantile treatment effects estimates for $\alpha(\tau_K, \tau_Y)$ in the working sample, measuring the effect of income on transfers in kind for a given quantile of the household income capacity (by panel) and a given quantile of K (within each panel). These marginal quantile treatment effects are calculated taking also into account the residuals of the given quantile of the household income capacity, and their interactions with income. Confidence bands at 99% level

Fixing quantiles τ_K of the household preferences for educational quality. For a given quantile of household preferences for education quality we find that the magnitude of the negative effect of household income on the educational transfers in kind decreases across the quantiles of the income distribution. To see this pattern, it is necessary to keep track of the effect of income on the same quantile of the K distribution across the nine panels in Fig. 3. Panel (b) of Table 5 reports the statistical test for the difference between the coefficient of interest at lowest income capacity ($\tau_Y = 10\%$) and highest income capacity ($\tau_Y = 90\%$). Differences are always significant and negative, and their magnitude is increasing with τ_K. The result is consistent with the assumption that the quality of the private educational sector is a normal good and households' utility increases at decreasing rates with household income. Furthermore, evidence supports our interpretation that high-income households evaluate a marginal increase in the use of public educational services relatively less than the marginal exogenous increase in income, which would allow them to buy higher quality in the private market. The marginal income increment would then provide decreasing incentives (smaller drops in opportunity costs along the income capacity distribution) to sort into private education. These findings confirm the redistributive nature of the educational transfers in kind.

4.4 Analysis across educational levels

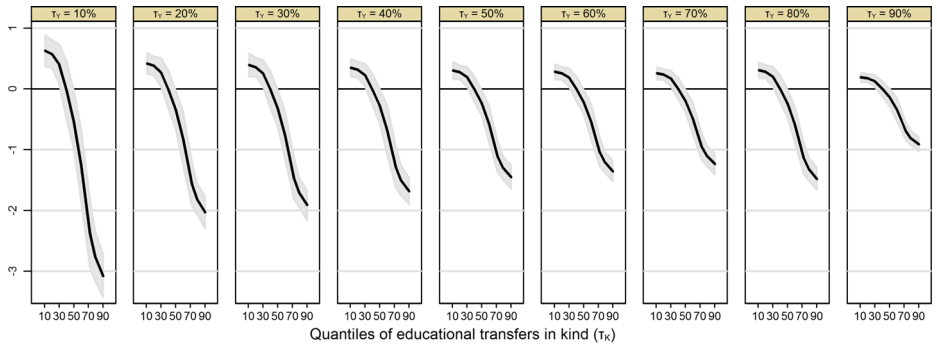
The redistributive nature of educational transfers in kind applies in full to mandatory education, where parents can only choose between private or public provision of educational services. The households' choice for post-compulsory education is, instead, sequential. First, the families decide whether or not to enroll the child at school. Then, they choose between private and public education provision only for those children who continue studying. To account for these different forms of selection, we replicate our main analysis for two subsamples that distinguish between households with children in compulsory schooling age and those with children in upper secondary schooling age.[32]

[32] In the Online Appendix we report estimates for other subsamples: households with children in both secondary and tertiary schooling age (post compulsory education); households with children in tertiary schooling age.

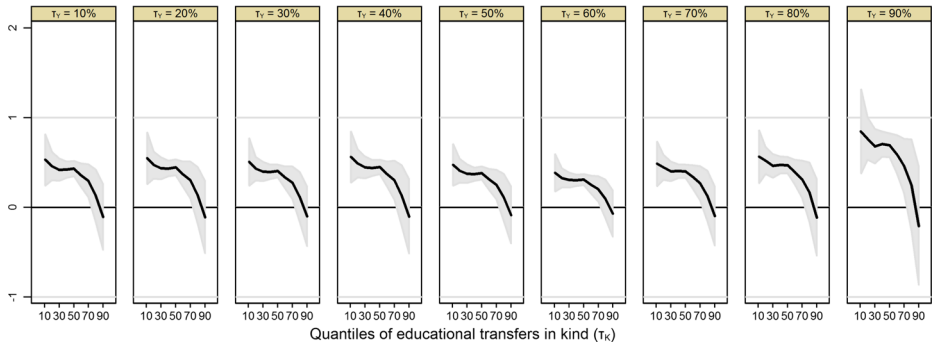
Table 5 Homogeneity tests

	Panel (a): 10th and 90th quantiles of K, given τ_Y								
	τ_Y : 10%	τ_Y : 20%	τ_Y : 30%	τ_Y : 40%	τ_Y : 50%	τ_Y : 60%	τ_Y : 70%	τ_Y : 80%	τ_Y : 90%
Diff.	0.239*	0.221*	0.204*	0.182*	0.168**	0.169**	0.168*	0.183**	0.149**
	(0.13)	(0.11)	(0.10)	(0.09)	(0.08)	(0.09)	(0.09)	(0.09)	(0.08)
	Panel (b): 10th and 90th quantiles of Y, given τ_K								
	τ_K : 10%	τ_K : 20%	τ_K : 30%	τ_K : 40%	τ_K : 50%	τ_K : 60%	τ_K : 70%	τ_K : 80%	τ_K : 90%
Diff.	–0.570***	−0.565***	−0.607***	−0.623***	−0.612***	−0.622***	−0.643***	−0.669***	−0.662***
	(0.13)	(0.11)	(0.09)	(0.08)	(0.06)	(0.05)	(0.06)	(0.06)	(0.08)

Note: The table reports the homogeneity tests of the marginal quantile treatment effects of income. Panel (a) displays the difference between the marginal income effects estimated at the 10th and the 90th quantiles of educational transfers in kind distribution, fixing quantiles of the household income capacity (i.e. $\hat{\alpha}(10\%, \tau_Y) - \hat{\alpha}(90\%, \tau_Y)$). Panel (b) displays instead the difference between the marginal income effects estimated at the 10th and the 90th quantiles of the household income capacity, fixing quantiles of the educational transfers in kind distribution (i.e. $\hat{\alpha}(\tau_K, 10\%) - \hat{\alpha}(\tau_K, 90\%)$). Standard errors are reported in parentheses. Significance levels: $***= 1\%$, $** = 5\%$, $* = 10\%$



(a) Compulsory education



(b) Upper secondary education

Fig. 4 Marginal quantile treatment effects of income: sub-samples. *Note:* The figure plots the marginal quantile treatment effects estimates for $\alpha(\tau_K, \tau_Y)$ in the sub-samples of compulsory education, (panel (a)), and upper secondary education, (panel (b)). These marginal quantile treatment effects are calculated controlling for the residuals of any given quantile of the household income capacity, and their interactions with income. Confidence bands at 99% level

Compulsory education Panel (a) of Fig. 4 illustrates the marginal effect of income on the amount of educational transfers in kind when the empirical assessment is restricted to households with at least one child in compulsory schooling age (primary and lower-secondary education). Estimates are based on a sample of 1,053 households. We find that an increase in income affects positively the educational transfers in kind up to the median, it is negligible and statistically insignificant at the median level, while it turns out to be significant and negative at quantiles above the median of the K distribution. This pattern is stable across all levels of household income capacity.

The case of compulsory education is interesting in its own right, as the implications of the mechanisms underlined in Section 2.1 apply in full. Given income capacity, households at the lower quantiles of the educational transfers in kind distribution are those who support the lower opportunity costs in sorting into private education. Their response to an exogenous increase in their incomes reveals that they value very little the quality offered by the private schools. In fact, an additional euro raises their demand for public education (no opting out). On the other hand, households at the top quantiles of K distribution are those who value more the quality of the private education sector, as long as they are willing to invest one

additional euro of income into private educational services. For this reason, the sign of the marginal effect of income on the amount of educational transfers in kind turns out to be negative for them, and it rises (in magnitude) along the distribution K.

The magnitude of the negative marginal effect of income attenuates along the income capacity distribution of those households with preferences for educational quality higher than the median (see Table 6). This suggests that households with higher income capacity are those who are more likely to opt out from the public system to buy private education and gain consequently a zero marginal benefit from public education provision.

Overall, the estimates bring evidence about the redistributive nature of public education provision at compulsory schooling level. The households with lower income capacity and with lower preferences for private education quality are those who benefit more from the publicly provided compulsory education. These households are willing to capitalize an additional exogenous increase in income into more educational services for the children, by resorting on public provision.

Upper secondary education Panel (b) of Fig. 4 shows patterns estimated on data on 883 households in the working sample with at least one child in upper secondary schooling age. The results are in stark contrast with what estimated before. In this case, the marginal effects of household equivalent income on expected educational transfers in kind are always positive, implying that household sorting behavior across private and public upper secondary education is connected to different mechanisms compared to compulsory education. If the expected returns to education of the children are positively correlated with the realized returns in income of the household of origin (i.e. the realized returns can be forecast by observed household income), then households may self-select into post-compulsory education (whether public or private) according to the expected returns. Moreover, for given expected returns, households are more likely to choose a higher level of education if the take-up opportunity costs, including the opportunity costs in terms of foregone wage, are smaller. As Fig. 4 shows, the marginal effects of income at the 10th quantile of the K distribution are always statistically positive and larger than the corresponding effects calculated at the 90th quantile, irrespectively of the household income capacity. On the contrary, the effects at the 90th quantile are never significant (Table 7). These findings suggest that household preferences towards the quality of upper secondary education offered by the private sector are not strong enough to induce self-selection behaviors.

Evidence on lack of redistributive effects of public post-compulsory education provision can be explained by the fact that there are no significant differences on quality of ancillary educational services offered by the private and the public sector. This is also consistent with findings in Bertola et al. (2007) and Bertola and Checchi (2013), where it is suggested that the teaching quality of private schooling for upper secondary education is not higher than the quality of public schools, implying a remedial scope for private secondary education in Italy.[33]

Mean (quantile) treatment effects and further robustness checks The assumptions made on the structure of the errors in the quantile treatment effect model provide insights into how the dimensions of income capacity and preferences for educational quality are

[33]The same qualitative result can be found when we use the subsample of households with children in post-compulsory schooling. There is instead no evidence of either a remedial role for private universities or a redistributive self-selection process into tertiary education. These results are shown in the Online Appendix.

Table 6 Homogeneity tests: compulsory education

	Panel (a): 10th and 90th quantiles of K, given τ_Y								
	τ_Y : 10%	τ_Y : 20%	τ_Y : 30%	τ_Y : 40%	τ_Y : 50%	τ_Y : 60%	τ_Y : 70%	τ_Y : 80%	τ_Y : 90%
Diff.	3.700***	2.444***	2.298***	2.026***	1.750***	1.631***	1.490***	1.783***	1.096***
	(0.17)	(0.12)	(0.12)	(0.09)	(0.09)	(0.08)	(0.08)	(0.08)	(0.05)
	Panel (b): 10th and 90th quantiles of Y, given τ_K								
	τ_K : 10%	τ_K : 20%	τ_K : 30%	τ_K : 40%	τ_K : 50%	τ_K : 60%	τ_K : 70%	τ_K : 80%	τ_K : 90%
Diff.	0.437***	0.395***	0.280**	−0.034	−0.392**	−0.900***	−1.686***	−1.948***	−2.166***
	(0.10)	(0.09)	(0.13)	(0.20)	(0.20)	(0.24)	(0.22)	(0.17)	(0.15)

Note: The table reports the homogeneity tests of marginal quantile treatment effects of income, sample of households with children in compulsory education. Panel (a) displays the difference between the marginal income effects estimated at the 10th and the 90th quantiles of educational transfers in kind distribution, fixing quantiles of the household income capacity (i.e. $\hat{\alpha}(10\%, \tau_Y) - \hat{\alpha}(90\%, \tau_Y)$). Panel (b) displays instead the difference between the marginal income effects estimated at the 10th and the 90th quantiles of the household income capacity, fixing quantiles of the educational transfers in kind distribution. Standard errors are reported in parentheses (i.e. $\hat{\alpha}(\tau_K, 10\%) - \hat{\alpha}(\tau_K, 90\%)$). Significance levels: $*** = 1\%$, $** = 5\%$, $* = 10\%$

Table 7 Homogeneity tests: upper secondary education

	Panel (a): 10th and 90th quantiles of K, given τ_Y								
	τ_Y : 10%	τ_Y : 20%	τ_Y : 30%	τ_Y : 40%	τ_Y : 50%	τ_Y : 60%	τ_Y : 70%	τ_Y : 80%	τ_Y : 90%
Diff.	0.636***	0.657***	0.605***	0.662***	0.558***	0.454***	0.581***	0.677***	1.053***
	(0.18)	(0.19)	(0.16)	(0.18)	(0.16)	(0.12)	(0.16)	(0.20)	(0.29)
	Panel (b): 10th and 90th quantiles of Y, given τ_K								
	τ_K : 10%	τ_K : 20%	τ_K : 30%	τ_K : 40%	τ_K : 50%	τ_K : 60%	τ_K : 70%	τ_K : 80%	τ_K : 90%
Diff.	−0.313	−0.302***	−0.257***	−0.283***	−0.256***	−0.230**	−0.162	−0.117	0.098
	(0.21)	(0.11)	(0.09)	(0.07)	(0.06)	(0.10)	(0.14)	(0.23)	(0.29)

Note: The table reports the homogeneity tests of marginal quantile treatment effects of income, sample of households with children in upper secondary education. Panel (a) displays the difference between the marginal income effects estimated at the 10th and the 90th quantiles of educational transfers in kind distribution, fixing quantiles of the household income capacity (i.e. $\hat{\alpha}(10\%, \tau_Y) - \hat{\alpha}(90\%, \tau_Y)$). Panel (b) displays instead the difference between the marginal income effects estimated at the 10th and the 90th quantiles of the household income capacity, fixing quantiles of the educational transfers in kind distribution. Standard errors are reported in parentheses (i.e. $\hat{\alpha}(\tau_K, 10\%) - \hat{\alpha}(\tau_K, 90\%)$). Significance levels: $***= 1\%$, $** = 5\%$, $* = 10\%$

correlated. As suggested by Ma and Koenker (2006), there are other relevant, but more aggregated, evaluation parameters that can be retrieved from structural quantile treatment effects estimation. The *mean quantile treatment effect* is obtained by integrating out the distribution of the household income capacity, while the *mean treatment effect* results from averaging these last effects with respect to the quantiles of the distribution of the educational transfers in kind. The mean treatment effect theoretically coincides with the CF estimates in the pure location shift version of the model. In our case, where the interaction terms are not significant, it should also approximate the *average treatment effect* estimated in Section 4.1 using the control function method. We make these calculations as a robustness check. The difference between these two mean treatment effects is small for all the main samples of interest and amounts to -0.33 for the working sample, -0.11 for the sample of households with at least one child in compulsory schooling age and to 0.17 for the sample with families with children in upper secondary education.

Further robustness checks are reported in the Online Appendix. First, we verify whether results are robust to different sub-samples and a different equivalence scale for the educational transfers in kind. All the tables and figures support our main findings. Second, we condition estimates from the main samples to information about the quality of the family background history of the household. We use this strategy to verify if, and to what extent, the family background could affect both the income and the amount of educational transfers in kind accruing to the household, by shaping either (both) income capacity or (and) preferences for educational quality.

We use two family background indicators for either education or socio-economic position of the grandparents to partition the observed households into homogeneous groups. Relevant information is available in SHIW.[34] We consider each of these two family background indicators separately. We use a similar taxonomy as in Lefranc et al. (2009) to classify the grandfathers (i.e. the fathers of both parents in a household) according to their occupational status.[35] To maintain a parsimonious structure, we collapse grandfathers' background information into two categories: the *disadvantaged background* group comprises all the households for which both grandfathers were unemployed or employed either in agriculture or as an unskilled manual worker; the *advantaged background* comprises all other types of households. We produce a similar classification of family background using as well the level of education of the grandparents. In this case, the purely disadvantaged background group includes all the households for which both spouses' parents had on average 5 or less years of education.[36] Baseline estimates presented in previous sections and related implications are unaffected by augmenting the testing model for various combinations of family background indicators.

[34]The questionnaire of the survey reports this questions: *"What were the educational qualifications, employment status and sector of activity of your parents when they were your present age? (If the parent was retired or deceased at that age, refer to time preceding retirement or death)"*.

[35]Lefranc et al. (2009) apply this taxonomy to show that in France exists inequality of opportunities in income acquisition since individuals experiencing different social origins related to their father's occupation are not guaranteed an equal access to advantage in earning income. Following them, we consider only the grandfather's occupational background since a large part of the grandmothers were housewives.

[36]We fix the level of disadvantage to be lower or equal 5 years of education level since enrollment in primary education reached 90% only in 1931. The presence of a double track schooling system weakened the enforceability of 8 years of compulsory education as dictated by both the Gentile's law and the article n.34 of the Italian Constitution (1948). It is only with Law n.1859, December 31st 1962, which abolished the second track (the *avviamento al lavoro*) of the schooling system, that all children were constrained until age 14 to follow a single program, encompassing primary education and lower secondary school.

5 Conclusions

This paper presents new evidence, based on Italian data, about the redistributive effect of availability of freely accessible public education provision. This effect is tested by looking at the impact of household equivalent income on the amount of expected educational transfers in kind accruing to the households who decide to benefit from freely available public education provision despite the presence of higher quality (in what we motivate are ancillary educational services) costly alternatives on the market.

We quantify the value of public educational services that are consumed by a household with children in education as the monetary equivalent educational transfer in kind received by the household opting for public education (coinciding with the expected cost supported by the government to provide the service almost inexpensively). We exploit such measure to infer about the households' preferences for the private educational quality.

We argue that the impact of household income on the decision of sorting into private or public education is determined by the interplay of three components: the heterogeneity in household preferences for the quality of the private education, the heterogeneity in household income capacity and the correlation between them. We estimate structural quantile treatment effects while keeping track of the unobserved heterogeneity in preferences for the private education quality and in income capacity of the households. In the main sample, as well as for the subsample of households with children in compulsory education, we show that an increase in income reduces the amount of educational transfers in kind (i) more for higher quantiles of the educational transfers in kind, keeping income capacity as fixed, (ii) more for lower quantiles of the household income capacity, holding preferences for the quality of private education as constant. Although we are aware of possible identification problems with the proposed instrument, our findings offer comprehensive support for the view that the households who value less the quality of the private educational services and have a lower income capacity are those who benefit more from compulsory educational services provided by the public sector.

An implication of our findings is that reforms of the public education system that affect the average cost of the mandatory educational services are expected to alter the household self-selection behavior and, as a consequence, can have non negligible redistributive effects. At compulsory schooling level, public education provision is redistributive. In the Italian case, this effect can be attributed to differences in quality of ancillary services (rather than core educational activities) offered by private schools compared to public schools.

We do not detect signs of redistribution from educational transfers in kind at post-compulsory education level. In this case, families likely sort into the education system according to the expected returns to their children education, which are related to the households income.

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