The Effect of Income Changes on the Accumulation of Children's Cognitive and Non-Cognitive Outcomes

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Abstract

The main scope of this paper is to assess the relationship and pathways that link gains and losses in family income to the cognitive and non-cognitive development of children. With data from the UK Millennium Cohort Study (MCS), I use a value added model to link distributional changes in family income to children's reading scores and internalising and externalising behaviour trajectories between age 3 and 15. I find that only income losses have a significant negative impact on the non-cognitive development of children and that one third of the effect operates through channels related to mental health and well-being of the parents. Instead, movements upwards and downwards the income distribution affect cognitive outcomes symmetrically. I find evidence suggesting that past income losses matter only in conjunction with current losses in explaining residualised reading test scores and that experiencing an income loss predicts the probability of entering the bottom quintile of the distribution of cognitive and non-cognitive skils.

Keywords: Cognitive skills, Non-cognitive skills, Income changes

JEL codes: J24, D31

1 Introduction

The analysis of parental income in relation to human capital is no new subject in economics. Considerable theoretical contributions describe how income enables parents to put in place investments that will foster their kids' human capital development, which in turn will shape their later life outcomes. Extensive work from Heckman and coauthors from the early 2000s has emphasised that human capital is a multidimensional concept that cannot be equated to cognitive skills only (see, among others, Heckman and Rubinstein, 2001; Heckman, Stixrud, and Urzua, 2006; Cunha, Heckman, and Shennach, 2010). The existing empirical literature, however, has largely focused on how parents' socio-economic status affects children's cognitive abilities, often neglecting non-cognitive ones, despite the growing body of evidence proving their importance in determining later life outcomes (see Cunha et al. 2010; Blanden and Machin 2010; Ermisch 2008; Flouri et al. 2012, 2014). Further evidence from neurobiology, developmental psychology, and economics underlines the importance of early age experiences and environment in shaping brain functions and future development. While there is an increasing consensus on the importance of non-cognitive skills, the evidence surrounding its determinants and, in particular, on the impact of economic shocks on the social and behavioural outcomes of children is still scarce. The main scope of this paper is to assess the relationship and pathways that link gains and losses in family income to the cognitive and non-cognitive development of children. Below follows a synthetic overview of the main contributions linking different dimensions of parental income to human capital formation.

Causal literature. There is a large literature looking at the relationship between family income and children's outcomes (see Dahl and Lochner, 2012 for a review). Part of this literature addresses the causal impact of income, exploiting the exogenous variations coming from policy changes (e.g. income transfer programs). With US data, Dahl and Lochner (2012) exploit discontinuities in the Earned Income Tax Credit to identify the effect of income on test scores, finding that a 1,000 dollars increase in income raises combined math and reading test scores by 6% of a standard deviation. Using the same policy discontinuities, Evans and Garthwaite (2010) find that higher income causes lower levels of both self-reported maternal stress and biological markers associated

with stress. Milligan and Stabile (2011) look at variations in income induced by child benefit policy expansion in Canada and find significant positive effects on child and mother's mental health. Blau (1999) performs a fixed effect analysis of the NLSY cohort, finding little to no effect of current income on cognitive, social, and emotional development of kids; however, he does not control for potentially endogenous transitory shocks. Dahl and Lochner (2012) improve Blau's identification strategy with an instrumental variables approach, finding larger effects. Kuehnle (2014) explores the link between income and self-reported health on the 1970 British Cohort Study. Using local unemployment rates as an instrument, he identifies a small positive causal effect of family income on children's health.

Descriptive evidence and channels. In general, most of these studies find a positive association between family income and children's human capital, the effect being larger for cognitive rather than non-cognitive outcomes (Duncan and Brooks-Gunn, 1997). While the papers mentioned above look at the effect of parents' income per-se on human capital accumulation (Shea, 2000), a broad range of descriptive studies find evidence of channels mediating the effect of income on child development (Washbrook et al., 2014; Yeung et al., 2002). Income, for instance, is known to be a determinant of individual well-being, with several studies establishing a causal link between the two (Frijters et al., 2004; Gardner and Oswald, 2007; Powdthavee, 2010). Parental well-being, in turn, determines parenting practices: higher well-being is associated with warmer and responsive parenting (McLoyd et al. 1994; Sampson and Laub, 1994; Smith and Brooks-Gunn, 1997), with positive spillovers on children's development (Conger et al., 1992; McLoyd, 1990). Looking at the correlation between a permanent and a transitory measure of income on preschool children's outcomes, Yeung et al. (2002) test for the presence of two main set of mediating channels, respectively linked to the family stress theory and the investment theory. They find that mothers' emotional affect and parenting style play a significant role in explaining the effect of income on preschool children's externalising behaviour; on the other hand, the effect of income on children's cognitive skills runs mostly through the setting up of material investments. Despite the important role of mediating factors, the authors find that a direct effect of income on cognitive skills and externalising behaviour still persists. Washbrook et al. (2014) find consistent results on the medi-

ating role of parents, using a broader set of measures of maternal psychosocial functioning. Frank and Meara (2009) find that maternal depression has a large negative effect on child development and the accumulation of non-cognitive skills, while it does not seem to affect math and reading test scores. However, these papers, using only cross sectional variations in income, fail to capture the dynamics between income changes, the short-term reaction of parents in terms of well-being, and children's behavioural and cognitive response. In this sense, a paper that comes closer to this objective is Barazzetta, Clark, and D'Ambrosio (2017), who use the same cross-sectional approach to estimate the effect of mothers' financial problems - a variable capturing financial distress rather than plain income - on a variety of childhood outcomes and find that only one quarter of the effect is captured by mothers' mental health.

The Millennium Cohort Study. The UK Millennium Cohort Study (MCS) is a longitudinal study following about 19,000 children born at the turn of the millennium and their families. An almost unique feature of the dataset is that it contains information on both cognitive and non-cognitive skills of children aged 3 to 15. Some papers already tried to link these measures to income: Kelly et al. (2011), using cognitive and non-cognitive measures of child development from waves 2 and 3 of MCS, find evidence of an income gradient, consistently with the previous literature. However, to the best of my knowledge, Noonan et al. (2016)'s is the only other longitudinal study linking family income to health and non-cognitive outcomes of children. Use behavioural outcomes at age 11, they find that permanent income has a protective effect of the likelihood of having behavioural problems at age 11.

In order to investigate the relationship between cognitive and non-cognitive skills formation and income changes, I use information from the six available waves of MCS. The outcomes of interest, namely cognitive and non-cognitive skills, are measured respectively through age-adjusted reading test scores and through the Strengths and Difficulties Questionnaire (SDQ), a widely recognised behavioural screening tool for children and adolescents. Using a value added model to assess the impact of income gains and losses on the aforementioned outcomes, I find that income losses are correlated with lower residualised cognitive and non-cognitive skills, while gains seem to matter only for cognitive skills. Consistently with the literature described above, results suggest that

the effect of losses on non-cognitive outcomes transits for one third through mothers' well-being. Similarly to Bruckauf and Chzhen (2016), I then explore mobility inwards and outwards the bottom of the cognitive and non-cognitive skills distribution. I find that income losses (gains) are positively (negatively) correlated with the probability of entering the bottom quintile of the distribution of all outcomes, and that the bottom of the distribution is stickier for non-cognitive outcomes rather than cognitive ones. To the best of my knowledge, this paper contributes to the literature in at least three original ways: it is the first study to use data on both cognitive and non-cognitive skills for all currently available waves of the MCS in relationship to movements across the income distribution; it uses a value added model approach to assess the contribution of income changes on the year-to-year formation of cognitive and non-cognitive skills; lastly, it relaxes the assumption underlying most of the empirical literature in this field, which is that income gains and losses have a symmetric effect on children's outcomes.

Here follows an outline of the remainder of the paper. Section 2 describes the dataset and the main variables of interest, and presents the empirical strategy. Section 3 describes the main results. Robustness checks are conducted in Section 4, to test for the sensitivity of the estimates to changes in the specification. Before concluding with Section 6, Section 5 shows some additional results addressing persistence and transition dynamics.

2 Data and Methodology

2.1 Data description

This paper uses data from five waves of the UK Millennium Cohort Study (MCS). MCS is a longitudinal birth cohort study following the lives of around 19,000 children born in the UK between 2000 and 2001. Six sweeps of the survey have been conducted so far, at age 9 months, 3 years, 5 years, 7 years, 11 years, and 15 years. The study collects a variety of socio-economic and demographic characteristics of the cohort members and their families, as well as information on parenting and childcare. From age 3 onward, data on cognitive and non-cognitive development

are also available.

As far as cognitive outcomes are concerned, reading and word assessment tests are consistently available throughout sweeps 2 to 6. Numerical skills, on the other hand, are measured less frequently and have limited cross-wave comparability. Cognitive skills are assessed through age-appropriate standardised tests from the British Ability Scales (BAS) from Sweeps 2 to 5. In order to capture reading and vocabulary skills, I rely on the BAS Naming Vocabulary scale for sweeps 2 and 3, the BAS Word Reading scale for sweep 4, and BAS Verbal Similarity for sweep 5 (see Hansen, 2014, for further details on the tests available for each wave). In sweep 6 the only available word assessment is devised on the basis of standardised vocabulary tests developed by the Applied Psychology Unit at the University of Edinburgh in 1976 (this measure was already used to evaluate children in the same age range in the 1970 British Cohort Study). The measure of cognitive ability I will use in the main section of the paper is derived from the standardisation of the age-adjusted standardised t-scores from each of the tests described above.[1]

The measure of non-cognitive outcomes available for most sweeps of the MCS is the Strength and Development Questionnaire (SDQ). The SDQ is a screening test consisting of a set of age-appropriate questions assessing the behavioural and emotional health of children aged 3 to 16. The questionnaire is compiled by the cohort member's main caregiver in waves 2 to 6. Additionally, teacher-reported SDQ is available in sweeps 4 and 5 of MCS. The questionnaire is made of 25 items, which can be divided between five different scales: emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behaviour. Emotional symptoms and peer problems make up the category "internalising problems", while conduct problems and hyperactivity/inattention constitute the "externalising problems" category. Both categories are measured on a scale going from 0 to 20, which I reverse so that high values of SDQ correspond to better behavioural outcomes. As argued by Goodman et al. (2010), in low-risk samples, using these two broader categories yields better cross-sectional discriminant validity with respect to using the five SDQ scales. See Table A.1 in the Appendix for more details on measurement and on the items that make up internalising and externalising SDQ.

[1]Except for the vocabulary test at sweep 6, whose raw score is the only available measure; I standardise it beforehand to match the same range of the standardised reading scores of the previous sweeps.

As it is often the case in cohort studies, the measure of income in MCS is not reported as a continuous variable, but is instead limited to a discrete number of bands that vary from wave to wave. Respecting the limits imposed by the extremes of each income band, the data providers developed a measure of imputed income using interval regression. Among the predictors of income were respondent's age, housing tenure, region of residence, education, and labour market status (see Hansen, 2014 for a full list of predictors and more details on the imputation procedure). The measure of imputed income was then equivalised in order to account for economies of scale within the family, using the OECD household equivalence scale. While this measure allows to have a continuous income variable in the dataset, it is likely to be affected by measurement error and to only partly reflect the latent income of the families in the sample. In order to limit the sensitivity of the results to this measurement issue, I build my main explanatory variables (i.e. income gains and losses) based on the quintiles of the equilvalised imputed income. This approach has the advantage of closely reflecting self-reported banded income, without suffering from the cross-wave differences in the definition of the bands. Furthermore, it allows me to capture "important" variations in family income, as transitions from one income quintile to another will arguably be observed only for sufficiently large income gains or losses. However, as shown more in detail in the Robustness checks section, results are qualitatively similar when using continuous equivalised imputed income. Transition matrices showing the raw probability of moving across quintiles of the distributions of income, cognitive skills, and non-cogntive skills from one wave to the next in the estimation sample are reported in the Appendix (Figures A.1 to A.4).

2.2 Empirical strategy

Value added models are an established tool in the field of economics of education and are typically used to assess the impact of teachers on kids' performance in school. In general, they can be used to evaluate the contribution of an input in the accumulation of human capital from a given point in time to a subsequent one (Koedel, Mihaly, and Rockoff, 2015). With respect to regressions to the mean, value added models offer the advantage of assessing the average year-to-year contribution of factors of interest to the trajectories of fairly persistent outcomes. In a way, they provide a

life-event approach to the short-term evolution of human capital that, under certain assumptions, allows to control for latent factors contributing to the human capital production function. Although widely used in relationship to teachers' quality, there are only few examples of their application to different contexts. One of them is the work by Boyce et al. (2013), who apply a value added model to assess the correlation between income changes and changes in life satisfaction, using data from Germany.

In this paper I try to explain to what extent a change in children's cognitive and non-cognitive outcomes between two consecutive periods is explained by a change in household income. In order to do so, I adopt a "lagged score" value added model (Koedel et al., 2015), which can be read as a model generating from an autoregressive process of order one. This method explores the dynamics human capital formation by capturing the residualised changes in cognitive and non-cognitive skills, while accounting for their unobserved time-invariant determinants. For each of the outcomes of interest (i.e. internalising SDQ, externalising SDQ, and cognitive ability), I estimate the following regressio using pooled OLS:

$$Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 L_{i,t} + \beta_3 G_{i,t} + \sum_{s=2}^{5} \gamma_s I^s_{i,t-1} + X'\delta + \zeta_t + \varepsilon_{i,t} \tag{1}$$

where $Y_{i,t}$ is one of the three outcomes of interest, all of which are standardised. $L_{i,t}$ and $G_{i,t}$ are dummy variables indicating respectively whether there was a loss or a gain in household income between period $t-1$ and period t. As discussed above, income is coded as quintiles of equivalised imputed income and a loss (gain) is realised when the household the cohort member belongs to is in a lower (higher) income quintile with respect to the previous wave. By controlling separately for gains and losses in household income, income changes are allowed to have an asymmetric effect on the accumulation of cognitive and non-cognitive skills. $\{I^2_{i,t-1}, ..., I^5_{i,t-1}\}$ is a set of four dummies indicating the income band reported by the carer of child i in wave $t-1$ ($I^1_{i,t-1}$, i.e. the dummy indicating the first income band, is omitted and used as the reference category). X is a vector of standard controls, including child and household's time-invariant characteristics such as sex, mother's age at birth,and child ethnicity; lagged characteristics and their variation between $t-1$

and t (housing tenure and its variation); covariates at time t, such as single-parent household, whether both parents participate to the labour market, and the square root of household size. Finally, ζ_t is a set of wave dummies. Standard errors are clustered at the child level.

Thanks to the richness of the dataset, I am able to test whether the effect of income changes on cognitive and non-cognitive outcomes is at least partly mediated by channels pertaining to the well-being of the parents. As it is often the case in cohort studies, parental variables are measured more accurately for mothers than they are for their spouse. This is because mothers tend to be the main caregiver and, hence, the main survey respondent. Furthermore, fathers might not always be present in the household at all sweeps and might not always coincide with the mother's partner or spouse. Because of this I focus on maternal well-being as a potential mediator of the effect of income changes on the accumulation of children's cognitive and non-cognitive skills. In order to capture mothers' physical well-being, I rely on a measure of self-assessed general health derived from the question "How would you describe your health generally?". Potential answers are "Excellent", "Very good", "Good", "Fair", and "Poor". As for psychological well-being, I use two measures to capture both the affects and the cognitive dimensions of well-being. The Kessler Psychological Distress Scale (K6), measuring affects, is a 6-items scale assessing mood and anxiety disorders in a short-term horizon. The question is introduced by the sentence "During the past 30 days, about how often did you feel...", followed by the items: "...nervous?", "...hopeless?", "...restless or fidgety?", "...so depressed that nothing could cheer you up?", "...that everything was an effort?", "...worthless?". Answers range from 1, meaning "all of the time", to 5, meaning "none of the time". Life satisfaction is used to measure cognitive well-being: respondents are faced with a scale going from 1, meaning "that you are completely dissatisfied" and 10, meaning "that you are completely satisfied" and asked to choose a number indicating how satisfied or dissatisfied they are about the way their life has turned out up to that moment.

The new specification mirrors the one described above, allowing for mothers' physical and psychological well-being to act as mediators:

$$Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 L_{i,t} + \beta_3 G_{i,t} + \sum_{s=2}^{5} \gamma_s I^s_{i,t-1} + (\Delta C_i)'\mu_1 + C'_{i,t-1}\mu_2 + \mathbf{X}'\delta + \zeta_t + \varepsilon_{i,t} \quad (2)$$

Where $C_{i,t-1}$ is a vector containing the aforementioned measures of maternal well-being at time $t-1$: the Kessler K6 score, life satisfaction, and a dummy equal one if self-assessed health is either "fair" or "poor". All measures are coded in such a way that higher values reflect better outcomes. ΔC_i is a vector capturing the changes in the maternal channels, containing the standardised differences of the levels of psychological well-being between time $t-1$ and time t, and a dummy equal one if there was a worsening in the mother's self-assessed general health between the two same periods.

The final estimation sample consists of 40,985 observations, made up of 14,741 cohort members, each observed on average for 3.8 waves, for which the outcome variables were non-missing.[2] Missing values of the explanatory variables were imputed using mean imputation; thus all regressions control for dummies indicating the position of the missing values for each variable.[3] Sampling weights and non-response weights are used throughout the analysis. Table A.2 in the Appendix describes the features of the estimation sample.

[2]Note that information on the first wave a cohort member is observed are only used as lagged values in relationship to the second wave of observation. So in practice, the estimation is conducted on average on 2.8 waves per cohort member.

[3]Missingness is not a big problem in MCS: as one can see from the last column of Table A.2, the percentage of imputed missing values is never above 5% for the main explanatory variables. Predictably, results are not sensitive to the imputation of missing values and hold also when the correspondent observations are dropped from the sample.

3 Results

3.1 Main regressions

Table 1 presents estimates of different versions of the baseline model of equation (1): for each of the outcomes, the first column (i.e. columns 1, 4, 7) reports pooled OLS estimates of the baseline model without the lagged outcome; then, in columns 2, 5, and 8, the lagged value of the outcome variable is added to the model; finally, columns 3, 6, and 9 report system GMM estimates for the model specified in equation (1). Irrespective of the specification used, income losses seem to be always correlated with lower levels of cognitive and non-cognitive skills. The same story holds for income gains and cognitive skills, with the relationship going in the opposite direction. Comparing the first two columns for each outcome, it seems that the adoption a value added specification improves the fit of the model without qualitatively affecting the OLS estimates.

While the value added model accounts for unobserved time-invariant factors explaining the outcome, there might still be some unobserved time-invariant factors affecting the residualised outcome, i.e. the part of the outcome that is not explained by its past value. Such residual unobserved between heterogeneity can be dealt with exploiting the panel structure of the data, by including individual fixed effects to isolate within variation only. However, one cannot simply combine a value added model with fixed effects, as estimates would suffer from the Nickell bias (Nickell, 1981): through the demeaning process of fixed effects regression, the demeaned regressor can no longer be distributed independently of the error term. The deriving endogeneity produces the so-called dynamic panel bias, which Nickell shows to be larger in samples with "small T and large N" - situation that mirrors the MCS sample. A solution to this problem is to use the system GMM estimator introduced by Blundell and Bond (1998).[4] Columns 3, 6, and 9 display estimates derived with this method; coefficients are robust with respect to the value added model in columns 2, 5, and 8, suggesting that the omission of time-invariant factors that are potentially correlated with the residualised outcome might not constitute a threat to current identification.

[4] I implement the system GMM estimator in Stata v 13.0 using the `xtabond2` command developed by David Roodman (see Roodman, 2009 for a pedagogic introduction to the linear GMM and the use of `xtabond2`).

Overall, the effect of moving to a lower income quintile is associated with a loss of about 0.1 points in the non-cognitive skills distributions and 0.5 points in the cognitive skills distribution. Although the effect sizes might look modest at first sight, the contribution of an income loss to the residualised internalising and externalising SDQ is comparable to about half the effect of being born with a weight lower than 2.5 kg, and for internalising SDQ it is not statistically different from the magnitude of the effect of a parent leaving the household between period $t-1$ and t.

3.2 Channels

The literature in economics and developmental psychology suggest that variations in income can affect children's human capital accumulation directly, through the provision of material inputs, and/or indirectly, through changes in the well-being of the parent which can in turn affect the process of skills formation. Table 2 uses the value added model described in specification (2) to explore the presence of mediators of the effect of income losses and gains reported in Table 1. The magnitude of the coefficients estimated in Table 1 might in fact be inflated because of the omission of channels, such as mothers' well-being, that are likely to be positively correlated with income changes. As expected, the introduction of variables capturing the changes between $t-1$ and t, as well as the levels in $t-1$, of the psychological and physical well-being of mothers are significant in explaining trajectories of human capital formation and their introduction in the specification reduces the magnitude of the coefficients for both gains and losses. For internalising and externalising SDQ, the effect of income losses seems to transit for one third through these channels. The coefficients of gains and losses for cognitive abilities are instead more robust to the introduction of potential mediators, perhaps suggesting that income changes have a stronger direct effect on school performance rather than internalising or externalising behaviour. This is consistent both with Duncan and Brooks-Gunn (1997), who suggest that cognitive skills, with respect to non-cognitive skills, rely more heavily on material inputs. Yeung et al. (2002)'s findings further corroborate the results presented in Table 2, in at least two ways: first, their paper shows that the effect of income instability on non-cognitive skills is mostly conveyed through maternal affects; secondly, they show that the effect on cognitive skills is in larger part mediated by material

Table 1: Baseline model: Pooled OLS and System GMM regressions

	SDQ Externalising			SDQ Internalising			Cognitive skills		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Outcome $(t-1)$		0.647***	0.285***		0.518***	0.308***		0.290***	0.089***
		(0.007)	(0.014)		(0.008)	(0.013)		(0.006)	(0.008)
Gain	0.020	0.007	0.018*	0.011	0.015	0.015	0.042***	0.035***	0.044***
	(0.016)	(0.012)	(0.010)	(0.016)	(0.014)	(0.011)	(0.013)	(0.012)	(0.011)
Loss	-0.028*	-0.035***	-0.038***	-0.049***	-0.039***	-0.041***	-0.045***	-0.044***	-0.036***
	(0.016)	(0.012)	(0.010)	(0.016)	(0.014)	(0.011)	(0.013)	(0.012)	(0.011)
2nd income quintile $(t-1)$	0.035	0.024	0.053***	0.054**	0.031	0.048***	0.066***	0.050***	0.065***
	(0.025)	(0.019)	(0.016)	(0.026)	(0.022)	(0.017)	(0.019)	(0.018)	(0.016)
3rd income quintile $(t-1)$	0.084***	0.052**	0.098***	0.107***	0.056**	0.099***	0.121***	0.094***	0.137***
	(0.030)	(0.021)	(0.018)	(0.029)	(0.023)	(0.019)	(0.022)	(0.020)	(0.018)
4th income quintile $(t-1)$	0.144***	0.077***	0.163***	0.171***	0.099***	0.142***	0.181***	0.139***	0.198***
	(0.033)	(0.023)	(0.020)	(0.031)	(0.025)	(0.021)	(0.025)	(0.022)	(0.021)
5th income quintile $(t-1)$	0.218***	0.113***	0.220***	0.281***	0.155***	0.186***	0.287***	0.229***	0.308***
	(0.037)	(0.025)	(0.023)	(0.036)	(0.027)	(0.024)	(0.029)	(0.025)	(0.023)
Observations	40,985	40,985	40,985	40,985	40,985	40,985	40,985	40,985	40,985
Adjusted R-squared	0.134	0.470		0.119	0.356		0.357	0.421	
Time-constant controls	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Time-varying controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of cohort members	14,741	14,741	14,741	14,741	14,741	14,741	14,741	14,741	14,741

Notes: Outcome $(t-1)$ represents the lagged value of the dependent variable at $t-1$. Controls include the following: Sweep dummy variables, gender, having a twin or being part of a triplet, having low birth-weight (< 2.5 kg), being a first-born, racial background dummy variables (mixed, Indian, Pakistani or Bangladeshi, Black, other), age of the mother at birth of the cohort member, dummy variables for the mother's 5-category National Vocation Qualification, single-parent household, whether both parents are in work, parental involvement at age 3 (i.e. frequency of reading to the child, regular bedtime, hours spent in front of the TV), country dummy variables (England, Wales, Scotland, NI), squared root of household size, dummy variables for housing-tenure at time $t-1$ (ownership, mortgage, rent, other) and variation in housing-tenure between $t-1$ and t. Sampling and non-response weights used in all columns except (3), (6), and (9).
Robust standard errors, clustered at the cohort member level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

investments, rather than mothers' emotional health. Qualitatively similar predictions are also supported by Washbrook et al. (2014).

4 Robustness Checks

4.1 Measurement issues

One important concern with the analysis conducted above is liked to the interpretation of the coefficients of gains (losses) for individuals at the top (bottom) income quintile in $t-1$. Due to the discrete nature of the income variable used, these individuals cannot transition upwards (downwards) the income distribution so gains (losses) are not defined for them. A way of getting around the issue is to replicate the estimates above using only cohort members who can potentially transition both upwards and downwards the income quintile scale., i.e. excluding from each wave individuals who were either in the top or in the bottom quintile of the household income distribution in the previous wave. Table A.3 in the Appendix replicates Table 1 for a truncated sample of kids whose family income is neither in the top nor in the bottom quintile of the income distribution around sweeps 2 to 5. Although the coefficients for cognitive skills are less precisely estimated due to the smaller sample size, the same considerations made for Table 1 qualitatively hold.

One might not still be fully convinced by the interpretability of results based on the association between changes in discrete variables. I therefore replicate the main results of this paper using a continuous source of income variation - namely, the imputed equivalised household income and its changes from one wave to the next. Results are reported in Table 3. To measure the change in income between $t-1$ and t, I use the difference of a logarithmic transformation of income between the two periods, i.e. $\Delta(lnIncome)_{t-1,t}$. In order to avoid the issue of bad controls (see section 3.2.3 of Angrist and Pischke, 2008 for a reference on the topic), all regressions in Table 3 exclude the controls that were used to build imputed household income (e.g. education of the parents, labour market status of the parents, region of residence) from their specification. Columns 1, 3, and 6 mirror the estimates in columns 2, 5, and 8 of Table 1. Note that here the coefficient of

Table 2: Value added models with channels

	SDQ Externalising		SDQ Internalising		Cognitive skills	
	(1)	(2)	(3)	(4)	(5)	(6)
Outcome $(t-1)$	0.647***	0.626***	0.518***	0.484***	0.290***	0.289
	(0.007)	(0.007)	(0.008)	(0.008)	(0.006)	(0.006)
Gain	0.007	0.001	0.015	0.006	0.035***	0.034***
	(0.012)	(0.012)	(0.014)	(0.013)	(0.012)	(0.012)
Loss	-0.035***	-0.024*	-0.039***	-0.025*	-0.044***	-0.042***
	(0.012)	(0.012)	(0.014)	(0.014)	(0.012)	(0.012)
2nd income quintile $(t-1)$	0.024	0.016	0.031	0.019	0.050***	0.049***
	(0.019)	(0.019)	(0.022)	(0.021)	(0.018)	(0.018)
3rd income quintile $(t-1)$	0.052**	0.036*	0.056**	0.031	0.094***	0.091***
	(0.021)	(0.021)	(0.023)	(0.023)	(0.020)	(0.020)
4th income quintile $(t-1)$	0.077***	0.056**	0.099***	0.064***	0.139***	0.135***
	(0.023)	(0.022)	(0.025)	(0.024)	(0.022)	(0.022)
5th income quintile $(t-1)$	0.113***	0.080***	0.155***	0.104***	0.229***	0.223***
	(0.025)	(0.025)	(0.027)	(0.026)	(0.025)	(0.025)
Δ(Kessler scale)$_{t-1,t}$		-0.116***		-0.154***		-0.020***
		(0.007)		(0.008)		(0.006)
Kessler scale $(t-1)$		-0.026***		-0.038***		-0.003*
		(0.002)		(0.002)		(0.002)
Δ(Life satisfaction)$_{t-1,t}$		0.029***		0.037***		0.002
		(0.006)		(0.007)		(0.006)
Life satisfaction $(t-1)$		0.012***		0.016***		-0.002
		(0.004)		(0.004)		(0.003)
Worsening in mother's health		-0.049**		-0.071***		-0.022
		(0.021)		(0.023)		(0.019)
Mother had poor health in $t-1$		0.006		-0.047***		-0.037***
		(0.015)		(0.017)		(0.014)
Observations	40,985	40,985	40,985	40,985	40,985	40,985
Adjusted R-squared	0.470	0.485	0.356	0.384	0.421	0.421

Notes: Outcome $(t-1)$ represents the standardized dependent variable at $t-1$ for SDQ, while for cognitive skills it is the quintile rank at $t-1$. Δ(Kessler scale)$_{t-1,t}$ represents the standardized difference of the mother's Kessler Psychological Distress Scale (K6) score between sweep $t-1$ and t. Similarly, Δ(Life satisfaction)$_{t-1,t}$ is the standardized difference in the mother's life satisfaction between two consecutive sweeps and Life satisfaction $(t-1)$ is the level of her life satisfaction in sweep $t-1$. Worsening in mother's health is a dummy equal 1 if there was a worsening in the self-reported mother's general health between sweep $t-1$ and t. Mother had poor health in $t-1$ is a dummy equal 1 if the mother had either "fair" or "poor" self-reported general health in sweep $t-1$. A list of standard controls is added in all specifications. Sampling and non-response weights used.
Robust standard errors, clustered at the cohort member level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

gains and of its interaction with the variation in income are not estimated. This is because there are not enough cases for which $\Delta(lnIncome)_{t-1,t}$ is equal to zero, hence the reference category of the dummy loss can only be gains. Columns 2, 4, and 6 estimate the effect of "heavy" losses and "large" gains, i.e. income falls of about 25% and gains of 35% with respect to the previous wave.[5] Here the definition of larger gains and losses allows to identify an intermediate group of relatively small changes that is used as the reference category.

Looking at columns 1, 3, and 5, the coefficients of an income drop and its interaction with the magnitude of the loss all confirm the narrative of the Tables in the main results section. Non-surprisingly, the total effect of losses is higher for cognitive skills rather than for non-cognitive skills, perhaps because of the different reactivity of the reference category to gains, as results from Table 1 would suggest. An interesting fact emerges from columns 2, 4, and, 6 of Table 3. Looking at the impact of large income gains on the residualised cognitive and non-cognitive skills, what seems to matter the most in defining the overall contribution of gains is the slope, i.e. the magnitude of the gain, rather than the intercept;[6] for heavy losses, on the contrary, the magnitude of the effect is less relevant than the intercept, i.e. the fact of experiencing a heavy loss per-se.

Finally, another problem arising when using self-reported measures is linked to a variety of reporting biases that are likely to somewhat affect the estimated coefficients. In particular, the regressions exploring the relationship between income and SDQ are likely to be affected by common-method variance, since both the dependent and the independent variables are reported by the same respondent. A way of getting around the issue would be to use an external measure of non-cognitive skills, derived from either a structured assessment administered by the interviewers (as it is the case with cognitive skills in MCS) or from an informal assessment of the cohort member by a third party. The only external source of information available in this sense comes from two waves of the teacher survey, a self-completion module administered to teachers when the cohort member was 7 and 11 years old (sweeps 4 and 5, respectively). In these waves teachers were asked to report the cohort

[5] In order to identify heavy losses and gains I chose the arbitrary threshold of ± 0.3 for $\Delta(lnIncome)_{t-1,t}$ (results hold for a variety of different income thresholds). Using this threshold heavy losses constitute about 30% of total income losses.

[6] The negative intercept of gains is likely to be due to the definition of "large" gains. For all values in the domain of large gains, the total effect of gains is positive and significant for each of the outcomes.)

Table 3: Robustness checks: continuous income

	SDQ Externalising		SDQ Internalising		Cognitive skills	
	(1)	(2)	(3)	(4)	(5)	(6)
Gain		-0.029		-0.040**		-0.080***
		(0.019)		(0.019)		(0.019)
Gain * Δ(ln Income)$_{t-1,t}$		0.146***		0.189***		0.279***
		(0.026)		(0.026)		(0.026)
Loss	-0.044***	-0.092***	-0.055***	-0.113***	-0.050***	-0.061**
	(0.012)	(0.027)	(0.013)	(0.030)	(0.012)	(0.027)
Loss * Δ(ln Income)$_{t-1,t}$	0.046**	-0.030	0.049**	-0.049	0.089***	0.039
	(0.023)	(0.036)	(0.023)	(0.033)	(0.025)	(0.039)
ln Income $(t-1)$	0.143***	0.173***	0.158***	0.196***	0.241***	0.294***
	(0.008)	(0.010)	(0.009)	(0.010)	(0.008)	(0.009)
Outcome $(t-1)$	0.665***	0.662***	0.532***	0.529***	0.320***	0.315***
	(0.007)	(0.007)	(0.008)	(0.008)	(0.006)	(0.006)
Observations	40,612	40,612	40,612	40,612	40,612	40,612
Adjusted R-squared	0.465	0.467	0.349	0.351	0.407	0.410

Notes: Loss is a dummy equal 1 if there was a loss in equivalized household income between $t-1$ and t. In columns 2,4, and 6, I consider only "heavy" losses, i.e. losses for which Δ(ln Income)$_{t-1,t}$ is below the arbitrary threshold of -0.3 (corresponding roughly to the bottom 30% of all income losses). Δ(ln Income)$_{t-1,t}$ is the difference of the logged equivalized income between sweep t and sweep $t-1$. Outcome $(t-1)$ represents the standardized dependent variable at $t-1$. A list of standard controls is added in all specifications, excluding controls that were used to build the imputed measure of income. Sampling and non-response weights used.
Robust standard errors, clustered at the cohort member level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

member's SDQ. There is a raw correlation of about 0.25 between the parent reported and teacher reported SDQ, for both the internalising and the externalising scales. Table 4 compares results using teacher-reported SDQ as the dependent variable to results using parent-reported SDQ. Due to the data restriction, the analysis is carried out only for wave 5, using retrospectively information from wave 4. When we replicate the analysis with parent-reported SDQ in this new sample, the effect of losses is significantly estimated only for internalising SDQ. For teachers-reported SDQ instead, neither upwards nor downwards transitions in the income distribution appear to be significant in explaining the residualised value of the outcome. Furthermore, the teacher who reported a cohort member's SDQ in sweep 4 is unlikely to be the same respondent of the teacher survey for sweep 5, and as much as I attempt to control for observable teacher characteristics, their unobserved heterogeneity could partly drive the results. Besides, the autocorrelation coefficient for teacher-reported SDQ is so low that ultimately a value added model might not represent the best specification in this particular context.

In addition, it should be noted that the sample of cohort members for which a teacher-reported

SDQ is available is likely to be selected: previous consent of the cohort member and his/her parents, the teacher is contacted and asked to fill-in a self-completion questionnaire. Moreover, due to the use of lagged values in the main specification, cohort members, as well as their teachers, need to be observed consecutively for sweep 4 and 5. Out of the eligible cases, response rates were 70% for teachers in sweep 4 of MCS, and 77.3% in sweep 5.[7]

Table 4: Robustness checks: Teacher- vs parents-reported SDQ

	SDQ Externalising		SDQ Internalising	
	Parents	Teacher	Parents	Teacher
Outcome (*Sweep 4*)	0.652***	0.062***	0.547***	0.122***
	(0.018)	(0.011)	(0.024)	(0.013)
Gain	-0.026	0.005	-0.003	0.006
	(0.041)	(0.018)	(0.052)	(0.023)
Loss	-0.064	0.004	-0.123**	-0.011
	(0.041)	(0.017)	(0.052)	(0.021)
2nd income quintile (*Sweep 4*)	-0.004	-0.014	-0.012	-0.041
	(0.062)	(0.024)	(0.079)	(0.031)
3rd income quintile (*Sweep 4*)	0.007	-0.008	0.073	0.002
	(0.070)	(0.029)	(0.089)	(0.036)
4th income quintile (*Sweep 4*)	0.063	-0.018	0.120	0.022
	(0.077)	(0.032)	(0.098)	(0.041)
5th income quintile (*Sweep 4*)	0.079	-0.006	0.218*	0.047
	(0.091)	(0.038)	(0.114)	(0.050)
Observations	4,064	4,064	3,965	3,965
Adjusted R-squared	0.485	0.052	0.334	0.054
Controls	Yes	Yes	Yes	Yes
School controls	No	Yes	No	Yes

Notes: Parents stands for parents-reported SDQ, while Teacher stands for teacher-reported SDQ. As teacher-reported SDQ is available only for Sweeps 4 and 5 (respectively, age 7 and 11), all regressions in this Table are limited to Sweep 5 and use retrospectively at a set controls from Sweep 4. A list of controls is added in all specifications. Further controls capturing teachers' and schools' characteristics are included in the specifications for teacher-reported SDQ. Sampling and non-response weights used.
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

4.2 Omitted variables

One question that might come spontaneous at this point concerns what might hide behind these upwards and downwards movements across the household income distribution. Income changes are indeed likely to depend on factors such as changes in the country's social security system, in the labour market status of the parents, in the household's demographic structure, in housing

[7] A mixed method followed up by a phone interview was used in this wave in the attempt to increase teachers' response rate.

tenure. However, is the process of human capital formation affected by these changes per-se, or does income have a direct way of affecting cognitive and non-cognitive outcomes? In other words, do these factors affect the outcomes only through changes in income or are they omitted variables threatening to confound its effect?

Table 6 is an attempt to clarify the matter. Columns 1, 3, and 5 replicate columns 2, 5, and 8 of Table 1. Columns 2, 4, and 6 introduce a list of life events between $t-1$ and t that are likely to be correlated with income changes. Since housing tenure and its changes are already controlled for in all specifications, remaining determinants of income changes I could control for are separations, job losses, and changes in the siblings composition. The coefficients of gains and losses are slightly reduced but appear to be overall robust to the introduction of these potential confounders, suggesting that their omission does not contribute to the creation of an omitted variables bias. This evidence is partly in contrast with Washbrook et al. (2014), who find that the income gradient of non-cognitive skills and health is completely shut out by distal factors such as socio-demographic and labour market outcomes, whereas only one fifth of the effect of income on cognitive skills survives to these channels.

5 Additional results

5.1 Persistence

As shown by results in Tables 1 and 2, income gains between $t-1$ and t do not seem to be statistically significant in explaining changes in non-cognitive skills, while income losses have an significant negative impact. However in Table 5, when looking at the effect of income gains and losses between period $t-2$ and $t-1$, I find gains to be positively correlated with higher residualised cognitive skills at period t. Since household income losses seem to affect cohort members partly through parents' well-being, it seems plausible that their effect is mostly immediate, driven by affects. However, as shown by Boyce et al. (2013), income gains typically have a positive impact on subjective well-being of a lower magnitude with respect to that of losses. Hence an income gain

Table 5: Robustness checks: Other life events as potential confounders

	SDQ Externalising		SDQ Internalising		Cognitive skills	
	(1)	(2)	(3)	(4)	(5)	(6)
Outcome $(t-1)$	0.646***	0.647***	0.518***	0.517***	0.290***	0.290***
	(0.007)	(0.007)	(0.008)	(0.008)	(0.006)	(0.006)
Gain	0.010	0.007	0.014	0.014	0.037***	0.034***
	(0.012)	(0.012)	(0.014)	(0.014)	(0.012)	(0.012)
Loss	-0.038***	-0.032**	-0.038***	-0.034**	-0.045***	-0.045***
	(0.012)	(0.013)	(0.014)	(0.014)	(0.012)	(0.012)
Life events between $t-1$ *and* t						
Parent left		-0.031		-0.054		0.038
		(0.026)		(0.033)		(0.024)
Mother lost job		0.003		0.024		0.011
		(0.022)		(0.026)		(0.021)
Father lost job		0.031		0.045		0.004
		(0.034)		(0.040)		(0.032)
1 new sibling		-0.067***		-0.024		-0.018
		(0.015)		(0.016)		(0.014)
2+ new siblings		-0.125**		-0.058		-0.063
		(0.059)		(0.064)		(0.053)
1+ siblings left		-0.030		-0.084***		-0.010
		(0.027)		(0.030)		(0.022)
Observations	40,985	40,963	40,985	40,963	40,985	40,963
Adjusted R-squared	0.471	0.471	0.356	0.356	0.421	0.421

Notes: Outcome $(t-1)$ represents the standardized dependent variable at $t-1$ for SDQ, while for cognitive skills it is the quintile rank at $t-1$. A list of controls is added in all specifications. Sampling and non-response weights used.
Robust standard errors, clustered at the cohort member level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

between time $t-2$ and $t-1$ might not have a strong enough impact on parents' well-being to justify a positive effect on human capital formation at time $t-1$ (or it could be the case that the psycho-physical well-being of parents affects children's human capital development asymmetrically), but it might still enable parents to put in place material investments to foster their children's skills that will have an effect at time t. In other words, for cognitive skills, the positive effect of income gains that potentially moves through a channel of material investments (as suggested by the literature in developmental psychology), persists at least in the period after the gain materialised. There is however no evidence of complementarity between income gains in two consecutive periods: if anything they appear to have a certain degree of substitutability. On the other hand, old income losses seem to matter only in relationship to current income losses, exacerbating their negative effect.

Results from Table 6 can be interpreted in relationship to the literature on homeostatic well-being (Cummins, 2016). As about one third of the effect of income losses on non-cognitive skills is mediated by mothers' well-being, one might wonder whether the absence of persistence of past income losses is due to an adaptation mechanism that pushes mothers' well-being back towards its homeostatic level. I test for this possibility, by replicating Table 6 for the two outcomes reflecting mothers' psychological well-being, namely life satisfaction and the Kessler (K6) scale of affects.[8] As expected, I find evidence of mothers adapting to income changes both in terms of affects and cognitive well-being, with the measure of affects intuitively adapting at a faster rate than the cognitive one. Since the effect of income changes on cognitive skills does not seem to be mediated by any parental well-being channel, the well-being adaptation mechanism does not affect the persistence of past losses and gains, which matter both in absolute terms and in conjunction with current income changes.

5.2 Transition dynamics

The results presented so far are just average effects across all income quintiles. However, following the approach of Bruckauf and Chzhen (2016), it might be interesting to focus on the risk factors

[8] Results are not shown in the paper but are available on request.

Table 6: Robustness checks: Persistence of the effect of gains and losses

	SDQ Externalising (1)	SDQ Internalising (2)	Cognitive skills (3)
$\text{Outcome}_{(t-2)}$	0.538***	0.450***	0.231***
	(0.009)	(0.012)	(0.007)
Gain_t	0.012	0.004	0.048***
	(0.020)	(0.022)	(0.017)
Loss_t	-0.040**	-0.055**	-0.058***
	(0.019)	(0.022)	(0.017)
$\text{Gain}_{(t-1)}$	0.041	0.020	0.043*
	(0.027)	(0.029)	(0.024)
$\text{Loss}_{(t-1)}$	0.001	-0.045	-0.025
	(0.026)	(0.029)	(0.023)
Gain_t * $\text{Gain}_{(t-1)}$	0.009	0.002	-0.067**
	(0.039)	(0.043)	(0.034)
Loss_t * $\text{Loss}_{(t-1)}$	0.025	0.079	-0.080*
	(0.048)	(0.057)	(0.045)
Observations	25,818	25,818	25,818
Adjusted R-squared	0.363	0.251	0.458

Notes: Outcome $(t-2)$ represents the standardized dependent variable at $t-2$. All regressions control for income quintile dummies for waves $t-2$ and $t-1$. A list of standard controls is added in all specifications (with respect to the tables above, the levels of time varying controls refer to wave $t-2$ and both the changes between $t-2$ and $t-1$, and between $t-1$ and t were controlled for). Sampling and non-response weights used. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

that predict the entry to and exit from the bottom quintile of the income distribution. Table 7 reports average marginal effects derived from logistic regressions predicting the probability of entering or exiting the bottom quintile of the cognitive and non-cognitive skills distribution. Note that the estimation samples are different: by construction cohort members who are already at the bottom quintile of the distribution are dropped from the estimation sample of the columns tagged "entry" (unless they transition into a higher quintile and then back again into the lowest one). For exit instead, only cohort members who already were in the bottom quintile of the outcome's distribution in $t-1$ are used to estimate the probability of exiting.

Controlling for the position in the income distribution in period $t-1$, a movement down the income distribution quintiles is associated with a 2% increase of the probability of entering the bottom quintile of the externalising SDQ distribution. While losses seem to predict the probability of entering in the bottom quintile of each outcome's distribution, gains only act as a buffer for internalising SDQ and cognitive skills, being associated with a lower likelihood of entering the bottom quintile of the outcome. While nether losses nor gains seem to contribute to the explanation

of dynamics out of the bottom quintile of non-cognitive outcomes, income gains are associated with a higher probability of exiting the bottom quintile of the cognitive skills distribution.

Table 7: Robustness checks: Entry and exit in the bottom quintile of the cognitive and non-cognitive skills distributions

	SDQ Externalising		SDQ Internalising		Cognitive skills	
	Entry	Exit	Entry	Exit	Entry	Exit
Gain	-0.003	-0.015	-0.015**	0.002	-0.012*	0.049***
	(0.005)	(0.016)	(0.006)	(0.016)	(0.006)	(0.017)
Loss	0.020***	0.028	0.016**	0.009	0.012*	-0.005
	(0.006)	(0.018)	(0.007)	(0.017)	(0.006)	(0.019)
Outcome quintiles in $t-1$ (reference: 5th quintile)						
2nd quintile	0.230***		0.214***		0.064***	
	(0.011)		(0.012)		(0.007)	
3rd quintile	0.130***		0.064***		0.096***	
	(0.012)		(0.012)		(0.008)	
4th quintile	0.067***		0.064***		0.052***	
	(0.013)		(0.013)		(0.008)	
Observations	32,449	8,532	31,422	9,555	33,151	7,832
Pseudo R-squared	0.147	0.147	0.091	0.091	0.101	0.101

Notes: The coefficients shown in the Table are average marginal effects derived from logistic regressions. The "Entry" and "Exit" columns represent respectively logistic regression where the outcome variable is the probability of moving in and out of the bottom quintile of the distribution of the outcome of reference. A list of controls is added in all specifications. Sampling and non-response weights used.
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

6 Conclusion

This paper explores the relationship between changes in family income and the accumulation of children's cognitive and non-cognitive skills. By relaxing the assumption of a symmetric impact of losses and gains, I find that losses matter more than gains in explaining changes in non-cognitive outcomes between one wave and the next. Movements downwards the distribution of family income are associated with about a 4% decrease of a standard deviation for both cognitive and non-cognitive outcomes, an effect size comparable to that of a parent leaving the household.

The effect of losses is mediated for one third by channels reflecting mothers' well-being. Losses also predict the probability of transitioning into the bottom quintile of the distribution of both non-cognitive and cognitive abilities; for the latter, experiencing a loss hinders the probability of moving out of the bottom of the distribution. Moving upwards the family income distribution, on the contrary, is correlated with both higher probability of exiting and lower probability of entering the bottom quintile of the cognitive skills distribution. The effect of gains on reading test scores is also persistent in time: past income gains still matter for today's cognitive trajectories, consistently with the theory of family investment.

Despite the robustness of the results presented above to a battery of sensitivity tests, the empirical strategies used throughout the paper remain exposed to potential endogeneity issues. However, results are consistent with the established literature in economics and developmental psychology and contribute to uncovering some novel mechanism. From a policy perspective, the findings of this paper suggest that income transfers, while fostering cognitive skills, might not have the same effect on non-cognitive skills. The fact that human capital accumulation appears to be more sensitive to income losses might provide yet another piece of evidence in support of insurance and welfare policies to limit the negative impact of adverse economic conditions, paying particular attention to the effects on psychological well-being of adults.

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Appendix

Table A.1: The Strengths and Difficulties Questionnaire

Please think about this child's behaviour over the last 6 months if you can:

This child:	NOT TRUE	SOMEWHAT TRUE	CERTAINLY TRUE
Emotional health:			
Often complains of headaches, stomachaches or sickness	0	1	2
Has many worries, often seems worried	0	1	2
Is often unhappy, down-hearted or tearful	0	1	2
Is nervous or clingy in new situations, easily loses confidence	0	1	2
Has many fears, is easily scared	0	1	2
Total emotional health score: 0-10			
Conduct problems:			
Has temper tantrums or hot tempers	0	1	2
Is generally obedient, usually does what adults request	2	1	0
Often fights with other children or bullies them	0	1	2
[a]Often lies or cheats	0	1	2
[b]Steals from home/school/elsewhere	0	1	2
Total conduct problems score: 0-10			
Hyperactity/Inattention:			
Is restless, overactive, cannot stay still for long	0	1	2
Constantly fidgets or squirms	0	1	2
Is easily distracted, concentration wandered	0	1	2
[c]Thinks things out before acting	2	1	0
Sees tasks through to the end, good attention span	2	1	0
Total hyperactivity score: 0-10			
Peer relationship problems:			
Is rather solitary, tends to play alone	0	1	2
Has at least one good friend	2	1	0
Is generally liked by other children	2	1	0
Is picked on or bullied by other children	0	1	2
Gets on better with adults than with other children	0	1	2
Total peer relationship problems score: 0-10			
Total internalising behaviour = emotional + peer relationship (0-20)			
Total externalising behaviour = behaviour + hyperactivity (0-20)			

[a] Changed to "Often argumentative with adults" in the questionnaire for 3-4 years old.

[b] Changed to "Can be spiteful to others" in the questionnaire for 3-4 years old.

[c] Changed to "Can stop and think things out before acting" in the questionnaire for 3-4 years old.

Table A.2: Descriptive statistics

Variables	**Obs.**	**Mean**	**SD**	**Min**	**Max**	**% imputed .**
Outcomes						
SDQ Externalising	40985	15.452	3.474	0	20	0
SDQ Internalising	40985	17.079	2.929	1	20	0
Age-adjusted reading t-scores	40985	54.490	11.980	20	80	0
Lagged outcomes						
SDQ Externalising	40985	14.820	3.654	0	20	0
SDQ Internalising	40985	17.240	2.676	1	20	0
Age-adjusted reading t-scores	40985	55.326	11.365	20	80	0
OECD equivalized income (MCS imputed)						
Δ(ln Income)$_{t-1,t}$	40985	0.089	0.465	-3.551	4.018	0
ln Income $(t-1)$	40985	9.708	0.639	6.408	11.168	0
Income loss	40985	0.416	0.492	0	1	0
Heavy loss (bottom 30% of all losses)	40985	0.129	0.335	0	1	0
OECD equivalized income (banded)						
First Income quintile	40985	0.179	0.383	0	1	0
Second Income quintile	40985	0.199	0.399	0	1	0
Third Income quintile	40985	0.210	0.407	0	1	0
Fourth Income quintile	40985	0.214	0.410	0	1	0
Fifth Income quintile	40985	0.198	0.398	0	1	0
Loss in income quintile between $t-1$ and t	40985	0.221	0.415	0	1	0
Gain in income quintile between $t-1$ and t	40985	0.269	0.444	0	1	0
Child characteristics						
Low birthweight (<2.5 kg)	40985	0.068	0.251	0	1	0.033
First born	40985	0.425	0.486	0	1	0.032
Twin or triplet	40985	0.022	0.147	0	1	0
White	40985	0.869	0.337	0	1	0
Mixed	40985	0.031	0.172	0	1	0
Indian	40985	0.021	0.144	0	1	0
Pakistani or Bangladeshi	40985	0.042	0.200	0	1	0
Black	40985	0.025	0.157	0	1	0
Other	40985	0.012	0.110	0	1	0
Female	40985	0.500	0.500	0	1	0
Household characteristics						
Single parent	40985	0.216	0.411	0	1	0
One working parent	40985	0.346	0.476	0	1	0
Two working parents	40985	0.517	0.500	0	1	0
Square root of household size	40985	2.121	0.298	1.414	4	0
England	40985	0.640	0.480	0	1	0
Wales	40985	0.140	0.347	0	1	0
Scotland	40985	0.121	0.326	0	1	0
Northern Ireland	40985	0.100	0.299	0	1	0
Ownership $(t-1)$	40985	0.057	0.233	0	1	0
Mortgage $(t-1)$	40985	0.627	0.484	0	1	0
Rented $(t-1)$	40985	0.292	0.455	0	1	0
Other $(t-1)$	40985	0.024	0.152	0	1	0
No ownership or mortgage between $t-1$ and t	40985	0.316	0.465	0	1	0
Lost house ownership between $t-1$ and t	40985	0.025	0.156	0	1	0
Parental investment at age 3						
Up to one hour of TV per day	40985	0.219	0.413	0	1	0.054
More than 1 hour of TV, less than 3 hours	40985	0.622	0.485	0	1	0.054

More than 3 hours of TV per day	40985	0.159	0.366	0	1	0.054
Regular bedtime	40985	0.815	0.389	0	1	0.054
Read every day to the child	40985	0.629	0.483	0	1	0.054
Read more than once per week, not every day	40985	0.312	0.463	0	1	0.054
Read less than twice per month	40985	0.059	0.236	0	1	0.054
Mother's characteristics						
Mother's age at birth	40985	29.006	5.829	14	58	0.000
NVQ 1 is highest level	40985	0.064	0.245	0	1	0
NVQ 2 is highest level	40985	0.261	0.439	0	1	0
NVQ 3 is highest level	40985	0.154	0.361	0	1	0
NVQ 4 is highest level	40985	0.336	0.472	0	1	0
NVQ 5 is highest level	40985	0.082	0.274	0	1	0
NVQ overseas qualification	40985	0.022	0.147	0	1	0
NVQ none	40985	0.081	0.273	0	1	0
Mother's well-being						
Δ(Kessler scale)$_{t-1,t}$	40985	0.226	3.713	-24	24	0.027
Kessler scale $(t-1)$	40985	3.379	3.793	0	24	0.027
Δ(Life satisfaction)$_{t-1,t}$	40985	-0.130	2.049	-10	9	0.025
Life satisfaction $(t-1)$	40985	7.640	1.864	1	10	0.025
Mother's health worsened	40985	0.066	0.249	0	1	0.001
Mother has poor health $(t-1)$	40985	0.141	0.348	0	1	0.001
Life events between $t-1$ and t						
One additional sibling	40985	0.127	0.334	0	1	0
Two or more additional siblings	40985	0.011	0.103	0	1	0
One or more siblings left household	40985	0.050	0.217	0	1	0
One parent left	40985	0.058	0.234	0	1	0
Mother lost job	40985	0.012	0.111	0	1	0
Father lost job	40985	0.021	0.134	0	1	0.109
School variables						
Teacher's sex	20819	0.826	0.255	0	1	0.275
Numbers of years teaching	20819	13.679	6.488	0	48	0.282
Numbers of years teaching in this school	20819	8.365	4.755	0	48	0.282
Teacher reported SDQ Externalising	12617	13.962	4.378	0	20	0
Teacher reported SDQ Internalising	12516	14.090	4.975	0	20	0
Mobility measures						
Entry bottom quintile of the SDQ Ex. distr.	32119	0.111	0.314	0	1	0
Entry bottom quintile of the SDQ In. distr.	31098	0.148	0.355	0	1	0
Entry bottom quintile of the cognitive distr.	32808	0.151	0.358	0	1	0
Exit bottom quintile of the SDQ Ex. distr.	8489	0.406	0.491	0	1	0
Exit bottom quintile of the SDQ In. distr.	9506	0.470	0.499	0	1	0
Exit bottom quintile of the cognitive distr.	7802	0.613	0.487	0	1	0

Note: the column "% imputed ." indicates the percentage of missing values that was imputed with mean imputation.

Table A.3: Baseline model: Pooled OLS and System GMM regressions

	SDQ Externalising			SDQ Internalising			Cognitive skills		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Outcome $(t-1)$		0.648***	0.219***		0.506***	0.289***		0.299***	0.114***
		(0.008)	(0.019)		(0.010)	(0.021)		(0.008)	(0.013)
Gain	0.017	-0.002	0.016	0.031*	0.023	0.023	0.031**	0.024	0.041***
	(0.019)	(0.015)	(0.012)	(0.019)	(0.016)	(0.014)	(0.016)	(0.015)	(0.014)
Loss	-0.025	-0.040**	-0.043***	-0.044**	-0.034*	-0.030*	-0.004	-0.015	-0.025
	(0.023)	(0.018)	(0.015)	(0.023)	(0.019)	(0.015)	(0.018)	(0.017)	(0.015)
2nd income quintile $(t-1)$	-0.113***	-0.050**	-0.125***	-0.142***	-0.083***	-0.105***	-0.099***	-0.070***	-0.124***
	(0.030)	(0.020)	(0.019)	(0.028)	(0.022)	(0.020)	(0.023)	(0.020)	(0.019)
3rd income quintile $(t-1)$	-0.063***	-0.028*	-0.075***	-0.078***	-0.053***	-0.053***	-0.042**	-0.027*	-0.049***
	(0.022)	(0.015)	(0.014)	(0.020)	(0.016)	(0.014)	(0.017)	(0.015)	(0.014)
Observations	21,419	21,419	21,419	21,419	21,419	21,419	21,419	21,419	21,419
Adjusted R-squared	0.095	0.449		0.090	0.335		0.323	0.397	
Time-constant controls	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Time-varying controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of cohort members	9,737	9,737	9,737	9,737	9,737	9,737	9,737	9,737	9,737

Notes: Outcome $(t-1)$ represents the lagged value of the dependent variable at $t-1$. Controls include the following: Sweep dummy variables, gender, having a twin or being part of a triplet, having low birth-weight (< 2.5 kg), being a first-born, racial background dummy variables (mixed, Indian, Pakistani or Bangladeshi, Black, other), age of the mother at birth of the cohort member, dummy variables for the mother's 5-category National Vocation Qualification, single-parent household, whether both parents are in work, parental involvement at age 3 (i.e. frequency of reading to the child, regular bedtime, hours spent in front of the TV), country dummy variables (England, Wales, Scotland, NI), squared root of household size, dummy variables for housing-tenure at time $t-1$ (ownership, mortgage, rent, other) and variation in housing-tenure between $t-1$ and t. Sampling and non-response weights used in all columns except (3), (6), and (9).
Robust standard errors, clustered at the cohort member level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Figure A.1: Transitions along the quintiles of SDQ Externalising

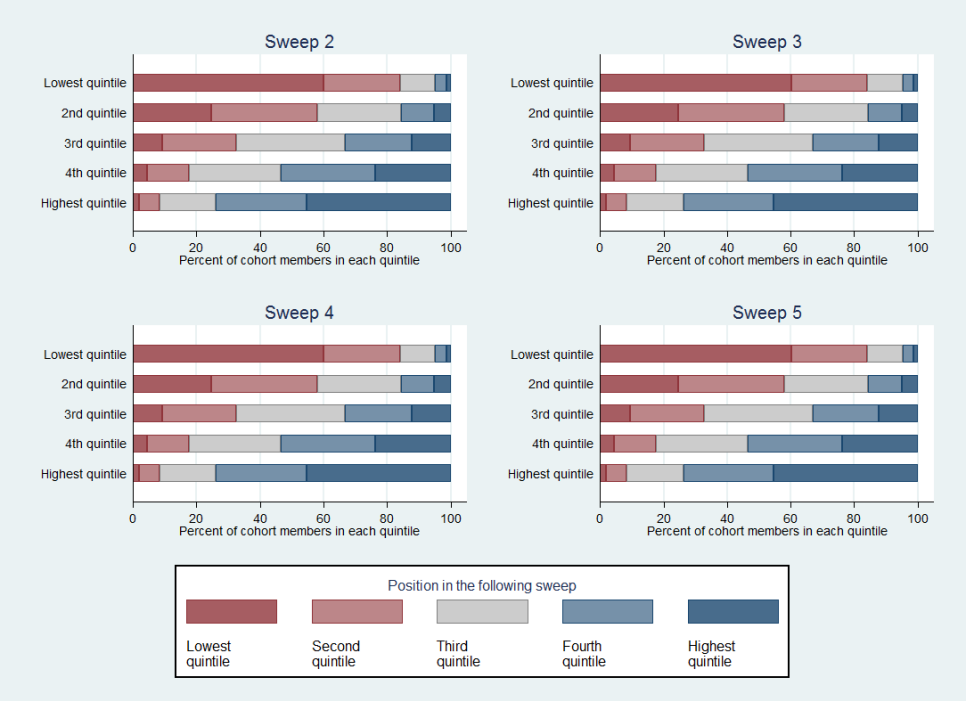

Figure A.2: Transitions along the quintiles of SDQ Internalising

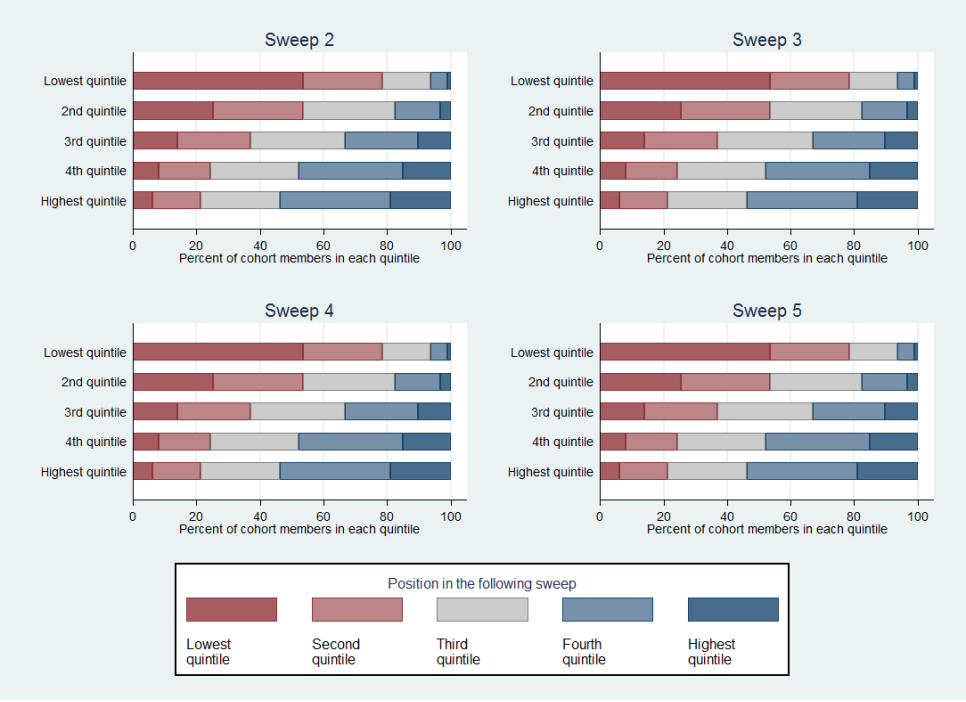

Figure A.3: Transitions along the quintiles of Cognitive Skills

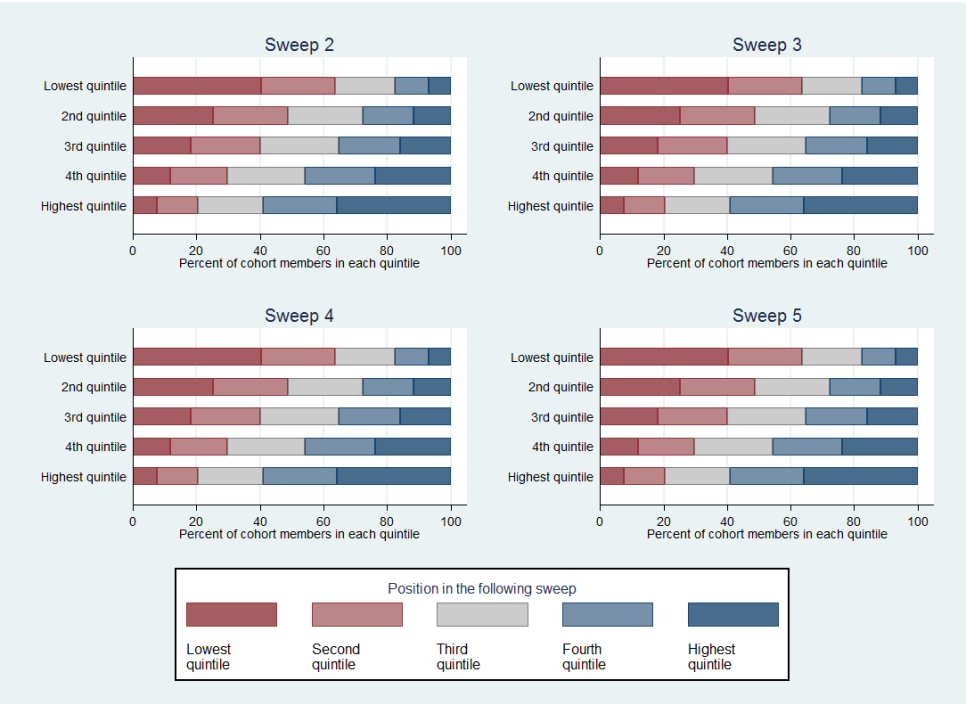

Figure A.4: Transitions along the quintiles of household income