The effects of parental income on Norwegian adolescents' school grades: A sibling analysis

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Abstract

Associations between family income and offspring's educational attainment are well-established. A debated topic is whether this association is due to the causal influence of family income per se or arises because of other family-related circumstances which correlate with income. This study examines the relationship between parental income and Norwegian adolescents' school grades, using register data on all 16-years old graduates from lower secondary schools during 2002-2011. Data are analyzed both by conventional ordinary least square regression and by sibling analyses using fixed effect models. The sibling analyses control not only for observed covariates, but also for unobserved time-invariant environmental and family-related characteristics, implying that the causal effects of income may be better approximated. The results indicate that generally, variations in parental income in contemporary Norway have modest effects on lower secondary school grades. However, noteworthy income effects are found among the five per cent families with lowest incomes, suggesting that in these families, lack of income hinders children's school performance.

Keywords

Socioeconomic inequality, family income, secondary school, Norway, fixed effects

Introduction

Associations between family background and children's educational achievement are well-established (OECD, 2010). To what extent the intergenerational transmission of social (dis)advantage is driven by differences in *family income* is a disputed issue (Duncan et al., 2014; Heckman and Mosso, 2014; Mayer, 1997). Also after controlling for parental education, family structure, and other background variables, an association between parental income and offspring's educational outcomes has been detected in a number of studies (for the Nordic countries, see, e.g., Bukodi et al., 2014; Humlum, 2011; Hægeland et al., 2004; Kilpi-Jakonen, 2012). Whether these observed associations can be identified as *causal effects* is a complex issue, however. The estimated coefficients may exaggerate the role of family income if studies suffer from "omitted variable bias" and "unobserved heterogeneity" (Morgan and Winship, 2007), for instance because parental traits which influence both family income and offspring's educational performance have not been included. A better understanding of the causal role of income will both have theoretical and policy interest. Knowledge about social mobility mechanisms may improve (Heckman and Mosso, 2014), and a realistic assessment of the effects of family income can inform debates on educational policy.

The present paper contributes to this debate by analyzing parental income and educational outcomes among Norwegian adolescents. Various aspects of the Norwegian setting, for instance that most educational institutions, from primary school to universities, are owned and funded by public authorities, suggest that differences in family income *per se* will not be important for educational outcomes. Nevertheless, several studies (reviewed later) indicate that family income has a causal effect on offspring's educational level. The present study analyzes a large sample of 16-years old pupils, using both conventional regression models and sibling fixed effects models, in order to examine the role of parental income. We test whether income effects vary by parental income level, and a particular addition to previous research is that we distinguish between absolute and relative income.

In the following, we first outline main perspectives on how family income could influence offspring's educational attainment. Then, we summarize previous research, in particular relevant Norwegian studies, and thereafter state our research questions, discuss the utility of the sibling fixed effects approach, and proceed to data description and analyses.

Causal pathways from family income to educational attainment

Usually, researchers refer to two main interpretations of how a family's income can be causally related to children's educational outcomes: the *investment* (or resource) and the *family process* (or family stress) explanation (Duncan et al., 2014; Mayer, 1997). The investment perspective highlights to what extent a family's income allows for outlays which might support the child's education (Becker and Thomes, 1986). A higher income means better possibilities for buying books, PCs, internet access, enlightening cultural consumption, private tutoring, summer courses, etc. Children from high-income families could also benefit from better schools, if, for instance, high-income neighbourhoods attract more competent teachers. High parental income may also allow for long-term economic support of offspring's higher education, while a low and insecure parental income could make such investments too risky (Goldthorpe, 2000:173).

The family process perspective, on the other hand, focuses on effects of income on family relations. Poverty and low income may generate adverse family interactions (Conger et al., 2010). Strained household finances could result in parental conflict and emotional stress, which hamper children's school work. School performance will also benefit from parental supervision and engagement (Bodovski, 2010; Heckman and Mosso, 2014:51-56; Lareau, 2000), and although some high-paid occupations imply long working hours, it is likely that overall, high-income families have more time for parental support (cf., Morrissey et al., 2014:742).

Thus, causal interpretations highlight how a higher income can be converted into environments which enhance educational outcomes through material, interactional, and psychological pathways. Researchers have also argued that the causal effects of income vary with the timing of family income. Developmental psychology indicates that children are especially sensitive to environmental stimuli in the first years of life (Heckman and Mosso, 2014:8-9), implying that family income during the preschool years will be particularly important (Duncan et al., 2011a). Also income volatility may be relevant: if family income varies much, parents may avoid long-term financial commitments for their children's education, and the children's schoolwork may suffer from experiencing unstable household finances (cf., Morrissey et al., 2014).

In addition, not only the absolute level of income, but also *relative income* could play a causal role (McEwen and Steward, 2014; Mayer, 2002:15-16). While a given absolute income represents a specific quantity of goods and services, relative income designates how a

given income corresponds to a rank, i.e., a relative position, in the income hierarchy. In public health research, low relative income is regarded as a health risk because of its links to stress and social exclusion (Marmot, 2004; Wilkinson and Pickett, 2009). Also children's educational outcomes may be affected: even if the income is more than sufficient for covering all basic needs, school performance may suffer if family income is low *relative* to most other families, since the child could be excluded from full participation in the prevailing lifestyles of his/her peers.

International research

Many contributions to this research field analyze data from the United States and Canada. Strong statistical associations between family income and offspring's educational achievement are regularly found, but the challenge has been to unveil the causal parts of these associations. Various methods for handling omitted variable bias have been employed, for instance instrumental variable approaches (e.g., Dahl and Lochner, 2012), child and sibling fixed effects models (Dooley and Stewart, 2004; Levy and Duncan, 2000), randomized experiments (Clark-Kauffman et al., 2003; Duncan et al., 2011b), and studies of adoptees (Plug and Vijverberg, 2005). With a few exceptions (e.g., Shea, 2000), the results indicate clear, although usually small, causal effects of family income (Blau, 1999; McEwen and Steward, 2014; Mayer, 2002). A recurrent finding is that effects of income are mostly found among low income families, but not higher up in the income hierarchy. Short-term changes in family income seem to have little effect, while long-term income levels are important, and some studies suggest stronger effects of family income in preschool years than in later childhood stages (e.g., Duncan et al., 2010; McEwen and Steward, 2014).

In Europe, British studies suggest "a significant impact of family income on educational attainment in the UK" (Blanden and Gregg, 2004: 248). For instance, attainment of a university or college degree was estimated to be 18 per cent if the background family was at the 10^{th} percentile in the income ranking, but 27 per cent if placed at the 90^{th} percentile. Relevant studies from other European countries often suggest that the role of income is weak, however. A German sibling fixed effects analysis of enrolment into secondary school tracks found no family income effects (Tamm, 2008), while a Danish analysis of PISA test results among 15 years old pupils found only very small income effects (Humlum, 2011). Similarly, Swedish studies on transitions from primary to secondary education have not indicated that family income is important (Erikson and Jonsson, 1996:17-27), but a study of family

dissolution found that part of the negative effect on school outcomes was due to income decline following parental breakup (Jonsson and Gahler, 1997).

The Norwegian setting and Norwegian studies

The relation between family income and children's educational outcomes is likely to be contingent on characteristics of both the school system and society at large (Erikson and Jonsson, 1996). Norway, a "large" Nordic welfare state (Kvist et al., 2012), could exemplify a country where both institutions and economic conditions are particularly favourable for reducing the role of family income. The Norwegian educational system is mainly public, tax-funded, and centrally regulated. Compulsory schooling ends with lower secondary school, normally completed at age 16. Private schooling increased slightly during the 2000s, but as much as 98.4 per cent of the pupils analyzed in this paper graduated from municipal schools. Also most higher secondary schools, colleges and universities are publicly owned and financed by taxes. Direct parental outlays for children's primary and secondary education are therefore minimal, and also modest for tertiary education because of low tuition fees and subsidized state loans to students. The Norwegian economy has avoided severe economic downturns (OECD, 2012), and average family income increased by 60 per cent in *real* terms 1986-2006 (NOU, 2009:38). Moreover, income inequalities are comparatively small (OECD, 2011), but in the mid-2000s, seven per cent of all children lived in low-income families (i.e., equalized disposable household income below 60 per cent of national median) for at least three subsequent years (NOU, 2009:65).

Nonetheless, Norwegian reports have documented marked associations between family income and offspring's educational achievement, both for lower secondary school (Bakken and Elstad, 2012; Hægeland et al., 2004; Hægeland et al., 2013; Steffensen and Ziade, 2009) and for higher education (e.g., Aakvik et al., 2005; Hansen, 2008). When adjusted for parents' education, family structure, immigrant status, and other potential confounders, the associations become weaker, but remain significant and noteworthy.

Several studies have explored these associations further. Using large register data, Aakvik et al. (2005), Duncan et al. (2011b), and Carneiro et al. (2013) utilized regression approaches with extensive controls and found clear, although not large, family income effects on years of schooling obtained as young adults. Also Løken et al. (2012), using an instrumental variable design, found income effects on educational levels obtained in young adulthood: when oil was discovered in the North Sea, families in the near-by county

experienced larger income increases than similar families in another, otherwise similar, county, and educational outcomes for the relevant birth cohorts in the two counties could be compared. Some studies have addressed the timing of income issue; Aakvik et al. (2005) found a relatively strong role of preschool income, but Duncan et al. (2011b) and Carneiro et al. (2013) found that income in adolescence was at least as important as income in early childhood. Also Norwegian studies, in line with international research, have detected stronger effects in lower income strata (Duncan et al., 2011a); Løken et al. (2012) found "large marginal effects in the lower part of the [income] distribution".

Summing up, these studies which have analyzed birth cohorts born during the 1960s – to early 1980s period, indicate that family income in Norway had some causal effects on the final educational level the children obtained, in particular among low income families.

A complementary issue is whether family income influences educational outcomes already in childhood and adolescence, and whether such effects are present also in the recent birth cohorts who grew up in more affluent times. A few studies have addressed grades in lower secondary school with methods which take unobserved heterogeneity into account: Hægeland et al. (2010) studied effects of parental education with fixed effects methods (see also Hægeland et al., 2013); Rege et al. (2011) examined effects of job loss with an instrumental variable design; Bettinger et al. (2013) applied difference-in-difference regression for analyzing effects of mothers' home-staying; and Black et al. (2014) used a regression discontinuity design for examining child care subsidies. The authors also reported estimates for family income effects. Interestingly, the results diverged somewhat: two of the studies found only negligible income effects (Rege et al., 2011; Bettinger et al., 2013), while the other two (Hægeland et al., 2010; Black et al., 2014) indicated that an augmented family income could actually lead to better performance in lower secondary school.

Research questions and research strategy

Accordingly, the role of parental income for children's and adolescents' school performance in contemporary Norway is not settled, and the aim of the present paper is to pursue this topic further. We analyze grades in Norwegian lower secondary school 2002-2011. The analyzed pupils were born in the late 1980s and early 1990s and have grown up in a period of generally improving economic conditions. Our overall question is: What has been the role of parental income for the school outcomes of these mid-adolescent pupils?

We address three specific topics. First, we try to contribute to the *causality* debate by comparing results from two statistical approaches: ordinary least square (OLS) regression with extensive controls, and sibling fixed effects (FE) models. The advantage of sibling FE models will be briefly discussed below. We use all pupils in the data for the OLS analyses, while a subsample with full siblings are used for the sibling FE models.

Second, we examine possible effects of *relative income*. As discussed above, a current hypothesis is that not only absolute income, but even the family's relative position in the income distribution, will influence children's school outcomes (McEwen and Steward, 2014; Mayer, 2002:15). Previous studies have used relative income measurements (see, e.g., Blanden and Gregg, 2004), but analyses of associations between families' *movements* in the relative income hierarchy and their offspring's educational outcomes seem very few, and this topic will be addressed by our analyses.

Third, we examine whether income effects vary by *parental income level*. Previous Norwegian research has indicated that income effects are most marked in the lower parts of the income distribution, but it is unclear whether this also holds good for lower secondary school results. We pursue this topic by analyzing income effects in different income strata.

Causal inference and the utility of sibling fixed effects analyses

In line with the counterfactual, also termed potential outcome, model (Angrist and Pischke, 2009:13-15; Morgan and Winship, 2007:5), the causal effect of income can be understood as the average difference between the school grades a category of pupils *actually* obtained and the grades they *would have* got if their parents' income had changed by a certain amount.

The challenge is to estimate the potential outcome, i.e., the expected outcome in the hypothetical situation that the family income had been otherwise. In ordinary least square (OLS) regression analyses, potential outcomes are estimated from the observed outcomes in different levels of family income, adjusted for available confounders. The OLS estimates may be misleading, however, if important variables are missing from the models. For instance, a correlation between family income and children's educational outcomes could arise because school results vary with children's abilities, which could reflect the parents' academic interests, which in themselves could influence parents' income. If such parental traits are not taken into account, estimates from OLS regression may be unduly strong since they include, more or less, effects of unmeasured parental traits.

In this respect, the sibling fixed effects (FE) model has an advantage (see general discussions in, e.g., Allison, 2009; Firebaugh et al., 2014; Halaby, 2004; for applications, see Bjorklund and Sundstrom, 2006; Levy and Duncan, 2000). Basically, this advantage relies on the assumption that the unmeasured variables, which threaten the OLS model, will often be *time-invariant*, i.e., they do not change during the period under study and they influence all siblings in a sibship in the same way. Examples are shared personal traits inherited from the parents, exposures to the same persisting parenting style or family cultural capital (Andersen and Hansen, 2012), living in the same unchanging neighbourhoods, and other stable environmental and family-related circumstances.

Since such time-invariant circumstances influence all the siblings in a family in a practically identical way, they cannot explain the *differences* between these siblings. When analyzing why siblings came to be different, we can therefore neglect the time-invariant variables. Rather, we must focus on what has varied between the siblings, for instance, that the parents' income was better when one sibling grew up than when the other sibling(s) grew up, or that other circumstances varied between the siblings. Using a sibling FE model, we can examine to what degree a sibling's school outcome deviates from his/her siblings' in a way which corresponds to how the family income has varied. Since *within-family* variations are examined, unobserved time-invariant characteristics, shared by all siblings in the family, are adjusted for. Thus, the potential outcome, i.e., what the sibling's school grades *would have been* if he/she had experienced another parental income, is estimated by drawing on information about the school results and parental income for the other siblings in the family.

Results from sibling FE models may approximate the causal effects of family income better than OLS estimates, since the sibling FE model also adjusts for the unobserved time-invariant confounders which complicate the interpretation of OLS regression estimates. Nevertheless, also sibling FE models have their difficulties. They control for time-*invariant* confounders, but biased estimates may arise because of unobserved time-*varying* variables. Moreover, the sibling FE analyses rely solely on within-family variations, and extrapolations to a broader context can be problematic. Furthermore, the sibling FE model, unlike the OLS model, will not give estimates of the effects of time-invariant circumstances such as immigrant background.

Methods

Data and samples

The database was constructed by Statistics Norway by linking individual information from a number of public registers. The data file includes all pupils who graduated from lower secondary school 2002-2011. Most of them were born 1986-1995 and therefore 16 years old in the graduation year (1.7 per cent of the pupils were born either in 1985 or 1996).

For the *OLS regression analyses*, we utilize the entire sample. Among the 598,517 pupils in the data file, 7.2 per cent lacked or had incomplete information either on school grades or parental income, and about 0.2 per cent had insufficient information on other relevant variables. The sample used for the OLS analyses numbered 554,142 adolescents.

For the *sibling FE models*, we constructed a sample of *full siblings* (same mother and father according to the population registry) living in stable families (parents were cohabitating, but not necessarily legally married, when the siblings included in the data file graduated). Altogether 107,343 sibships with 236,703 siblings could be located in the data. Among them, 2.4 per cent had to be excluded because of missing information on school grades or parental income, and another 0.2 per cent lacked other relevant information. The analyzed sibling sample has 230,517 full siblings distributed on 104,772 sibships; 75.0 per cent of the siblings were in two-sibling sibships and 21.0 per cent in three-sibling sibships, while large sibships were rare (two had nine siblings!).

Outcome and income

When graduating from compulsory lower secondary school, pupils are awarded grades on a scale from 1 (failing) to 6 (excellent). The outcome analyzed here, termed Grade Points Average (GPA), is the *average* final grades for ten subjects which changed little during 2002-2011: oral and written Norwegian, mathematics, science and environment, oral and written English, social studies, physical education, religion and ethics, arts and craft, music, and home economics.[1] GPA indicates overall educational achievement around age 16 and will be highly associated with later educational attainment (Falch et al., 2014).

The GPA average was 4.07 (standard deviation SD = 0.80), but GPA varied between graduation years and increased somewhat during the studied period. In order to enhance comparisons across graduation years, GPA has been *standardized* separately for each graduation year (thus, mean = 0.00 and standard deviation SD = 1.00 for each year).

In the data file, information on parental income was only available in a special form: *the yearly average of the sum of the two parents' pretax income when the child was aged 6-13 years*. Parents' income includes wages, salaries, net incomes from self-employment, income from capital, pensions, sickness and unemployment benefits, and some other welfare transfers. The income measurement, given in Norwegian Kroner (NOK), has been adjusted for inflation according to the consumer price index (2008=100). Because of favourable economic conditions in Norway, median parental income for the pupils who graduated in 2011 was 31.4 per cent higher in *real* terms than the median income for the 2002 graduates.

An advantage of the income measurement is that it covers a long time period (eight years) corresponding to the primary school years – an important formative phase for a child. A drawback is that it does not allow for examining the timing of income issue, i.e., the hypothesis that income effects differ between different childhood stages. Another drawback is that it only approximates the family's purchasing power, since it measures pretax and not disposable income, and does not take wealth, tax evasions, or unregistered money transfers (e.g., gifts from grand parents) into consideration. Also free or subsidized public services (e.g., health care) influence a family's financial situation, and such services tend to be relatively more favourable for low income than for high income families.

Parental income was used in the statistical models in two versions. To indicate *absolute* income, the income measurement (unit: 100,000 NOK) was recalculated into natural logarithms.[2] The log transformation of income is often used in this research field (e.g., Duncan et al., 2011a; Hægeland et al., 2010; Dahl and Lochner, 2012); it corresponds to the expectation that the effect of a specific increase in parental income, say, 100,000 NOK, will have diminishing effects the higher the family is placed in the income hierarchy.

To indicate *relative income*, the percentile position in the distribution of parental income was calculated, separately for each graduation year. Thus, for each year in the 2002-2011 period, the value of the relative income measurement varies from 1 to 99.

Control variables

Other variables used in the analyses are described in Table 1. All variables (except GPA and income) are categorical and indicated by dummy variables. *Parental educational level* has five levels plus one missing category, constructed by information on father's and mother's educational level the year the offspring graduated.[3] *Immigrant background* means that both parents were born abroad. *Average family income* is the mean parental income for the siblings

in the sibship. These family-level variables can be used in the OLS analyses, but they are omitted from the sibling FE analyses since they have constant values within each sibship.

Also individual-level control variables are used, both in the OLS models and (since they often vary within a sibship) the sibling FE analyses. *Graduation year* (ten minus one dummies) adjusts for period and birth cohort effects. Immigrant background is associated with school results, but this variable drops out of the sibling FE analyses since it is constant for each sibship. Adjustment for immigration in the sibling FE models is approximated by the variable *length of residence* in Norway, which will vary between the siblings in some immigrant families. The reference category is non-immigrant pupils and immigrant pupils with 13+ years of residence, and the coding reflects that the immigrant disadvantage in school seems to be small after 6-8 years of residence (Bakken, 2010: 138; Hægeland et al., 2004: 23).

Moreover, intra-family social relations could be a source of outcome differences between siblings (Conley et al., 2007; Conley, 2008). Since such characteristics could also be related to parental income, ideally they should be adjusted for. No information on intra-familial processes is available in these register data, however, but such processes may to some extent be represented by variables which indicate the child's position in the family. In the analyses, we include variables indicating the pupil's gender, maternal and paternal age when the child was born (cf., Kalmijn and Kraaykamp, 2005), birth order (Kristensen and Bjerkedal, 2010; Bonesronning and Massih, 2011; Black et al., 2005), and number of younger siblings (Black et al., 2005). Lastly, to adjust for the possibility that stable school characteristics could be implicated in the association between parental income and school grades, school fixed effects are included in the estimations (923 minus one dummies in the OLS analyses, 713 minus one dummies in the sibling FE models).[4] – The OLS and sibling FE models are estimated by the STATA *reg* and *xtreg* program, respectively. Standard errors clustered on mothers' ID (anonymized identification number) are calculated.

Results

Table 2 shows the OLS regression results for the entire pupil cohorts and the sibling FE results for the sibling sample. The coefficients for the control variables are often interesting in themselves, but our comments will concentrate on the coefficients for *absolute* parental income (i.e., log income), and *relative* parental income (i.e., percentiles).

In the OLS regression analyses, parental income has a marked effect on GPA. The coefficient for log income is 0.274, which implies that one log unit change of income

corresponds to a change of about 27 per cent of the standard deviation of GPA. To illustrate the size of the effect, we can calculate the expected GPA increase if income had doubled: 0.274 * ln(2) = 0.274 * 0.6935 = 0.190. In other words: a doubling of parental income is associated with an improvement in school grades of nearly 20 per cent of the GPA standard deviation. Also *relative* income has strong effects, according to the OLS regression results. The coefficient is 0.0049, implying that a one percentile change in relative income corresponds to a change in GPA by about 0.5 per cent of a standard deviation.

The results from the sibling FE analyses diverge considerably from the OLS results, however. Here, the coefficient for parental log income is 0.059, which, although significant in statistical terms, is less than a quarter of the OLS estimate (which was 0.274). The calculation used above (0.059 * ln(2) = 0.041) suggests that a doubling of parental income would correspond to an average rise in school grades of about 4 per cent of the GPA standard deviation. Thus, the sibling FE model suggests limited improvement in school outcomes, even if absolute income increases a lot. As to relative income, the FE estimate indicates no effects, which (if valid) means that offspring's school performance will hardly benefit from the family's "climbing" in the income hierarchy.

Thus, the two estimation methods give different results. If sibling FE models approximate the causal effects of parental income better than OLS regression models, the results suggest that an absolute increase in parental income would have a modest average effect, while the relative position in the income distribution means practically nothing.

Effects of parental income change could be stronger in lower income strata, however. In order to examine this hypothesis, the samples were stratified into four parental income levels, using the median income in the entire sample (652,000 NOK) as reference.

The OLS regression models reported in Table 3 show clear effects of both absolute and relative income in all income categories, except for the insignificant absolute income effect in the lowest income category (average parental income below 60 per cent of the median). In contrast, the sibling FE results concur with the hypothesis (Table 3). In the lowest parental income category, the coefficient for log income is 0.170, i.e., almost three times higher than the FE coefficient in the entire sibling sample (which was 0.059). A doubling of parental income in these income-poor families (which comprise 5.0 per cent of the siblings) corresponds to improved school results by about 12 per cent of the GPA standard deviation. In the three higher income categories, the coefficients are small and insignificant in statistical terms. The results for relative income are similar. The coefficient for the income-poor families suggests a quite strong effect (0.0080, i.e., a one percentile movement in the income hierarchy

corresponds to 0.8 per cent of GPA standard deviation), but the p-value (0.075) is not significant in statistical terms. In higher income categories, no relative income effect appears.

To probe further into how income effects vary by parental income level, supplementary analyses with the same sibling FE models were performed. Parental income was now entered into the models with no log transformation (unit: 100,000 NOK). The results are displayed in Figure 1. In sibships with less than 300,000 NOK in average income, the coefficient is 0.079, implying that an increase in parental income of 100,000 NOK in this income category corresponds to a gain of about eight per cent of the GPA standard deviation. Similar effects appear in the two next income categories. For sibships with average parental incomes above 400,000 NOK, the coefficients are close to zero, however.[5] Thus, these supplementary analyses corroborate the findings of some income effects in income-poor families. The families with average parental income below 400,000 NOK comprise 6.1 per cent of the siblings and 5.7 per cent of the families in the sibling sample.

Discussion

Findings and interpretations

In this study, effects of parental income on school grades (GPA) among 16-years old pupils have been estimated both by conventional ordinary least square (OLS) regression models and by sibling fixed effects (FE) analyses. The advantage of the latter is that they adjust for constant (time-invariant), but unobserved, parental, family, and environmental characteristics which affect all siblings in a sibship in the same way – for instance, parents' abilities, or persisting parenting styles. Since such characteristics are hard to measure, they will often be missing in the data. This is a problem for conventional regression analyses which only adjust for *observed* covariates, implying that estimates may exaggerate the causal strength of income. This problem is less when using sibling fixed effects models since these models, unlike conventional regression, also adjust for unobserved, time-invariant, parental and family traits. Therefore, estimates provided by sibling fixed effects analyses may come closer to the causal impact of parental income than conventional regression estimates.

In our analyses, the conventional regression models gave clearly higher estimates of parental income effects than the sibling fixed effects models. However, as argued above, the conventional regression estimates may be upwardly biased. We will therefore highlight the results from the sibling fixed effects models when interpreting the results. They suggest that variations in *absolute* parental income play, in general, a rather modest role for the school

results of these mid-adolescents: a doubling of parental income corresponds, on average, to a gain of about four per cent of the standard deviation of school grades. Thus, for most pupils, only small changes in school grades could be expected from even quite large parental income increase. Moreover, according to the sibling fixed effects analyses, variations in *relative* income are of little consequence and the results do not support the hypothesis that a family's relative position in the income hierarchy is important for school outcomes.[6]

This assessment refers, however, to *average* effects across all income levels. A conspicuous finding is that in the *lower* end of the parental income distribution, marked income effects on school grades are observed. Among the families with average parental income below 60 per cent of the median (around five per cent of the families), a doubling of parental income corresponds to about 12 per cent of the standard deviation in school grades, which is a noteworthy and non-trivial effect. In addition, the sibling fixed effects analyses of relative income show noticeable effects in income-poor families. Thus, in such disadvantaged families, lack of income seems to be an obstacle to doing well in school.

As discussed in the beginning of this article, there are two main interpretations of how income could be causally related to school outcomes (Mayer, 1997): the *investment* perspective meaning that low income restricts families' consumption of goods and services which enhance school outcomes, and the *family process* perspective implying that financial problems typically lead to family conflicts and relational strain which hamper children's schoolwork. Among the majority of families in today's Norway, however, neither of these perspectives seem relevant for understanding differences in school grades. The results suggest that the tax-funded school system in combination with comparatively good household incomes in most families have curbed, to a large degree, the potential causal effects on school grades of variations in parental incomes.

However, in the lowest income strata, the results indicate that lack of income hamper school outcomes. The data do not allow for exploring the mechanisms leading to these effects in income-poor families, however. They could be due to lack of money for purchasing school-enhancing goods or services, or arise because of strained family interactions due to economic problems, or because of both these mechanisms. Nevertheless, these findings can have policy implications. They suggest that if income increased substantially in income-poor families, for instance in terms of wage rises in low-paid occupations or more generous welfare transfers, the children in such families might do better in lower secondary school.

Critical issues

The interpretations given above presuppose that the sibling fixed effects analyses have provided fairly credible estimations of the causal effects of parental income, but this can be problematized. Although the sibling analyses adjust for time-*invariant* circumstances, the estimates could be biased if important time-*varying* circumstances are left out of the model. If, for instance, a parent was healthy when the first sibling grew up, but sick in the formative years of the second, a correspondence between reduced parental income and worse school results could emerge. The explanation would probably not be the income difference, but rather how parental ill health led both to income decline and family stress. Another possibility: parents' upward career mobility could imply higher prestige and more access to influential social networks, which could enhance offspring's school grades. If so, improved school results may be due to environmental changes because of the family's social standing, rather than being due to the income increase which accompanies parents' career mobility.

Such examples would result in upwardly biased estimates, but lack of information on time-varying factors could also lead to downward bias. If a mother decides to drop paid work and stay home in order to support the children's schoolwork, school outcomes could improve (cf., Bettinger et al., 2013), while parental income could decline. In the analyses, we have controlled for indicators of the child's position in the family (birth order, number of younger siblings, etc.), which may to some extent correspond to variations in the siblings' environments apart from the differences in parental income. These adjustments are not optimal, and the validity of the estimates as *causal* effects depends on the assumption that relevant unmeasured time-varying factors are practically unrelated to parental income.

One may also ask whether the discrepancy between the conventional regression and the sibling fixed effects results is due to sample differences. The sibling sample consists only of unbroken families. If low income implies not only less good school results, but also a higher propensity for marital breakup, families where the effects of low income are most detrimental may be underrepresented in the sibling sample and the sibling analyses may underestimate the effects of income. Table 1 shows that there were often more favourable environments in the sibling sample – not only did they live in stable families, but parental education and parental income were also somewhat higher. The consequences of this are uncertain. However, when analyzing the sibling sample using conventional regression models (the siblings analyzed as individual, unrelated pupils, so to speak – table not shown), the income effects turn out to be practically identical to the effects found in the entire pupil

cohorts. This suggests that the way income is related to school results does not differ very much between the two samples.

A further potential problem in sibling fixed effects analyses is that within-family variations in both outcome and explanatory variables could be unduly restricted. The years used for calculating the eight-years average parental income will of course overlap between the siblings in most sibships, and large within-sibship differences in income are rare. As a robustness test, we have analyzed subsamples where within-family variations in parental income are larger; first, sibships where the youngest sibling graduated at least six years later than the eldest sibling (N=43,187), and second, sibships where the parental income percentile for the youngest sibling deviated by at least ten percentiles from the eldest (N=45,084). The effects of parental log income was *lower* in these subsamples than in the entire sibling sample (table not shown, results available from the authors), suggesting that restricted parental income variation in the sibling sample has not biased the estimates downwards.

Lastly, a few comments on what could seem as an incongruity. Previous studies on Norwegian data (Carneiro et al., 2013; Duncan et al., 2011a; Løken et al., 2012) have indicated that the final educational level obtained *as adults* is influenced by family income. Although we found parental income effects in income-poor families, our findings suggest less income effects on grades in lower secondary school than the effects on final educational level as adults indicated by the above-mentioned studies. One possible reason for this discrepancy is that we have analyzed younger birth cohorts who grew up in more affluent families than the birth cohorts examined by the previous studies. Another interpretation would take the distinction between *primary* and *secondary* effects of family background into account (Boudon, 1974; Goldthorpe, 2000: 169-172). The scope for "making a difference" in educational performance by spending money may be very restricted in primary and lower secondary school. Later on, the role of family economic resources could increase. Costly services and amenities, seldom relevant for children and young adolescents, become realistic means for improving educational performance when the offspring is in his/her late adolescence and early adulthood: private tutoring, language courses abroad, economic support for longer university studies, etc. Hence, variations in parental income could be more consequential for *final* educational attainment in adulthood than for grades in lower secondary school.

Conclusion

The analyses of this study indicate that overall, causal effects of parental income on performance in contemporary Norwegian lower secondary schools are small. Measuring parental income by relative income indicators does not alter this. However, in the lower income strata, parental income effects are evident, and their magnitude may have policy implications. The findings indicate that in spite of the public, tax-funded and nearly free school system in Norway, and relatively small income inequalities, lack of family income hampers the educational performance of children and adolescents in income-poor families.

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Notes

1. In the GPA calculation, all subjects count equally. Following Hægeland et al. (2004), we have also weighted the ten subjects according to their proportion of teaching lessons, which implies, for instance, that grades in mathematics count more than grades in arts and craft. As the unweighted and the weighted GPA led to practically identical results, we only use the unweighted GPA in this paper.
2. The log transformation requires positive numbers. In the data file made available for this research, the eight-years parental income average was always positive (although sometimes very low).
3. In the sibling sample, parental education changed from the first to the last sibling for about two per cent of the sibships. The changes were usually small, and parental education has therefore been regarded as time-invariant in the sibling FE analyses.
4. The pupils graduated from more than 1000 different schools; many of them very small. Schools with less than ten graduates on average per year were pooled into one school unit.

5. For the three lowest income categories, p-values are 0.029, 0.063, and 0.042. For the categories with average parental income above 400,000 NOK, the coefficients' p-values are not statistically significant except for the small negative coefficient (-0.027) in the 450-550,000 NOK category.

6. The absolute and relative income measures correlate highly. The relative income hypothesis can be further tested by including both measurements in the same model; when this is done, relative income adds practically nothing above the effects of log income (results not shown).

References

Aakvik A, Vaage K and Salvanes KG (2005) Educational attainment and family background. *German Economic Review* 6(3):377-394.

Allison PD (2009) *Fixed effects regression models. Series: Quantitative applications in the social sciences 160.* Thousand Oak, California: SAGE Publications.

Andersen PL and Hansen MN (2012) Class and Cultural Capital-The Case of Class Inequality in Educational Performance. *European Sociological Review* 28(5):607-621.

Angrist JD and Pischke J-S (2009) *Mostly harmless econometrics. An empiricist's companion.* Princeton and Oxford: Princeton University Press.

Bakken A (2010) *Prestasjonsforskjeller i Kunnskapsløftets første år - kjønn, minoritetsstatus og foreldres utdanning.* [Achievement inequality the first years after the Knowledge Promotion Reform - gender, immigrants, and parental eduction, in Norwegian]. Oslo: NOVA - Norwegian Social Research.

Bakken A and Elstad JI (2012) *For store forventninger? Kunnskapsløftet og ulikhetene i grunnskolekarakterer* [Too great expectations? The Knowledge Promotion Reform and inequalities in school grades in lower secondary school, in Norwegian]. Oslo: NOVA - Norwegian Social Research.

Becker GS and Thomes N (1986) Human capital and the rise and fall in families. *Journal of Labor Economics* 4(1):1-39.

Bettinger E, Rege M and Hægeland T (2013) *Home with mom: the effects of stay-at-home parents on children's long run educational outcomes.* Oslo: Statistics Norway, Discussion Papers No 739.

Bjorklund A and Sundstrom M (2006) Parental separation and children's educational attainment: A siblings analysis on Swedish register data. *Economica* 73(292):605-624.

Black SE, Devereux PJ, Loken KV, et al. (2014) Care or Cash? The Effect of Child Care Subsidies on Student Performance. *Review of Economics and Statistics* 96(5):824-837.

Black SE, Devereux PJ and Salvanes KG (2005) The more the merrier? The effect of family size and birth order on children's education. *Quarterly Journal of Economics* 120(2):669-700.

Blanden J and Gregg P (2004) Family income and educational attainment: A review of approaches and evidence for Britain. *Oxford Review of Economic Policy* 20(2):245-263.

Blau DM (1999) The effect of income on child development. *Review of Economics and Statistics* 81(2):261-276.

Bodovski K (2010) Parental practices and educational achievement: social class, race, and habitus. *British Journal of Sociology of Education* 31(2):139-156.

Bonesronning H and Massih SS (2011) Birth order effects on young students' academic achievement. *Journal of Socio-Economics* 40(6):824-832.

Boudon R (1974) *Education, opportunity and social inequality.* New York: Wiley.

Bukodi E, Erikson R and Goldthorpe JH (2014) The effects of social origins and cognitive ability on educational attainment: Evidence from Britain and Sweden. *Acta Sociologica* 57(4):293-310. [Online data supplements http://asj.sagepub.com/content/by/supplemental-data].

Carneiro P, Carcia IL, Salvanes KG, et al. (2013) *Intergenerational mobility and the timing of parental income*. London: Department of Economics, UCL. Available at www.sole-jole.org/14396.pdf (accessed 25 January, 2015).

Clark-Kauffman E, Duncan GJ and Morris P (2003) How welfare policies affect child and adolescent achievement. *American Economic Review* 93(2):299-303.

Conger RD, Conger KJ and Martin MJ (2010) Socioeconomic status, family processes, and individual development. *Journal of Marriage and Family* 72(3):685-704.

Conley D (2008) Bringing sibling differences in: Enlarging our understanding of the transmission of advantage in families. In: Lareau A and Conley D (eds) *Social class. How does it work?* New York: Russel Sage Foundation, pp.179-200.

Conley D, Pfeiffer KM and Velez M (2007) Explaining sibling differences in achievement and behavioral outcomes: The importance of within- and between-family factors. *Social Science Research* 36(3):1087-1104.

Dahl GB and Lochner L (2012) The impact of family income on child achievement: Evidence from the Earned Income Tax Credit. *American Economic Review* 102(5):1927-1956.

Dooley M and Stewart J (2004) Family income and child outcomes in Canada. *Canadian Journal of Economics-Revue Canadienne D Economique* 37(4):898-917.

Duncan GJ, Magnuson K and Votruba-Drzal E (2014) Boosting Family Income to Promote Child Development. *Future of Children* 24(1):99-120.

Duncan GJ, Telle K, Ziol-Guest KM, et al. (2011a) Economic deprivation in early childhood and adult attainment: Comparative evidence from Norwegian registry data and the U.S. Panel Study of Income Dynamics. In: Smeeding TM, Erikson R and Jäntti M

(eds) *Persistence, privilege, and parenting. The comparative study of intergenerational mobility.* New York: Russel Sage Foundation, pp.209-234.

Duncan GJ, Morris PA and Rodrigues C (2011b) Does money really matter? Estimating impacts of family income on young children's achievement with data from random-assignment experiments. *Developmental Psychology* 47(5):1263-1279.

Duncan GJ, Ziol-Guest KM and Kalil A (2010) Early-childhood poverty and adult attainment, behavior, and health. *Child Development* 81(1):306-325.

Erikson R and Jonsson JO (1996) Introduction: Explaining class inequality in education: the Swedish test case. In: Erikson R and Jonsson JO (eds) *Can education be equalized? The Swedish case in comparative perspective.* Boulder, Colorado: Westview Press, pp.1-64.

Falch T, Nyhus OH and Strøm B (2014) Performance of young adults: The importance of different skills. *CESifo Economic Studies* 60(2):435-462.

Firebaugh G, Warner C and Massoglia M (2014) Fixed effects, random effects, and hybrid models for causal analysis. In: Morgan SL (ed) *Handbook of causal analysis for social research.* Dordrecht: Springer, pp.113-132.

Goldthorpe JH (2000) Class analysis and the reorientation of class theory: The case of persisting differentials in educational attainment. In: Goldthorpe JH (ed) *On sociology. Numbers, narratives, and the integration of research and theory.* Oxford: Oxford University Press, pp.161-181.

Halaby CN (2004) Panel models in sociological research: Theory into practice. *Annual Review of Sociology* 30: 507-544.

Hansen MN (2008) Rational action theory and educational attainment. Changes in the impact of economic resources. *European Sociological Review* 24(1):1-17.

Heckman JJ and Mosso S (2014) *The economics of human development and social mobilit.* Bonn: IZA Discussion Paper No. 8000.

Humlum MK (2011) Timing of family income, borrowing constraints, and child achievement. *Journal of Population Economics* 24(3):979-1004.

Hægeland T, Kirkebøen LJ, Raaum O, et al. (2004) *Marks across lower secondary schools in Norway. What can be explained by the composition of pupils and school resources? Report 2004/11,* Oslo: Statistics Norway.

Hægeland T, Kirkebøen LJ, Raaum O, et al. (2010) *Why children of college graduates outperform their schoolmates. A study of cousins and adoptees.* Bonn: IZA Discussion Paper No. 5369.

Hægeland T, Kirkebøen LJ, Raaum O, et al. (2013) Hvorfor gjør barn av høyt utdannede det bedre på skolen? [Why do children with better educated parents get better school grades? In Norwegian] In: Holmseth S (ed) *Utdanning 2013 - fra barnehage til doktorgrad [Education 2013 - from kindergarten to doctorate]*. Oslo/Kongsvinger: Statistics Norway, pp.83-103.

Jonsson JO and Gahler M (1997) Family dissolution, family reconstitution, and children's educational careers: Recent evidence for Sweden. *Demography* 34(2):277-293.

Kalmijn M and Kraaykamp G (2005) Late or later? A sibling analysis of the effect of maternal age on children's schooling. *Social Science Research* 34(3):634-650.

Kilpi-Jakonen E (2012) Does Finnish educational equality extend to children of immigrants? *Nordic Journal of Migration Research* 2(2):167-181.

Kristensen P and Bjerkedal T (2010) Educational attainment of 25 year old Norwegians according to birth order and gender. *Intelligence* 38(1):123-136.

Kvist J, Fritzell J, Hvinden B, et al. (2012) *Changing social equality. The Nordic welfare model in the 21st century.* Bristol: Policy Press.

Lareau A (2000) *Home advantage. Social class and parental intervention in elementary education.* Lanham, Md.: Rowman & Littlefield.

Levy DM and Duncan G (2000) *Using sibling samples to assess the effects of childhood family income on completed schooling.* Northwestern University, Illinois: Joint Center for Poverty Research, Working paper 168.

Løken KV, Mogstad M and Wiswall M (2012) What linear estimators miss: The effects of family income on child outcomes. *American Economic Journal-Applied Economics* 4(2):1-35.

Marmot MG (2004) *Status syndrome. How your social standing directly affects your health and life expectancy*. London: Bloomsbury.

Mayer SE (1997) *What money can't buy. Family income and children's life* chances. Cambridge, Mass. & London, UK.: Harvard University Press.

Mayer SE (2002) *The influence of parental income on children's* outcomes. Wellington, New Zealand: Ministry of Social Development.

McEwen A and Steward J (2014) The relationships between income and children's outcomes: a synthesis of Canadian evidence. *Canadian Public Policy* 40(1):99-109.

Morgan SL and Winship C (2007) *Counterfactuals and causal inference. Methods and principles for social* research. New York: Cambridge University Press.

Morrissey TW, Hutchison L and Winsler A (2014) Family income, school attendance, and academic achievement in elementary school. *Developmental Psychology* 50(3):741-753.

NOU (2009) *Fordelingsutvalget. Norges offentlige utredninger 2009:10 [Commission on distribution. Official Norwegian Reports 2009:10]*. Oslo: Departementenes servicesenter.

OECD (2010) *PISA 2009 Results: Overcoming social background (Volume II).* http:/dx.doi.org/10.1787/9789264091504-en (accessed 24 February, 2015).

OECD (2011) *Divided we stand. Why inequality keeps rising.* Paris: Organisation for Economic Co-operation and Development. http://dx.doi.org/10.1787/9789264119536-3-en (accessed 1 March, 2015).

OECD (2012) *Economic Survey of Norway 2012*. Paris: Organisation for Economic Co-operation and Development.

Plug E and Vijverberg W (2005) Does family income matter for schooling outcomes? Using adoptees as a natural experiment. *Economic Journal* 115(506):879-906.

Rege M, Telle K and Votruba M (2011) Parental job loss and children's school performance. *Review of Economic Studies* 78(4):1462-1489.

Shea J (2000) Does parents' money matter? *Journal of Public Economics* 77(2):155-184.

Steffensen K and Ziade SE (2009) *Skoleresultater 2008. En kartlegging av karakterer fra grunnskolen og videregående skoler i Norge. Report 2009/23* [School results 2008, in Norwegian]. Oslo: Statistics Norway.

Tamm M (2008) Does money buy higher schooling? Evidence from secondary school track choice in Germany. *Economics of Education Review* 27(5):536-545.

Wilkinson RG and Pickett K (2009) *The spirit level. Why more equal societies almost always do better.* London: Allen Lane.

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Table 1. Descriptive statistics; OLS sample and sibling sample.

	OLS sample (N=554,142)	Sibling sample (N=230,517)
Mean GPA (standard deviation SD)	4.07 (0.80)	4.19 (0.77)
Mean parental income, unit 100,000 NOK (SD)	7.20 (8.826)	7.57 (7.920)
Mean log income (SD)	1.856 (0.452)	1.912 (0.424)
Parents' education % - lowest level	16.6	13.3
- second lowest level	17.8	15.9
- medium	31.3	31.5
- second highest level	24.8	28.0
- highest level	8.2	10.3
- missing parental education information	1.3	1.1
Graduation year % - 2002	9.1	7.7
- 2003	9.3	8.3
- 2004	10.0	9.6
- 2005	10.2	11.0
- 2006	10.4	11.7
- 2007	10.2	12.0
- 2008	10.3	11.7
- 2009	10.3	10.4
- 2010	10.1	8.9
- 2011	10.2	8.7
Immigrant background %	6.5	7.4
Residence length in Norway %		
– 13+ years, including non-immigrants	97.1	97.3
- 8-12 years	1.3	1.3
- 0-7 years	1.6	1.4
Parents cohabitating %	65.5	100.0
Girls %	49.0	48.4
Mother's age at birth % – 13-20 years	5.8	3.0
- 21-38 years	91.6	95.1
- 39-53 years	2.7	1.9
Father's age at birth % – 15-22 years	5.7	3.2
- 23-42 years	89.7	94.3
- 43-73 years	3.4	2.5
- missing	1.2	0.0
Birth order % – first-born	46.2	35.9
- second-born	31.8	39.9
- third-born	15.6	16.8
- fourth-born and higher	6.4	7.4
Number of younger siblings % - 0	34.9	30.7
- 1	34.6	40.6
- 2	19.4	20.2
- 3 and more	11.1	8.4

Table 2. Absolute and relative parental income effects on standard deviation of GPA, OLS regression and sibling FE models.

Estimation method	**OLS regression (N=554,142)**						**Sibling FE models (N=230,517)**					
Parental income measurement	**Absolute income (log of parental income)**			**Relative income (percentiles)**			**Absolute income (log of parental income)**			**Relative income (percentiles)**		
	Coeff.	SE	p-val	Coeff.	SE	p-val	Coeff.	SE	p-val	Coeff.	SE	p-val
Parental income	0.274	0.004	<0.001	0.0049	0.0001	<0.001	0.059	0.018	0.001	-0.0001	0.0003	0.728
Parents' education, ref: lowest level							-	-	-	-	-	-
- second lowest level	0.180	0.005	<0.001	0.175	0.005	<0.001						
- medium	0.450	0.004	<0.001	0.431	0.004	<0.001						
- second highest level	0.800	0.005	<0.001	0.760	0.005	<0.001						
- highest level	1.054	0.006	<0.001	1.011	0.006	<0.001						
- missing information	0.226	0.016	<0.001	0.185	0.016	<0.001						
Immigrant background	0.049	0.008	<0.001	0.071	0.008	<0.001	-	-	-	-	-	-
Residence in Norway, ref: 13+ years												
- 8-12 years	-0.055	0.014	<0.001	-0.059	0.014	<0.001	-0.063	0.031	0.039	-0.064	0.031	0.035
- 0-7 years	-0.136	0.016	<0.001	-0.211	0.016	<0.001	-0.301	0.043	<0.001	-0.311	0.043	<0.001
Gender, ref: boy	0.458	0.002	<0.001	0.457	0.002	<0.001	0.458	0.004	<0.001	0.458	0.004	<0.001
Parents not cohabitating	-0.311	0.003	<0.001	-0.314	0.003	<0.001	-	-	-	-	-	-
Parental age when child born												
Mother, ref: 21-38 years												
- 39-53 years	0.086	0.008	<0.001	0.086	0.008	<0.001	-0.003	0.018	0.866	-0.005	0.018	0.800
- 13-20 years	-0.178	0.006	<0.001	-0.168	0.006	<0.001	0.001	0.014	0.996	-0.001	0.014	0.955
Father, ref: 23-42 years												
- 43-73 years	0.056	0.007	<0.001	0.058	0.007	<0.001	0.010	0.018	0.582	0.008	0.018	0.662
- 15 – 22 years	-0.153	0.006	<0.001	-0.144	0.006	<0.001	0.006	0.014	0.662	0.005	0.014	0.728
- unknown	0.241	0.014	<0.001	0.145	0.013	<0.001	-	-	-	-	-	-
Sibling's birth order – ref: first-born												
- second-born	-0.150	0.003	<0.001	-0.149	0.003	<0.001	-0.141	0.009	<0.001	-0.140	0.009	<0.001
- third-born	-0.208	0.004	<0.001	-0.207	0.004	<0.001	-0.198	0.017	<0.001	-0.200	0.017	<0.001
- fourth-born and higher	-0.269	0.006	<0.001	-0.264	0.006	<0.001	-0.218	0.026	<0.001	-0.215	0.026	<0.001
Number of younger siblings ref: 0												
- 1	-0.025	0.003	<0.001	-0.021	0.003	<0.001	0.060	0.009	<0.001	0.061	0.009	<0.001
- 2	-0.054	0.004	<0.001	-0.047	0.004	<0.001	0.082	0.018	<0.001	0.082	0.018	<0.001
- 3 and more	-0.129	0.005	<0.001	-0.118	0.005	<0.001	0.077	0.027	0.004	0.078	0.027	0.004
R square / FE model within R square		0.280			0.283			0.124			0.124	

SE = standard errors clustered on mother's ID. Adjusted for graduation year (9 dummies) and school fixed effects (922/712 dummies). Sibling FE models: no coefficients for variables with constant values within sibships.

Table 3. Absolute and relative parental income effects on standard deviation of GPA, four parental income levels, OLS regression and sibling FE models.

Estimation method	**OLS regression**					
Income measurement	**Absolute income (log of parental income)**			**Relative income (percentiles)**		
	Coeff.	SE	p-val	Coeff.	SE	p-val
Parental income category						
Below 60% of median (N= 46,475)	-0.015	0.012	0.222	0.0049	0.0019	0.011
60-90% of median (N=154,807)	0.308	0.023	<0.001	0.0040	0.0003	<0.001
90-120% of median (N=195,067)	0.591	0.025	<0.001	0.0048	0.0002	<0,001
120%+ of median (N=157,793)	0.171	0.006	<0.001	0.0078	0.0003	<0.001
Estimation method	**Sibling FE models**					
Income measurement	**Absolute income (log of parental income)**			**Relative income (percentiles)**		
Average parental income in sibship						
Below 60% of median (N=11,515)	0.170	0.041	<0.001	0.0080	0.0045	0.075
60-90% of median (N=60,787)	-0.044	0.053	0.410	-0.0009	0.0007	0.165
90-120% of median (N=86,179)	-0.012	0.046	0.796	-0.0000	0.0004	0.970
120%+ of median (N=72,036)	0.048	0.026	0.061	0.0009	0.0006	0.145

Income categories calculated with reference to median income = 652,000 NOK. SE = standard errors clustered on mother's ID. Controls (categorical variables indicated by dummies): Graduation year, parental educational level (omitted from FE estimations), immigrant background (omitted from FE analyses), length of residency in Norway, pupil's gender, parent cohabitation, mother's and father's age when child was born, birth order, number of smaller siblings, school fixed effects.

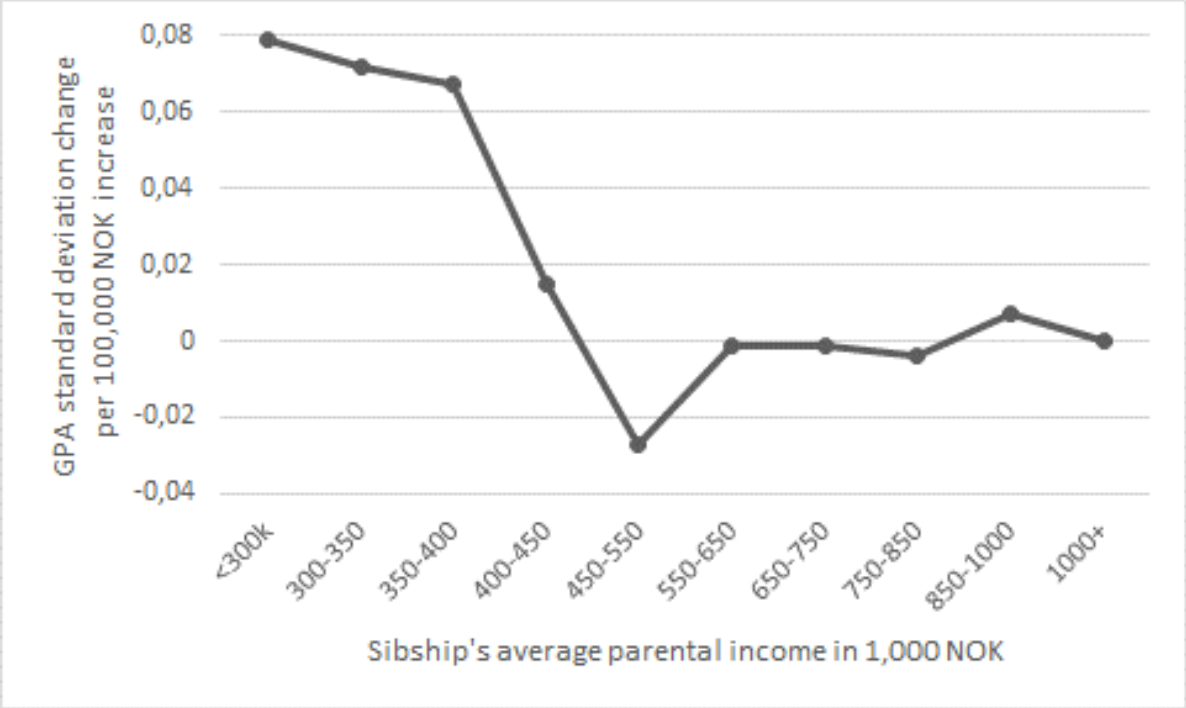

Figure 1. Sibling FE estimations of change in standard deviation of GPA per parental income increase of 100,000 NOK, in ten categories of average parental income levels.