Dollars and Pounds: The Impact of Household Income on Childhood Weight

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ABSTRACT

This paper examines the impact of household income on childhood weight status for children in the United States using matched mother-child data from the National Longitudinal Survey of Youth (NLSY). Instrumental variable (IV) models, household fixed effects (FE) models and household fixed effects IV (FEIV) models are estimated in order to control for causality. The results suggest that although the prevalence of childhood obesity is higher in low-income families in the sample, household income might be acting primarily as a proxy for other unobserved characteristics that determine the child's weight status rather having a major direct causative role in determining the child's weight status.

1. INTRODUCTION

Childhood obesity is fast becoming one of the most prevalent childhood health conditions in many countries, especially in developed countries like the United States. In 2003-2004, 17.1% of children and adolescents in the U.S. were obese (Ogden *et al.*, 2006). In contrast, only 4% of children between the ages of 6 and 11 and 5% of adolescents between the ages of 12 to 19 in the U.S. were obese back in the 1960s (Ogden *et al*., 2002a).

The main reason as to why public health authorities are concerned about the increase in the prevalence of childhood obesity is that childhood obesity is known to have adverse health effects and these effects might prove to be costly to society in the long run. Some of the health issues associated with childhood obesity include increased likelihoods of developing physical health conditions such as sleep apnea, asthma, fatty liver disease, type II diabetes and either early or delayed puberty (Lobstein *et al.*, 2004). In addition, children who are at-risk-of-overweight or obese are more likely to grow up into overweight or obese adults who have elevated risks for cardiovascular conditions. (Srinivasan *et al.*, 1996).

There have been several studies in the economics literature that have examined the potential causes of the increase in obesity prevalence. Philipson and Posner (1999) and Lakdawalla and Philipson (2002) argue that technological change has increased the cost of physical activity and lowered costs of calories, thus causing the increase in weight observed in the United States. Cutler, Glaeser and Shapiro (2003) suggest that technological changes in food preparation in the U.S. have led to decreases in both fixed and marginal time costs of food production, thus leading to increased caloric consumption. Anderson, Butcher and Levine (2003) and Chia (2008) present evidence to suggest that increased maternal participation in the labour force can lead to an increase in the likelihood of childhood obesity.

The prevalence of childhood obesity has been observed to differ for different socio-economic segments of society. The relationship between household income and childhood obesity prevalence differs between developed countries and developing countries. In developed countries, children from lower-income families are at a higher risk of becoming obese (Armstrong *et al.*, 2003, Wang *et al.*, 2002). On the other hand, in developing countries, children from higher-income families are at a higher risk of being obese (de Onis and Blössner, 2000, Wang *et al.*, 2002).

Most of the studies that have examined the impact of family income on weight have produced statistical correlations rather than causal estimates. The main econometric issue involved with estimating the causal impact of family income on weight is that it is very likely that there are unobserved factors that affect both income and weight. Does income have a major direct causal impact on the determination of weight outcomes or does income act mostly a proxy for other factors that affect weight? In a recent paper, Schmeiser (2007) uses exogenous variation in family income produced by state-level and federal-level changes in the maximum Earned Income Tax Credit (EITC) benefit amount available to families to investigate the causal impact of income on weight for low-income adults. This study produces estimates that suggest that an increase in income leads to an increase in the Body Mass Index (BMI) values for low-income adults in the United States (Schmeiser, 2007).

The main objective of this paper is to examine the impact of household income on childhood weight outcomes for children in the United States using matched mother-child data from the National Longitudinal Survey of Youth (NLSY). In order to produce causal estimates, I adopt the instrumental variable (IV) strategy used in Dahl and Lochner (2005). One of the main sources of identification for this IV strategy is exogenous changes made to the federal income tax code. Section 2.1 provides background information on changes in the Earned Income Tax Credit (EITC) program that serve as an important source for exogenous changes in the federal income tax code. Section 2.2 examines the econometric model and instrumental variable framework. Section 2.3 describes the data used in this paper. Section 3 describes the results obtained and Section 4 concludes the paper.

2. METHODS

2.1 The Earned Income Tax Credit (EITC)

The Earned Income Tax Credit (EITC) started as a relatively modest anti-poverty program in 1975 and has since grown into the largest federally funded means-tested cash assistance program in the United States (Hotz and Schloz, 2003). The total real monetary amount of the refunded portion of the credit from the EITC program has increased from $3.08 billion (2003 dollars) in 1975 to $30.9 billion in 2003 (U.S. House of Representatives, 2004). The number of recipient families has also grown from 6.2 million in 1975 to 19.3 million in 2003 (U.S. House of Representatives, 2004). The real average credit per family has increased from $687 (2003 dollars) in 1975 to $1784 in 2003 (U.S. House of Representatives, 2004). The changes made to the EITC program are of specific interest to my analysis because they provide exogenous sources of variation in after-tax, after-transfer household income over the time period covered by my sample.

The EITC is a refundable tax credit for low-income working taxpayers and taxpayers apply for it through their income tax returns. The credit takes the form of a specified percentage (credit rate) of earned income up to a maximum amount. The maximum amount is applicable for earned incomes in a specified income range. The credit is then phased out to zero over a certain income range (phaseout range). The credit rates, phaseout rates and income ranges eligible for the credit have changed several times since the inception of the program in 1975 and have resulted in the expansion of the EITC program (U.S. House of Representatives, 2004). In 1987, the credit was indexed for inflation. In 1991, the EITC program was significantly expanded. The credit rate and the maximum credit were raised and the range of incomes eligible for the credit was increased significantly. Separate schedules were also established for families with one child and families with two or more children. Prior to 1991, families had faced the same EITC schedules regardless of the number of children in the family. Since 1991, families with two or more children have faced a more generous EITC schedule than families with fewer children. The EITC program was again extensively expanded in 1994, raising the credit rates, maximum credits and phaseout rates significantly (U.S. House of Representatives, 2004). Table I summarizes the main EITC parameters for the tax years that are applicable to the sample used in this paper.

[INSERT TABLE I HERE]

2.2 Econometric Model and Instrumental Variables Estimation Strategy

The econometric model and instrumental variables estimation strategy used in this paper are derived from Dahl and Lochner (2005). Dahl and Lochner (2005) looks at the impact of household income on the child's educational outcomes. The notation used below is also derived from the notation used in the Dahl and Lochner (2005) paper.

The relationship between the child *i*'s weight-related outcomes and family income in period *t* is represented by the following equation:

$$weight_{it} = \beta_0 + \beta_x X_i + \beta_w W_{it} + \theta I_{it} + \varepsilon_{it} \qquad (1)$$

where $weight_{it}$ represents the child's weight-related outcome, X_i consists of fixed characteristics that affect the child's weight, W_{it} represents time-varying characteristics that affect the child's weight and I_{it} is total after-tax and after-transfer household income.

I_{it} can be further decomposed into total pre-tax household income and net transfers:

$$I_{it} = PI_{it} + \tau_t^{s_{it}}\left(PI_{it}\right) \qquad (2)$$

where PI_{it} is total pre-tax household income in period *t* and $\tau_t^{s_{it}}\left(PI_{it}\right)$ represents net transfers under the federal tax code in period *t*. $\tau_t^{s_{it}}(\bullet)$ represents the federal tax function in period *t* and s_{it} denotes the federal tax schedule that is relevant for the child's family in period *t* based on family characteristics such as marital status and number of children in the household.[1]

Total pre-tax household income, PI_{it}, is in turn the sum of the different categories listed on the personal income tax forms such as wage and salary income (including self-

[1] The tax burdens in this paper are calculated using the TAXSIM interface on the NBER website (http://www.nber.org/taxsim).

employment income), non-taxable transfer income, unemployment compensation, other income and so on and can thus be denoted as

$$PI_{it} = \sum_{n=1}^{N} pi_{\text{int}} \quad (3)$$

where *n* indexes the components of pre-tax household income, *N* is the total number of pre-tax household income categories listed on the income tax forms that I have data for[2] and pi_{int} is the n^{th} component of pre-tax household income for child *i's* family in period *t*. In this paper, PI_{it} is constructed from the income that the mother and her spouse (if present in the household) receive from various sources such as wages, salaries, tips, business income, farm income, military income, unemployment income, interest income, educational benefits, veteran benefits, disability benefits, social security income, welfare, AFDC, alimony, child support and other sources.

The instrumental variable strategy used to estimate equation (1) is based on the approach used in Dahl and Lochner (2005) and relies on the fact that total after-tax, after-transfer household income is a function of family characteristics and the tax code. A subset (denoted as z_{it}) of the variables in X_i and W_{it} are exogenous variables that affect the components of pre-tax household income. This vector z_{it} consists of variables such as the mother's age, race, immigrant status, educational attainment at age 23 and AFQT percentile. As such, the *nth* pre-tax income component can be written as

$$pi_{\text{int}} = \gamma_{nt} z_{it} + \upsilon_{\text{int}} \qquad (4)$$

where γ_{nt} is allowed to vary over time and component.

[2] The components of N include wage and salary income (including self-employment income), non-taxable transfer income, unemployment compensation, other income. I set the values of the pre-tax household income categories listed on the income tax forms that I do not have information on to zero in order for the tax calculator in TAXSIM to be able to calculate the tax burdens.

Thus, total after-tax household income can be expressed as

$$I_{it} = \sum_{n=1}^{N} \left(\gamma_{nt} z_{it} + \upsilon_{\text{int}} \right) + \tau_t^{s_{it}} \left(\sum_{n=1}^{N} \left(\gamma_{nt} z_{it} + \upsilon_{\text{int}} \right) \right) \quad (5)$$

The procedure for constructing the instrumental variable for total after-tax, after-transfer household income is as follows. I first estimate each component of pre-tax household income as a function of the exogenous characteristics z_{it} (i.e. I estimate equation (4) for each of the *N* components of pre-tax household income) in order to obtain predicted values of each pre-tax income component ($\hat{pi}_{\text{int}} = \hat{\gamma}_{nt} z_{it}$) and predicted total pre-tax household income ($\hat{PI}_{it} = \sum_{n=1}^{N} \hat{\gamma}_{nt} z_{it}$). The construction of the instrumental variable in this paper differs from Dahl and Lochner (2005) in that I allow each of the *N* components of pre-tax income listed on the income tax forms to be determined differently by z_{it} while Dahl and Lochner (2005) allows only total pre-tax income to vary with z_{it}.[3] Using these predicted pre-tax income values, I then calculate the predicted net transfer $\tau_t^{s_{it}}(\hat{PI}_{it})$ using the tax schedule that the family faces in period *t*. Finally, I construct the predicted total after-tax, after-transfer household income $\hat{I}_{it}$ where $\hat{I}_{it} = \hat{PI}_{it} + \tau_t^{s_{it}}(\hat{PI}_{it})$. $\hat{I}_{it}$ is the instrumental variable used in this paper for I_{it}.

The constructed instrumental variable $\hat{I}_{it}$ is a function of the exogenous maternal characteristics and the exogenously determined federal tax code. As such, there are two main sources of identification. The first source of identification comes from changes in

[3] One of the reasons for this modification is that in order for me to calculate the tax burdens through the TAXSIM interface on the NBER website, I need to fill in the individual values for the various pre-tax household income categories listed on the TAXSIM interface.

returns to income sources attributable to various specific maternal characteristics that have occurred over the time period covered by the sample. The second source of identification comes from exogenous changes to the federal tax code. As noted in the previous section, the Earned Income Tax Credit (EITC) program underwent large, non-linear expansions at certain points in time over the time period covered by my sample. As such, changes in the EITC program serves as one of the main drivers of exogenous variation in the tax code.

2.3 Data and Sample Selection

This paper makes use of data from the public-use children files and adult files of the National Longitudinal Survey of Youth (NLSY). The National Longitudinal Survey of Youth (NLSY) was started in 1979 as a survey of American youths between the ages of 14 and 21. Starting in 1986, the NLSY administrators started collecting data on children born to mothers who were part of the NLSY 1979 cohort. Follow-up surveys on these children have been conducted once every two years since then. The data collected for the child can be matched up to data collected for the mother to create matched mother-child pairs. This paper makes use of the data available for the matched mother-child pairs from the data cycles collected starting in 1988 and ending in 2004.[4] The sample is restricted to children in each cycle who are: (1) over the age of two, (2) still eligible to be interviewed as children in the NLSY and (3) for whom weight status and household income are available.

[4] The relevant survey years are 1988, 1990, 1992, 1994, 1996, 1998, 2000, 2002 and 2004. Since the income data available is for the calendar year prior to the survey year, the tax years that are relevant for the sample used in this paper are 1987, 1989, 1991, 1993, 1995, 1997, 1999, 2001 and 2003.

The NLSY contains information on the heights and weights of the children surveyed in the children files. Their weights and heights are recorded in two ways: they are either actual measured values measured by the interviewer or they are estimates given by the mother. As such, indicator variables for whether the height is based on the mother's estimate and for whether the weight is based on the mother's estimate are included as covariates in the regressions to account for this discrepancy. From the heights and weights of the children, I can calculate their Body Mass Index (BMI) values. Based on the BMI values, I can determine whether a child is considered to be underweight, at-risk-of-overweight or obese by comparing the BMI of the child to the age and gender specific cutoffs from the Centers for Disease Control and Prevention (CDC). These cutoffs are percentile values from age and gender specific growth charts developed by the CDC based on data from five reference populations surveyed between 1963 and 1994 (Ogden *et al.* 2002b).[5] The cutoffs are available for children between the ages of 2 to 20 years. Children who have BMIs below the 5th percentile value are classified as being underweight. Children who have BMIs between the 85th and 95th percentile values are classified as being at-risk-of-overweight. Children who have BMIs higher than the 95th percentile values are classified as being obese. [6] Children who have BMIs between the 5th and 85th percentile values are classified as being in the medically healthy weight range.

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[5] The growth chart data can be found at: http://www.cdc.gov/nchs/about/major/nhanes/growthcharts/datafiles.htm

[6] The terminology used in this paper differs slightly from the terminology adopted by the Centres for Disease Control and Prevention (CDC). Due to the perceived stigma attached to the term "obese", the CDC has decided to avoid using "obese" to describe children. Instead, the CDC has adopted a terminology in which children whose BMIs are greater than the 95th percentiles are described as being "overweight". However, the 95th percentile cutoffs are considered to be comparable to cutoffs used to define childhood obesity in other systems of classification such as the International Obesity Task Force (IOTF) classification system.

The mothers are asked to provide detailed information on the amount of income that they and their spouses (if present in the household) receive from various different sources in the previous calendar year. These sources include wages, salaries, tips, business income, farm income, military income, unemployment income, interest income, educational benefits, veteran benefits, disability benefits, social security income, welfare, AFDC, alimony, child support and other sources. As such, it is possible to construct measures of pre-tax household income components and total pre-tax household income in the calendar year prior to the survey year from the sources available in the survey. The NLSY does not ask the respondents to report the amount of income taxes that they have paid. In order to calculate the federal income tax liabilities and EITC payments for the families in my sample, I make use of the TAXSIM program available from the NBER website.[7]

The NLSY also contains a wealth of information on other aspects related to the child. In particular, the NLSY contains data on the child's birthweight. Since weight at birth affects the child's future weight, birthweight is included as a control in my analysis. Studies from the medical literature also suggests that breastfeeding lowers the risk of childhood obesity (von Kries *et al.*, 1999, Gillman *et al.*, 2001, Armstrong *et al.*, 2002). As such, I include an indicator for whether the child was breastfed as a control in the regressions. Additional child demographic controls that are included in my analysis are the child's age, gender, race and birth order.

Studies have suggested that overweight parents are more likely to have overweight children (Whitaker *et al.*, 1997, Lake *et al.*, 1997). The NLSY contains

[7] The TAXSIM program can be found at http://www.nber.org/taxsim. For more information on the TAXSIM program, refer to Feenberg and Coutts (1993).

information on the mother's weight and height and I use this information to control for whether the mother is overweight and/or obese in the regressions.[8] I also control for other maternal characteristics such as the mother's educational attainment at age 23, AFQT percentile, age of the mother at the birth of the child, immigrant status, health status, marital status and an indicator for whether the mother lived with both biological parents at age 14.

In addition, family specific controls such as the number of children in the household, the number of adults in the household and an indicator for whether the area of residence is rural are also included as controls in my analysis.

3. RESULTS

3.1 Descriptive Statistics

Table II describes the EITC-related characteristics of the sample for each survey year. Given the sampling design of the NLSY, it is not surprising that average household pre-tax income increases steadily throughout the sample period as a reflection of the mothers progressing through their lifecycles. The changes in the number of children meeting the sample selection requirements over the sample period also reflect the lifecycle progressions of the mothers. The number of children increases initially because the mothers are young mothers in the early survey years and are still giving birth to new children who enter the NLSY survey. The number of children eligible eventually decreases as the children grow older and start to move out of the mother's household. Since average pre-tax household income is steadily increasing throughout the sample period, it is not entirely surprising that the proportion of households eligible for the EITC

[8] The NLSY does not contain information on the father's weight and height.

actually falls in the later years of the sample period even though there were expansions in the EITC program happening simultaneously. However, for families that are eligible for the EITC, the magnitude of the average real EITC payment increases up till the tax year of 1999. The figures suggest that the changes made to the EITC program have created variation in the magnitude of the average EITC payment between survey years. Because of the expansion of the EITC program in the 1991 tax year, the average EITC payment for eligible families in the sample jumps from $706 (2003 dollars) in the 1989 tax year to $936 (2003 dollars) in the 1991 tax year, a difference of $230. The even more generous expansion of the EITC program in the 1994 tax year leads to an even larger increase in the average EITC payment for eligible families post expansion. In the last cycle prior to the 1994 expansion, the average EITC payment for eligible families in the sample is $1084 (2003 dollars). In the first cycle after the 1994 expansion, the average EITC payment for eligible families has increased to $1813 (2003 dollars).

[INSERT TABLE II HERE]

Table III summarizes the main characteristics of the sample used in this paper. A comparison of the characteristics of the children from the low-income, EITC-eligible families with the characteristics of the children from the higher-income families suggests that there are differences between the two groups outside of weight outcomes and family income. Children from the low-income families are more likely to be at-risk-of-overweight or obese than children from the higher-income families. 31.2% of the children from the low-income, EITC-eligible families are at-risk-of-overweight or obese compared to 28% of the children from the higher-income families. On the other hand, there is no difference in the proportion of children who are underweight between the two sub-samples. Children in the low-income sub-sample are much more likely to be Black than children in the higher-income sub-sample. They are also more likely to be Hispanic. Children from low-income families are also more likely to be born with low birthweight and are less likely to be breastfed as infants.

[INSERT TABLE III HERE]

There are also several significant differences between the mothers of the children in the two sub-samples. The mothers in the low-income sub-sample are much less likely to be married and have a spouse present in the household compared to the mothers in the higher-income sub-sample. They also tend to be younger at the birth of the child. One of the things to note is that the mothers in the low-income sub-sample are more likely to be overweight or obese than mothers in the higher-income sub-sample. 50.3% of the mothers in the low-income sub-sample are overweight or obese compared to 44.6% of the mothers in the higher-income sub-sample.

One factor that might affect both the child's weight and household income is the mother's human capital. Mothers with high human capital are likely to earn higher wages. They might also provide better care for their children. If mothers with high human capital tend to be better informed on healthy nutritional practices and childhood activities, then the children of mothers with high human capital will be more likely to be within the healthy weight range. As such, maternal human capital should be accounted for when looking at the relationship between childhood weight and household income. In the NLSY, maternal educational attainment at age 23 and maternal AFQT score are available and can serve as proxies for maternal human capital. The figures presented in Table III suggest that there are significant differences in maternal educational attainment at age 23 and maternal AFQT score between mothers in the two sub-samples. Mothers in the low-income sub-sample have much lower AFQT scores and are also much less likely to be educated beyond high school at age 23 compared to mothers in the higher-income sub-sample.

3.2 OLS Estimates

The results from the OLS specifications are summarized in Table IV.[9] In the basic OLS specification where additional child, household and maternal variables are not included as regressors, a $10000 increase in household income is associated with a 0.93-percentage-point increase in the likelihood that the child is in the medically healthy weight range This correlation is statistically significant at the 1% level.[10] However, once the additional child, household and maternal controls are included in the full OLS specification, the magnitude of the estimated coefficient on household income falls considerably and the estimated coefficient is statistically significant only at the 10% level. In the full OLS specification, a $10000 increase in household income is associated with a 0.26-percentage-point increase in the probability that the child is in the medically healthy weight range. The decrease in statistical significance and magnitude of the estimated coefficient on household income is not surprising since many of the additional household and maternal variables potentially affect both household income and child weight status.

[INSERT TABLE IV HERE]

[9] The equations of interest were also estimated using logit and probit. The results from the logit and probit regressions are similar to those from the OLS regressions and are available upon request. Since one of the objectives of this paper is to report fixed effects (FE) and fixed effects instrumental variables (FEIV) estimates, I chose to implement a linear probability model instead of logit or probit. This decision was made because fixed effects estimators of nonlinear panel models are known to have the potential to be severely biased (for an overview, see Greene, 2004).

[10] The standard errors in all regressions are clustered by family because there are multiple observations per family.

Since household income is positively correlated with the likelihood of the child being in the medically healthy weight range, the next question to ask is: At which end is the correlation coming from? Are children from higher-income families more likely to be in the medically healthy weight range because they are less likely to be underweight? Or is it because children from higher-income families are less likely to be at-risk-of-overweight or obese? In order to answer this question, I also estimate regressions where the weight outcomes are the underweight indicator, the at-risk-of-overweight indicator and the obese indicator respectively. The OLS results for these specifications are summarized in the remaining columns of Table IV.

In the OLS regressions where the dependent variable is the underweight indicator, the estimated coefficients on household income are not statistically significant. This is perhaps not surprising because the proportions of underweight children are roughly the same for both the low-income and higher-income sub-samples.

In the basic OLS specification for the regressions where the outcome variable is the at-risk-of-overweight indicator, total after-tax household income is negatively associated with the probability that the child is at-risk-of-overweight. However, once the additional child, household and maternal variables are added as controls, the estimated coefficient on household income is no longer statistically significant.

For the OLS specifications where the outcome variable is the obese indicator, the estimated coefficients on total household income are always negative and statistically significant. Similar to the set of regressions where the outcome variable is the healthy weight indicator, the inclusion of additional child, household and maternal variables as controls in the full specification reduces the absolute magnitude and statistical significance of the estimated coefficient on total household income. In the OLS specification with the full set of controls, a $10000 increase in household income is associated with a 0.20-percentage-point decrease in the likelihood that the child is obese.

Overall, the OLS results provide some evidence to suggest that an increase in household income is associated with an increase in the likelihood that the child is in the medically healthy weight range and a decrease in the likelihood that the child is obese. However, the inclusion of additional child, household and maternal variables as controls does decrease the absolute magnitudes and the levels of statistical significance of the estimated coefficients on total household income. This suggests that household income might be mostly a proxy for other unobserved characteristics that affect the child's weight status rather than having a major direct causative impact on the child's weight status itself.

3.3 Instrumental Variable (IV) Estimates

Table V summarizes the results from the IV specifications where predicted total after-tax, after-transfer household income acts as an instrument for actual total after-tax, after-transfer household income. The first-stage regressions suggest that predicted total after-tax household income is a strong predictor of actual total after-tax household income (see Appendix Table I).

[INSERT TABLE V HERE]

In the basic IV specification where additional child, household and maternal variables are not included as regressors, total after-tax, after-transfer household income has a positive correlation with the likelihood that the child is in the medically healthy weight range and the estimated coefficient on household income is statistically significant at the 1% level. The magnitude of the IV estimate in the basic IV specification is also larger than the corresponding OLS estimate. However, after the additional child, household and maternal variables are added as controls, the estimated coefficient on total household income becomes negative and statistically insignificant. For the specifications where the dependent variable is the underweight indicator, the IV estimates of the coefficient on total household income are not statistically significant. This is similar to the OLS results obtained for the underweight regressions. Similarly, for the specifications where the dependent variable is the at-risk-of-overweight indicator, the IV estimates of the coefficient on total household income are not statistically significant.

In the basic IV specification where the dependent variable is the obese indicator and where additional child, household and maternal variables are not included as controls, the estimated coefficient on household income is negative and statistically significant at the 1% level. However, once the additional child, household and maternal variables are included as controls, the IV estimate of the coefficient on total household income becomes positive and statistically insignificant.

To summarize, the IV estimates of the coefficients on total household income are not statistically significant in the specifications with the full set of controls for all of the weight-related indicators studied. This might suggest that household income acts mostly as a proxy for other characteristics that determine the child's weight rather than household income playing a major direct causative role in the determination of the child's weight.

3.4 Household Fixed Effects (FE) Estimates

Table VI summarizes the results from the household fixed effects (FE) specifications. Although the household fixed effects estimates of the coefficients on household income generally have the same signs as the corresponding OLS estimates, they are not statistically significant for any of the weight indicators being studied. This might be further evidence to suggest that household income is acting mainly as a proxy for unobserved characteristics that affect the child's weight rather than acting as a major causative agent that directly affects the child weight.

[INSERT TABLE VI HERE]

3.5 Household Fixed Effects Instrumental Variable (FEIV) Estimates

Table VII summarizes the household fixed effects instrumental variable (FEIV) results. The first-stage regressions for the FEIV model suggest that predicted total after-tax household income is a strong predictor of actual total after-tax household income (see Appendix Table II).

[INSERT TABLE VII HERE]

Similar to the household fixed effects estimates presented in the previous sub-section, the FEIV estimates of the coefficients on household income are never statistically significant for any of the weight indicators being studied. This provides more evidence that household income might be mainly a proxy for unobserved characteristics that determine the child's weight rather than being a major causative agent in the determination of the child's weight.

4. DISCUSSION

This paper has attempted to examine the impact of family income on childhood weight for children in the United States. The descriptive statistics support the common perception that the prevalence of childhood obesity is higher in low-income families than in higher-income families in the United States. However, when examined together, the results from the various different estimation procedures suggest that household income might act primarily as a proxy for other characteristics that determine the child's weight, rather having a major direct causative role in determining the child's weight.

The OLS results provide some evidence to suggest that an increase in household income is associated with an increase in the likelihood that the child is in the medically healthy weight range and that this correlation is mostly due to the observation that children from higher-income families in the sample are less likely to be obese. However, the inclusion of additional child, household and maternal variables as controls in the OLS specifications does decrease the absolute magnitudes and levels of statistical significance of the estimated coefficients on total household income, raising the possibility that household income might be acting mainly as a proxy for unobserved variables that affect both income and the child's weight.

In order to account for unobserved family characteristics that might affect both family income and the child's weight status, instrumental variable (IV) models, household fixed effects (FE) models and household fixed effects instrumental variable (FEIV) models are also estimated. The IV estimates of the coefficients on total household income are not statistically significant in the specifications with the full set of controls for all of the weight-related indicators studied. The household fixed effects estimates and the

FEIV estimates of the coefficients on household income are never statistically significant for any of the weight indicators studied. Thus, when examined together, the results from the various estimation procedures seem to suggest that household income might be acting primarily as a proxy for other characteristics that determine the child's weight rather than having a major direct causative impact in determining the child's weight.

This paper presents a preliminary attempt to examine the causal impact of household income on childhood weight. Many questions about the relationships between socio-economic factors and the childhood obesity epidemic remain to be answered through future research.

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Ethics Statement: The research undertaken in this paper does not involve experiments performed on identifiable human test subjects or animal test subjects.

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Table I: Earned Income Credit Parameters (Monetary values are nominal values unless otherwise stated)

Calendar (tax) year	Credit rate (percent)	Minimum income for maximum credit	Maximum credit	Phaseout rate
1987	14.00	$6,080	$851	10.00
1989	14.00	6500	910	10.00
1991				
One child	16.70	7140	1192	11.93
Two children	17.30	7140	1235	12.36
1993				
One child	18.50	7750	1434	13.21
Two children	19.50	7750	1511	13.93
1995				
No children	7.65	4100	314	7.65
One child	34.00	6160	2094	15.98
Two children	36.00	8640	3110	20.22
1997				
No children	7.65	4340	332	7.65
One child	34.00	6500	2210	15.98
Two children	40.00	9140	3656	21.06
1999				
No children	7.65	4530	353	7.65
One child	34.00	6800	2312	15.98
Two children	40.00	9540	3816	21.06
2001				
No children	7.65	4760	364	7.65
One child	34.00	7140	2428	15.98
Two children	40.00	10020	4008	21.06
2003				
No children	7.65	4990	382	7.65
One child	34.00	7490	2537	15.98
Two children	40.00	10510	4204	21.06

Source: U.S. House of Representatives (2004)

Table II: Summary of EITC-related Characteristics for Sample

Survey year	Tax year	Number of children	Average pre-tax income (2003 dollars)	Fraction eligible for EITC	Mean EITC payment if eligible (2003 dollars)
1988	1987	3958	38731.61	0.26	649.72
1990	1989	3698	45782.63	0.26	706.49
1992	1991	4100	48244.37	0.25	936.16
1994	1993	3701	54150.91	0.23	1084.22
1996	1995	3390	63254.95	0.22	1813.41
1998	1997	3018	67497.98	0.20	2068.62
2000	1999	2161	74175.52	0.19	2358.15
2002	2001	2074	86748.45	0.16	2009.66
2004	2003	1704	89400.21	0.13	1905.54

Note: Weighted with child sampling weights.

Table III: Descriptive Statistics for Sample

	[1] Full sample	[2] Eligible for EITC	[3] Ineligible for EITC	[4] [2]-[3]
Main variables:				
Child is at-risk-of-overweight or obese	0.287	0.312	0.280	0.032
Child is at-risk-of-overweight	0.141	0.150	0.138	0.012
Child is obese	0.146	0.161	0.142	0.019
Child is underweight	0.099	0.099	0.099	0.000
Pre-tax income (2003 dollars)	60821.790	19182.580	72417.290	-53234.710
After-tax income (2003 dollars)	52858.080	20187.890	61955.920	-41768.030
Child variables:				
Age of child (years)	8.565	9.054	8.429	0.625
Child is male	0.513	0.507	0.514	-0.008
Child is Black	0.146	0.264	0.113	0.152
Child is Hispanic	0.068	0.087	0.063	0.024
Child is firstborn	0.423	0.388	0.433	-0.044
Birthweight (ounces)	118.767	115.235	119.762	-4.527
Low birthweight (birthweight<5.5 lbs)	0.071	0.091	0.066	0.025
Child was breastfed	0.550	0.407	0.590	-0.183
Mother variables:				
Age of mother at birth	26.116	24.561	26.549	-1.988
Current age of mother	34.663	33.594	34.961	-1.367
Mother is overweight or obese	0.458	0.503	0.446	0.057
Mother is obese	0.203	0.259	0.187	0.071
Mother has health limitations	0.064	0.081	0.059	0.023
Mother's AFQT percentile	46.630	32.128	50.669	-18.541
Mother is an immigrant	0.040	0.043	0.039	0.004
Mother lived with both parents at age 14	0.728	0.623	0.757	-0.134
Mother is married	0.716	0.332	0.822	-0.490
Mother's education at age 23:				0.000
Less than high school	0.145	0.252	0.116	0.136
High school graduate	0.482	0.568	0.458	0.110
Some college	0.217	0.159	0.234	-0.075
College graduate	0.155	0.021	0.193	-0.171
				0.000
Family variables:				0.000
Number of children	2.496	2.516	2.496	0.020
Number of adults in household	2.200	1.880	2.200	-0.321
Area of residence is rural	0.285	0.293	0.285	0.009
Number of observations	27804	7498	20306	

Note: Weighted with child sampling weights.

Table IV: OLS Estimates

	Healthy Weight [Basic]	Healthy Weight [Full]	Underweight [Basic]	Underweight [Full]	At-Risk-of-Overweight [Basic]	At-Risk-of-Overweight [Full]	Obese [Basic]	Obese [Full]
After-tax income ($10000)	0.00928	0.00261	-0.00047	-0.00076	-0.00134	0.0001	-0.0075	-0.00195
	[8.05]**	[1.82]+	[0.67]	[0.89]	[1.75]+	[0.10]	[8.23]**	[1.81]+
Mother's education: High school		0.0101		0.01543		-0.01036		-0.01517
		[0.58]		[1.79]+		[0.95]		[1.10]
Mother's education: Some college		0.01896		0.00883		-0.01678		-0.01101
		[0.90]		[0.76]		[1.26]		[0.67]
Mother's education: College graduate		0.06273		0.00589		-0.01592		-0.0527
		[2.32]*		[0.37]		[0.87]		[2.65]**
Mother's AFQT percentile		0.00073		-0.00004		-0.0001		-0.0006
		[2.52]*		[0.24]		[0.55]		[2.56]*
Constant	0.57589	0.61141	0.13369	0.32902	0.11094	0.06602	0.17948	-0.00644
	[22.34]**	[7.49]**	[7.59]**	[6.40]**	[6.71]**	[1.24]	[9.04]**	[0.10]
Observations	27650	23430	27650	23430	27650	23430	27650	23430

Robust t statistics in brackets. Regressions are weighted with child sampling weights.

All specifications are estimated with year fixed effects and with dummies for the child's age, gender and region of residence.

The full set of controls also includes the child's birthweight, a dummy for low birthweight, a dummy for whether the child was breastfed, the number of adults in the household, number of children, age of mother at birth of child, dummy for firstborn status, dummies for the child's race, dummies for the mother having health limitations, for the mother being an immigrant, for the mother being married, for the mother being overweight or obese, for the mother living with both parents at age 14 and a dummy for the area of residence being rural.

+ significant at 10%; * significant at 5%; ** significant at 1%

Table V: Instrumental Variables (IV) Estimates

	Healthy Weight [Basic]	Healthy Weight [Full]	Underweight [Basic]	Underweight [Full]	At-Risk-of-Overweight [Basic]	At-Risk-of-Overweight [Full]	Obese [Basic]	Obese [Full]
After-tax income ($10000)	0.02728	-0.00471	-0.00179	0.00177	-0.00258	0.00101	-0.02291	0.00192
	[9.85]**	[0.26]	[1.17]	[0.16]	[1.50]	[0.08]	[10.50]**	[0.15]
Mother's education: High school		0.01144		0.01497		-0.01053		-0.01587
		[0.65]		[1.71]+		[0.94]		[1.14]
Mother's education: Some college		0.02479		0.00681		-0.01751		-0.0141
		[0.98]		[0.47]		[1.06]		[0.73]
Mother's education: College graduate		0.08046		-0.00025		-0.01814		-0.06207
		[1.58]		[0.01]		[0.53]		[1.71]+
Mother's AFQT percentile		0.00088		-0.00009		-0.00012		-0.00066
		[1.94]+		[0.31]		[0.40]		[1.98]*
Constant	0.48819	0.6017	0.14017	0.33238	0.11701	0.06723	0.25463	-0.00131
	[17.19]**	[7.09]**	[7.54]**	[6.24]**	[6.61]**	[1.20]	[11.28]**	[0.02]
Observations	27650	23430	27650	23430	27650	23430	27650	23430

Robust t statistics in brackets. Regressions are weighted with child sampling weights.
All specifications are estimated with year fixed effects and with dummies for the child's age, gender and region of residence.
The full set of controls also includes the child's birthweight, a dummy for low birthweight, a dummy for whether the child was breastfed, the number of adults in the household, number of children, age of mother at birth of child, dummy for firstborn status, dummies for the child's race, dummies for the mother having health limitations, for the mother being an immigrant, for the mother being married, for the mother being overweight or obese, for the mother living with both parents at age 14 and a dummy for the area of residence being rural.
+ significant at 10%; * significant at 5%; ** significant at 1%

Table VI: Household Fixed Effects (FE) Estimates

	Healthy Weight [Basic]	Healthy Weight [Full]	Underweight [Basic]	Underweight [Full]	At-Risk-of-Overweight [Basic]	At-Risk-of-Overweight [Full]	Obese [Basic]	Obese [Full]
After-tax income ($10000)	0.00218	0.00174	-0.00082	-0.00007	-0.00053	0.00011	-0.0008	-0.00177
	[1.34]	[0.91]	[0.82]	[0.06]	[0.46]	[0.08]	[0.72]	[1.35]
Constant	0.54833	0.497	0.13214	0.29064	0.1758	0.41658	0.14373	-0.20422
	[12.97]**	[1.79]+	[5.38]**	[1.79]+	[5.69]**	[1.99]*	[5.15]**	[1.12]
Observations	27650	23430	27650	23430	27650	23430	27650	23430

Robust t statistics in brackets. Regressions are weighted with child sampling weights.
All specifications are estimated with year fixed effects and with dummies for the child's age, gender and region of residence.
The full set of controls also includes the child's birthweight, a dummy for low birthweight, a dummy for whether the child was breastfed, the number of adults in the household, number of children, age of mother at birth of child, dummy for firstborn status, dummies for the child's race, dummies for the mother having health limitations, for the mother being an immigrant, for the mother being married, for the mother being overweight or obese, for the mother living with both parents at age 14 and a dummy for the area of residence being rural.
+ significant at 10%; * significant at 5%; ** significant at 1%

Table VII: Household Fixed Effects Instrumental Variable (FEIV) Estimates

	Healthy Weight [Basic]	Healthy Weight [Full]	Underweight [Basic]	Underweight [Full]	At-Risk-of-Overweight [Basic]	At-Risk-of-Overweight [Full]	Obese [Basic]	Obese [Full]
After-tax income ($10000)	-0.00497	-0.04481	-0.00637	-0.00659	0.00445	0.01955	0.00689	0.03185
	[0.30]	[1.22]	[0.62]	[0.29]	[0.37]	[0.72]	[0.59]	[1.22]
Constant	0.55516	0.79119	0.16817	0.44161	0.12806	0.19598	0.14862	-0.44382
	[6.56]**	[0.00]	[3.17]**	[0.00]	[2.04]*	[0.00]	[2.44]*	[0.00]
Observations	27650	23430	27650	23430	27650	23430	27650	23430

Robust t statistics in brackets.
All specifications are estimated with year fixed effects and with dummies for the child's age, gender and region of residence.
The full set of controls also includes the child's birthweight, a dummy for low birthweight, a dummy for whether the child was breastfed, the number of adults in the household, number of children, age of mother at birth of child, dummy for firstborn status, dummies for the child's race, dummies for the mother having health limitations, for the mother being an immigrant, for the mother being married, for the mother being overweight or obese, for the mother living with both parents at age 14 and a dummy for the area of residence being rural.
+ significant at 10%; * significant at 5%; ** significant at 1%

Appendix Table I: First Stage Regressions for Cross-Sectional IV Strategy

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
	Income	**Income**	**Income**	**Income**	**Income**	**Income**	**Income**	**Income**	**Income**	**Income**	**Income**
Predicted after-tax income	0.95153	0.86833	0.84126	0.80955	0.79065	0.78863	0.7386	0.80587	0.82117	0.8175	0.42619
	[19.65]**	[15.44]**	[15.14]**	[14.66]**	[14.66]**	[14.67]**	[10.03]**	[10.11]**	[10.18]**	[10.16]**	[5.48]**
Child is male	-0.01259	-0.03388	-0.0397	-0.04368	-0.05487	-0.04887	-0.0526	-0.05213	-0.05256	-0.05262	-0.06393
	[0.15]	[0.41]	[0.48]	[0.53]	[0.68]	[0.60]	[0.65]	[0.64]	[0.65]	[0.65]	[0.83]
Child is Black		-0.43691	-0.50675	-0.51897	-0.36684	-0.40247	-0.48917	-0.45332	-0.43815	-0.38138	0.14237
		[3.23]**	[3.51]**	[3.60]**	[2.50]*	[2.72]**	[2.80]**	[2.71]**	[2.62]**	[2.23]*	[0.91]
Child is Hispanic		0.00947	-0.16699	-0.17553	-0.08285	-0.09095	-0.13671	-0.14712	-0.07603	-0.06847	0.09306
		[0.06]	[1.01]	[1.06]	[0.50]	[0.55]	[0.80]	[0.85]	[0.43]	[0.39]	[0.56]
Child is firstborn		0.19215	0.27403	0.36225	0.37325	0.3627	0.35662	0.35666	0.35779	0.35271	0.23788
		[2.33]*	[3.76]**	[4.61]**	[4.79]**	[4.70]**	[4.59]**	[4.60]**	[4.61]**	[4.55]**	[3.18]**
Birthweight (ounces)		0.00123	0.00086	0.00109	0.00348	0.00366	0.00381	0.00384	0.00393	0.00387	0.00088
		[0.39]	[0.27]	[0.35]	[1.11]	[1.15]	[1.20]	[1.20]	[1.23]	[1.21]	[0.29]
Low birthweight		-0.20582	-0.22785	-0.2389	-0.18296	-0.12711	-0.12467	-0.126	-0.12299	-0.14189	-0.1389
		[0.81]	[0.89]	[0.93]	[0.73]	[0.49]	[0.48]	[0.48]	[0.47]	[0.54]	[0.55]
Child was breastfed		0.28428	0.26056	0.25329	0.21673	0.21606	0.21992	0.22806	0.2322	0.23476	0.15566
		[1.98]*	[1.83]+	[1.79]+	[1.53]	[1.51]	[1.56]	[1.60]	[1.63]	[1.65]+	[1.13]
Number of adults in household			0.61727	0.61549	0.62363	0.61371	0.61967	0.61516	0.61844	0.61249	0.06758
			[7.59]**	[7.66]**	[7.76]**	[7.40]**	[7.49]**	[7.48]**	[7.48]**	[7.41]**	[0.98]
Number of children			0.05945	0.06786	0.08539	0.10388	0.1025	0.09738	0.09644	0.09756	0.06175
			[0.91]	[1.03]	[1.31]	[1.56]	[1.52]	[1.45]	[1.44]	[1.46]	[0.93]
Area of residence is rural			-0.46951	-0.46071	-0.43697	-0.47114	-0.47057	-0.47297	-0.48344	-0.48423	-0.54667
			[3.43]**	[3.38]**	[3.26]**	[3.49]**	[3.49]**	[3.52]**	[3.59]**	[3.60]**	[4.18]**
Age of mother at birth				0.09112	0.09003	0.09413	0.0973	0.09764	0.09776	0.09495	0.08232
				[2.66]**	[2.64]**	[2.86]**	[2.97]**	[2.98]**	[2.98]**	[2.88]**	[2.60]**
Mother is overweight or obese					-0.39868	-0.36869	-0.36463	-0.3662	-0.36869	-0.37295	-0.38872
					[2.37]*	[2.14]*	[2.13]*	[2.14]*	[2.15]*	[2.18]*	[2.29]*
Mother is obese					-0.57547	-0.58867	-0.58982	-0.58782	-0.58794	-0.58655	-0.54687
					[3.77]**	[3.83]**	[3.84]**	[3.83]**	[3.83]**	[3.84]**	[3.65]**

Mother has health limitations						-0.82607	-0.83163	-0.83116	-0.83003	-0.82618	-0.62538
						[4.70]**	[4.71]**	[4.71]**	[4.70]**	[4.70]**	[3.86]**
Mother's education: High school							-0.07036	-0.09854	-0.11814	-0.14218	-0.12092
							[0.45]	[0.65]	[0.77]	[0.91]	[0.84]
Mother's education: Some college							0.06204	-0.01076	-0.03955	-0.07402	0.09151
							[0.22]	[0.04]	[0.15]	[0.28]	[0.36]
Mother's education: College graduate							0.26328	0.07759	0.01673	-0.01015	0.87028
							[0.60]	[0.19]	[0.04]	[0.02]	[2.15]*
Mother's AFQT percentile								-0.00355	-0.00416	-0.00423	0.00608
								[0.89]	[1.05]	[1.06]	[1.65]+
Mother is an immigrant									-0.44279	-0.46635	-0.50283
									[1.69]+	[1.79]+	[2.12]*
Mother lived with both parents at age 14										0.21168	0.05496
										[1.54]	[0.43]
Mother is married											2.78176
											[27.04]**
Constant	0.75958	1.00964	-0.09513	-2.37596	-2.43102	-2.51123	-2.39539	-2.45529	-2.4783	-2.49474	-1.56922
	[2.30]*	[2.08]*	[0.18]	[2.36]*	[2.44]*	[2.60]**	[2.52]*	[2.58]**	[2.60]**	[2.63]**	[1.73]+
Observations	27650	25068	24524	24524	24524	23481	23481	23481	23481	23430	23430
R-squared	0.31	0.31	0.32	0.32	0.33	0.33	0.33	0.33	0.33	0.33	0.39

Robust t statistics in brackets. Regressions are weighted with child sampling weights.

All specifications are estimated with year fixed effects and with dummies for the child's age, gender and region of residence.

+ significant at 10%; * significant at 5%; ** significant at 1%

Appendix Table II: First Stage Regressions for FEIV Strategy

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
	Income	**Income**	**Income**	**Income**	**Income**	**Income**	**Income**	**Income**	**Income**	**Income**	**Income**
Predicted after-tax income	0.37322	0.33639	0.28915	0.28914	0.28883	0.28551	0.28551	0.28551	0.28551	0.2843	0.18325
	[14.20]**	[12.42]**	[10.42]**	[10.42]**	[10.41]**	[10.01]**	[10.01]**	[10.01]**	[10.01]**	[9.96]**	[6.69]**
Child is male	-0.00617	0.00233	0.00573	0.00574	0.00545	0.00559	0.00559	0.00559	0.00559	0.0058	-0.00772
	[0.20]	[0.07]	[0.17]	[0.17]	[0.16]	[0.16]	[0.16]	[0.16]	[0.16]	[0.17]	[0.23]
Child is firstborn		-0.03789	-0.06263	-0.06283	-0.06309	-0.05675	-0.05675	-0.05675	-0.05675	-0.05588	-0.08408
		[0.94]	[1.53]	[1.54]	[1.54]	[1.35]	[1.35]	[1.35]	[1.35]	[1.33]	[2.09]*
Birthweight (ounces)		-0.00043	-0.00026	-0.00026	-0.00026	-0.00038	-0.00038	-0.00038	-0.00038	-0.00039	-0.00018
		[0.33]	[0.20]	[0.20]	[0.20]	[0.28]	[0.28]	[0.28]	[0.28]	[0.29]	[0.14]
Low birthweight		-0.03399	-0.03875	-0.03863	-0.03945	-0.0312	-0.0312	-0.0312	-0.0312	-0.03148	-0.03469
		[0.39]	[0.44]	[0.44]	[0.44]	[0.34]	[0.34]	[0.34]	[0.34]	[0.34]	[0.39]
Child was breastfed		0.09123	0.0723	0.07235	0.07098	0.07968	0.07968	0.07968	0.07968	0.08052	0.04129
		[1.57]	[1.23]	[1.23]	[1.21]	[1.31]	[1.31]	[1.31]	[1.31]	[1.33]	[0.71]
Number of adults in household			0.32804	0.32805	0.32657	0.33512	0.33512	0.33512	0.33512	0.33483	0.09258
			[14.40]**	[14.40]**	[14.33]**	[14.21]**	[14.21]**	[14.21]**	[14.21]**	[14.18]**	[3.98]**
Number of children			0.13951	0.13949	0.14027	0.16437	0.16437	0.16437	0.16437	0.16399	0.12684
			[5.24]**	[5.24]**	[5.27]**	[5.88]**	[5.88]**	[5.88]**	[5.88]**	[5.86]**	[4.73]**
Area of residence is rural			-0.05391	-0.05387	-0.05379	-0.07323	-0.07323	-0.07323	-0.07323	-0.07294	-0.11183
			[0.95]	[0.95]	[0.95]	[1.26]	[1.26]	[1.26]	[1.26]	[1.25]	[2.00]*
Age of mother at birth				-0.00329	-0.00282	0.00085	0.00085	0.00085	0.00085	0.00113	0.0015
				[0.09]	[0.08]	[0.02]	[0.02]	[0.02]	[0.02]	[0.03]	[0.04]
Mother is overweight or obese					0.15668	0.14881	0.14881	0.14881	0.14881	0.14269	0.0434
					[3.06]**	[2.80]**	[2.80]**	[2.80]**	[2.80]**	[2.68]**	[0.85]
Mother is obese					0.03241	0.00276	0.00276	0.00276	0.00276	0.00519	-0.10194
					[0.55]	[0.05]	[0.05]	[0.05]	[0.05]	[0.08]	[1.73]+
Mother has health limitations						-0.05692	-0.05692	-0.05692	-0.05692	-0.05671	-0.02659
						[0.78]	[0.78]	[0.78]	[0.78]	[0.78]	[0.38]
Mother is married											2.39849
											[43.26]**

Constant	3.34065	3.50348	2.76583	2.84827	2.77804	2.74829	2.74829	3.04814	3.04814	2.98317	1.61597
	[18.46]**	[14.28]**	[10.64]**	[2.94]**	[2.87]**	[2.76]**	[2.76]**	[0.00]	[0.00]	[0.00]	[0.00]
Observations	27650	25068	24524	24524	24524	23481	23481	23481	23481	23430	23430
R-squared	0.78	0.77	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.8

Robust t statistics in brackets. Regressions are weighted with child sampling weights.

All specifications are estimated with year fixed effects and with dummies for the child's age, gender and region of residence.

+ significant at 10%; * significant at 5%; ** significant at 1%