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Increasing Our Understanding of the Health-Income Gradient♦

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Abstract

There have been numerous attempts to both document the income-health gradient and to understand the nature of the tie. In this paper we review and summarize existing studies and then use a unique school based panel data set to attempt to further our understanding of the relationship. The school based nature of the data allow us to add community SES to the model and the long duration (5 observations) allow us to add to the understanding of the pattern of the tie and to test for a variety of measures of income. Increasing understanding of the income-health gradient has clear policy implications in terms of effective targeting of interventions to decrease the gradient and hence decrease health disparities among children.

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Increasing Our Understanding of the Health-Income Gradient

The observation that there is a relationship between income and health has a long history but research on the nature of the relationship and its causes has exploded in recent years. Part of the interest may be tied to trying to understand the increasing inequality in income and wealth found in many developed countries; but part of it is likely tied to the large disparities in health that seem to exist and perhaps increase even in the face of more and more effective health care. These disparities seem closely tied to disparities in income and more generally socio-economic status (SES). The relationship has been difficult to study because the causal pattern is far from clear: does poor health lead to low incomes? Does low income contribute to poor health? Are there other factors that simultaneously cause both poor health and poverty? And there are clearly derivative questions for policy such as how to design policies to reduce disparities in health.

Recent efforts to understand the so-called income gradient have focused on two strategies: study children for whom the likely path is from family income to health and the study of natural experiments. We will follow the first strategy and focus on children but we note here that the study of natural experiments has provided consistent evidence that an increase in income, or in some cases an increase in community resources, is tied to improvements in health. These studies include unexpected changes in pensions for elderly black and Coloured in South Africa (Case, 2004), an experimental program providing conditional cash transfers in Mexico (the Progresa or Opportunidades program (see Ferdinand, Gertler and Neufield, 2008)), and the introduction of casinos by American Indian tribes once legalization was established in 1988 (see Costello, 2003 and Wolfe, et al 2010).

Children are studied because, for most children, family income does not depend on their own health. This eliminates one possible causal path.

That there is a consistent difference in children's health by income can be seen in Table 1 for the United States. This difference is documented in terms of a higher probability of low birth

weight, chronic conditions, mental problems, activity limitations and general health. And as indicated by activity limitations, the disparity appears to increase as children age. The disparities by income also exist for adults and across countries. In appendix one we show regression adjusted differences for adults in the U.S. and Australia.

What might lie behind this gradient? Is it deprivation or poverty that leads those with extremely low incomes to suffer from poor health? That is, is the poor health of those living in poverty or near poverty due to inadequate nutrition, lack of access to and utilization of quality health care, is it exposure to a variety of physical hazards or is it high stress levels associated with extreme poverty? If so, then we expect to see a much flatter gradient in countries with more generous support systems either in terms of income and/or access to health care.

Is it instead that ever more income continues to lead to better health, as those with more income can buy more nutritious food, live in a safer environment, belong to health clubs, obtain high quality medical care? That is, does more income continuously allow one to have better health? And if so, is there a declining marginal gain in health from increasing income at high levels of income? This last question is particularly relevant for transfer programs and, if true, suggests that among two communities with equal average income, the one with more equality in income will have better average health than a community with more inequality in income.

In the rest of the paper we focus on children in order to better understand the gradient. We first review the existing literature beginning with the Case, Lubotsky, and Paxson paper of 2002 before turning to our own work.

BASIC MODEL

Underlying the research on the income gradient that focuses on children is a standard model based on work by Grossman (1972 and 2000).

The model begins with a family utility maximization model

$$U_t = U(H_t, X_t, C_t, L_t^l; \eta_t^u, \varepsilon_t^u) \quad (1)$$

where U_t is utility of the family at time t, H_t is the health of a child, X_t is a set of goods that affects child health (e.g., food, toys and housing), C_t represents other commodities consumed by the household, (L_t^l) is leisure time, and η_t^u and ε_t^u are exogenous observable and unobservable factors respectively that influence U_t.

Following the accumulation of health stock in Grossman , the production of child health can be represented as:

$$H_t = H(X_t, L_t^h; \eta_t^h, \varepsilon_t^h) \quad (2)$$

where L_t^h *is the amount of time used in the production of child* health, η_t^h *and* ε_t^h *are respectively exogenous observable and unobservable* variables influencing H_t. *(Note:* H_{t-1} is sometimes included in these models as well but the original Grossman model used initial health stock, which might best be captured by stock at birth and is sometimes empirically captured as birth weight.)

The budget constraint of the household or family can be represented as

$$Y_t = w_t L_t^L = P_t^X X_t + P_t^C C_t \quad (3)$$

where Y_t *is family income,* L_t^L *is the time spent to earn wage income,* w_t , P_t^X *and* P_t^C *are respectively the wage rate, prices of* X_t *and* C_t.

The household's time constraint is

$$L = L_t^l + L_t^L + L_t^h \quad (4)$$

where *L* is the total fixed amount of time available (e.g., 24 hours per day).

A household maximizes its intertemporal utility with a discount rate *a*, subject to the budget and time constraints plus the condition of positive initial stock of child health ($H_0 > 0$, frequently conceived of as birth weight).

Taking first derivatives of the Lagrangian function with respect to child health, and taking its lag repeatedly until the initial condition is met, the Marshallian demand function for child health is:

$$H_t^* = H(H_0, \omega_k; \eta_t^h, \eta_t^u, \varepsilon_t^h, \varepsilon_t^u) \tag{5}$$

where $\omega = \{H, X, C, L^L, L^l, L^H\}$ *and k=1, 2, . . ., t−1.*

According to (5) the optimal level of child health is determined by allocation of parental time between income generated through work, household chores and leisure, the consumption of child health-related goods and other goods and services

The empirical specification is then something like the following:

$$H_{it} = \alpha Y + \beta Z_{it} + \mu_{it} \tag{6}$$

where H_{it} is the stock of health of child i in period t, H_{it-1} is the stock of health of child i in period t−1, Y represents average income of the family, where there is a question of whether current or permanent income is preferred, Z_{it} is a set of exogenous variables that affects child health and μ_{it} represents unobservable determinants of H. Again H_{it-1} is sometimes included to reduce unobserved influences on child health. The error term of this demand equation, μ_{it} has two components: a child specific component that does not vary over time and a time varying component which is assumed to be exogenous and uncorrelated over time.

Once this model is specified there remain several core issues: (1) even with children, family income may be endogenous (in the case of a child with severe disability, parents may alter their work behavior and hence income) (2) How to measure health? The most commonly used measure is general health in which an individual or responsible adult responds whether their children's health is excellent, very good, good, fair or poor (3) How to best measure income? The possibilities include current or annual, permanent, neighborhood, or for some purposes, whether the family is poor or near poor.

The first paper to explore the question of the time path of the income gradient among children is Case, Lubotsky and Paxson (2002) (CLP). Using primarily cross sectional data from the National Health Interview Survey for years 1986 to 1995 for children 0–17 they explore the time path using four age categories (0–3; 4–8; 9–12 and 13–17). Using the general health measure and ordered probit regression they find clear evidence of an income—health gradient at all ages and a steepening gradient with age. They explore this pattern as well using a panel data set (Panel Study of Income Dynamics) and find the same pattern. And using the panel data they explore an alternative set of income measures which all find the same steepening influence of income as children age.

This paper set off a chain of other studies—some use data from other countries, which have universal health insurance, while others use alternative data sets for the U.S. Many of these are included in Table 2 below, which covers the question asked, the data set used, methods, findings and a sentence on implications. For example, Currie and Stabile (2003) use data on Canada to ask if the same steepening pattern exists for children under universal coverage. In addition to replicating the CLP study they also attempt to understand if the "cause" for this pattern is that low income children are less able to recover from a health shock than higher income children or that low income children are subject to more health shocks. Health shocks are defined by a set of chronic conditions. Their results suggest that, at least in Canada, low income children recover as well as higher income children from a health shock but have more of them.

In Table 3 we compare results across studies and countries. We bring together the coefficients from ordered probit runs using log income. Each of these studies uses the same five response general health outcome variable, running from excellent = 1 to poor = 5.[1] The right hand

[1]In some cases these categories have been collapsed to two or three categories. Numerous studies have explored the reliability of self or parent reported general health. The focus is on their ability to predict future morbidity and mortality. Maarten Lindeboom and Eddy van Doorslaer 2004 in *Journal of Health Economics* 23(6): 1083–1099 reported on using data on Canadian adults and found homogenous reporting of health status for language, income and education. Marja Jylha 2009 in *Social Science & Medicine* 69(3): 307–316 states this more strongly: "In population studies, self-rated health is probably the most feasible,

side control variables generally include child's sex, race/ethnicity, mother's age, mother's education and parent's marital status. In each case we see a substantial increase in the coefficient going from the youngest age group, 0–3 to the next age group, 4–8. However moving to the third age group, 9–12, the results are more mixed with half of the studies showing no steepening between the second and third group. Finally moving to the oldest group, 13+, suggests an increase or steepening, with the study of the U.K. as the only exception (the fifth study of Australian children only has the two youngest ages included.) Thus all five of the included studies provides evidence of a general steepening of the income gradient as children age with strong evidence for young children but more mixed evidence for the 9–12 year olds. All of these studies are either done with cross sectional data or short panels (2 observations per child). This limits their ability to study whether it is current income or permanent income that appears more closely tied to a child's health.[2] The one study that uses the PSID has two observations on child health but does not make use of the fuller data on family income. Murasko (2008) does explore a few dimensions of income including hot deck imputations for missing income, the use of income from one year rather than a 2 year average and the use of wage income in place of family income. He finds that the two year average income (and family income vs. wage income) shows a stronger tie to child health. But his use of year two income, measured subsequent to the initial observation of child health casts some doubt on the reliability of his comparison of permanent versus current income. The approach used in both Khanama et al and Murasko is to use the earliest or prior health status to capture the influence of income on children prior to the age under study. Thus they suggest that including prior health (by an indicator of poor/fair health for example) captures the influence of income on health up until the most recent period of time. Under this perspective, estimates of the tie between income and health in the current period capture only the marginal

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most inclusive and most informative measure of health status. In a given cultural environment, it is a powerful predictor of future health and use of health services."

[2]Permanent income is generally defined in these short panels as the average income over two years and is then used to explore the health income gradient for all measures of health regardless of timing.

influence of income on health. This approach reduces the coefficient on income but still retains the overall pattern of results.

The addition of parent's health in the Khanama et al estimates reduces the statistical significance of income as a determinant of a child's health, though the steepening pattern as a child ages remains. The authors suggest that this is a way in which income influences health; that is, a parent's poorer health is tied to lower incomes so that by including this channel the direct influence of income is reduced.

Thus the existing literature confirms that children's health is tied to income with some steepening as child age, particularly in earlier childhood, and, that universal health care is not sufficient to significantly reduce, let alone eliminate this income gradient. What then can we add?

Each of the studies we outline above has one or more of the following limitations: (1) use of cross-sectional data or short panel data (2) reliance on noisy income measures and (3) inability to control for health endowments (e.g. birth weight). In addition previous studies have been unable to control for environmental confounding influences, such as neighborhood SES and crime, which can affect both family income and child health status. In this study we are able to overcome these limitations by using the Early Childhood Longitudinal Study-Kindergarten Cohort data, which follows children over 9 years between Kindergarten entry and 8th grade and includes five observations of health and family income per child. The ECLS-K also uses a school-based sampling scheme, which allows both school fixed effects and the use of average income of the school; it also includes measures of the child's health endowment (birth weight). The multiple observations per child allow us to construct a variety of long term (permanent) income measures. In particular, unlike previous studies, we are not forced to use income from future observations (averaging over the short panel) in the construction of permanent income. We turn to our research below.

DATA

In the research reported below we use the Early Childhood Longitudinal Study-Kindergarten Cohort data [ECLS-K]. These data were collected beginning in 1998–99 and trace children from kindergarten through grade 8. The correspondence between grade and child's age is: Kindergarten 6.28 (.88); 1st grade 7.24 (.87), 3rd grade 9.25 (.87), 5th grade 11.87 (0.80) and 8th grade, 14.45 (.49) thus the sample goes from about age 6 to age 15. There are 6431 observations. Table 4 shows basic descriptive information of our sample at kindergarten and 8th grade. Across all five observations, the proportion of children in the sample with health that is less than or equal to good health varies from .15 to .2 over the five observations with a S.D of .36–.40. Current income in 10,000s varies from $5.1 to $7.0 with a S.D. that varies from 4.6 to 5.2. Permanent income (in 10,000s) varies from $5.1 to $ 6.1 with a S.D of 4.4 to 5.1. These rather narrow and consistently sized S.D. suggest that any pattern that emerges should not be due to changing S.D. in income or health.

RESULTS

Employing the model shown above, we first replicate the CLP model using the ECLS-K data which are panel data over 9 years. These results are shown in figure 1 and appendix table 1. The equations we estimate are:

$$H_{it} = \alpha + \beta_1 \log(Y_{it}) + \beta_2 X_{it} + \varepsilon_{it}$$

where the health measure is the five response general health in which 1 = poor and 5 = excellent health in the specified grade. In addition to current log income (which is based on 26 categories with a top category of greater than $200,000) the additional control variables are male, age in years, dummy variables for race (Black, Hispanic and Other race with White, non-Hispanic as the

omitted category), Mother's age, mother's marital status and mother's education and a dummy variable indicating missing parent information[3].

Two sets of estimates are presented: the first showing the simple bivariate ordered probit results and the second including the standard set of control variables indicated above. Both show the expected tie between more income and better health from K to 5th grade but a flat or decreasing tie by the 8th grade[4]. These results then are consistent with the literature reviewed above and suggest that the use of grades in place of age maintains the income-health gradient.

To explicitly review the comparability of using grade based data for ages, we compare our results using grades to the Khanama et al study based on Australian data which also used grade levels. Appendix Table 2 presents these results. Both show a tie between health and income that steepens between kindergarten and 1st grade. Not surprisingly the estimated tie is greater for the U.S. than for Australia (.123 versus .092 for K) but of surprise is the greater increase or steepening in Australia compared to the U.S.[5] The table does provide evidence of the consistency of using grades for age in studies of the income-health gradient of children.

Next we explore the income health gradient making use of the unique features of the ECLS-K.

Permanent income: The first issue we explore is a comparison of current income with permanent income (where permanent income uses only those measures of income observed up to the present at each grade level). We expect that permanent income is a more accurate measure of income and hence might expect a "better" fit. To do so, we run the same basic ordered probit but

[3] Consistent with most of the literature we use family income without adjusting for family size. We tested the importance of this by adjusting family income using the equivalence scale suggested by the National Academy Committee's recommendations for measuring poverty; the results are robust to this change.

[4] Pooling the data, we can test whether the coefficient on income is statistically different across data waves in comparison to the effect in Kindergarten. We find that the effect, relative to baseline, becomes statistically distinguishable in the 5th grade and 8th grade waves in models that control for demographic variables. The 5th grade and 3rd grade effects are different at $p<0.12$ level.

[5]Note that since the Australian study reported self rated health using 5=excellent to 1= poor we report results in this form in this table.

substitute our measure of permanent income for current income.[6] Figure 2 indicates that the gradient is steeper with the use of permanent income and shows a pattern of continual steepening, with a far greater slope between first and third grade and a difference that reaches .074 or about 30 percent higher by 8th grade. All of the coefficients on income are statistically significant at the one percent level.[7] With our data we are also able to compare our definition of permanent income with that used in other studies; that is we compare permanent income which only uses income already observed at the time the health data is gathered with a definition that uses all five observations from grade K to grade 8 and tie that measure to health at each grade. The use of this pre-post measure of income suggests a greater tie between income and health at early grades than our other measures but a flatter overall tie and a decrease in the gradient from 1st grade to 3rd grade.[8] Compared to the coefficients on current income and our preferred measure of permanent income, the pre-post measure does not seem to accurately represent the income health gradient in the earlier years when the measure is most likely to be an error of the families' income at those points in time. Overall our interpretation of this three way comparison is that the pre-post measure of permanent income overstates the initial extent of the income gradient and understates the steepening. Nevertheless we believe that these results suggest that the finding of a strong income health gradient is not sensitive to the measure of family income used, although the exact pattern of the steepening of the gradient as a child ages is sensitive to the measure of income employed.

Including birth weight: We next explore the importance of adding a measure of initial health. Initial health is frequently thought of as health at birth. Our indicator for this is birth weight. In Table 5 below we add birth weight as a control and compare this to our estimates

[6]The control variables, in addition to log income, include male, age, 3 race dummies, mother's education, mother's age and a dummy for missing family information. The coefficients for current income are shown in Table 5.

[7]By definition the gradient begins at the identical spot for kindergarten.

[8]By definition the coefficient on log income at grade 8 is the same for both measures of permanent income.

without birth weight. In this table we report the actual coefficients along with the standard error for log income first in a set of estimates without birth weight and then adding birth weight. The pattern is very close across the two specifications. Of note are the slightly larger coefficients on log income when birth weight is included and the slight decrease in the coefficient for 8th grade compared to 5th grade when birth weight is included. The differences are so small that there does not seem to be significant bias in the income coefficient when birth weight or initial health is not included in other models.

Including maternal mental health: Propper et al. (2007) have recently provided some evidence using a birth cohort dataset from the UK that controlling for maternal mental health eliminates the income-health gradient. In Appendix Table 5 we examine this issue in our US dataset by controlling for a measure of maternal depression[9]. The main results suggest a minimal reduction in the income-health link in our sample, suggesting that the observed children's income gradient in the U.S. is not the result of mother's mental health and raising some question of what the underlying phenomena is in the UK that might explain these very different results.

Community SES: A unique aspect of the ECLS-K data is the school based design. This allows us to take into account the average SES of the neighborhood in which these children live. That is, we view each school as being similar to a relatively homogeneous community in terms of SES. We base this perspective on the neighborhood feeder pattern of a large majority of schools in the U.S.[10] We do this in two ways: first we run a school fixed effects model over children in all schools in the sample and second, we do so only for children in public schools. We do this second

[9] Since the maternal depression questions are only asked in every other wave of the ECLS-K data, we use either the current or previous wave depression measure. The question available in the survey is "How often during the past week have you felt depressed?". The answers included "never", "some of the time", "a moderate amount of time", or "most of the time".

[10]For example Jorge Martinez-Vazquez, Mark Rider and Mary Beth Walker 1997 found in their study of the heterogeneity of geographic areas by race that the number of school districts tend to increase when racial heterogeneity of a state population increases.

step as an extra sensitivity test since private schools may have children from a larger geographic area and may have a more diverse student body.[11]

Table 6 shows the results comparing the estimates for the full sample with that for public schools only. Turning first to the full sample school fixed effects results we see a general pattern of an increasing income gradient but one that suggests a decreasing slope between grades 5 and 8. In order to test whether this might be due to the generally larger school attended in 8th grade, we substitute the 5th grade school and find that this has no effect on the results. Turning to the school fixed effects results only for public schools we find a similar pattern but a larger decline in the coefficients comparing 5th and 8th grade. These results suggest that the larger community income is capturing some of the influence of income or SES on child health among these older children. The differences are not large so we do not wish to overstate the results but they do suggest that for somewhat older children (young preadolescents and early adolescents) community SES may influence their own health in a way that dampens the influence of parental income. And the results at least raise the question of whether previous results that do not include community SES may overstate the role of family income for age groups likely sensitive to their peers—pre and actual adolescents.

Finally, we examine whether there appears to be an additional influence of average school income on the health of students as well as ask whether there is evidence of potential interactions between family income and school/community income in Table 7. In order to calculate community income, we aggregate the individual level income measures to the school level (leaving out the focal individual). The results suggest, on average, that in kindergarten and first grade, attending school with wealthier classmates seems to be tied to reporting better health and that this does not differ according to own family income. To get a sense of the likely influence we calculated marginal effects and find, for example, that during first grade a marginal

[11]It might be the case that some private schools are more homogenous than public schools. This is likely to be so in the case of parochial schools in a local parish. We are not able to identify schools and so cannot include only a subset of private schools in our estimates.

effect of .068 on log own family income of increasing the probability of reporting excellent health while in the specification with school average income we find the marginal effects to be .044 on log own family income and .087 on log school average income; for kindergarten we calculate equal marginal effects of .049 for logs of both own income and school income. In all these calculations, the income variables are statistically significant at the 1% level and these marginal effects are calculated at the mean of all variables in the model. There is also some evidence of an interactive effect suggesting a positive influence of school average income on children's health that is greater for children in lower income families but this is only the case during third grade.

CONCLUSION

After reviewing many aspects of the existing literature we find robust evidence of a strong and generally steepening income gradient of health. The unique aspects of this work include: we study the same children over a longer period of time –a panel over 9 years with five observations per child. Thus we are able to address the question of the form of the steepening of the gradient with age using more satisfactory data. Second, since we have such a long period of time over which we observe each child, we construct measures of long term or permanent income over time in which the measure is only based on measures of family income up until this observation of a child; that is, we use no income data after the observation of health of a child at each age (i.e. future income). We suggest our measure of permanent income is preferable to that used in most other studies to date. Third, we have a measure of the child's health status at birth, birth weight, which we think better captures the concept of early health endowment in the Grossman model of the production of health. We believe this captures some unobserved characteristics of the child such that including it in our empirical estimates allows us to better identify the tie between current health and income. Fourth, we add to the current exploration that focuses only on family income, by including community SES as captured by the SES of the children who attend the same school as the "observation" child. That is, by using school fixed

effects, we control for otherwise unobserved community SES and implicitly include a test for the extent to which the child's family income matters, once we take community SES into account. We also show some suggestive interactive effects between own family and school-level income measures.

Our results using panel data of children from age 6 to 15 provides additional evidence of a tie between family income and child health that steepens at least from ages 6 to about 12. Our results suggest that the pattern is robust to the inclusion of a measure of initial health as captured by birth weight as well as to a measure of maternal mental health. We also provide evidence that the use of permanent income including only income measured prior to the period when a child's health is measured is a preferred measure of family income and we provide evidence that, at least for pre and early adolescents, community SES may itself influence a child's health and that studies unable to include community SES may overstate the role of family income for this age group. This is at least the case when we use current family income

To bring these comparisons together we add a figure that captures these differences in figure 3 below.[12] Here we show four estimates for each grade all of which include birth weight as a control variable: one that uses current income and then a similar equation using school fixed effects and a similar set using permanent income. We have seen all but the results with permanent income including birth weight as a control variable using school fixed effects earlier. These new results are actually the strongest of our empirical results in showing a steepening of the income gradient throughout the full 9 years and five observations. These results suggest the importance of the quality of the income measure and now suggest that when accurately measuring family income, including the community SES actually increases the gradient. This then provides some suggestion that not only own income but also relative income or SES may matter when it comes to health. Why might community or school SES matter for pre and early adolescents but not for

[12]The full set of equations that go with this figure are in appendix Table 3.

early primary school? We conjecture that peers (friends) become more important as children age. Pre teens and teens are much more likely to follow risk taking activities of their friends and if their friends are in lower SES communities risk taking may be far greater. Thus the effects of family SES may be magnified for older children as they are influenced by children of similar SES.

Of course there are caveats in using the ECLS-K data. Chief among these is that not all children are present at each wave. In the analysis presented above we chose to present the results using the maximum sample possible at each grade. But this opens up the possibility that temporary attrition may influence the results. To partly answer this, we conducted an analysis using a balanced sample. These results, presented in appendix 4 suggests that while there are some differences in using the balanced sample, the overall pattern remains and so again the evidence on the income gradient appears robust to numerous modifications.

What might these results suggest for public policy? One, they provide evidence of the importance of the income distribution, especially low income, for health of the next generation. Two and tied to this, they suggest a pattern by which intergenerational mobility might be limited. Three, these results enforce the importance of increasing the income of low income families in determining future productivity.

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Tables

Table 1: Health of Poor vs. Nonpoor Children; NHIS Data, Children 2-17 US 2001–05

Health Measure	Poor	Nonpoor
Low birth weight	0.112	0.078
Ever told had asthma	.159	.131
Ever mental problems	.119	.079
Ever told ADHD	.071	.060
Activity limitations	.114	.070
ages 2-3	.061	.037
ages 4-8	.097	.062
ages 9-12	.139	.067
Days missed Illness/injury 12 mos	4.471	3.531
Any chronic condition	.324	.265
N	7,363	36,858

Source: Currie and Lin 2007.

Table 2: Table of Studies of Children

Table of Studies of Children							
Paper	Case, A., Lubotsky,D., and Paxson, C., 2002	Currie, J. and Stabile, M., 2003	Condliffe, S. and Link, C. R., 2008	Currie, A., Shields, M.A., and Price, W., 2007	Currie, J., Decker, S., and Lin, W., 2008	Murasko, J. 2008	R Khanama, HS Nghiemb and L Connelly 2009
Motivation	Focus on children; sources of the gradient	Canada;Focus on recovery and quantity of shocks	US; Focus on recovery and quantity of shocks	England; Compare with US	Focus on public health insurance expansions	health; cumulative vs. current income; panel	Australia; panel; explain gradient
Data	Maternal reported general health status of children (0-17)		US MEPS and PSID, 1996-2002	HSE (2-15)	US NHIS 1986-2005	US MEPS 1996-2005	LSAC 2 Cohorts
Method	Ordered probit regression	Ordered probit regression and linear probability regression	Ordered probit regression and linear probability regression	Ordered probit regression and linear probability regression	Index of generosity of the state's public health insurance programs as IV for individual Medicaid/SCHIP eligibility and conduct 2SLS	ordered probit	binary and ordered Probit models
Findings	Children's health is positively related to family income at every age, and the slope of the gradient increases for older children	Despite the universal health coverage, there exists an income gradient of children's health that steepens during childhood. The gradient is likely due to higher rate of health shocks among low-income children.	In U.S., children in low income families are more likely than children in high income families to still suffer from chronic conditions present 5 years ago. Income gradient becomes steeper with age, partly because low income children are less able to recover from health shocks.	Although family income has a positive relationship with general health status, strength of the relationship is smaller than in US. Gradient does not increase with children's age. No evidence of a significant income differential in probability of a child having a chronic health condition	More generous insurance coverage at early childhood is associated with better health at older ages (ages 9-17). In addition, the relationship between family income and children's health has weakened for older children after the year the SCHIP initiated	Replicate Case (2002) pattern though somewhat weaker. Increased persistence of health status among older children; stronger contemporaneous influence of income on adolescents	Similar findings as US studies in that children from higher income families have better health but gradient flatter. No evidence of more health shocks or failure to respond to shocks by income. Some suggestion that health of mother part of explanation of the gradient
Implications	low family income on children's health tend to accumulate during childhood. Thus, children from lower income families may suffer from both lower SES and poorer health when they transition into adulthood	Policies that focus only on reducing gaps in access to medical care may not be sufficient to reduce disparities in health.	Public policies that increase access to medical care for low income children could be useful in reducing the income gradient of children's health.	Family income may not be a major determinant of children's health in England. NHS may influence. Challenged by Case, Lee and Paxson that findings reflect miscoding of chronic condiitons.	Assuring access to health care in early childhood may prevent the income gradient of children's health from becoming steeper over time.	Since influence of SES cumulative, interventions at an earlier age may be most effective	National health service can reduce gradient but not come close to eliminating it.

Table 3: A Comparison of Results from Studies of Four Countries of the Tie between Family Income and Child Health
Parent's reports of child general health, 1=excellent, 5=poor. Ordered probits

		Age of Child			
Study	Country	0–3	4–8	9–12	13+
CLP	USA	-0.183	-0.244	-0.268	-0.323
		[0.008]	[0.008]	[0.009]	[0.008]
CS	Canada	-0.151	-0.216	-0.252	-0.272
		[0.026]	[0.019]	[0.024]	[0.040]
CLP	UK	-0.143	-0.212	-0.203	-0.194
		[0.036]	[0.026]	[0.030]	[0.034]
KNC	AU	-0.05	-0.131		
		[0.024]	[0.024]		
M	USA	-0.079	-0.134	-0.132	-0.195
		[0.023]	[0.018]	[0.022]	[0.036]

Notes: CLP = Case. Lubotsky and Paxson 2002 using NHIS; CS = Currie and Stabile, 2003 using NLSCY.
CLP=Case, Lee and Paxson 2007 using HSE and KNC= Khanam, Ngheim and Connelly 2009 using LSAC.
M=Murasko 2008 using MEPS. Control variables include age dummies, sex, race, parent education, ln family size with some additions that vary by study.

Table 4: Descriptive Characteristics of ECLS-K Sample

	Kinder			8th Grade		
Variable	Obs	Mean	Std.	Obs	Mean	Std.
Poor Health	7,431	0.17	0.37	6,953	0.15	0.36
Child Health Status (5=excellent, 1=poor)	7,431	4.33	0.83			
Child Health Status = Excellent	7,431	0.53				
Child Health Status = Very Good	7,431	0.30				
Child Health Status = Good	7,431	0.14				
Child Health Status = Fair	7,431	0.03				
Child Health Status = Poor	7,431	0.00				
Log Income	7,405	10.51	0.96	6,953	10.84	0.85
Current Income (10000s)	7,431	5.17	5.15	6,953	6.98	5.18
Permanent Income (current and previous wave) (10000s)	7,431	5.17	5.15	6,953	6.09	4.46
School average income (10000s)	7,032	5.71	3.31	6,369	6.02	2.66
Parent Health (1=excellent, 5=poor)	7,411	2.26	0.79	6,933	2.26	0.79
Mom Depressed (1=never, 4=most of the time)	7,395	1.34	0.50	6,928	1.35	0.51
Birth weight (lbs)	7,291	7.38	1.32			
Male	7,431	0.52	0.50	6,953	0.51	0.50
Age	7,426	6.23	0.38	6,948	14.45	0.49
Black	7,431	0.17	0.37	6,953	0.16	0.36
Hispanic	7,431	0.17	0.38	6,953	0.18	0.38
Other Race	7,431	0.04	0.20	6,953	0.04	0.20
Mom Education	7,431	13.48	2.45	6,953	13.50	2.46
Mom Age (wave 1)	7,431	33.56	6.49	6,953	33.82	6.28
Married	7,431	0.71	0.45	6,953	0.70	0.46

Table 5: Comparison of Income Gradient With and Without Birth Weight in Ordered Probit; Self Reported Health

	Xs	Xs	Xs	Xs	Xs
Grade	K	1	3	5	8
Current Log Income	0.122***	0.162***	0.207***	0.248***	0.247***
	(0.035)	(0.041)	(0.040)	(0.034)	(0.041)
Current log income with BW	0.135***	0.163***	0.204***	0.238***	0.231***
	(0.036)	(0.043)	(0.042)	(0.036)	(0.043)
Number of observations	7,265	6,559	6,247	7,032	6,534

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1.

Table 6: School Fixed Effects: General Health as Dependent Variable; Ordered Probit. Estimates Include Birth Weight. Coefficient on log income reported in table

Grade	*K*		*1st*		*3rd*		*5th*		*8th*	
Sample	Full	Public	Full	Public	Full	Public	Full	Public	Full	Public
Coef.	0.152	0.145	0.183	0.151	0.238	0.203	0.305	0.312	0.222	0.191
SE	0.039	0.041	0.048	0.049	0.049	0.052	0.042	0.046	0.054	0.056

Table 7
The Effects of Family Income, School SES, and Interaction Effects on Childhood Health Status

Grade Level	K	K	1	1	3	3	5	5	8	8
Log (Permanent Income)	0.123***	0.151***	0.111***	0.170	0.200***	0.321***	0.231***	0.225***	0.256***	0.215***
	(0.036)	(0.072)	(0.041)	(0.084)	(0.050)	(0.091)	(0.047)	(0.094)	(0.051)	(0.109)
Log Average School Income	0.123**	0.327	0.220***	-0.103	0.066	0.970*	0.071	0.031	0.056	-0.219
	(0.062)	(0.476)	(0.059)	(0.537)	(0.065)	(0.548)	(0.056)	(0.563)	(0.058)	(0.665)
Own X School Income		-0.019		-0.031		-0.085*		-0.004		0.026
		(0.044)		(0.050)		(0.051)		(0.052)		(0.062)
Male	-0.128***	-0.129***	-0.037	-0.036	0.020	0.017	-0.045	-0.045	-0.082	-0.082
	(0.049)	(0.049)	(0.052)	(0.052)	(0.056)	(0.056)	(0.046)	(0.046)	(0.055)	(0.055)
Age	-0.112	-0.114	-0.065	-0.067	-0.164**	-0.167**	-0.171	-0.171	-0.129**	-0.128**
	(0.077)	(0.077)	(0.074)	(0.074)	(0.079)	(0.079)	(0.108)	(0.108)	(0.063)	(0.063)
Black	-0.014	0.019	-0.098	-0.105	-0.139	-0.116	-0.121	-0.122	-0.117	-0.119
	(0.098)	(0.099)	(0.098)	(0.099)	(0.103)	(0.106)	(0.106)	(0.108)	(0.088)	(0.088)
Hispanic	-0.077	-0.076	-0.187***	-0.188***	-0.006	0.002	-0.202***	-0.202***	-0.185***	-0.187***
	(0.062)	(0.062)	(0.067)	(0.067)	(0.065)	(0.065)	(0.064)	(0.065)	(0.069)	(0.069)
Other Race	-0.045	-0.044	-0.053	-0.056	0.076	0.083	-0.153	-0.153	0.009	0.006
	(0.101)	(0.101)	(0.118)	(0.118)	(0.099)	(0.100)	(0.130)	(0.130)	(0.134)	(0.135)
Maternal Education	0.062***	0.062***	0.057***	0.056***	0.054***	0.056***	0.058***	0.058***	0.035***	0.035***
	(0.011)	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)
Maternal Age	0.003	0.003	-0.007**	-0.007**	-0.001	0.000	-0.004	-0.004	-0.003	-0.004
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Missing Family Information	0.263**	0.261**	0.075	0.081	-0.079	-0.091	0.389**	0.389**	0.281	0.282
	(0.106)	(0.107)	(0.200)	(0.199)	(0.219)	(0.220)	(0.194)	(0.194)	(0.203)	(0.202)
Birth weight	0.022	0.021	0.019	0.019	0.032	0.032	0.029	0.029	-0.004	-0.004
	(0.019)	(0.019)	(0.021)	(0.021)	(0.021)	(0.021)	(0.019)	(0.019)	(0.019)	(0.019)
Observations	7243	7243	6863	6863	6479	6479	6563	6563	6440	6440

Table 8

Panel data estimation incorporating all data in single estimate

Grade	simple weighted	most Xs	Add birthweight	add mom depression
K	0.234***	0.138***	0.150***	0.134***
1st	0.310**	0.184	0.169	0.146
3rd	0.314**	0.18	0.173	0.150
5th	0.382***	0.241***	0.252***	0.227***
8th	0.358***	0.209*	0.200	0.174

Other variables in columns 3-5 include male, age, race, mom age, grade level dummies and mom education.

Figures

Figure 1: Basic Results on Income Gradient
ECLS Data, Current Income, Ordered Probit, Weighted Data

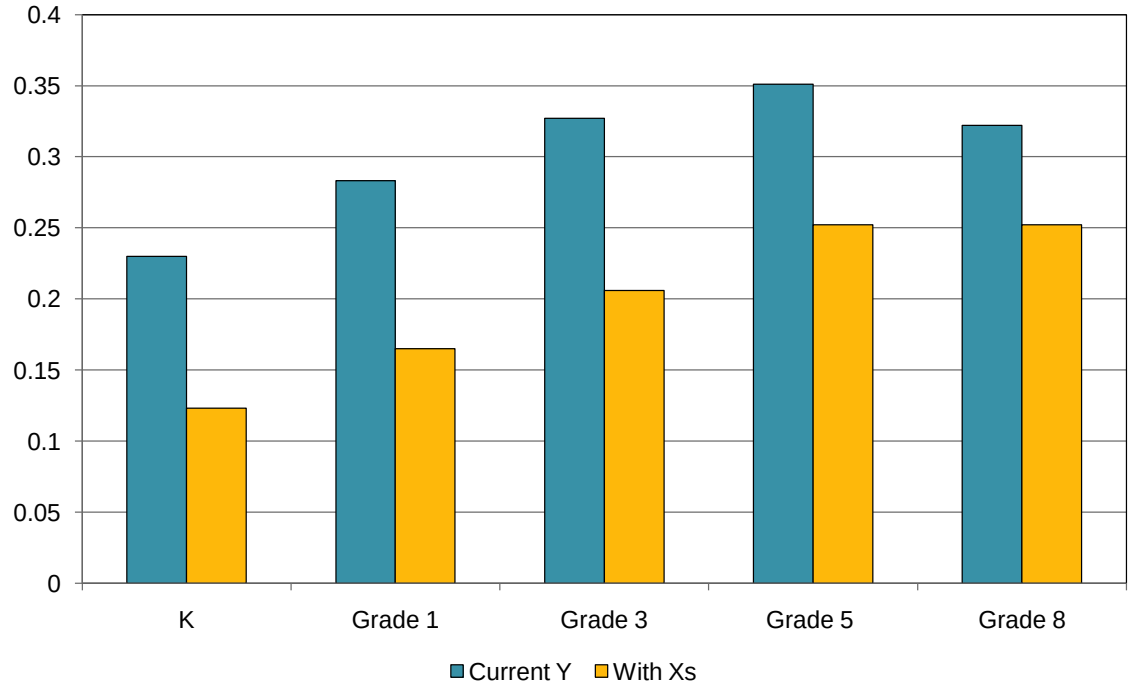


Figure 2: Does Measure of Income Matter?
Permanent Income Based on Current And Prior Years:
Permanent B –Based on All Years.

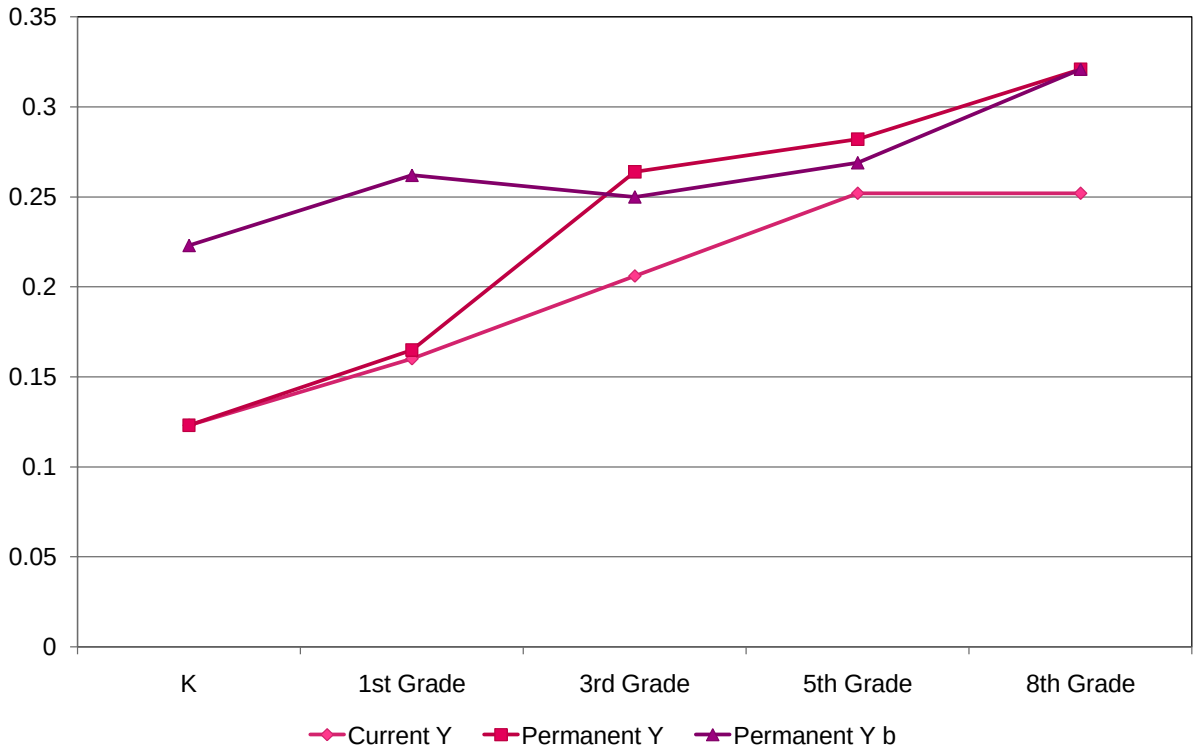
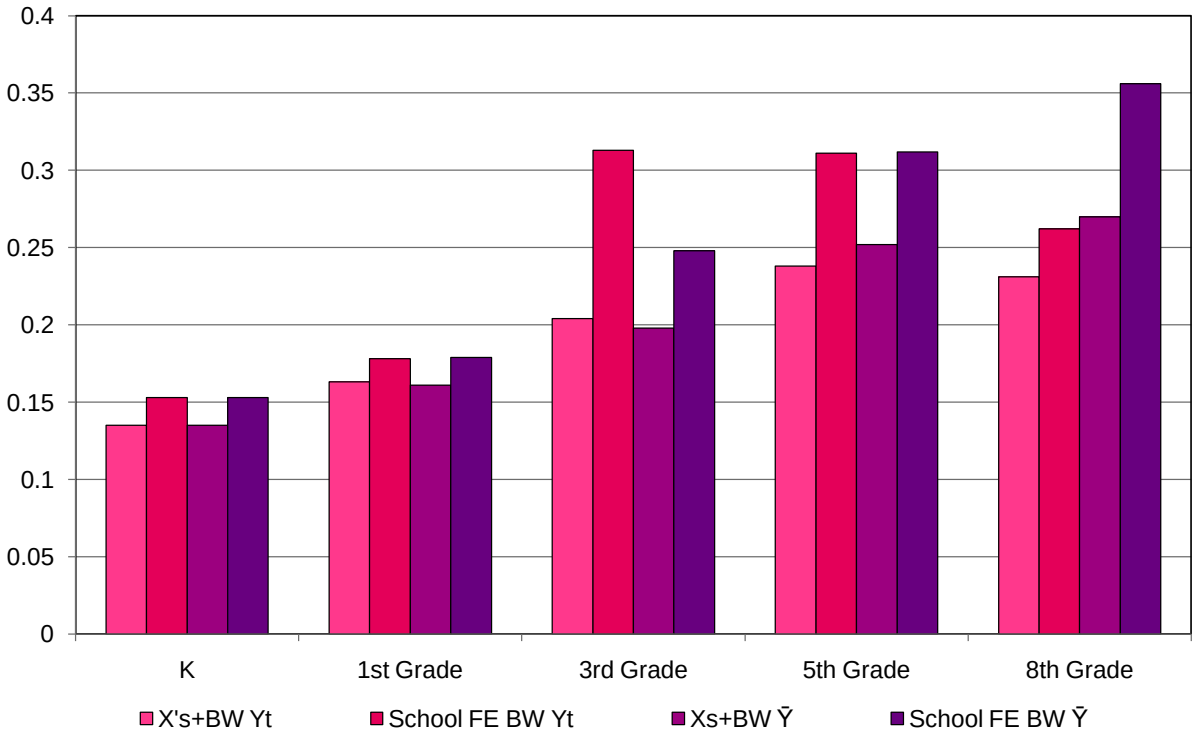


Figure 3: Comparison Of Preferred Runs: Include Birth Weight Compare Current Income to Permanent Income and the Importance of School FE



Appendix Tables and Figures

Appendix Table 1: Core Results with Xs, ECLS-K Data; Self Reported Health 1=Poor; 5=Excellent

Specification	Xs	Xs	Xs	Xs	Xs
Grade Core results with Xs	K	1	3	5	8
Current Log Income	0.122***	0.162***	0.207***	0.248***	0.247***
	(0.035)	(0.041)	(0.040)	(0.034)	(0.041)
Male	-0.122**	-0.002	0.013	-0.076*	-0.086*
	(0.048)	(0.053)	(0.054)	(0.044)	(0.051)
Age	-0.101	-0.050	-0.110	-0.097	-0.161***
	(0.075)	(0.076)	(0.071)	(0.090)	(0.056)
Black	-0.049	-0.169*	-0.143	-0.216**	-0.227***
	(0.096)	(0.095)	(0.087)	(0.085)	(0.080)
Hispanic	-0.106*	-0.200***	-0.071	-0.198***	-0.208***
	(0.060)	(0.060)	(0.062)	(0.059)	(0.067)
Other Race	-0.125	-0.110	0.175*	-0.147	0.037
	(0.106)	(0.127)	(0.106)	(0.101)	(0.118)
Maternal Age	0.002	-0.006	-0.004	-0.001	-0.002
	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)
Married Parents	0.080	0.043	-0.156**	-0.141**	-0.146**
	(0.068)	(0.070)	(0.072)	(0.059)	(0.062)
Maternal Education	0.069***	0.058***	0.061***	0.063***	0.039***
	(0.011)	(0.012)	(0.012)	(0.011)	(0.012)
Missing Family Information	0.308***	-0.127	-0.110	-0.013	-0.072
	(0.109)	(0.093)	(0.109)	(0.101)	(0.107)
Constant	1.561***	1.811***	1.785**	2.180*	0.579
	(0.605)	(0.702)	(0.797)	(1.126)	(0.946)
Observations	7,400	6,901	6,573	7,494	6,948

Comparison of FW to Australian Study Kindergarten as 1st observation

Appendix Table 2: Steepening of the Health-Income Gradient with Child Age US and Australia, K-Cohort, Panel Data, Ordered Probits

	Grade				
Study	K	1st	3rd	5th	8th
Australia	-0.092	-0.151			
Khanam et al. 2009	[0.031]	[0.034]			
USA	-0.123	-0.160	-0.206	-.252	-.252
Fletcher Wolfe 2010	[0.035]	[0.040]	[0.040]	[0.035]	[0.041]

Notes: Dependent variable is ordered general health. Australia – LSAC data. Includes age and wave, sex, race, log HH size, presence and age biological parents, parent's education and employment. USA: ECLS-K data. Includes age and wave, sex, race, presence and age of mother, marital status of parents, parent's education and dummy if income missing.

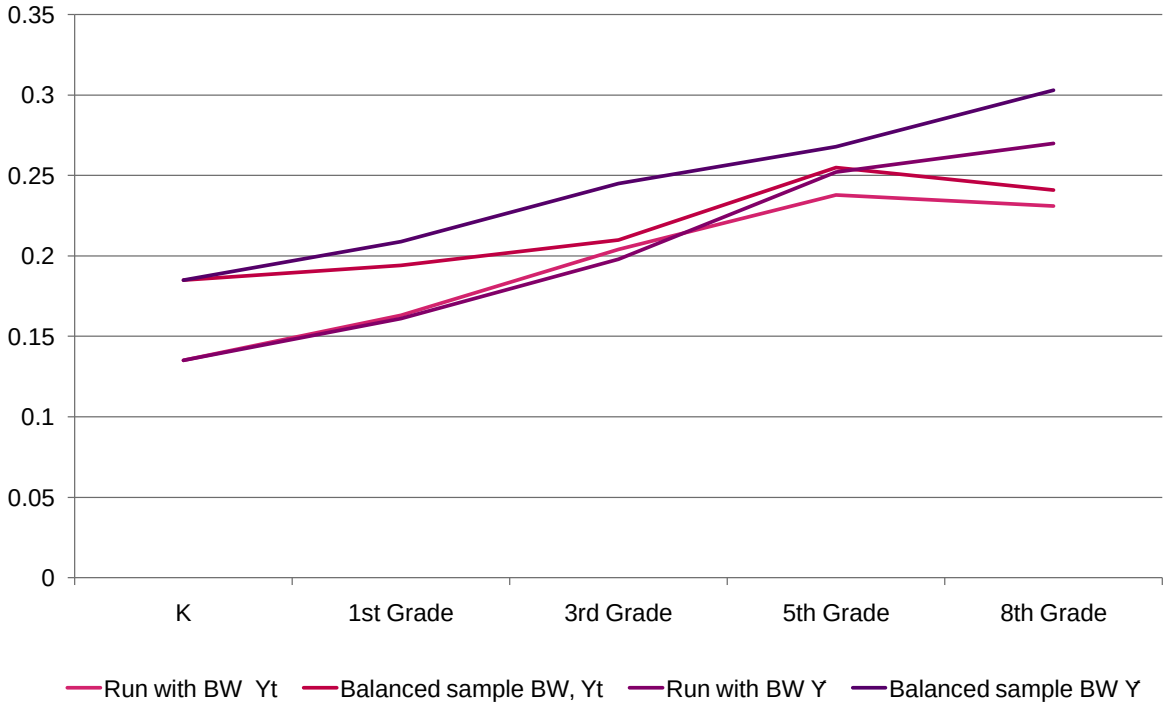
Appendix Table 3: Full Regression Results for Figure 3

Income Measure	Current		Permanent		Current		Permanent		Current		Permanent	
Grade	K	K	K	K	1	1	1	1	3	3	3	3
Fixed Effects	None	School	None	School	None	School	None	School	None	School	None	School
Income	0.146***	0.152***	0.146***	0.152***	0.175***	0.183***	0.172***	0.171***	0.166***	0.238***	0.164***	0.207***
	(0.034)	(0.039)	(0.034)	(0.039)	(0.041)	(0.048)	(0.041)	(0.050)	(0.039)	(0.049)	(0.045)	(0.052)
Male	-0.116**	-0.174***	-0.116**	-0.174***	0.002	-0.052	-0.008	-0.048	-0.004	-0.051	0.001	-0.045
	(0.049)	(0.058)	(0.049)	(0.058)	(0.056)	(0.066)	(0.053)	(0.061)	(0.057)	(0.069)	(0.053)	(0.063)
Age	-0.109	-0.160*	-0.109	-0.160*	-0.048	-0.091	-0.065	-0.108	-0.095	-0.133	-0.132*	-0.199**
	(0.077)	(0.089)	(0.077)	(0.089)	(0.078)	(0.090)	(0.074)	(0.087)	(0.073)	(0.098)	(0.074)	(0.096)
Black	-0.033	0.057	-0.033	0.057	-0.178*	-0.048	-0.184*	0.046	-0.079	0.062	-0.161*	-0.011
	(0.094)	(0.160)	(0.094)	(0.160)	(0.100)	(0.155)	(0.095)	(0.153)	(0.091)	(0.137)	(0.094)	(0.134)
Hispanic	-0.103*	0.106	-0.103*	0.106	-0.191***	0.058	-0.227***	0.023	-0.073	0.018	-0.109*	0.003
	(0.060)	(0.100)	(0.060)	(0.100)	(0.063)	(0.116)	(0.062)	(0.120)	(0.065)	(0.116)	(0.063)	(0.106)
Other Race	-0.113	0.037	-0.113	0.037	-0.108	0.081	-0.135	0.129	0.154	0.048	0.098	-0.002
	(0.108)	(0.180)	(0.108)	(0.180)	(0.138)	(0.193)	(0.139)	(0.186)	(0.112)	(0.179)	(0.108)	(0.165)
Maternal Education	0.065***	0.061***	0.065***	0.061***	0.054***	0.059***	0.053***	0.055***	0.064***	0.040**	0.061***	0.052***
	(0.011)	(0.013)	(0.011)	(0.013)	(0.013)	(0.015)	(0.013)	(0.015)	(0.013)	(0.016)	(0.012)	(0.015)
Maternal Age	0.004	0.005	0.004	0.005	-0.007	-0.003	-0.007*	-0.006	-0.004	0.010	-0.004	0.008
	(0.004)	(0.005)	(0.004)	(0.005)	(0.004)	(0.005)	(0.004)	(0.005)	(0.005)	(0.006)	(0.004)	(0.005)
Birth Weight	0.022	0.045**	0.022	0.045**	0.012	0.026	0.017	0.030	0.026	0.048**	0.028	0.050**
	(0.019)	(0.023)	(0.019)	(0.023)	(0.022)	(0.028)	(0.021)	(0.026)	(0.022)	(0.021)	(0.020)	(0.020)
Missing Family Info	0.282***	0.273**	0.282***	0.273**	0.091	0.184	0.046	0.147	-0.040	-0.092	-0.045	-0.167
	(0.106)	(0.115)	(0.106)	(0.115)	(0.196)	(0.246)	(0.185)	(0.219)	(0.245)	(0.247)	(0.226)	(0.225)
Observations	7,265	7,239	7,265	7,239	6,559	6,369	7,001	6,800	6,247	5,833	6,800	6,350

Appendix Table 3, continued

Income Measure	Current		Permanent		Current		Permanent	
Grade	5	5	5	5	8	8	8	8
Fixed Effects	None	School	None	School	None	School	None	School
Income	0.212***	0.305***	0.231***	0.318***	0.194***	0.222***	0.237***	0.312***
	(0.034)	(0.042)	(0.042)	(0.052)	(0.041)	(0.054)	(0.048)	(0.066)
Male	-0.078*	-0.077	-0.077*	-0.076	-0.089*	-0.149**	-0.087	-0.149**
	(0.046)	(0.049)	(0.046)	(0.049)	(0.054)	(0.065)	(0.054)	(0.065)
Age	-0.082	-0.098	-0.077	-0.108	-0.139**	-0.037	-0.134**	-0.031
	(0.096)	(0.102)	(0.098)	(0.101)	(0.062)	(0.084)	(0.063)	(0.086)
Black	-0.217**	0.021	-0.201**	-0.004	-0.183**	-0.146	-0.147*	-0.099
	(0.091)	(0.158)	(0.093)	(0.157)	(0.083)	(0.107)	(0.087)	(0.110)
Hispanic	-0.219***	-0.130	-0.208***	-0.135	-0.237***	-0.271***	-0.222***	-0.242**
	(0.061)	(0.095)	(0.061)	(0.095)	(0.066)	(0.097)	(0.067)	(0.097)
Other Race	-0.145	-0.184	-0.153	-0.204	0.014	-0.042	0.018	-0.032
	(0.109)	(0.195)	(0.112)	(0.206)	(0.127)	(0.171)	(0.132)	(0.171)
Maternal Education	0.063***	0.048***	0.062***	0.048***	0.045***	0.035**	0.039***	0.025
	(0.011)	(0.013)	(0.012)	(0.013)	(0.012)	(0.016)	(0.013)	(0.016)
Maternal Age	-0.001	0.001	-0.002	0.001	-0.003	-0.003	-0.004	-0.004
	(0.004)	(0.005)	(0.004)	(0.005)	(0.004)	(0.005)	(0.004)	(0.005)
Birth Weight	0.017	0.041*	0.014	0.039*	0.003	0.015	0.003	0.015
	(0.019)	(0.023)	(0.019)	(0.022)	(0.019)	(0.021)	(0.019)	(0.021)
Missing Family Information	0.229	0.280	0.261	0.271	0.230	0.373*	0.249	0.397*
	(0.191)	(0.233)	(0.192)	(0.236)	(0.197)	(0.213)	(0.202)	(0.219)
Observations	7,032	6,549	7,032	6,549	6,534	6,202	6,534	6,202

Appendix 4: Comparison of Full vs. Balanced Sample, Current and Permanent Income
K=7405; 1st=6909 3rd=6596; 5th = 7325; 8th = 6953



Appendix Table 5
The Effects of Income on Childhood Health: Controls for Maternal Depression

Outcome	Child Health	Child Health	Child Health	Child Health	Child Health	Child Health	Child Health	Child Health	Child Health	Child Health
Grade	K	K	1	1	3	3	5	5	8	8
Specification	Birthweight	Mom Depressed	Birthweight	Mom Depressed	Birthweight	Mom Depressed	Birthweight	Mom Depressed	Birthweight	Mom Depressed
Log (Permanent Income)	0.146***	0.131***	0.172***	0.160***	0.164***	0.148***	0.231***	0.206***	0.237***	0.222***
	(0.034)	(0.034)	(0.041)	(0.042)	(0.045)	(0.047)	(0.042)	(0.045)	(0.048)	(0.049)
Male	-0.116**	-0.116**	-0.008	0.011	0.001	0.009	-0.077*	-0.086*	-0.087	-0.101*
	(0.049)	(0.050)	(0.053)	(0.054)	(0.053)	(0.054)	(0.046)	(0.047)	(0.054)	(0.055)
Age	-0.109	-0.120	-0.065	-0.084	-0.132*	-0.119	-0.077	-0.092	-0.134**	-0.128**
	(0.077)	(0.078)	(0.074)	(0.075)	(0.074)	(0.074)	(0.098)	(0.104)	(0.063)	(0.063)
Black	-0.033	-0.070	-0.184*	-0.199**	-0.161*	-0.149	-0.201**	-0.167	-0.147*	-0.171*
	(0.094)	(0.097)	(0.095)	(0.099)	(0.094)	(0.101)	(0.093)	(0.104)	(0.087)	(0.088)
Hispanic	-0.103*	-0.110*	-0.227***	-0.220***	-0.109*	-0.090	-0.208***	-0.186***	-0.222***	-0.224***
	(0.060)	(0.062)	(0.062)	(0.063)	(0.063)	(0.064)	(0.061)	(0.064)	(0.067)	(0.067)
Other Race	-0.113	-0.091	-0.135	-0.125	0.098	0.095	-0.153	-0.117	0.018	0.021
	(0.108)	(0.116)	(0.139)	(0.145)	(0.108)	(0.109)	(0.112)	(0.117)	(0.132)	(0.139)
Maternal Education	0.065***	0.065***	0.053***	0.048***	0.061***	0.061***	0.062***	0.060***	0.039***	0.037***
	(0.011)	(0.011)	(0.013)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)
Maternal Age	0.004	0.005	-0.007*	-0.005	-0.004	-0.003	-0.002	0.001	-0.004	-0.004
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Missing Information	0.282***	0.283	0.046	0.101	-0.045	0.349*	0.261	0.130	0.249	0.136
	(0.106)	(0.178)	(0.185)	(0.220)	(0.226)	(0.194)	(0.192)	(0.198)	(0.202)	(0.212)
Birth Weight	0.022	0.024	0.017	0.013	0.028	0.027	0.014	0.014	0.003	0.002
	(0.019)	(0.020)	(0.021)	(0.021)	(0.020)	(0.020)	(0.019)	(0.020)	(0.019)	(0.019)
Maternal Depression		-0.122***		-0.163***		-0.112***		-0.115***		-0.124***
		(0.037)		(0.041)		(0.039)		(0.036)		(0.046)
Observations	7265	7033	7001	6814	6800	6671	7032	6525	6534	6459