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ABSTRACT

Partial Insurance and Investments in Children*

This paper studies the impact of permanent and transitory shocks to income on parental investments in children. We use panel data on family income, and an index of investments in children in time and goods, from the Children of the National Longitudinal Survey of Youth. Consistent with the literature focusing on non-durable expenditure, we find that there is only partial insurance of parental investments against permanent income shocks, but the magnitude of the estimated responses is small. We cannot reject the hypothesis full insurance against temporary shocks. Another interpretation of our findings is that there is very little insurance available, but the fact that skill is a non-separable function of parental investments over time results in small reactions of these investments to income shocks, especially at later ages.

JEL Classification: D12, D91, I30, J1

Keywords: insurance, human capital, consumption

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1 Introduction

According to the National Center for Children in Poverty at Columbia University, 15 million children in the United States live in families with incomes below the federal poverty line. This means that more than one in every five children is poor. In the United Kingdom, the Office of National Statistics puts the number of children in poverty at 2.3 million (or 18% of all children). Child poverty is at the center of the debate about social policy, and the main reason is that growing up in poverty is strongly associated with future disadvantage.

For many families poverty is not a permanent condition, and we need to distinguish episodic from the much more severe permanent poverty (e.g., Duncan and Brooks-Gunn, 1997). For those experiencing permanent poverty the question is how to address the structural problems behind their permanent condition. But for those going in and out of poverty, a relevant issue is how well they can insure against fluctuations in income. This is especially true because the timing of investments in children could be as important as the total amount invested (e.g., Duncan and Brooks-Gunn, 1997, Cunha, Heckman and Schennach, 2010, Carneiro, Garcia, Salvanes and Tominey, 2014).

Our paper measures the reaction of parental investments in children in time and goods to permanent and transitory income shocks. To construct these measures we use panel data on family income and measures of investments in children from the Children of the National Longitudinal Survey of Youth (CNLSY). We find that parental inputs respond to permanent income shocks, but we cannot reject the hypothesis that they do not respond to temporary income shocks. The estimated response to permanent shocks is smaller in magnitude than some estimates of the response of household consumption to permanent shocks (Blundell, Pistaferri and Preston, 2008). A permanent shock corresponding to 10% of income leads to an increase in parental investments by 2% of a standard deviation of the distribution of parental investments for children who are less than 8 years of age.

When we allow the parents' reaction to vary with the age of the child we find that permanent income shocks have statistically significant effects only on inputs of children between ages 0 and 7. In addition, we only reject the null of no effects of permanent shocks for the sample of non-college mothers, who are likely to be more disadvantaged. With our data, we are not able to say whether the lack of response to income shocks at later ages is due to the household's ability to insure, or due to non-separabilities in the production function of skill, since our estimates of models including shocks in multiple time periods are quite imprecise.

We also note that parental inputs include time and goods, and it is important to account for the interaction between different inputs in empirical applications. Our reliance on indices which represent time and goods in this paper highlights an important data limitation: the lack of panels which includes simultaneously family income, time diaries (focusing also on parent-child interactions) and detailed family expenditures.[1]

The role of partial insurance in explaining the relationship between consumption and income inequality is well studied in the literature.[2] However, the addition of parental investments in children to the standard life-cycle model poses new challenges, because investment decisions have important dynamic implications. Forward-looking parents anticipate the effects of current and future spending in time and money on their children's adult behaviors and human capital. Childhood experiences accumulate over the life cycle and evolve into skills, work habits, or engagement in risky behaviors when individuals reach adulthood. Therefore, the relevant framework to study this question should have features of a life-cycle model of consumption with nonseparable utility over time, such as in models with habit persistence and durable goods. Investments which are complements over time have characteristics of habit persistence. Investments which are substitutes have characteristics of durable goods (e.g., Hayashi, 1985, Heaton, 1993, Attanasio, 1999).

Our paper is also related to the literature studying consumption responses to income shocks (e.g., Cochrane, 1991, Mace, 1991, Hayashi et al., 1996, Blundell, Pistaferri and Preston, 2008, Heathcote et al, 2009, Kaplan and Violante, 2009, among others). Consistent with that literature, we find that permanent shocks are transferred into parental inputs.

This paper complements the large literature assessing the impact of income on home environments and child development (e.g., see the reviews in Duncan and Brooks-Gunn, 1997 and Carneiro and Heckman, 2003; see also the recent work by Yeung, Livers and Brooks-Gunn, 2002, Dahl and Lochner, 2012, and Carneiro, Garcia, Salvanes and Tominey, 2014). Several papers in this literature do not find effects of family income on child outcomes (e.g., Mayer, 1997), although this is not true of more recent papers (e.g., Løken, 2010, Løken, Mogstad and Wisall, 2012, Dahl and Lochner, 2012). Relative to this literature, we focus to investments in children, and decompose income shocks into permanent and transitory components. Especially relevant to us are recent papers emphasizing the dynamic nature of the process of skill formation, and the importance of the timing of investments in children

[1]To our knowledge, only the Japanese Panel Survey of Consumers is close to this setup.

[2]The hypothesis of complete markets (that consumption is insured against both permanent and transitory shocks) has been rejected for U.S. data (see Attanasio and Davis, 1996, and Hayashi, Altonji and Kotlikoff, 1996). Cochrance, 1991, presents mixed evidence on the rejection of full insurance hypothesis. The permanent income hypothesis assumes that savings are the sole mechanism for income smoothing, thus these can be used to smooth transitory, but not permanent income shocks (Deaton, 1992). More recently, Blundell, Pistaferri and Preston, 2008, uncover the degree of insurance in the U.S. against income shocks of different degree of persistency and they find imperfect insurance against permanent shocks and full insurance of transitory shocks, except among poor households.

(e.g., Carneiro and Heckman, 2003, Cunha, Heckman and Schennach, 2010, Caucutt and Lochner, 2012, Carneiro, Garcia, Salvanes and Tominey, 2014).

Ferreira and Schady (2009) review the large empirical literature on the effects of aggregate shocks on child human capital, and potential mechanisms mediating the results in that literature. They show that, in the United States, child health and education outcomes are counter-cyclical (improving during recessions), but in poorer countries, these outcomes are pro-cyclical (with infant mortality rising, and school enrollment and nutrition falling during recessions). Their idea is that a recession is associated to an income and a substitution effects. The income effect associated with the reduction in resources works toward a deterioration of outcomes (through less child schooling and higher infant mortality). The substitution effect is associated with the decrease in relative wage, which is the opportunity cost of time spent in school (for children) or in health-promoting activities (for parents), and this could work in the opposite direction resulting in improved education and health status. They explain the findings in literature by competing income and price effects, with the income effect associated with pro-cyclical child outcomes dominating in poorer economies.[3]

To the best of our knowledge, we are the first to estimate how parental investments in children respond to income shocks, using data on changes in income, and changes in an index of goods and time dedicated to children. Possible insurance mechanisms are financial markets, social and family networks, labor supply, and welfare transfers.[4] Therefore, our analysis can potentially inform the design of the welfare system.

We start by removing demographic determinants of parental investments and income changes. We then impose covariance restrictions on these residual inputs and income to identify how permanent and transitory income shocks are transferred to changes in parental inputs.[5] Our choice to rely on covariance restrictions is driven by our goal to separate the effects of permanent and transitory income changes and by the difficulty to find exogenous

[3]Concerning the US, both Chay and Greenstone, 2003, and Dehejia and Lleras-Muney, 2004, find counter-cyclical patterns in infant mortality, with more babies dying during economic expansions. Chay and Greenstone, 2003, show that pollution falls during recessions and using variation over time and across counties in pollution levels, they show that lower pollution levels result in fewer infant deaths. Dehejia and Lleras-Muney, 2004, use state-level data to show a decrease in the incidence of low and very low birth-weight babies and in infant mortality during recessions.

[4]Literature has shown that families may resort on several mechanisms of insurance: by changing the timing of durable purchases (Browning and Crossley 2003), government public policy programs, such as unemployment insurance (Engen and Gruber 2001), Medicaid (Gruber and Yelowitz 1999), AFDC (Gruber 2000), and food stamps (Blundell and Pistaferri 2003). Recent work by Blundell, Preston and Pistaferri (2008) present evidence on the role of welfare transfers and assets; Blundell, Pistaferri and Saporta-Eksten (2012) focus on family labor supply.

[5]Examples of permanent income shocks are those to long-term unemployment, health shocks, promotions or demotions. Transitory shocks include overtime labor supply, piece-rate compensation, bonuses and premia, which have not lasting effects.

permanent and transitory income shocks. Moreover this approach has also been extensively used in the consumption literature (see the review by Meghir and Pistaferri, 2011). We show the bias in estimates of parental inputs from ignoring two types of nonseparabilities: nonseparabilities across periods and between different types of inputs within periods.

Unfortunately we cannot be sure of the exogeneity of the permanent and temporary income shocks we identify from the data. This is a common problem in the insurance literature relying on this type of approach. Our assumption is that, conditional on the child fixed effects and the remaining time varying controls, the remaining fluctuations in income are exogenous, but we realize this is a strong assumption.

This paper proceeds as follows. In the next section we present the simple theoretical framework that guides our thinking on the topic and also our empirical strategy. Section 3 describes the data set used in our analysis. Section 4 includes our results and in section 5 we conclude.

2 Theoretical and Empirical Frameworks

Evidence on the extent to which family income affects child development is mixed (see the reviews by Duncan and Brooks-Gunn, 1997, and Mayer, 1997; and Løken, 2010, Løken, Mogstad and Wiswall, 2012, and Dahl and Lochner, 2012). Family income might affect child development because poverty is associated with increased levels of parental stress, depression, and poor health which are conditions that might adversely affect parents' ability to nurture their children (see, e.g., Haushofer and Fehr, 2014). Thus, the level of family income affects the quality of interactions between a parents and children, and it might also matter for the development of a child if parents use the money to acquire child specific goods as books, quality daycare or preschool programs, for better health care, or to move to a better neighborhood.

In this paper we are interested not in the effects of income on child achievement, but in understanding to which extent income fluctuations transfer to changes in the quality of interactions between parents and their children and changes in acquisition of child-specific goods. We are faced with two potential challenges in such study: one is conceptual and the other is empirical.

The conceptual challenge can be divided into two. First, child achievement depends on her ability, as well as past and present child inputs. Therefore, the cumulative nature of this process induces non-separabilities across the child's life cycle, in which income at an earlier age affects not only the resources devoted to the child in that period, potentially her skills, but also in subsequent periods (see Todd and Wolpin, 2003, and Cunha, Heckman and Schennach, 2010). We explain below the implications of such interdependence when estimating the impacts of income on the allocation of inputs to children.

Second, understanding how changes in family income affect the use of resources has been widely studied in consumption literature (see the reviews by Jappeli and Pistaferri, 2010, and Meghir and Pistaferri, 2011). To understand what are the effects of income changes one must distinguish between whether the interest lies on anticipated or unanticipated income changes, since the theory predicts different responses in the allocation of resources depending on the type of change. We study here the effects of unanticipated income changes. The life-cycle and permanent income models posit that people use saving to smooth income fluctuations, and that they should respond little or nothing to changes in income that are anticipated. The theoretical predictions to the responses to unanticipated income shocks depend on the degree of persistence of the shock. According to the theory transitory income shocks should have a small impact on consumption and permanent shocks should lead to major revisions in consumption. However, as we describe in below, the framework used to study the response of changes in (nondurable) consumption to changes in current income may lead to biased estimates of parental responses to income shocks.

On the empirical side, it is hard to identify situations in which income changes in a unpredictable way. Furthermore, to understand if parents react differently to shocks of different persistence, we need to identify both temporary and permanent shocks to income. Two complications can lead to omitted variables bias when estimating the effects of permanent and temporary income changes on parents' reaction. First, the income shock can be endogenous if a parent becomes depressed or ill, since both their earnings and the quality of parent-child interactions will be affected, which bias the estimates for the effects of income. Second, as mentioned above the process of accumulation of human capital introduces non-separabilities across and within periods which affect the interpretation of the estimates of the coefficients on income.

Another empirical issue is of course the measurement of parental investments. The dataset we use is one of the richest datasets available with regard to these measures. Nevertheless, we are still limited in what we can observe. For example, the quality of the time spent with the child may be very dificult to capture with any survey instrument (other than, say, frequent observation of the parent-child interaction).

2.1 Theoretical Framework

The standard model As a benchmark, it is useful to start by abstracting from parental investents, and present the standard life-cycle model of consumption and savings, where consumers have access to a single risk-free bond. The individual's problem is:

$$
\begin{aligned}
V^t(A_t) &= \max_{c_t, A_{t+1}} u(c_t) + \beta E_t V^{t+1}(A_{t+1}) \\
& \quad s.t. \\
A_{t+1} &= (1+r)[A_t + y_t - c_t]
\end{aligned}
\tag{1}
$$

where c_t is consumption in period t, A_t is assets, y_t is income, and r is the interest rate.

The Euler equation for this model is:

$$\beta(1+r)E_t\left\{\frac{u_c(c_{t+1})}{u_c(c_t)}\right\} = 1. \tag{2}$$

Log income, y, can be decomposed into a permanent component, p, and a transitory shock, v (assuming for the time being that income is measured without error):

$$y_{it} = p_{it} + v_{it}. \tag{3}$$

Throughout the paper we assume that the permanent component p_{it} follows a martingale process of the form

$$p_{it} = p_{it-1} + \eta_{it} \tag{4}$$

where η_{it} is serially uncorrelated, and the transitory component v_{it} follows an $MA(q)$ process, where the order q is established empirically:

$$v_{it} = \sum_{j=0}^{q} \theta_j \varepsilon_{it-j} \tag{5}$$

with $\theta_0 = 1$. Substituting (4) and (5) into (3) and taking first differences, income growth is given by

$$\Delta y_{it} = \eta_{it} + \Delta v_{it}. \tag{6}$$

Although in general one cannot obtain analytical expressions for the solution to this problem, Blundell, Pistaferri and Preston (2008) show that under the absence of credit constraints, it is possible to obtain the following approximation to the relation between consumption and income changes:

$$\Delta c_{it} = \phi_{it}\eta_{it} + \psi_{it}\varepsilon_{it} + \xi_{it} \tag{7}$$

where ξ_{it} includes, for example, measurement error or preference shocks, that is, changes in investments which are independent of income changes. We start by estimating ϕ and ψ, which Blundell, Pistaferri and Preston, 2008, call partial insurance parameters.[6] Equation (7) is extremely useful since it nests the two extreme cases of insurance to income shocks: the case of complete markets which assumes that $\phi_{it} = \psi_{it} = 0$, and no insurance ($\phi_{it} = \psi_{it} = 1$). Empirically, it can exist some degree of insurance, in which case ϕ_{it} and ψ_{it} would take some value between 0 and 1. The closer the coefficient to zero, the higher is the degree of insurance. This is the case since families have access to several insurance mechanisms, such as financial markets, welfare programs, progressive taxation, within family labor supply and help of relatives and/or neighbors.

Notice that we estimate insurance parameters after conditioning on observable time varying demographics. In addition, we also allow the effect of some time invariant demographics on income to vary over time. We then remove all time invariant determinants of investment (as ability and invariant differences across families) by taking differences within child. Our goal is to make sure that our measures of shocks are truly unpredictable from the point of view of the household.

Model with parental investments in children Consider now an extension of the model (1) where each individual has a child and he/she chooses how to allocate income between consumption (c_t), assets (A_{t+1}), and investments in the human capital of his/her child. Let h_t be the stock of the child's human capital at time t, g_t be investments in children, and q_t be the price of investments (c_t is numeraire). While living with parents, the child does not make any decision. Then, one can write the decision problem of the individual as:

$$\begin{aligned} V^t(A_t, h_{t-1}) &= \max_{c_t, g_t, A_{t+1}} u(c_t, h_t) + \beta E_t V^{t+1}(A_{t+1}, h_t) \\ & \quad s.t. \\ A_{t+1} &= (1+r)\left[A_t + y_t - c_t - q_t g_t\right] \\ h_t &= f(g_t, h_{t-1}) \end{aligned} \tag{8}$$

where $f(.)$ is the production function of skill (which is assumed to depend only on g_t and h_{t-1}, although this assumption could be relaxed).[7] In this specification h_t is allowed to directly affect utility at time t, as well as future utility through the production of future human capital. After some manipulations and simplifying assumptions (see Appendix B)

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[6]This framework is extended to include labor supply in Blundell, Pistaferri and Saporta-Eksten (2012). In contrast, Kaplan and Violante (2009) solve the model numerically.

[7]In principle the production function at time t could depend on the whole history of investments (and shocks to the technology) up to that period.

one can write the Euler equation for this problem as:

$$\beta\,(1+r)\,E_t\left\{\frac{u_h(h_{t+1})\frac{\partial h_{t+1}}{\partial g_{t+1}}}{u_h(h_t)\frac{\partial h_t}{\partial g_t}}\right\}=1. \tag{9}$$

This expression is obtained considering a deviation from the optimal trajectory analogous to the deviation used to price capital (see Deaton and Muellbauer, 1980), in which the parent may defer investment by one period in moment t, such that neither his/her consumption and the child's human capital after $t+1$ are not affected by postponing investment one period. Three assumptions are imposed to derive the expression above. First, this one-period deviation can only be constructed under the assumption that investments are not perfect complements across periods, so that the production function exhibits at least some degree of substitutability between periods, which may vary by age. Thus, such expression is obtained under mild assumptions for the shape of the production function of child's human capital. Second, we assume that the parent can predict the future (real) prices and interest rates between any periods, q and r, and that parents perfectly forecast the marginal return of investment human capital. The last assumption requires that parents have perfect knowledge of the production function of the child's human capital (this is a debatable assumption, see Cunha, Elo, Culhane, 2013). Finally, the last assumption necessary to obtain the condition (9) requires that the savings from deviating from the optimum in period t are equal to the savings from waiting one period to deviate (that is, deviations can be built between any two adjacent periods).[8]

One important difference between the model just presented and the standard life cycle model described above, is that it is no longer possible to derive a simple equation such as equation (7) (as in Blundell, Pistaferri and Preston, 2008). Nevertheless, the model just presented can still inform us about what we should expect from the relationship between income shocks and investments in children.

In particular, condition (9) is useful to understand how one needs to be cautious about the interpretation of estimates of ϕ and ψ from equation (7) when Δc_{it} refers to measures of parental inputs rather than typical measures of consumption. In (9), $h(.)$ can be written as function of the past inputs, so that, $h_t = f(g_t, g_{t-1}, ..., g_1, g_0)$. In turn, we can write h as a function of past income shocks. Thus, if past shocks are not accounted for estimates of ϕ and ψ will be biased, unless past inputs do not matter, which is not likely to be the case (see Cunha, Heckman and Schennach, 2010). If inputs are complements across periods and this

[8]This derivation assumes that the parent care about the child's human capital, h_t, in each period t. In Appendix B, we also show how a similar condition can be written if parents care about the child's human capital when she reaches adulthood.

is not accounted for, the response to shocks is potentially underestimated (if ϕ^1 and ψ^1 are positive and omitted from the model).[9] Thus, in addition to equation (7), we also estimate:

$$\Delta c_{it} = \phi^0 \eta_{it} + \psi^0 \varepsilon_{it} + \phi^1 \eta_{t-1} + \psi^1 \varepsilon_{t-1}. \tag{10}$$

In principle, we should include many more lags of permanent and temporary shocks in the model, but unfortunately our panels are not long enough for us to do this (notice that, for most of the observation period, we only have data every two years, as we explain below).[10]

Finally, we consider two types of parental inputs within period: time and goods. Then we estimate the following system

$$\begin{aligned} \Delta y_{it} &= \eta_{it} + \Delta v_{it} \\ \Delta e_t &= \phi_e \eta_t + \psi_e \varepsilon_t + \varphi_e \Delta g_t \\ \Delta g_t &= \phi_g \eta_t + \psi_g \varepsilon_t + \varphi_g \Delta e_t \end{aligned} \tag{11}$$

where e and g represent time and goods inputs, respectively. Parameters φ_e (φ_g) captures how parental time (goods) responds to changes in investment goods (time). Positive estimates for φ_e and φ_g indicate complementarity between the two types of inputs. This system can be solved to write Δe_t and Δg_t as functions of the permanent and persistent shocks and the degree of substitution/complementarity between the two sets of inputs. We assume that the parameter of complementarity/substitution is the same on both equations, since the system above is under-identified without further restrictions (see Appendix C). We realize this is a strong assumption. One appeal of this assumption is that it makes the cross responses to different types of investments to be somewhat symmetric, so it is a reasonable starting point. In Appendix C we present the proof of identification of variances, of the coefficients of permanent and transitory shocks, and of the degree of substitution/complementarity between indices of time and goods.

2.2 Empirical Framework

We assume that real (log) income, $\log Y$, can be decomposed into a permanent component, p, and a mean-reverting transitory component, v. Thus, we can write the income process of

[9] See also Cerletti and Pijoan-Mas, 2012, who estimate how households adjust the acquisition of durable goods when facing permanent and transitory shocks.

[10] When we attempted to do this empirically our results where very imprecise. This problem is especially acute when we allow the effect of shocks, ϕ and ψ, to vary with the age of the child.

each family of child i at age a as

$$logY_{it} = \mathbf{Z}'_{\mathbf{it}}\varphi_{\mathbf{t}} + p_{it} + v_{it} \tag{12}$$

where t is the child's age and $\mathbf{Z}$ is a set of observable characteristics which affect income, including demographics, education of parents, ethnicity, common shocks to all families and place of residence. We allow the effects of most of these characteristics to vary with calendar year (see section 4).

The Children of the NLSY79 (the main data set used in our analysis) only records information on parental involvement biannually, implying that we can only construct second differences for inputs, that is, $\Delta^2 c_t$. Additionally, our interest lies on the child's life cycle, which implies that our time reference is the age of each child. Thus, starting at age 0 we can construct the following pairs of ages at which we observe both family income and parental inputs: 0-1, 2-3, 4-5, 6-7, 8-9, 10-11, 12-13 and 14-15, as measures of parental investments are only available up to age 14. Since, we difference both income and parental inputs, the panels we construct have at most $T = 8$, that is, we can construct at most seven first differences (although this will be the case only for a small group of children who are observed during their whole childhood).[11] Therefore, we can write the equation that relates changes in (residual of) parental inputs to permanent and transitory income changes as:

$$\Delta^2 c_t = \phi\left(\eta_t + \eta_{t-1}\right) + \psi\left(\varepsilon_t + \varepsilon_{t-1}\right) + \xi_t^g + \xi_{t-1}^g. \tag{13}$$

We start by estimating equation (13) assuming that all parental inputs are subsumed into one index measure for quality of the home environment. Then, the parameters for partial insurance are identified by the following moments (see Appendix C):

$$\frac{E\left[\Delta^2 c_t\left(\Delta^2 y_{t-2} + \Delta^2 y_t + \Delta^2 y_{t+2}\right)\right]}{E\left[\Delta^2 y_t\left(\Delta^2 y_{t-2} + \Delta^2 y_t + \Delta^2 y_{t+2}\right)\right]} = 2\phi \tag{14}$$

$$\frac{E\left[\Delta^2 c_t \Delta^2 y_{t+2}\right]}{E\left[\Delta^2 y_t \Delta^2 y_{t+2}\right]} = \psi. \tag{15}$$

In our empirical application we also account for measurement error in parental inputs. The need to account for the measurement error on the measures of parental inputs is discussed in section 4.[12]

[11] Dahl and Lochner, 2012, also use this data and proceed also with second differences of family income. Information on family income is retrieved annually from 1979 to 1994 and biannually after this year.

[12] We should add two important remarks: one about measurement error in income and other about the measurement error in parental inputs. Regarding measurement in income, Meghir and Pistaferri, 2004, show that the variance of measurement error in income cannot be separately identified from the variance of

The basic model of equation (13) can be extended to allow the response of parental inputs to permanent and transitory income shocks to vary with the age of the child. In practice, when we allow for ϕ and ψ to vary across three (or more) age groups (instead of two) we experienced convergence problems, therefore we can only allow the response to shocks to vary for two age groups: 0-7 and 8-15 (we also present sensitivity analysis presenting effects allowing the effect to vary for ages 0-5 and 6-15 and 0-9 and 10-15; see table A.8 in Appendix A). This is likely to reflect the fact that, when we limit age ranges, we are using much less information to identify the parameters of interest. Allowing parental responses to shocks to vary according to the child's life cycle is important, since the timing of investments matters in the production function of child achievement. If investments are complement over time and if parents are more sensitive to shocks when children are younger, parental response to negative shocks early in the life of a child may explain part of the inequalities found later in life.

The model just described corresponds to the standard model in Blundell, Pistaferri and Preston, 2008, but adapted to bi-annual data, and replacing consumption by parental investment as the main dependent variable. However, this corresponds to a very restrictive model, which does not allow for time non-separabilities in parental investments in children (which would arise naturally in the production function of human capital).

Therefore, we then turn to the estimation of models where we allow for non-separability across periods by allowing parental inputs to respond to past shocks in equation (10) (although with some empirical limitations, as described below). We show in Appendix C that the variance of shocks and the effect of transitory shocks, ψ_0, are identified as before.

Finally, we present results where we allow for two types of parental inputs: time and goods aggregates, which we construct using individual components of the HOME score available in the CNLSY. We allow these two types of investment to be nonseparable from each other and estimate the degree of substitution/complementarity between them.

Our empirical strategy is implemented in two steps. First, we construct the differences for income and parental inputs, $\Delta^2 y_{it}$ and $\Delta^2 c_{it}$, after regressing them on observable characteristics. Second, we estimate the variances of the permanent and transitory income shocks,

transitory shocks, thus the estimates presented for the coefficient on transmission of transitory shocks are a lower bound of the true value. Additionally, we assume, as most of the literature, that permanent and transitory shocks to income are i.i.d. This assumption is not without controversy, and Meghir and Pistaferri, 2004, show that modelling the conditional variance of shocks through an ARCH(1) structure with observed and unobserved heterogeneity requires at least 8 income periods for identification. This is in principle feasible in the data we currently use since we have 7 differences in income (and 8 income periods), however the estimates would be unstable for such an augmented model. In the empirical application, whenever stated, we allow the variance of income shocks to vary with the age of the child, and our estimates are not sensitive to this assumption. Concerning measurement error in inputs, in the empirical application, we allow measurement error in it to vary by age of children.

and parameters ϕ and ψ. We use a GMM strategy, in particular, we use diagonally weighted minimum distance.[13]

3 Data

The main data used in our analysis comes from female respondents in the National Longitudinal Survey of the Youth of 1979 (NLSY79) and their children, the Children of the National Longitudinal Survey of Youth of 1979 (CNLSY), for the period 1986-2008. The NLSY79 is a panel of individuals whose age was between 14 and 21 by December 31, 1978 (of whom approximately 50 percent are women). The survey has been carried out annually since 1979 and interviews have become biannual after 1994. The CNLSY is a biannual survey which began in 1986 and contains information about cognitive, social and behavioral development of individuals (assembled through a battery of age specific instruments), from birth to early adulthood. The original NLSY79 comprises three subsamples (1) a representative sample of the US population, (2) an oversample of civilian Hispanic, black, and economically disadvantaged non-black/non-Hispanic youth, and (3) a subsample of respondents enlisted in one of the four branches of the military (which is not included in the analysis).

The CNLSY is the best dataset to study how changes in parental inputs react to fluctuations in family income, since it is a panel and it includes demographic characteristics, education and labor market information for parents of a child, together with information on home environments, and children's education, health, cognitive and behavioral outcomes.

Our main measure of income is disposable family income. In particular, the NLSY79 reports many components of family income, including (1) respondent and her spouse's wages, commissions, or tips from all jobs, income from farm and non-farm business or income from military services received in past calendar year (before taxes and other deductions; annual measure); (2) transfers from the government through programs such as unemployment compensation, AFDC payments, Food Stamps, SSI, and other welfare payments, (3) transfers from non-government sources such as child support, alimony, and parental payments, (4) income from other sources such as scholarships, V.A. benefits, interest, dividends, and rent. We, then, obtain the family's disposable income by adding these four groups of income sources and subtracting federal income taxes. To impute each family's federal tax payments we use the TAXSIM program (version 9a) maintained by the NBER (see Feenberg and Coutts, 1993, and `http://www.nber.org/taxsim`).[14]

[13]We obtain similar results if we use an identity matrix as weighting matrix.

[14]All monetary values are deflated to 2000 US dollars, using CPI-U (see Economic Report of the President, 2009).

In our analysis, we focus on measures of parental inputs, most of which are gathered under the HOME - Home Observation Measurement of the Environment (Short Form). These measures are used to assess the cognitive stimulation and emotional support children receive through their home environment and are applied between ages 0 and 14. Table 1 includes the measures of parental inputs used throughout the paper. Notice that not all components are surveyed at every age of the child, and due to the sample restrictions and to the CNLSY's biannual nature, each child has these measures collected at most 8 times. We measure parental inputs by the HOME score, and its individual components[15]. Finally, a few of the items in this table are not part of the HOME score, and these have the letters **NH** ("not part of HOME score") in front of their description, but we also used them as individual outcomes (since they represent parent-child interactions), and to construct indices which represent parental inputs in terms of time and goods.

The grouping of the measures into indices of goods and time is presented in table 1. In order to construct these two indices we first recoded those individual outcome variables which take multiple values into indicator variables (using the same recoding that the Bureau of Labor Statistics (BLS) uses when constructing the HOME score; see CHRR, 2002), and then we average them. Each index is then re-standardized to have mean zero and standard deviation one for a clearer interpretation of results. The number of variables used to construct the time and goods indices we use in the paper varies by the age of children, and the exact components used at each age are presented in table 1.[16]

To ensure that the same sample is used throughout the paper, a number of selection criteria are imposed. Out of the 11495 children data we exclude 1174 children who faced throughout their sampling period extreme changes in income (ΔlnY above 6 or less than -3). We further drop 1607 children for whom a HOME score was never constructed[17], and for whom it was not collected information on family income. Finally, we drop 1309 children without at least two consecutive observations of HOME score and income (we impose this data restriction because we will construct below measures of income and outcomes in differences). We are then left with a final sample of 7404 children who are observed at least twice.

We now turn to clarify the exact timing of family income (which is recorded by the NLSY79) and parental inputs measures (obtained from the CNLSY). Individuals are asked

[15]In the data, the total raw score for the HOME is simply a summation of the individual item scores, which varies by age group, as the number of individual items varies according to the age of the child. Then, the scores were standardized by age, having a mean of 100 and a standard deviation of 15. In practice, we used these values to normalize the HOME to have mean 0 and standard deviation 1.

[16]The mean and standard deviation of each of the individual components is presented in table A.4 in Appendix A.

[17]Of these 1607 children, 1039 were born before 1986, which is the first year in which HOME is collected.

about their income in the year prior to the survey. Income measures collected in year t refer to year $t-1$. The timing of parental inputs, measured by the HOME score, is less clear. Some of the components of the home refer to the year prior to the survey (for example, "how often was the child taken to museum last year?", "how often was the child taken to any performance last year?"), and some refer instead to behaviors in which the household engages frequently (for example, "about how many magazines does your family get regularly?"). Under the assumption that these frequent behaviors are also there the year prior to each survey round, we can say that the HOME score collected at time t concerns parental investments at time $t-1$.

3.1 Descriptive Statistics

Table 2 shows the mean and standard deviations of the variables used in our analysis. The table consists of three panels. The first panel includes our measures of parental inputs; the second panel includes characteristics of children which we use as controls in our specification (gender, race, age of child, age of mother at child's birth and number of siblings in each period). Finally, the third panel includes characteristics of families, some of which are related to the mother's background, such has maternal education, ability measured by the AFQT (Armed Forces Qualification Test), whether mother lived with both parents at age 14, education of maternal grandparents, others relate to characteristics that vary over time, as mother marital status, number of children, family size, disposable income, residence in a big city, mother's (and her spouse, if present in household) labor market participation, and an indicator for whether the family receives welfare income.

The table includes four columns (number of observations, the mean for the whole sample and the mean separately for the samples of children whose mother is a high school dropout or graduate, and for those whose mother attended at least some college). The average HOME score for the children present our sample is -0.19 (which is below the mean HOME score of a nationally representative sample of children, which is equal to zero). About half of the sample are boys, a third are Black, and the remaining are Hispanic children. The low value for the mean of the HOME score, and the high proportion of Black and Hispanic children in our sample, are due to an oversample of disadvantaged individuals in the NLSY79.[18] Mothers of children were around 25 years old at birth, and the mean age of children in our sample is 7.6 years old. Most children in the data have 2 or more siblings.

[18]Note that about half of the children in the sample used in the analysis are part of the over-sample of Hispanic, Black, and economically disadvantaged white.

4 Results

In this section, we discuss the impact of (unexpected) changes in family income on parents' inputs. Before reporting estimates for the partial insurance parameters in equations (7), (10) and (11), we discuss our choice for measures of parental inputs, based on the literature and inspection of the data used. We next present OLS estimates of regressions of parental inputs on current and past family (disposable) income. We then turn to estimate the impacts of permanent and transitory shocks to income. We present estimates of the insurance parameters under different assumptions on parental credit constraints and under different assumptions on the dynamics of income transmission to inputs, in particular, whether there is inertia in the reaction to shocks, and whether different types of investments available to parents are complements or substitutes. We also analyze whether the effects of income shocks vary across different demographic groups (child's gender and race), and whether income differentially affects younger versus older children.

4.1 Parental inputs and child development

In this paper we do not attempt to build an explicit empirical model of the process of child development (see Cunha, Heckman and Schennach, 2010, and Del Boca, Flinn and Wiswall, 2014). However, before presenting estimates of the extent to which parental inputs responde to income fluctuations, it is useful to discuss how parental inputs are expected to contribute to child development.

Table 1 presents the measures of individual parental inputs we use in the analysis. The CNLSY includes three aggregate indices (constructed by the BLS) capturing the quality of the home environment (HOME, Cognitive Stimulation and Emotional Support), which we use in our empirical work. However, we also study how some individual components of these indices (described in the table) react to income changes. In addition, we use them to construct additional indices: one including time related inputs, and another including inputs more related to goods.

The components used to construct measures of time inputs closely relate to measures of time available in time use surveys (the ATUS and the Time Use Survey of PSID), and are typically used in the literature on child development (see, for example, Guryan, Hurst and Kearney, 2008, Carneiro, Meghir and Parey, 2013, Bharadwaj, Løken, and Neilson, 2013, and Del Boca, Flinn and Wiswall, 2014).

Our measures of parental inputs are also commonly used in the literature. Relative to Cunha, Heckman and Schennach, 2010, we exclude only two of their measures ("How often the child is praised" and "How often child gets positive encouragement"), but we also add several indicators.[19] Todd and Wolpin, 2007, use the measure of HOME. Carneiro, Meghir and Parey, 2013, study the effect of maternal education on child achievement and they use only a selected set of measures of parental inputs as possible mediators for the impact of increasing maternal education on test scores and child behaviors.

In order to understand whether the indices of quality of the home environment (HOME, Cognitive Stimulation and Emotional Support) measure parental interactions, we perform the following exercise. In the CNLSY there are no measures of parental use of time or expenditures in children's goods. However, the Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID), which was applied in 1997 and 2002 to children under 13 years of age, contains time diaries for children. The data includes not only time diaries of children, but also information about who participated on a given activity the child was undertaking. This makes it possible to capture the number of hours a day a child spends actively interacting with the mother and the father. In addition, the CDS contains also the same measure of home environment, the HOME score, available in the CNLSY.[20] We can then use the CDS to correlate the indices HOME, Cognitive Stimulation and Emotional Support, with the time children spend engaging in activities with parents.

This is reported in table A.1 in Appendix A.[21] The table presents regressions of index measures of quality of the home environment (HOME, Cognitive Stimulation and Emotional Support) on the child's time with the mother (Panels A-C) or the father (Panel D). We consider two possible measures of time use: total minutes per day with mother or father and in leisure activities. We include the following controls not displayed in the table: indicators for the education of the head of household (high school graduate, some college, college degree; high school dropout is the omitted category), permanent income, indicators for wether the head of household is black or male, indicators for the number of children in household, dummies for the age of child (in years) and year fixed effects.[22] The main message of this table is that, even after including such a rich set of controls, the time children spend with mothers or fathers is positively correlated with home scores. In particular, keeping constant

[19] In particular, we add: "child attends private school or preschool care", "Child taken at least once/week to grocery", "Child sees the father(-figure) daily", "Mother helps child learning numbers", "Mother helps child learning alphabet", "Mother helps child learning colors", "Mother helps child learning shapes", "Child spends time with father/father-figure at least once a week", "Child spends time with his/her father/father-figure in outdoor activities once a week", "When family watches TV, mother discusses programs with child", "Parents when shopping for child at least once last month", "Child and parents go on outings together at least once last month", "Child worked with mother on schoolwork last week", "Child went to movies with parents last month", "Child went for dinner out with parents last month", "Child did things together with parents last month".

[20] See Appendix D for details about the CDS.

[21] We only use the 1997 wave of the CDS since in 2002 children in date are already 6 years or over.

[22] The measure of permanent income is the average of family's disposal income before the child turns 17.

the set of observable characteristics included in the estimation, increasing time with mothers by 1 minute per day is associated with an increase in the HOME score of 0.02% of a SD, whereas increasing time with fathers by 1 minute per day is associated with an increase in the HOME score of 0.04% of a SD. Unfortunately, there is no dataset for the US which includes simultaneously measures of home environment and expenditures in children, so we cannot replicate the same type of analysis using with the measures of parental inputs.

When examining measures of parental investments in children one may be concerned about measurement error. Cunha, Heckman and Schennach, 2010, use the same data set than we do and they decompose the variance of several parental inputs into signal and noise. They find that investment measures are substantially contaminated with noise, and that these inputs are noisier when taken at earlier ages than when taken at later ages of children. For example, for the measure "Number of Books" the signal to noise ratio more than doubles between ages 5-6 and 11-12. They report that, in most cases, more than 70% of the variance in these inputs is noise. The high noise share of the variance of these inputs makes it important to control for measurement error, which we account for when estimating equations (7), (10) and (11).[23]

As mentioned above, the goal of this paper is not to model child achievement, but to which extent shocks to parental income are transmitted to parental investments in children. We now show that changes in parental inputs are associated with changes in measures of child (cognitive and noncognitive) achievement, although there is substantial literature on this already (Todd and Wolpin, 2007, Cunha, Heckman and Schennach, 2010, Del Boca, Flinn and Wiswall, 2014).

Tables A.2 and A.3 in Appendix A present estimates of correlations between the HOME score and measures of children's achievement in math and reading, which are standardized scores on the Peabody Individual Achievement Tests (PIAT), and measures of behavior problems (measured by the Behavioral Problems Index, BPI, and indicators for high school enrolment and arrestments or convictions by age 17-18). PIAT assessments measure ability in mathematics, oral reading, and word recognition ability (reading recognition), and the ability to derive meaning from printed words (reading comprehension).[24] In order to make the PIAT test scores easier to interpret, we normalize test scores to have a mean of zero and a standard deviation of one based on the sample of test takers. To reduce the number of outcome measures, we create a combined math-reading score, which is the average of the normalized math and reading PIAT scores for each child. This score is then normalized

[23]In the empirical application, we allow for measurement error in inputs in equations (7), (10) and (11); see Appendix C.

[24]From 1986 to 2008, the tests were administered biennially to children ages 5 and older. Children took each individual test at most five times due to the age restrictions.

again to have a mean of zero and standard deviation of one in the sample.

Table A.2 presents estimates measured at one point of the children's life. Columns (1)-(4) include children ages 13 or 14, and columns (5) and (6) present estimates for adolescents ages 17 or 18. The table controls additionally by child's gender, dummies for the age of the child, number of siblings, race and year fixed effects. We control also for mothers' characteristics such as age, completed education (high school, some college or college), the Armed Forces Qualification Test (AFQT) score, and whether the mother lived with both her natural parents at age 14. Our list of control variables includes in addition the mother's marital status in the previous year (corresponding to the year income is measured), household composition variables such as age and education of spouse (when present), and the education of the mother's parents. Finally, we include the (log) of permanent income, which is the average of family's disposable income before the child turns 17.

Table A.2 shows that after controlling for measures of maternal background and permanent income, a increase of 1 SD in current HOME score is associated with a .18 SD higher PIAT score (column 1) and .25 SD lower incidence of behavioral problems (column 3). Since cognitive and noncognitive skills accumulate over time, we also include in columns (2) and (4) past home scores, and we still find a positive association between HOME (as early as ages 0-2) and PIAT and BPI. Measures of HOME score are still associated with high school enrolment (column 5) and the likelihood of arrests/convictions at ages 17-18. An increase in HOME score of 1SD between ages 11-14 is associate with a decrease in 2.1% in the likelihood of any arrests/convictions by ages 17-18.[25]

Estimates presented in table A.3 use the fact that in the CNLSY there are multiple measures of PIAT and BPI per child, as well of as HOME, which allows to control for time invariant unobserved characteristics of children. Using the same children than in table A.2, table A.3 also shows that lagged inputs are associated to child's achievement.[26] The estimates in A.3 have a smaller magnitude than those in table A.2. Nevertheless, a 1SD increase in HOME in $t-4$ is associated with a 2.6% SD increase in PIAT.

4.2 Income changes and parental inputs

OLS Estimates Before we present estimates for the coefficients of partial insurance in equations (7), (10) and (11), we start with simple OLS estimates of the relationship between

[25]Since the latest age at which HOME is constructed is 14, columns (5) and (6) do not include current score.

[26]We do not present versions of tables A.2 and A.3 using individual components of the indexes since the large number of components and the high correlation between them means that the estimates are very noisy, but the results are available from the authors.

income fluctuations and investments in children. In particular, we estimate associations between changes in income and changes in investments in children using the following equation:

$$G_{it} = \gamma \ln Y_{it} + Z_{it}\beta + \alpha_i + \varepsilon_{it} \tag{16}$$

Z_{it} is a vector of controls for child i at year t, α_i is an individual fixed effect that captures all time invariant determinants of investment specific to the child or the family (such as child's ability), and ε_{it} is the residual, which is independent of everything else in the model. G_{it} is measured by the HOME score, its two subcomponents (cognitive stimulation and emotional support), and by indices of inputs which represent time and goods. The vector Z_{it} includes controls for maternal characteristics, such as mother's education, race, highest grade completed of the mother's mother and father (the maternal grandparents of the child), and maternal AFQT. These variables are time invariant, and therefore colinear with the child fixed effect. However, in our specification we interact them with year effects. We also control for other family characteristics such as: family size, current state of residence, an indicator for whether the family lives in a big city (we allow the effect of these two variables to vary with year), mother's marital status, indicators for the number of sibling the child has, and for the total number of children in family. Finally, we control for indicators for the age of the child and race (which again we interact with the year effects).[27]

Y_{it} is disposable family income for individual i in year t, as defined in section 3. γ measures the association between changes in log income and changes in parental investments in children. As mentioned above, we control for an extensive set of demographics and other observable determinants of income. Therefore, the association between income changes and changes in parental inputs is not driven by changing demographics, nor by changes in the impact of demographics over time.

The results are presented in table 3. The table includes three sets of estimates: one set for the whole sample, and separate estimates for children whose mothers have different levels of education (measured by a binary variable indicating whether the mother attended at least some college, or whether she completed high school or less). We present results by maternal education to capture long term credit constraints faced by families (see Carneiro and Heckman, 2002). In columns (2), (4) and (6) we also allow the results to vary depending on whether the child is between ages 0 and 7, or between ages 8 and 15.[28] Each panel of table 3 corresponds to one outcome variable.

We start by focusing on Panel A of table 3, which presents estimates for the HOME

[27]These are the same controls used to estimate equation 12, with the exception of the child fixed effect.

[28]We do not present results with a finer division by age for consistency with the estimates presented for equation (7), since when we estimate these models we encounter stability problems.

score. Column 1 shows that, for the whole sample, we reject the hypothesis that $\gamma = 0$. In particular, a 1% increase in income is associated with a 2.6% of a SD increase in the HOME score. When we disaggregate the estimates by maternal education, in column (3), we cannot reject that the coefficient is equal to zero for the sample of college mothers, but column (5) presents a positive association between changes in income and parental inputs for mothers who never went to college. Panels B to E present estimates for the other four outcomes we analyze. Across these panels, we reject the hypothesis that $\gamma = 0$ for the whole sample, and for the sample of non-college mothers (columns 1 and 5). One explanation for our results is that families in which mothers with some college education or above are able to fully insure their investments in children against income shocks.

The patterns in this table can be observed with a simple OLS regression of change in investments on changes in income. Since we cannot reject the hypothesis that $\gamma = 0$ for the college sample, when we estimate equation (7) we do not expect ϕ and ψ to be different from zero in this subsample.

In columns (2), (4) and (6), where we allow for differential effects based on children's age, there is, in general, a stronger association between changes in income and changes in the quality of the home environment for the younger age group (ages 0-7), driven by the sample of non-college mothers.[29]

In table 4 we present estimates under a more flexible model, where current inputs may respond to shocks with a lag, as suggested in section 2. The results in this table show that when we consider the cumulative effect of shocks in current period and in the two previous periods, the cumulative effects of income changes in three consecutive periods are not associated to significative changes to parental inputs for any sample.[30] Only current changes in income seem to matter.

Insurance We now focus on estimates for the parameters in models (7), (10) and (11): the variances of the permanent and the transitory shock, σ^2_η and σ^2_ε, and the coefficients for the permanent shock (ϕ) and for the transitory shock (ψ). Due to the noisy nature of parental inputs in our estimates we allow investments to be measured with error. We allow the variance of the measurement error in parental inputs to vary with the child's age in

[29]Table A.4 in Appendix includes estimates for model (16) for the individual components. Out of the 31 components included in the table, we can only reject the null of no effect of income changes for four items: on whether the family receives daily newspaper, whether the child eats with both parents at least once a day, whether the child see father(-figure) daily, and whether the child has a music instrument at home she can play. We also include in columns (4)-(6) estimates that include lagged log income. The conclusions remain largely unchanged relative to columns (1)-(3).

[30]The lack of significance of the cumulative effects of income changes for the three consecutive periods can be due to the decrease in sample size, since the cumulative effect is significant with just one lagged income measure (results available from the authors).

most of the results we present, to capture the fact that the components used to construct the indices used as dependent variable vary with the child's age, and also the signal to noise ratio (as mentioned above) of the measurements used at different ages.[31]

We present results for the whole sample, and separately by maternal education (college versus no college mothers). We start by focusing on parameters ϕ and ψ for the five main outcomes measures, and the estimates for equation (7) are presented in table 5. We then discuss the estimated variances of the permanent shock and the estimated variances of the transitory shock and compare our estimates to those in the literature. Starting by column (1) of table 5 for the HOME score: we cannot reject the null that ϕ and ψ (the partial insurance coefficient for the permanent and transitory shocks, respectively) are equal to zero (Panel A). The point estimates are also smaller than those found in the (non-durable) consumption literature. To put the point estimates of Panel A - column (1) in perspective, we compare them with those in Blundell, Pistaferri and Preston (2008). We find that a 10% permanent increase in income is associated with an increase of 0.6% SD in the HOME score. They find that a 10% permanent increase in income is associated to an increase of 6.4% in consumption, which corresponds to 11% of a SD in consumption.

The point estimates presented in Panels B and C of table 5 are remarkably different for the sample of college and non-college mothers. Although we cannot reject the null that the estimates in Panel C for the sample of children of non-college mothers are equal to zero, estimates of the insurance parameters for both the permanent and transitory shocks are larger than those for the whole sample. This suggests that the sample of non-college mothers is more sensitive to income shocks.

To broaden our understanding of the estimates in column (1), we present in columns (2)-(5) results for the four other measures of parental inputs: cognitive stimulation, emotional support, time and goods. Estimates in columns (2)-(5) of Panel A show that cognitive stimulation, time and goods react to permanent shocks. The coefficients on insurance to transitory shocks in columns (2)-(5) are not statistically different from zero and are small in magnitude. When we disaggregate the sample by maternal education in Panels B and C, the estimates for both ϕ and ψ are small for the sample of college mothers (Panel B), but the results in Panel C suggest that children in families with non-college mothers are more likely to be vulnerable to permanent income changes. In particular, column (2) of Panel C shows that a 10% permanent increase in income is associated to an increase of 2.2% SD in cognitive stimulation by parents (see also columns 4 and 5). In table A.5 in the Appendix

[31] As Blundell, Pistaferri and Preston, 2008, we allow for i.i.d. unobserved heterogeneity in the individual inputs gradient, and estimate its variance (σ^2_ξ). In most results we present, the variance of measurement error in inputs, σ^2_{ug}, is allowed to vary with the age of the child (the exception are the results in tables 5 and 6, and tables A.5 and A.6 in Appendix A. See Appendix C for the details on identification).

we show how estimates vary by race (non-Black vs. Black) and child's gender. We find that parents react to permanent income shocks regardless of their race (Panels A and B), but we cannot reject the null that parents of boys do not react to income shocks (Panel C).

We now turn to a brief discussion of the estimated variances of the permanent (σ^2_η) and of the transitory (σ^2_ε) shocks. We keep the discussion short since the main goal of this paper is not to provide a detailed understanding of the income dynamics in this sample. Nevertheless, it is important to learn what are the implications of the estimated variances for the transmission of income shocks to parents inputs. The estimates for variances of shocks are presented in table A.6 in Appendix A. The estimates for σ^2_η and σ^2_ε in the table are substantially larger than those presented by Meghir and Pistaferri, 2004, and Blundell, Pistaferri and Preston, 2008. This results from two differences in the sample used in those papers relative to ours. First, we do not restrict our sample to continuously married couples led by a male. Instead, we control for mother's marital status. We do not impose this restriction in our sample since it would cause a drop in sample size to 3685 children (see results using the sample of married mothers in table A.9 in Appendix A). Second, as in the papers mentioned above, we also drop income outliers. However, we are not as strict in the definition of outliers, since the families in our sample are on average younger than the families in those papers, and thus are more likely to face larger income fluctuations which we want to capture in our analysis.[32]

Non-separability of parental inputs across the life cycle In table 6 we present estimates that allow for a more flexible dependence between changes in current inputs and income shocks: we allow current inputs to depend on current and lagged shocks $(t-2)$[33]. Unfortunately, the estimates are too imprecise and unstable. Overall, the estimates in the table are imprecise, but two general patterns emerge. First, from Panels A and C (whole sample and non-college sample, respectively) there is a sluggish reaction to permanent shocks, with similar coefficients on current and lagged shocks, which suggests interdependence of investments across periods. Second, all the coefficients on Panel B (college sample) are

[32]The mean age of mothers in our sample is 33, varying between 22-51; the mean age of heads in Blundell, Pistaferri and Preston, 2008 is 43-45 years old - similar age range to the sample used in Blundell, Pistaferri and Saporta, 2012. Additionally, the mother of children in the NLSY79 are drawn from a younger cohort (born between 1957-1964 vs. 1921-1959 in Meghir and Pistaferri, 2004, and Blundell, Pistaferri and Preston, 2008).

When we estimate the variances of permanent and transitory shocks imposing sample restrictions closer to Blundell, Pistaferri and Preston, 2008, we obtain the following variances: 0.036 (0.024) and 0.053 (0.018) for the permanent and transitory shocks, respectively (standard errors in parenthesis). To estimate these variances we use just the males from the NLSY79 who are continuously married between 1985 and 2008 and drop those with an income growth above 500 percent, below -100 percent (they use -80 percent), or with a level of income below $50 in a given year.

[33]See equation C.13 in Appendix C.

statistically indistinguishable from zero and, importantly, precisely close to zero. Attempts to include additional lags of shocks in the model resulted in very imprecise estimates.

In table 7 we allow the coefficient on insurance parameters ϕ and ψ to vary by child's age. Since demographic characteristics are removed by the first stage estimation, which includes controls for fixed effects for the age of children, we expect that ϕ and ψ capture differences in the insurance possibilities of families for children at different ages. We also allow for time nonstationarity in estimation of the variance of permanent and transitory shocks[34] As for the partial insurance coefficients for the permanent shock (ϕ) and for the transitory shock (ψ), we assume that they take on two different values, for ages 0-7 and 8-15 (see table A.8 in Appendix A for sensitivity to these estimates when we allow the effect to vary instead by ages: (1) 0-5 and 6-15 and (2) 0-9 and 10-15). The estimates in the table show that unexpected changes in income significantly affect parental inputs before age 8. For the whole sample (column 1) a 10% permanent income increase is associated with a 2% SD increase in inputs (HOME) for younger children. We cannot reject the null of no reaction to permanent shocks for older children, and for transitory shocks. The effects detected for the whole sample are driven by the non-college sample (column 3), where estimates of ϕ are statistically significant for both age groups, but larger among the youngest.[35]

Two types of parental inputs: time and goods In table 8 we present estimates for model (11). Since we want to examine empirically the complementarity/subsititution between inputs which represent predominantly time and goods, we only use these two indices. Comparing the estimates in table 8 with those for the restricted model in table 5, it seems that ignoring the interdependence between time and goods related investments underestimates only slightly the transmission of income shocks to changes in parental inputs. In particular, estimates in column (1) show that a 10% permanent income increase is associated with 1.2% SD increase in goods-inputs and 0.9% SD in time-inputs, which is comparable to the figures in Panel A of table 5. Again, these estimates are driven by the sample of non-college mothers. Finally, for all three samples the estimate for the degree of interdependence between time and goods is positive (φ), suggesting complementarity between the two types of inputs. In Appendix C we show that model (11) is under-identified if $\varphi_e \neq \varphi_g$. Therefore, we choose

[34]When we let the variances of the permanent and the transitory shock to vary with the age of child we obtain variances of income shocks similar for all age groups. For the permanent shock we obtain: ages 0-7 0.174(0.024), ages 8-9 0.185 (0.032), ages 10-15 0.138 (0.022). For the transitory shock we obtain: ages 0-5 0.187 (0.018), ages 6-7 0.175 (0.024), ages 8-9 0.198 (0.020), ages 10-11 0.219 (0.023), ages 12-15 0.229 (0.015); standard errors in parenthesis.

[35]Table A.7 in Appendix A presents a version of table 7 using the five outcomes used throughout the paper.

to present in the main text estimates that restrict $\varphi_e = \varphi_g$.[36]

4.3 Sensitivity Analysis

We now turn to some sensitivity analysis. All results are included in table A.9 in Appendix A, but we briefly discuss them here because they have some relevance for the understanding of our main results presented above. The table has two panels. In the estimates in panel A we consider that the effect of shocks is the same regardless of the age of the child, whereas in the panel B we allow the effect to vary for children according to their age (0-7 and 8-15). To keep the analysis simple we only present estimates using the HOME score.

We first analyze how the estimates in tables 5 and 7 are affected when we impose a more stringent sample restriction. In particular, in columns (1)-(3) we include the sample of children in families where the mother was married at least part of the period in which we observe the child in the sample. In columns (4)-(6) we include the sample of children whose mother was never married during the sampling period. In general, the coefficients of both permanent and transitory shocks are larger in columns (4)-(6) (not married sample) than in columns (1)-(3) (married sample). When the effect of shocks is allowed to vary according to the age of the child (panel B), we reject the null that permanent income shocks do not affect parental investments for the sample of never married mothers. This result suggests that father's labor supply could be an important insurance mechanism for families.

Second, one large parental input missing is the location of residence, which affects the social network available to families. Therefore, we re-estimate tables 5 and 7, but dividing the state of residence into "high" and "low" insurance states. We divide states into "high" and "low" insurance using the maximum benefit (per capita) that families are potentially entitled for the AFDC/TANF.[37] A state is "high" insurance type if it frequently has an average per capita transfer above the median for most years since 1979. As expected, the effects of (permanent) shocks are only present for those living in "low" insurance states. Finally, although we control for fixed effects for the state of residence in our first step estimates, one large parental input missing is the neighborhood where the parent chooses to live in.[38] This affects not only the school the child attends, but his peers and the parental inputs of his peers that might spillover. Thus, if this investment makes up the bulk of the parental investments, there may exist few scope for parental response to income shocks. To account for this possibility we re-estimated the first step controlling not for state but county

[36] Estimates with $\varphi_e \neq \varphi_g$ proved to be too unstable, but the results are available from the authors.

[37] AFDC stands for Aid to Families with Dependent Children, which was replaced in 1996 by TANF (Temporary Assistance for Needy Families).

[38] We thank an anonymous referee for this point.

of residence fixed effects (and these interacted with year effects). Once this dimension is accounted for the estimates are very similar to those reported on tables 5 and 7, but more imprecise due to the large number of fixed effects added. Thus, we report here only the estimates for the non-college sample and for the model where we allow the effects to vary by age of children (this where we find the strongest effects). The coefficient estimate (standard errors in parenthesis) for ϕ for ages 0-7 is equal 0.284 (0.210); and for ages 8-17 it is equal to 0.180 (0.172). The estimates fo ψ for ages 0-7 is equal to -0.024 (0.130); and for ages 8-15 it is equal to 0.042 (0.054).

5 Conclusion

This paper presents the first estimates of the response of parental investments in children to permanent and transitory shocks to income. We find that investments react to permanent fluctuations in family income. This is true whether we look at the raw data in a simple way, with within child regressions, or if we decompose income fluctuations into permanent and transitory components. This decomposition allows us to learn that investments in children react to the permanent but not to the transitory component of family income, especially when the child is younger than 8 years of age and in families of non-college mothers. Although the literature measuring the impact of income on child development is still controversial (e.g., Mayer, 1997, Dahl and Lochner, 2012), our results suggest that, if income fluctuations affect child outcomes, it is possibly through the reaction of parents to permanent income shocks.

It is important to insure families against these income fluctuations. The case for public insurance is perhaps stronger here than in the standard literature looking at overall household consumption, because investments in children can have long term negative (and potentially irreversible) consequences. The effects we estimate suggest that income fluctuations may explain part of the differences in the adolescent and adult outcomes between individuals who are otherwise equal.

There is, however, still a tremendous amount of work to do in this research area. Our paper is quite simple because it gives us a first approach to this problem. Nevertheless it produced very interesting and novel results. What we did here was just to mainly borrow the methodology used for the study of non-durable consumption (Blundell, Preston and Pistaferri, 2008). We tried to extend it by adding lagged income shocks but the results were imprecise. We also show that how extending their setup to account for two types of parental inputs (goods and time) is important to capture the degree of sensitivity to income shocks.

What is required is a better study of the theory laid out in section 2, possibly even with the inclusion of time explicitly in the model. A whole other set of issues regard the measurement of investments in children, and the distinction between time and money investments, which can only be solved by gathering data on these dimensions. Finally, we need a better study of dynamics, the role of the timing of different types of shocks, and the possible interactions between shocks taking place in different time periods.

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6 Tables

Table 1: Measures of quality of home environment.

Available at ages	0-2	3-5	6-9	10-14
Goods				
(NH) Child attends a private school or child care	x	x	x	x
Child has 10 or more soft toys at home	x			
Child has 10 or more push/pull toys at home	x			
Family gets at least 3 magazines regularly		x		
Child has a CD player		x		
Family subscribes daily newspapers			x	x
Child has a musical instrument that she can use			x	x
Child has more than 10 books at home	x	x	x	x
Time				
Child taken at least once per week to grocery	x			
Child goes on outings more than 3 times per month	x	x		
Child eats at least one meal a day with both parents	x	x	x	x
Child sees the father(-figure) daily	x	x	x	x
Mother reads to the child at least once a week	x	x	x	
Mother/family member helps child learning numbers		x		
Mother/family member helps child learning alphabet		x		
Mother/family member helps child learning colors		x		
Mother/family member helps child learning shapes		x		
Child was taken more than twice to museum in past year		x	x	x
Child spends time with father/father-figure at least four times per week	x	x		
Family gets together with friends/relatives at least 2 times a month			x	x
Child spends time with father/father-figure in outdoor activities once a week			x	x
When family watches TV, mother discusses programs with child			x	x
Child was taken more than twice to teather/performance in past year			x	x
(NH) Child went with parents shopping last month				x
(NH) Child went with parents on an outing last month				x
(NH) Child worked with parents on schoolwork last week				x
(NH) Child went with parents to movies last month				x
(NH) Child went with parents to dinner last mont				x
(NH) Child did things together with parents last week				x

Table 2: Descriptive Statistics

	(1)	(2)	(3)	(4)
	All Sample		HS/Dropout	College
Variable	Obs	Mean	Mean	Mean
Parental Inputs				
HOME score	36577	-0.19	-0.44	0.07
Emotional Support	32671	-0.14	-0.27	0.00
Cognitive Stimulation	34620	-0.17	-0.44	0.11
Index of consumption	36259	0.03	-0.21	0.28
Index of time use	36229	0.01	-0.13	0.15
Child Characteristics				
Time invariant				
Male	7404	0.51	0.51	0.50
Black	7404	0.31	0.31	0.30
Hispanic	7404	0.20	0.21	0.17
Mother's age at child's birth	7404	25.50	24.11	27.17
Time varying				
Age of child	36577	7.61	7.79	7.41
1 if "No siblings"	36577	0.08	0.07	0.09
1 if "Child has one sibling"	36577	0.35	0.31	0.39
1 if "Child has 2 or more siblings"	36577	0.58	0.62	0.52
Family Characteristics				
Time invariant				
Mother has HS degree	3274	0.53		
Mothers AFQT score	3274	36.96	25.55	49.71
Mother lived with both natural parents at age 14	3270	0.66	0.61	0.71
Years of education of mothers mother	3103	10.59	9.73	11.52
Years of education of mothers father	2769	10.57	9.41	11.74
Time varying				
Mother married last year	36577	0.64	0.57	0.72
Family Size	36577	4.42	4.53	4.30
Family Income Net of Federal Taxes	36577	45228.06	32542.65	58923.94
Live in big city	36577	0.39	0.40	0.38
Mother worked last year	36577	0.74	0.68	0.81
Mother's spouse/partner worked last year	25092	0.98	0.98	0.99
Receive welfare income	36217	0.23	0.33	0.12

Notes: Data from the Children of the NLSY linked to their mothers in the main NLSY79. The unit of observation is a child. The sample is restricted to the sample used in table 3. Children must have valid HOME score, child and family control measures, and family disposable income for the reported year. Children must also have at least two years of valid observations of HOME score and disposable income to be included in sample.
The sample of high school graduates (HS) or dropouts includes 4053 children, whereas the sample of children whose mothers attended some college has 3351 children.

Table 3: OLS Estimates of the Effect of Family Income on Parental Inputs: Current Income.

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	All		College		HS/Dropout	
			Panel A: HOME			
Ln $Y_t(\gamma)$	0.026**	0.020	-0.006	-0.026	0.039**	0.043**
	[0.011]	[0.015]	[0.016]	[0.018]	[0.015]	[0.021]
Ln $Y_t \times$ Age 8-15 (γ_1)		0.011		0.041**		-0.006
		[0.015]		[0.018]		[0.022]
Observations	36,577	36,577	17,588	17,588	18,989	18,989
P-Value for H0: $\gamma + \gamma_1 = 0$		0.018		0.415		0.027
			Panel B: Cognitive Stimulation			
Ln $Y_t(\gamma)$	0.023*	0.018	-0.003	-0.035*	0.031*	0.045*
	[0.013]	[0.016]	[0.017]	[0.019]	[0.017]	[0.023]
Ln $Y_t \times$ Age 8-15 (γ_1)		0.010		0.065***		-0.027
		[0.016]		[0.019]		[0.023]
Observations	34,620	34,620	16,706	16,706	17,914	17,914
P-Value for H0: $\gamma + \gamma_1 = 0$		0.037		0.130		0.297
			Panel C: Emotional Support			
Ln $Y_t(\gamma)$	0.027*	0.019	-0.013	-0.018	0.051***	0.034
	[0.014]	[0.016]	[0.020]	[0.022]	[0.019]	[0.023]
Ln $Y_t \times$ Age 8-15 (γ_1)		0.015		0.011		0.032
		[0.016]		[0.021]		[0.025]
Observations	32,671	32,671	15,823	15,823	16,848	16,848
P-Value for H0: $\gamma + \gamma_1 = 0$		0.030		0.747		0.002
			Panel D: Goods			
Ln $Y_t(\gamma)$	0.024**	0.013	0.010	-0.024	0.034***	0.038**
	[0.010]	[0.013]	[0.015]	[0.019]	[0.013]	[0.018]
Ln $Y_t \times$ Age 8-15 (γ_1)		0.022		0.069***		-0.007
		[0.015]		[0.022]		[0.021]
Observations	36,259	36,259	17,485	17,485	18,774	18,774
P-Value for H0: $\gamma + \gamma_1 = 0$		0.003		0.011		0.047
			Panel E: Time			
Ln $Y_t(\gamma)$	0.030***	0.043***	0.007	-0.000	0.042***	0.069***
	[0.011]	[0.013]	[0.016]	[0.018]	[0.015]	[0.018]
Ln $Y_t \times$ Age 8-15 (γ_1)		-0.026*		0.015		-0.049**
		[0.014]		[0.020]		[0.020]
Observations	36,229	36,229	17,466	17,466	18,763	18,763
P-Value for H0: $\gamma + \gamma_1 = 0$		0.186		0.457		0.282

Note: The table presents OLS estimates of parental inputs on family disposable income. The controls included in regressions and not presented in the table include the following: a set of observable family time varying characteristics (family size, current state of residence, an indicator for whether the family lives in a big city, mother's marital status, indicators for the number of sibling the child has and for the total number of children in family). We include interactions of the following variables with year effects: child's race, state of residence, residence in big city, maternal AFQT, and education of maternal grandmother and grandfather. We include the following fixed effects: year, age of the child, and child fixed effects. The unit of observation is child-year.
The standard errors are clustered by mother. *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

Table 4: OLS Estimates of the Effect of Family Income on Parental Inputs: Current and Lagged Income.

	(1)	(2)	(3)	(4)	(5)
	HOME	Cognitve Stimulation	Emotional Support	Time	Goods
			Panel A: All Sample		
Ln Yt	0.030*	0.032*	0.025	0.031**	0.025*
	[0.016]	[0.018]	[0.019]	[0.014]	[0.015]
Ln Yt-2	0.001	-0.007	0.001	0.003	-0.003
	[0.014]	[0.015]	[0.018]	[0.012]	[0.014]
Ln Yt-4	-0.013	-0.008	-0.011	0.001	-0.012
	[0.013]	[0.014]	[0.016]	[0.012]	[0.014]
Observations	27,687	26,357	24,594	27,430	27,411
Cumulative Effect	0.019	0.017	0.015	0.035	0.010
	[0.027]	[0.029]	[0.035]	[0.024]	[0.026]
			Panel B: Mother attended some college		
Ln Yt	-0.001	-0.003	-0.006	0.009	0.002
	[0.021]	[0.023]	[0.027]	[0.021]	[0.022]
Ln Yt-2	-0.002	0.002	0.004	0.019	-0.003
	[0.019]	[0.021]	[0.024]	[0.018]	[0.020]
Ln Yt-4	-0.018	-0.011	0.001	0.003	-0.036*
	[0.017]	[0.018]	[0.022]	[0.018]	[0.019]
Observations	14,212	13,557	12,736	14,128	14,114
Cumulative Effect	-0.021	-0.012	0.000	0.031	-0.037
	[0.039]	[0.043]	[0.045]	[0.037]	[0.038]
			Panel C: Mother is HS graduate or dropout		
Ln Yt	0.047**	0.048*	0.050*	0.047**	0.043**
	[0.022]	[0.025]	[0.028]	[0.019]	[0.020]
Ln Yt-2	0.012	-0.008	0.005	-0.006	-0.000
	[0.020]	[0.021]	[0.026]	[0.016]	[0.019]
Ln Yt-4	-0.005	-0.006	-0.019	-0.005	0.007
	[0.019]	[0.019]	[0.023]	[0.016]	[0.020]
Observations	13,475	12,800	11,858	13,302	13,297
Cumulative Effect	0.0547	0.0331	0.0362	0.0364	0.0497
	[0.036]	[0.039]	[0.052]	[0.032]	[0.036]

Note: The table presents OLS regression of parental inputs on family disposable income. The controls included in regressions and not presented in the table include the following: a set of observable family time varying characteristics (family size, current state of residence, an indicator for whether the family lives in a big city, mother marital status, indicators number of children for the number of sibling the child has and for the total number of children in family). We include interactions of the following variables with year effects: child's race, region of residence, residence in big city, maternal AFQT, and education of maternal grandmother and grandfather. We include the following fixed effects: year, age of the child, and child fixed effect. The unit of observation is child-year.
The standard errors are clustered by mother. *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

Table 5: Minimum Distance Estimates: Transmission of Income Shocks to Parental Inputs.

	(1)	(2)	(3)	(4)	(5)
	HOME	Cognitive Stimulation	Emotional Support	Time	Goods
			Panel A: All Sample		
Insurance permanent shock (ϕ)	0.059	0.123	0.045	0.130	0.068
	(0.044)	(0.049)**	0.0486	(0.045)***	(0.038)*
Insurance transitory shock (ψ)	0.063	0.003	0.036	-0.004	0.047
	(0.038)	(0.035)	(0.040)	(0.033)	(0.031)
			Panel B: Mother attended some college		
Insurance permanent shock (ϕ)	-0.006	0.015	-0.050	0.022	0.080
	(0.063)	(0.067)	(0.070)	(0.063)	(0.058)
Insurance transitory shock (ψ)	0.030	0.042	0.015	0.002	0.002
	(0.052)	(0.053)	(0.056)	(0.051)	(0.050)
			Panel C: Mother is HS graduate or dropout		
Insurance permanent shock (ϕ)	0.105	0.216	0.107	0.171	0.115
	(0.070)	(0.076)***	0.0756	(0.063)***	(0.057)**
Insurance transitory shock (ψ)	0.083	-0.038	0.050	0.022	0.035
	(0.060)	(0.050)	(0.059)	(0.044)	(0.039)

Note: This table reports diagonally weighted minimum distance estimates of the partial insurance coefficients for permanent and transitory income shocks. Asymptotic standard errors in parenthesis (computed as suggested in Chamberlain, 1984). *, **, *** significant at 10%, 5% and 1%, respectively.

Table 6: Minimum Distance Estimates: Transmission of Income Shocks to Parental Inputs.

	(1)	(2)	(3)	(4)	(5)
	HOME	Cognitive Stimulation	Emotional Support	Time	Goods
			Panel A: All Sample		
Insurance permanent shock ϕ^0	0.053	-0.070	0.080	0.144	0.022
	(0.107)	(0.122)	(0.144)	(0.109)	(0.095)
Insurance transitory shock ψ^0	0.068	0.076	0.010	0.062	0.065
	(0.041)*	(0.043)*	(0.045)	(0.034)*	(0.031)**
Insurance permanent shock ϕ^1	0.031	0.133	0.002	-0.096	-0.004
	(0.118)	(0.152)	(0.130)	(0.113)	(0.104)
Insurance transitory shock ψ^1	0.010	-0.027	0.001	0.040	-0.024
	(0.063)	(0.064)	(0.067)	(0.055)	(0.048)
			Panel B: Mother attended some college		
Insurance permanent shock ϕ^0	-0.125	-0.179	-0.098	0.017	0.080
	(0.147)	(0.177)	(0.186)	(0.162)	(0.139)
Insurance transitory shock ψ^0	0.036	0.034	0.016	-0.001	0.018
	(0.058)	(0.055)	(0.076)	(0.051)	(0.051)
Insurance permanent shock ϕ^1	0.149	0.237	0.051	0.063	0.132
	(0.183)	(0.251)	(0.182)	(0.167)	(0.161)
Insurance transitory shock ψ^1	-0.037	-0.073	-0.018	0.017	-0.071
	(0.082)	(0.082)	(0.088)	(0.082)	(0.073)
			Panel C: Mother is HS graduate or dropout		
Insurance permanent shock ϕ^0	0.066	-0.007	0.120	0.160	-0.068
	(0.170)	(0.177)	(0.211)	(0.156)	(0.145)
Insurance transitory shock ψ^0	0.078	0.098	0.055	0.107	-0.003
	(0.060)	(0.067)	(0.059)	(0.050)**	(0.043)
Insurance permanent shock ϕ^1	0.054	0.064	-0.017	-0.154	0.154
	(0.177)	(0.203)	(0.197)	(0.167)	(0.154)
Insurance transitory shock ψ^1	-0.022	-0.009	0.004	0.023	-0.131
	(0.091)	(0.093)	(0.104)	(0.075)	(0.063)**

Note: This table reports diagonally weighted minimum distance estimates of the partial insurance coefficients for permanent and transitory income shocks. Asymptotic standard errors in parenthesis (computed as suggested in Chamberlain, 1984). *, **, *** significant at 10%, 5% and 1%, respectively.

Table 7: Minimum Distance Estimates: Transmission of Income Shocks to Parental Inputs: HOME score.

Sample	(1) All	(2) College	(3) HS/Dropout
Insurance permanent shock ϕ			
Ages 0-7	0.196	-0.025	0.341
	(0.119)*	(0.094)	(0.190)*
Ages 8-15	0.087	0.058	0.170
	(0.062)	(0.125)	(0.099)*
Insurance transitory shock ψ			
Ages 0-7	-0.036	0.000	-0.019
	(0.087)	(0.098)	(0.118)
Ages 8-15	0.037	0.003	0.010
	(0.034)	(0.057)	(0.048)

Note: This table reports diagonally weighted minimum distance estimates of the partial insurance coefficients for permanent and transitory income shocks. Asymptotic standard errors in parenthesis (computed as suggested in Chamberlain, 1984). *, **, *** significant at 10%, 5% and 1%, respectively.

Table 8: Minimum Distance Estimates: Transmission of Income Shocks to Parental Inputs - Time and Goods.

Sample	(1) All	(2) College	(3) HS/Dropout
Goods			
Insurance permanent shock ϕ	0.120	0.061	0.127
	(0.040)***	(0.056)	(0.057)**
Insurance transitory shock ψ	0.0025	0.017	0.022
	(0.031)	(0.051)	(0.039)
Time			
Insurance permanent shock ϕ	0.093	0.026	0.201
	(0.044)**	(0.063)	(0.0670)***
Insurance transitory shock ψ	0.0227	-0.002	-0.010
	(0.033)	(0.051)	(0.045)
Complementarity (φ)	0.025	0.017	0.030
	(0.005)***	(0.008)**	(0.008)***

Note: This table reports diagonally weighted minimum distance estimates of the partial insurance coefficients for permanent and transitory income shocks. Asymptotic standard errors in parenthesis (computed as suggested in Chamberlain, 1984). *, **, *** significant at 10%, 5% and 1%, respectively.

A Tables

Table A.1: Correlation between home environment and time with mother or father (Data: PSID-CDS).

	(1)	(2)
β	Total Time	Leisure
Time with	Mother	
	Panel A: HOME	
β	0.0002**	0.0001
	[0.0001]	[0.0001]
Mean of HOME	0.016	
SD	1.018	
	Panel B: Cognitive Stimulation	
β	0.0002*	0.0000
	[0.0001]	[0.0001]
Mean of Cognitive Stimulation	-0.001	
SD	1.008	
	Panel C: Emotional Support	
β	0.0001	0.0002*
	[0.0001]	[0.0001]
Mean of Emotional Support	0.028	
SD	1.006	
Observations		
Mean of time var. (minutes per day)	177.2	118.3
SD	153.8	117.7
Time with	Father	
	Panel D: HOME	
β	0.0004***	0.0005***
	[0.0001]	[0.0002]
Mean Y	0.016	
SD Y	1.018	
Observations	2,600	2,600
Mean of time var. (minutes per day)	83.69	55.32
SD	100.8	80.11

Note: This table presents regressions of index measures of quality of the home environment (HOME, Congnitive Stimulation and Emotional Support) on child's time with mother (Panels A-C) or father (Panel D). We consider two possible measures time use: minutes per day with mother or father and in leisure activities. We include the following controls not displayed in the table: indicators for the education of the head of household (high school graduate, some college, college degree; high school dropout is the omitted category), permanent income, indicators for wether the head is black or male, indicators for the number of children in household, dummies for the age of child (in years) and year fixed effects. The measure of permanent income is the average of family's disposal income before she turns 17. Standard errors robust to heteroskedasticity in brackets. *, **, *** significant at 10%, 5% and 1%, respectively.

Table A.2: OLS estimates of cognitive scores and behaviors on parental inputs (Data: CNLSY).

	(1)	(2)	(3)	(4)	(5)	(6)
Variable	PIAT		BPI		HS Enrolment	Arrested
Ages	13-14				Ages 17-18	
HOME Current	0.188***	0.136***	-0.249***	-0.185***		
	[0.022]	[0.023]	[0.023]	[0.024]		
HOME 0-2		0.047**		-0.036*	0.009	-0.003
		[0.020]		[0.022]	[0.007]	[0.007]
HOME 3-5		0.128***		-0.102***	0.005	-0.004
		[0.026]		[0.027]	[0.009]	[0.009]
HOME 6-9		0.052*		-0.110***	0.013	0.008
		[0.028]		[0.030]	[0.010]	[0.009]
HOME 11-14					0.014	-0.021**
					[0.010]	[0.009]
(Log) Permanent Income	0.226***	0.160***	-0.113***	-0.038	0.050***	-0.035***
	[0.040]	[0.040]	[0.038]	[0.039]	[0.013]	[0.011]
Observations	2,623	2,623	2,761	2,761	2,354	2,459
Mean depend. var.	-0.091		0.310		0.893	0.083
SD	1.037		0.991		0.309	0.277
P-Value: joint test on HOME vars.		0		0	0.011	0.152

Note: Controls excluded from table include child's gender, dummies for the age of the child, number of siblings, race and year fixed effects. We control also for mothers characteristics: age, completed education (high school, some college or college), Armed Forces Qualification Test (AFQT) score, and whether she lived with both natural parents at age 14. It also includes the mothers marital status in the previous year (corresponding to the year income is measured), household composition variables such as age and education of spouse, and education measures of the mothers parents. The measure of permanent income is the average of family's disposal income before the child turns 17. Robust standard errors clustered by mother in parenthesis. *, **, *** significant at 10%, 5% and 1%, respectively.

Table A.3: Within child regressions of cognitive scores and behaviors on parental inputs (Data: CNLSY).

	(1) PIAT	(2) BPI
HOME t	0.018	-0.056***
	[0.011]	[0.013]
HOME t-2	0.025**	-0.000
	[0.012]	[0.012]
HOME t-4	0.026**	-0.000
	[0.012]	[0.011]
Cumulative Effect	0.069***	-0.057**
	[0.025]	[0.023]
Observations	8,708	10,956
Mean	0.115	0.272
SD	0.979	0.999
P-Value: joint test on HOME vars.	0.107	0.000

Note: Controls excluded from table include dummies for the age of the child, number of siblings and year fixed effects. We control also for mothers characteristics: age, marital status in the previous year (corresponding to the year income is measured), and as age and education of spouse. Estimates in columns (1) and (2) include child fixed effects. The sample used in the table includes the same children used to estimate the results in table A.2. Children are ages 5-14. Robust standard errors clustered by mother in parenthesis. *, **, *** significant at 10%, 5% and 1%, respectively.

Table A.4: OLS Estimates of Parental Inputs on Family Income: Current and Lagged Income.

Samples	(1) All	(2) Non College	(3) College	(4) All	(5) Non College	(6) College
Child attends private school/child care: Log Y_t	0.000	-0.003	0.004	-0.001	-0.006	0.007
	[0.005]	[0.006]	[0.008]	[0.006]	[0.007]	[0.010]
Log Y_{t-2}				-0.001	-0.008	0.005
				[0.005]	[0.006]	[0.008]
Observations	26,546	13,006	13,540	24,376	11,776	12,600
	0.307	0.254	0.359			
SD	0.461	0.435	0.480			
Cumulative Effect				-0.002	-0.014	0.012
				[0.009]	[0.010]	[0.014]
Child has 10+ soft toys: Log Y_t	0.002	0.027	-0.007	0.001	0.019	0.004
	[0.057]	[0.104]	[0.099]	[0.074]	[0.141]	[0.125]
Log Y_{t-2}				-0.007	-0.009	0.006
				[0.065]	[0.099]	[0.140]
Observations	5,665	2,731	2,934	4,389	1,980	2,409
	0.492	0.464	0.519			
SD	0.500	0.499	0.500			
Cumulative Effect				-0.006	0.010	0.010
				[0.118]	[0.212]	[0.213]
Child has 10+ push/pull toys: Log Y_t	-0.016	-0.003	-0.012	-0.030	0.032	-0.053
	[0.040]	[0.070]	[0.084]	[0.053]	[0.100]	[0.096]
Log Y_{t-2}				-0.025	0.014	-0.076
				[0.054]	[0.083]	[0.102]
Observations	5,682	2,739	2,943	4,409	1,988	2,421
	0.128	0.126	0.130			
SD	0.334	0.332	0.336			
Cumulative Effect				-0.054	0.047	-0.129
				[0.091]	[0.159]	[0.151]
Child has more than 10 books: Log Y_t	-0.000	-0.001	0.001	0.003	0.003	0.002
	[0.005]	[0.007]	[0.007]	[0.006]	[0.008]	[0.008]
Log Y_{t-2}				-0.000	-0.000	-0.001
				[0.005]	[0.007]	[0.007]
Observations	36,144	18,729	17,415	32,069	16,170	15,899
	0.712	0.624	0.806			
SD	0.453	0.484	0.396			
Cumulative Effect				0.003	0.002	0.001
				[0.008]	[0.011]	[0.011]
Family gets at least 3 magazines: Log Y_t	0.030	0.077	0.011	0.001	0.060	-0.004
	[0.044]	[0.075]	[0.063]	[0.054]	[0.091]	[0.081]
Log Y_{t-2}				-0.015	-0.026	-0.011
				[0.047]	[0.078]	[0.071]
Observations	7,589	3,793	3,796	6,344	2,999	3,345
	0.370	0.282	0.458			
SD	0.483	0.450	0.498			
Cumulative Effect				-0.015	0.034	-0.015
				[0.084]	[0.140]	[0.128]
Child has a CD player: Log Y_t	0.011	0.024	0.005	0.017	0.039	0.002
	[0.039]	[0.086]	[0.054]	[0.049]	[0.101]	[0.070]
Log Y_{t-2}				0.027	0.051	0.010
				[0.045]	[0.084]	[0.068]
Observations	7,565	3,773	3,792	6,322	2,980	3,342
	0.756	0.676	0.836			
SD	0.429	0.468	0.370			
Cumulative Effect				0.044	0.090	0.012
				[0.079]	[0.151]	[0.116]

OLS Estimates of Parental Inputs on Family Income: Current and Lagged Income (cont.).

	(1)	(2)	(3)	(4)	(5)	(6)
Samples	All	Non College	College	All	Non College	College
Family subscribes daily newspapers: Y_t	0.026***	0.027**	0.028**	0.027***	0.027**	0.034**
	[0.008]	[0.011]	[0.012]	[0.009]	[0.013]	[0.014]
Log Y_{t-2}				-0.007	-0.006	-0.007
				[0.008]	[0.010]	[0.012]
Observations	22,735	12,120	10,615	21,199	11,120	10,079
	0.456	0.407	0.512			
SD	0.498	0.491	0.500			
Cumulative Effect				0.021	0.021	0.027
				[0.013]	[0.018]	[0.020]
Child has a musical instrument: Y_t	0.009	0.020**	-0.008	0.011	0.024**	-0.006
	[0.008]	[0.010]	[0.014]	[0.009]	[0.012]	[0.016]
Log Y_{t-2}				0.006	0.010	0.003
				[0.008]	[0.011]	[0.013]
Observations	22,732	12,123	10,609	21,197	11,123	10,074
	0.490	0.384	0.611			
SD	0.500	0.486	0.487			
Cumulative Effect				0.017	0.034**	-0.003
				[0.013]	[0.017]	[0.022]
Mother reads to the child at least once a week: Y_t	-0.002	-0.003	-0.005	-0.003	-0.004	-0.006
	[0.007]	[0.009]	[0.011]	[0.009]	[0.011]	[0.013]
Log Y_{t-2}				0.001	0.008	-0.014
				[0.008]	[0.011]	[0.011]
Observations	24,313	12,345	11,968	20,700	10,080	10,620
	0.704	0.651	0.759			
SD	0.456	0.477	0.428			
Cumulative Effect				-0.002	0.004	-0.020
				[0.012]	[0.017]	[0.019]
Child eats at least one meal a day with parents: Y_t	0.010*	0.011	0.007	0.011	0.008	0.011
	[0.006]	[0.009]	[0.009]	[0.007]	[0.010]	[0.010]
Log Y_{t-2}				-0.009	-0.004	-0.017*
				[0.006]	[0.008]	[0.009]
Observations	34,617	17,646	16,971	31,254	15,598	15,656
	0.572	0.573	0.572			
SD	0.495	0.495	0.495			
Cumulative Effect				0.002	0.004	-0.006
				[0.010]	[0.013]	[0.014]
Child goes on outings more than 3 times/month: Y_t	0.015	0.016	0.017	0.024	0.021	0.037
	[0.013]	[0.019]	[0.019]	[0.016]	[0.023]	[0.023]
Log Y_{t-2}				0.006	0.010	0.001
				[0.014]	[0.022]	[0.022]
Observations	13,374	6,587	6,787	10,844	5,033	5,811
	0.710	0.658	0.760			
SD	0.454	0.474	0.427			
Cumulative Effect				0.030	0.031	0.039
				[0.023]	[0.035]	[0.035]
Child taken at least once/week to grocery: Y_t	0.042	0.033	0.057	0.057	0.066	0.051
	[0.048]	[0.083]	[0.075]	[0.059]	[0.123]	[0.086]
Log Y_{t-2}				0.016	-0.019	0.001
				[0.063]	[0.110]	[0.095]
Observations	5,694	2,747	2,947	4,415	1,992	2,423
	0.790	0.784	0.795			
SD	0.407	0.411	0.403			
Cumulative Effect				0.073	0.048	0.052
				[0.105]	[0.211]	[0.133]

OLS Estimates of Parental Inputs on Family Income: Current and Lagged Income (cont.).

Samples	(1) All	(2) Non College	(3) College	(4) All	(5) Non College	(6) College
Child spends time with father(-figure) 4×/week: Log Y_t	0.023**	0.029*	0.015	0.021	0.013	0.024
	[0.010]	[0.015]	[0.014]	[0.014]	[0.019]	[0.021]
Log Y_{t-2}				0.003	0.009	0.001
				[0.011]	[0.017]	[0.014]
Observations	13,329	6,571	6,758	10,804	5,021	5,783
	0.823	0.790	0.855			
SD	0.382	0.407	0.352			
Cumulative Effect				0.024	0.023	0.025
				[0.020]	0.029	0.0283
Mother/family member helps child learning numbers: Log Y_t	0.014	0.030	0.009	0.011	0.028	0.001
	[0.032]	[0.060]	[0.046]	[0.041]	[0.077]	[0.058]
Log Y_{t-2}				-0.010	-0.014	-0.016
				[0.031]	[0.063]	[0.041]
Observations	7,641	3,823	3,818	6,393	3,028	3,365
	0.925	0.912	0.938			
SD	0.263	0.283	0.242			
Cumulative Effect				0.001	0.014	-0.015
				[0.062]	[0.122]	[0.083]
Mother/family member helps child learning alphabet: Log Y_t	0.016	0.009	0.016	0.008	-0.031	0.020
	[0.032]	[0.066]	[0.037]	[0.038]	[0.079]	[0.048]
Log Y_{t-2}				0.017	0.025	0.004
				[0.034]	[0.062]	[0.046]
Observations	7,640	3,822	3,818	6,393	3,028	3,365
	0.901	0.875	0.927			
SD	0.298	0.330	0.260			
Cumulative Effect				0.025	-0.006	0.024
				[0.060]	[0.123]	[0.078]
Mother/family member helps child learning colors: Log Y_t	-0.012	-0.010	-0.027	-0.017	-0.038	-0.025
	[0.030]	[0.055]	[0.042]	[0.039]	[0.072]	[0.056]
Log Y_{t-2}				-0.012	-0.035	-0.016
				[0.033]	[0.068]	[0.041]
Observations	7,641	3,823	3,818	6,394	3,029	3,365
	0.920	0.905	0.935			
SD	0.271	0.293	0.246			
Cumulative Effect				-0.029	-0.073	-0.041
				[0.062]	[0.122]	[0.082]
Mother/family member helps child learning shapes: Log Y_t	0.022	0.048	0.017	0.015	0.027	-0.002
	[0.038]	[0.073]	[0.053]	[0.047]	[0.094]	[0.064]
Log Y_{t-2}				-0.028	-0.029	-0.052
				[0.039]	[0.075]	[0.053]
Observations	7,637	3,819	3,818	6,390	3,025	3,365
	0.809	0.753	0.865			
SD	0.393	0.431	0.341			
Cumulative Effect				-0.014	-0.003	-0.054
				[0.073]	[0.144]	[0.099]
Child was taken 2× or more to museum past year: Log Y_t	0.001	0.006	0.000	0.004	0.010	0.003
	[0.006]	[0.008]	[0.010]	[0.008]	[0.010]	[0.012]
Log Y_{t-2}				0.001	-0.002	0.005
				[0.007]	[0.008]	[0.011]
Observations	30,347	15,926	14,421	27,568	14,135	13,433
	0.349	0.286	0.419			
SD	0.477	0.452	0.493			
Cumulative Effect				0.005	0.008	0.008
				[0.010]	[0.013]	[0.016]

OLS Estimates of Parental Inputs on Family Income: Current and Lagged Income (cont.).

	(1)	(2)	(3)	(4)	(5)	(6)
Samples	All	Non College	College	All	Non College	College
Child goes on outings more than 3×/month: Log Y_t	0.015	0.016	0.017	0.024	0.021	0.037
	[0.013]	[0.019]	[0.019]	[0.016]	[0.023]	[0.023]
Log Y_{t-2}				0.006	0.010	0.001
				[0.014]	[0.022]	[0.022]
Observations	13,374	6,587	6,787	10,844	5,033	5,811
	0.710	0.658	0.760			
SD	0.454	0.474	0.427			
Cumulative Effect				0.030	0.031	0.039
				[0.023]	[0.035]	[0.035]
Child was taken 2×or + to performance past year: Log Y_t	0.003	0.006	-0.001	-0.000	0.003	-0.003
	[0.007]	[0.009]	[0.013]	[0.008]	[0.010]	[0.015]
Log Y_{t-2}				-0.001	0.009	-0.007
				[0.008]	[0.009]	[0.014]
Observations	22,737	12,128	10,609	21,202	11,127	10,075
	0.230	0.180	0.287			
SD	0.421	0.384	0.452			
Cumulative Effect				-0.001	0.011	-0.010
				[0.012]	[0.015]	[0.020]
Child spends time w/ father(-figure) at least 4×/week: Log Y_t	0.011	0.012	0.008	0.006	0.005	0.006
	[0.007]	[0.010]	[0.011]	[0.009]	[0.012]	[0.013]
Log Y_{t-2}				-0.006	-0.009	-0.003
				[0.007]	[0.011]	[0.010]
Observations	21,439	11,213	10,226	20,087	10,369	9,718
	0.746	0.715	0.781			
SD	0.435	0.452	0.414			
Cumulative Effect				0.000	-0.005	0.002
				[0.012]	[0.017]	[0.017]
Family gets together w/ friends at least 2×/month: Log Y_t	-0.012	-0.010	-0.014	-0.008	-0.005	-0.007
	[0.009]	[0.012]	[0.014]	[0.010]	[0.013]	[0.015]
Log Y_{t-2}				0.012	0.007	0.027*
				[0.009]	[0.012]	[0.015]
Observations	22,731	12,116	10,615	21,199	11,118	10,081
	0.555	0.559	0.550			
SD	0.497	0.497	0.498			
Cumulative Effect				0.004	0.002	0.020
				[0.014]	[0.018]	[0.022]
When watches TV, mother discusses progrs. w/ child: Log Y_t	0.012*	0.016	0.004	0.015*	0.023**	0.002
	[0.007]	[0.010]	[0.011]	[0.008]	[0.011]	[0.013]
Log Y_{t-2}				0.005	0.001	0.009
				[0.007]	[0.010]	[0.011]
Observations	22,286	11,810	10,476	20,781	10,831	9,950
	0.813	0.774	0.856			
SD	0.390	0.418	0.351			
Cumulative Effect				0.020	0.024	0.012
				[0.012]*	[0.016]	[0.017]
Child spends time w/ father(-fig.) outdoors once/week: Log Y_t	-0.001	-0.003	0.000	-0.005	-0.005	-0.007
	[0.008]	[0.010]	[0.013]	[0.009]	[0.012]	[0.015]
Log Y_{t-2}				-0.016*	-0.009	-0.027**
				[0.009]	[0.012]	[0.013]
Observations	21,589	11,301	10,288	20,243	10,456	9,787
	0.566	0.557	0.576			
SD	0.496	0.497	0.494			
Cumulative Effect				-0.021	-0.014	-0.033
				[0.014]	[0.018]	[0.022]

OLS Estimates of Parental Inputs on Family Income: Current and Lagged Income (cont.).

Samples	(1) All	(2) Non College	(3) College	(4) All	(5) Non College	(6) College
Child went w/ parents on an outing last month: Log Y_t	-0.007	0.012	-0.032	-0.006	0.009	-0.026
	[0.019]	[0.023]	[0.035]	[0.021]	[0.027]	[0.038]
Log Y_{t-2}				0.009	-0.010	0.026
				[0.019]	[0.025]	[0.034]
Observations	11,114	5,904	5,210	10,878	5,777	5,101
	0.384	0.339	0.435			
SD	0.486	0.473	0.496			
Cumulative Effect				0.003	-0.001	-0.001
				[0.032]	[0.042]	[0.061]
Child worked w/ parents on schoolwork last week: Log Y_t	-0.007	0.007	-0.028	0.002	0.012	-0.016
	[0.017]	[0.023]	[0.029]	[0.019]	[0.026]	[0.032]
Log Y_{t-2}				0.014	-0.010	0.036
				[0.019]	[0.025]	[0.032]
Observations	11,103	5,909	5,194	10,865	5,782	5,083
	0.362	0.388	0.333			
SD	0.481	0.487	0.471			
Cumulative Effect				0.016	0.003	0.021
				[0.031]	[0.042]	[0.052]
Child went w/ parents to movies last month: Log Y_t	0.002	0.008	0.006	0.003	0.011	-0.006
	[0.000]	[0.026]	[0.030]	[0.020]	[0.029]	[0.033]
Log Y_{t-2}				0.002	0.017	-0.032
				[0.018]	[0.025]	[0.031]
Observations	11,131	5,912	5,219	10,895	5,785	5,110
	0.384	0.338	0.437			
SD	0.486	0.473	0.496			
Cumulative Effect				0.005	0.029	-0.037
				[0.031]	[0.044]	[0.051]
Child went w/ parents to dinner last month: Log Y_t	0.002	-0.004	0.011	0.005	-0.005	0.014
	[0.018]	[0.025]	[0.029]	[0.020]	[0.029]	[0.032]
Log Y_{t-2}				0.002	-0.002	0.001
				[0.019]	[0.026]	[0.029]
Observations	11,149	5,920	5,229	10,912	5,792	5,120
	0.688	0.648	0.734			
SD	0.463	0.478	0.442			
Cumulative Effect				0.008	-0.007	0.015
				[0.031]	[0.044]	[0.049]
Child did things w/ parents last week: Log Y_t	-0.019	-0.015	-0.012	-0.020	-0.012	-0.012
	[0.019]	[0.024]	[0.034]	[0.022]	[0.029]	[0.038]
Log Y_{t-2}				-0.000	0.008	-0.002
				[0.019]	[0.026]	[0.035]
Observations	11,114	5,915	5,199	10,877	5,787	5,090
	0.508	0.499	0.519			
SD	0.500	0.500	0.500			
Cumulative Effect				-0.020	-0.005	-0.013
				[0.033]	[0.044]	[0.059]

OLS Estimates of Parental Inputs on Family Income: Current and Lagged Income (cont.).

	(1)	(2)	(3)	(4)	(5)	(6)
Samples	All	Non College	College	All	Non College	College
Child went with parents shopping last mont: Log Y_t	0.012	0.025	-0.001	0.020	0.034	0.007
	[0.016]	[0.023]	[0.026]	[0.019]	[0.027]	[0.029]
Log Y_{t-2}				0.010	0.015	0.005
				[0.016]	[0.023]	[0.027]
Observations	11,194	5,955	5,239	10,955	5,827	5,128
	0.792	0.793	0.790			
SD	0.406	0.405	0.407			
Cumulative Effect				0.030	0.049	0.012
				[0.029]	[0.041]	[0.047]

Note: The table presents OLS estimates of parental inputs on family disposable income. The controls included in regressions and not presented in the table include the following: a set of observable family time varying characteristics (family size, current state of residence, an indicator for whether the family lives in a big city, mother's marital status, indicators for the number of sibling the child has and for the total number of children in family). We include interactions of the following variables with year effects: child's race, state of residence, residence in big city, maternal AFQT, and education of maternal grandmother and grandfather. We include the following fixed effects: year, age of the child, and child fixed effects. The unit of observation is child-year.
The standard errors are clustered by mother. *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

Table A.5: Minimum Distance Estimates: Transmission of Income Shocks to Parental Inputs (by race and gender).

	(1)	(2)	(3)	(4)	(5)
	HOME	Cognitive Stimulation	Emotional Support	Time	Goods
			Panel A: Non Black		
Insurance permanent shock (ϕ)	0.117	0.073	0.087	0.077	0.069
	(0.054)**	(0.054)	(0.059)	(0.051)	(0.046)
Insurance transitory shock (ψ)	0.006	0.036	-0.002	0.044	0.042
	(0.044)	(0.039)	(0.048)	(0.042)	(0.038)
			Panel B: Black		
Insurance permanent shock (ϕ)	0.151	0.179	-0.052	0.008	0.056
	(0.088)*	(0.104)*	(0.096)	(0.080)	(0.071)
Insurance transitory shock (ψ)	-0.010	-0.023	0.106	0.086	0.059
	(0.075)	(0.072)	(0.076)	(0.055)	(0.053)
			Panel C: Boys		
Insurance permanent shock (ϕ)	0.067	0.046	0.060	0.055	0.032
	(0.059)	(0.065)	(0.064)	(0.065)	(0.053)
Insurance transitory shock (ψ)	0.070	0.046	0.060	0.039	0.069
	(0.057)	(0.053)	(0.058)	(0.053)	(0.046)
			Panel D: Girls		
Insurance permanent shock (ϕ)	0.045	0.173	0.035	0.034	0.102
	(0.069)	(0.080)**	(0.077)	(0.062)	(0.058)*
Insurance transitory shock (ψ)	0.058	-0.009	0.000	0.043	0.027
	(0.055)	(0.049)	(0.058)	(0.050)	(0.042)

Note: This table reports diagonally weighted minimum distance estimates of the partial insurance coefficients for permanent and transitory income shocks. Asymptotic standard errors in parenthesis (computed as suggested in Chamberlain, 1984). *, **, *** significant at 10%, 5% and 1%, respectively.

Table A.6: Minimum Distance Estimates: Transmission of Income Shocks to Parental Inputs (HOME score).

Sample	(1) All	(2) College	(3) HS/Dropout
Variance of permanent shock (σ^2_η)	0.087	0.071	0.099
	(0.009)***	(0.011)***	(0.014)***
Variance of transitory shock (σ^2_ε)	0.199	0.162	0.238
	(0.010)***	(0.011)***	(0.017)***
Insurance permanent shock (ϕ)	0.059	-0.006	0.105
	(0.044)	(0.063)	(0.070)
Insurance transitory shock (ψ)	0.063	0.030	0.083
	(0.038)	(0.052)	(0.060)
Variance of unobserved heterogeneity (σ^2_ξ)	0.083	0.059	0.100
	(0.012)***	(0.014)***	(0.021)***
Variance of measurement error in inputs (σ^2_{ug})	0.333	0.291	0.375
	(0.015)***	(0.016)***	(0.026)***

Note: This table reports diagonally weighted minimum distance estimates of the partial insurance coefficients for permanent and transitory income shocks. Asymptotic standard errors in parenthesis (computed as suggested in Chamberlain, 1984). *, **, *** significant at 10%, 5% and 1%, respectively.

Table A.7: Minimum Distance Estimates: Transmission of Income Shocks to Parental Inputs.

	(1)	(2)	(3)	(4)	(5)
	HOME	Cognitive Stimulation	Emotional Support	Time	Goods
			Panel A: All Sample		
Insurance permanent shock ϕ					
Ages 0-7	0.196	0.1033	0.087	0.156	0.0799
	(0.119)*	0.1088	(0.118)	(0.140)	0.0726
Ages 8-15	0.087	0.1556	0.115	0.045	0.1477
	(0.062)	0.1394	(0.128)	(0.060)	(0.072)**
Insurance transitory shock ψ					
Ages 0-7	-0.036	-0.0125	0.015	0.025	-0.0290
	(0.087)	0.0780	(0.092)	(0.089)	0.0668
Ages 8-15	0.037	-0.0004	-0.017	0.041	0.0163
	(0.034)	0.0480	(0.055)	(0.034)	0.0335
			Panel B: Mother attended some college		
Insurance permanent shock ϕ					
Ages 0-7	-0.025	-0.279	0.003	0.052	0.102
	(0.094)	(0.247)	(0.112)	(0.153)	(0.133)
Ages 8-15	0.058	0.036	-0.072	-0.003	0.047
	(0.125)	(0.098)	(0.202)	(0.091)	(0.069)
Insurance transitory shock ψ					
Ages 0-7	0.000	0.071	-0.022	0.003	-0.060
	(0.098)	(0.134)	(0.115)	(0.110)	(0.108)
Ages 8-15	0.003	0.080	0.015	0.004	0.055
	(0.057)	(0.052)	(0.076)	(0.056)	(0.044)
			Panel C: Mother is HS graduate or dropout		
Insurance permanent shock ϕ					
Ages 0-7	0.341	0.429	0.246	0.394	0.079
	(0.190)*	(0.250)*	(0.235)	(0.202)**	(0.103)
Ages 8-15	0.170	0.102	0.174	0.135	0.225
	(0.099)*	(0.104)	(0.141)	(0.108)	(0.118)*
Insurance transitory shock ψ					
Ages 0-7	-0.019	-0.073	-0.019	-0.050	-0.010
	(0.118)	(0.113)	(0.142)	(0.115)	(0.083)
Ages 8-15	0.010	0.037	-0.007	0.041	0.000
	(0.048)	(0.042)	(0.065)	(0.043)	(0.046)

Note: This table reports diagonally weighted minimum distance estimates of the partial insurance coefficients for permanent and transitory income shocks. Asymptotic standard errors in parenthesis (computed as suggested in Chamberlain, 1984). *, **, *** significant at 10%, 5% and 1%, respectively.

Table A.8: Minimum Distance Estimates: Transmission of Income Shocks to Parental Inputs: HOME score.

	(1)	(2)
Young	Ages 0-5	Ages 0-9
Old	Ages 6-15	Ages 10-15
Permanent Shocks		
Young	0.143	0.173
	(0.118)	(0.092)*
Old	0.107	0.119
	(0.059)*	(0.102)
Transitory Shocks		
Young	-0.020	-0.020
	(0.082)	(0.068)
Old	0.033	0.010
	(0.036)	(0.043)

Note: This table reports diagonally weighted minimum distance estimates of the partial insurance coefficients for permanent and transitory income shocks. Asymptotic standard errors in parenthesis (computed as suggested in Chamberlain, 1984). *, **, *** significant at 10%, 5% and 1%, respectively.

Table A.9: Sensitivity Analysis: Marital Status of Mothers and State Welfare Policy.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Married			Not Married		Low Ins	High Ins
Sample	All	College	HS/Dropout	All	College	HS/Dropout	All	All
Panel A: All ages								
Insurance permanent shock (ϕ)	0.020	0.040	0.011	0.077	-0.041	0.141	0.099	0.117
	(0.064)	(0.082)	(0.097)	(0.069)	(0.102)	(0.100)	(0.097)	(0.104)
Insurance transitory shock (ψ)	0.055	0.008	0.089	0.080	0.034	0.102	0.114	0.027
	(0.051)	(0.071)	(0.086)	(0.059)	(0.079)	(0.085)	(0.092)	(0.085)
Panel B: By Age								
Permanent Shocks (ϕ)								
Ages 0-7	0.009	-0.034	0.100	0.280	0.002	0.502	0.339	0.128
	(0.125)	(0.170)	(0.234)	(0.159)*	(0.129)	(0.251)**	(0.173)*	(0.164)
Ages 8-15	0.131	-0.033	0.121	0.151	0.011	0.199	0.035	0.147
	(0.169)	(0.182)	(0.217)	(0.099)	(0.144)	(0.112)*	(0.073)	(0.110)
Transitory Shocks (ψ)								
Ages 0-7	0.010	-0.014	0.001	-0.011	0.040	-0.049	-0.103	-0.012
	(0.111)	(0.140)	(0.214)	(0.103)	(0.133)	0.1306	(0.106)	(0.132)
Ages 8-15	-0.004	0.083	-0.001	-0.005	-0.031	0.036	0.052	0.016
	(0.059)	(0.073)	(0.081)	(0.055)	(0.097)	0.0603	0.0407	(0.059)

Note: This table reports diagonally weighted minimum distance estimates of the partial insurance coefficients for permanent and transitory income shocks. Asymptotic standard errors in parenthesis (computed as suggested in Chamberlain, 1984). *, **, *** significant at 10%, 5% and 1%, respectively.

B Model

Consider a "one parent-one child" family in a partial equilibrium framework. The parent has to decide how to divide (stochastic) income in each period among several alternatives: allocate resources to his own consumption, c_t, to the child's specific goods, g_t, and the amount of the risk-free asset to leave for the next period, A_{t+1}, with real return r. Parent's consumption good is the numeraire and q_t is the relative price of child's goods. We assume that labor supply of parent is inelastic. Parent's within period utility is $u(c_t, h_t)$, where c_t are goods consumed by the parent and h_t is child's human capital at the end of t years of life.[39] The parent is altruistic and he/she cares about child's welfare in each period, which is a function of her human capital in the end of period, h_t. In turn, the human capital at age t, h_t depends on previous stock h_{t-1} and current investment,

$$h_t = f(g_t, h_{t-1}). \tag{B.1}$$

The child leaves parental house at age $T+1$ and there is no depreciation in child's human capital between periods. While living with parents, the child does not make any decision and parent's decisions of investments are based on altruism.

Assets evolve according to the usual intertemporal budget constraint

$$A_{t+1} = (1+r)[A_t + y_t - c_t - q_t g_t] \tag{B.2}$$

where y_t is the family's disposable income (including earnings and transfers). The bequests must be nonnegative, $A_{T+1} \geq 0$.

Keeping implicit preferences shocks and characteristics of the family that affect preferences and the production of child's human capital, such as parental education and demographic characteristics as number and age of children, the parent of a t years old child maximizes expected utility subject to the skill formation technology and inter-temporal budget constraint (B.1) and (B.2), respectively[40]:

$$V^t(A_t, h_{t-1}, t) = \max_{c_t, g_t, A_{t+1}} \left\{ u(c_t, h_t) + \beta E_t V^{t+1}(A_{t+1}, h_t, t+1) \right\}$$

where E_t is the expectations operator associated with the probability distribution of future variables that are uncertain conditional on the information available at year t, that is, future prices, interest rates and income. Let $u_c(t) = \frac{\partial u(c_t, h_t)}{\partial c_t}$, $u_h(t) = \frac{\partial u(c_t, h_t)}{\partial h_t}$, then the first order conditions of this optimization problem for c and g are, respectively:

$$E_t\left[u_c(t) - \beta(1+r)\frac{\partial V^{t+1}(.)}{\partial A_{t+1}}\right] = 0 \tag{B.3}$$

$$E_t\left[u_h(t)\frac{\partial h_t}{\partial g_t} + \beta\frac{\partial V^{t+1}(.)}{\partial h_t}\frac{\partial h_t}{\partial g_t} - q_t\beta(1+r)\frac{\partial V^{t+1}(.)}{\partial A_{t+1}}\right] = 0. \tag{B.4}$$

[39] In this formulation, human capital is similar accumulation of stock.

[40] Throughout the discussion, period t and age t are used interchangeable, as we are not modelling family formation, but only time and expenditures choices while young children are living with parents. Fertility decisions are accounted for by observable taste-shifters.

Note that we assume that liquidity constraints are not bidding in the formulation above. Using the Envelope Theorem it is possible to obtain $\frac{\partial V^t}{\partial A_t}, \frac{\partial V^t}{\partial h_{t-1}}$, then the optimal allocation of financial resources and child's human capital imply that:

$$\begin{aligned}
\frac{\partial V^t}{\partial A_t} &= E_t\left[\beta(1+r)\frac{\partial V^{t+1}}{\partial A_{t+1}}\right] \\
\frac{\partial V^t}{\partial h_{t-1}} &= E_t\left[u_h(t)\frac{\partial h_t}{\partial h_{t-1}} + \beta\frac{\partial V^{t+1}}{\partial h_t}\frac{\partial h_t}{\partial h_{t-1}}\right] \\
&= E_t\left[u_h(t)\frac{\partial h_t}{\partial h_{t-1}} + \beta\left(u_h(t+1)\frac{\partial h_{t+1}}{\partial h_t} + \beta\frac{\partial V^{t+2}}{\partial h_{t+1}}\frac{\partial h_{t+1}}{\partial h_t}\right)\frac{\partial h_t}{\partial h_{t-1}}\right] = ... = \\
&= E_t\left[\sum_{j=0}^{T-t}\beta^j u_h(t+j)\prod_{k=0}^{j}\frac{\partial h_{t+k}}{\partial h_{t+k-1}} + \Omega\right]
\end{aligned}$$

where

$$\Omega = \frac{\partial V^T}{\partial h_T} = u_h(T)\frac{\partial h_T}{\partial h_{T-1}} + \beta\frac{\partial V^{T+1}}{\partial h_{T+1}}\frac{\partial h_{T+1}}{\partial h_T} = u_h(T)\frac{\partial h_T}{\partial h_{T-1}}$$

since $\frac{\partial V^{T+1}}{\partial h_{T+1}} = 0$, that is, the parent values the discounted value of the child's human capital she had acquired when leaving the house. This stock determines the productivity of future own investments. Then, FOCs above can be re-written as:

$$\begin{aligned}
c &: E_t\left[u_c(t) - \beta(1+r)u_c(t+1)\right] = 0 \\
g &: E_t\left[u_h(t)\frac{\partial h_t}{\partial g_t} + \beta\frac{\partial V^{t+1}}{\partial h_t}\frac{\partial h_t}{\partial g_t} - q_t u_c(t)\right] = 0
\end{aligned}$$

that is, current investment is a function of current, past and future investments. Note that the production function of human capital is a generalization of the usual formula for durables or habit formation (see for example, Hayashi, 1985 or Dynan, 2000, respectively). Using $\frac{\partial V^{t+1}}{\partial A_{t+1}}$ and $\frac{\partial V^{t+1}}{\partial h_t}$ in the first order condition for periods t and $t+1$ for g it is possible to obtain the Euler equation:

$$E_t\left[u_h(t)\frac{\partial h_t}{\partial g_t} + \beta\frac{\partial V^{t+1}}{\partial h_t}\frac{\partial h_t}{\partial g_t}\right] = E_t\left\{\frac{q_t}{q_{t+1}}\beta(1+r)\left[u_h(t+1)\frac{\partial h_{t+1}}{\partial g_{t+1}} + \beta\frac{\partial V^{t+2}}{\partial h_{t+1}}\frac{\partial h_{t+1}}{\partial g_{t+1}}\right]\right\}. \tag{B.5}$$

The left-hand side of this equation is the marginal cost of forgoing one unit of expenditure on investment g. The right-hand side is the marginal benefit that accrue by using the proceeds period's t savings and increasing by $\frac{q_t}{q_{t+1}}(1+r)$ units investment g in $t+1$. Both sides of this expression involve the expected value of a sum from t on the left hand side (and $t+1$ on the right hand side) to T, as a change in current investment influences current and future investment.

Using a user cost argument (see Deaton and Muellbauer, 1980), it is possible to re-write expression (B.5) as

$$\beta\left(1+r\right)E_t\left\{\frac{u_h(t+1)\frac{\partial h_{t+1}}{\partial g_{t+1}}}{\frac{\left[(1+r)q_{t+1}-\Delta_{t+2}q_{t+2}\right]}{\left[(1+r)q_t-\Delta_{t+1}q_{t+1}\right]}u_h(t)\frac{\partial h_t}{\partial g_t}}\right\}=1 \tag{B.6}$$

where $\left[(1+r)\,q_t-\Delta_{t+1}q_{t+1}\right]$ and $\left[(1+r)\,q_{t+1}-\Delta_{t+2}q_{t+2}\right]$ represent the cost of holding one unit of child's human capital in periods t and $t+1$, respectively. The previous expression can be obtained considering a deviation from the optimal trajectory analogous to the deviation used to price capital. That is, the parent may defer investment by one period in moment t, such that neither his/her consumption and the child's human capital after $t+1$ are affected by postponing investment one period. If parent reduces investment in child g by one unit, he/she saves q_t. This reduction in investment is associated with a reduction in dh_t in the child's human capital. In the following period, the parent uses the proceeding of accumulated saving $(1+r)\,q_t$ to invest in child Δ_{t+1}, where $\Delta_{t+1}=\frac{\frac{\partial h_{t+1}}{\partial h_t}\frac{\partial h_t}{\partial g_t}}{\frac{\partial h_{t+1}}{\partial g_{t+1}}}$, at a unitary price of q_{t+1}, such that the stock of human capital that the child carries to next period remains unchanged, $dh_{t+1}=0$. This one-period deviation can only be constructed under the assumption that investments are not perfect complements across periods, so that the production exhibits at least some degree of substitutability between periods, which may vary by age. The cost of obtaining such expression relies on the assumption that the parent can predict the future (real) prices and interest rate, that is, r and q_{t+1},q_{t+2}, and the return of investment in human capital, $\Delta_{t+1},\Delta_{t+2}$.[41] In practice, the deviations are constructed as follows. Suppose the parent reduces investment in education g in period t by one unit and he increases next period by Δ_{t+1}. With this deviation the parent has an additional saving of q_t in period t, and the additional income in period $t+1$ is $\left[(1+r)\,q_t-\Delta_{t+1}q_{t+1}\right]$. This deviation leaves h_{t+1} unchanged from its optimal level and should neither decrease nor increase the objective function. Therefore, this deviation reduces h_t in $\frac{\partial h_t}{\partial g_t}$, but also $dh_{t+1}=0$, so that:

$$dh_{t+1}=\frac{\partial h_{t+1}}{\partial h_t}\frac{\partial h_t}{\partial g_t}\underbrace{dg_t}_{=-1}+\frac{\partial h_{t+1}}{\partial g_{t+1}}dg_{t+1}=0.$$

Let Δ_{t+1} to be:

$$\Delta_{t+1}=\frac{\frac{\partial h_{t+1}}{\partial h_t}\frac{\partial h_t}{\partial g_t}}{\frac{\partial h_{t+1}}{\partial g_{t+1}}}.$$

This is how much g_{t+1} needs to change to keep h_{t+1} fixed. If the objective function is not changing (and current consumption does not change either) then:

$$u_h(t)\frac{\partial h_t}{\partial g_t}=E_t\left\{\beta\left[(1+r)\,q_t-\Delta_{t+1}q_{t+1}\right]\frac{\partial V^{t+1}}{\partial A_{t+1}}\right\} \tag{B.7}$$

that is, the marginal value of my additional savings minus the cost of replenishing h_{t+1} has

[41] The last assumption requires that parents have perfect knowledge of the production function of the child's human capital.

to equal the marginal value of the utility lost from having less h_t.

The optimum decision rule is such that the present value of marginal utility of income should be constant across periods, so that,

$$\frac{\partial V^t}{\partial A_t} = \beta\left(1+r\right)E_t\left[\frac{\partial V^{t+1}}{\partial A_{t+1}}\right]. \tag{B.8}$$

Condition (B.7) one period ahead can be written as:

$$\beta\left(1+r\right)E_t\left\{u_h(t+1)\frac{\partial h_{t+1}}{\partial g_{t+1}}\right\} = \beta\left(1+r\right)E_t\left\{\beta\left[\left(1+r\right)q_{t+1}-\Delta_{t+2}q_{t+2}\right]E_{t+1}\left(\frac{\partial V^{t+2}}{\partial A_{t+2}}\right)\right\}. \tag{B.9}$$

Using (B.8) and the law of iterated expectations, the right hand side of condition (B.9) can be written as

$$\begin{aligned}\beta\left(1+r\right)E_t\left\{u_h(t+1)\frac{\partial h_{t+1}}{\partial g_{t+1}}\right\} &= \beta\left(1+r\right)E_t\left\{\beta\left[\left(1+r_t\right)q_{t+1}-\Delta_{t+2}q_{t+2}\right]\left[\beta\left(1+r\right)\right]^{-1}\frac{\partial V^{t+1}}{\partial A_{t+1}}\right\} \\ &= E_t\left\{\beta\left[\left(1+r\right)q_{t+1}-\Delta_{t+2}q_{t+2}\right]\frac{\partial V^{t+1}}{\partial A_{t+1}}\right\}.\end{aligned}$$

If in period t the parent is able to perfectly forecast the prices q_{t+1} and the marginal productivity of investments in $t+1$ and $t+2$, so that Δ_{t+1} and Δ_{t+2} are known and if, additionally,

$$\begin{aligned}\beta\left[\left(1+r\right)q_{t+1}-\Delta_{t+2}q_{t+2}\right] &= \beta\left[\left(1+r\right)q_t-\Delta_{t+1}q_{t+1}\right]\Leftrightarrow \\ \left(1+r\right)\left(q_{t+1}-q_t\right) &= \Delta_{t+2}q_{t+2}-\Delta_{t+1}q_{t+1}\end{aligned}$$

that is, if the saving from deviating from optimum in period t are equal to the savings from waiting one period to deviate, then it is possible to obtain condition:

$$\beta\left(1+r\right)E_t\left\{u_h(t+1)\frac{\partial h_{t+1}}{\partial g_{t+1}}\right\} = u_h(t)\frac{\partial h_t}{\partial g_t}. \tag{B.10}$$

Parent values the human capital of child when she leaves as adult We now consider a "one parent-one child" family in which the individual lives for 2 periods with the parent (this can be generalized to T periods), and in period $T+1$ the child leaves the parent's house with human capital h'. During the 2 periods the child lives the parent, he has to decide how to divide (stochastic) income in each period among his own consumption, c_t, to the child's specific goods, g_t, and the amount of the risk-free asset to leave for the next period, A_2, for the period 3 when the child leaves the house, A_3 (A_1 is the level of asset that that family has when the child is born). Parent's consumption good is the numeraire and q_1, q_2 is the relative price of child's goods. As before, the labor supply of parent is inelastic. Parent's within period utility is $u\left(c\right)$. The human capital of the child when she leave the house, h', depends on the investment of the parent in the two periods in which she lived in the family, g_1, g_2, and it evolves according to

$$h' = f(g_1, g_2). \tag{B.11}$$

The budget constraints faced by the parent in each period she lives with the child are:

$$A_2 = (1+r)[A_1 + y_1 - c_1 - q_1 g_1] \tag{B.12}$$
$$A_3 = (1+r)[A_2 + y_2 - c_2 - q_2 g_2]. \tag{B.13}$$

Thus, assuming no borrowing constraints, the intertemporal budget constraint is then given by

$$A_3 = (1+r)^2 (A_1 + y_1 - c_1 - q_1 g_1) + (1+r)(y_2 - c_2 - q_2 g_2). \tag{B.14}$$

Then, the parent chooses the how much to consume in each period (c_1, c_2), how much to invest in the child (g_1, g_2) and how much to leave to period 3, A_3, so that his problem is given by

$$V(A_1, h) = \max\left\{u(c_1) + \beta u(c_2) + \delta\beta^2 E[V(A_3, h')]\right\}$$

subject to the technology (B.11) and to the budget constraint (B.14). δ denotes the parental altruism towards the child.

The first order conditions for g_1 and g_2, respectively, are given by

$$q_1 \frac{\partial u(c_1)}{\partial c_1} + \delta\beta^2 E\left[\frac{\partial V(A_3, h')}{\partial h'}\frac{\partial h'}{\partial g_1}\right] - q_1 \delta\beta^2 (1+r)^2 E\left[\frac{\partial V(A_3, h')}{\partial A_3}\right] = 0 \tag{B.15}$$
$$q_2 \frac{\partial u(c_2)}{\partial c_2} + \delta\beta E\left[\frac{\partial V(A_3, h')}{\partial h'}\frac{\partial h'}{\partial g_2}\right] - q_2 \delta\beta (1+r) E\left[\frac{\partial V(A_3, h')}{\partial A_3}\right] = 0. \tag{B.16}$$

The first order conditions above are similar to condition B.4 obtained in a setup where the parent values the child's human capital in each period.

References

[1] Deaton, Angus and Muellbauer,John, 1980, "Economics and Consumer Behavior," Cambridge Books, Cambridge University Press, number 9780521296762, April.

C Moment conditions

We assume that real (log) income, $logY$, can be decomposed into a permanent component, P, and a mean-reverting transitory component, v. Thus, we can write the income process of each family of child i at age a as

$$logY_{it} = \mathbf{Z'_{it}}\varphi_{\mathbf{t}} + P_{it} + v_{it} \tag{C.1}$$

where a is the child's age and $\mathbf{Z}$ is a set of observable characteristics which affect income, including demographics, education of parents, ethnicity, common shocks to all families and local of residence. We allow the effects of most of these characteristics to vary with calendar year. We assume that the permanent component P_{it} follows a random walk process

$$P_{it} = P_{it-1} + \eta_{it} \tag{C.2}$$

where η_{it} is serially uncorrelated, and the transitory component v_{it} an $MA(q)$ process, where the order q is established empirically

$$v_{it} = \sum_{j=0}^{q} \theta_j \varepsilon_{it-j} \tag{C.3}$$

with $\theta_0 = 1$. Then, the (unexplained) income growth is given by

$$\Delta y_{it} = \eta_{it} + \Delta v_{it} \tag{C.4}$$

where $y_{it} = logY_{it} - \mathbf{Z'_{it}}\varphi_{\mathbf{t}}$ is the log of real income net of predictable components.

The CNLSY only records information on parental involvement biannually, implying that we can only construct second differences for inputs, that is, $\Delta^2 g_t = \Delta g_t + \Delta g_{t-1}$. Additionally, our interest lies on the child's life cycle, which implies that our time reference is the age of each child not calendar years. Thus, starting at age 0 we can construct the following pairs of ages in which we observe both family income and parental inputs: 0-1, 2-3, 4-5, 6-7, 8-9, 10-11, 12-13 and 14-15. Since, we different both income and parental inputs, the panels we construct have at most length 7.

Therefore, we can write the equation that relates changes in (residual of) parental inputs to permanent and transitory income changes as:

$$\Delta^2 g_t \;\; = \;\; \phi_1 \left(\eta_t + \eta_{t-1}\right) + \psi_1 \left(\varepsilon_t + \varepsilon_{t-1}\right) + \xi_t^g + \xi_{t-1}^g \tag{C.5}$$

Unless stated otherwise, we assume stationarity.

C.1 One type of parental inputs and separability across periods

Moments for income The biannual structure of the CNLSY implies that we construct panels in second differences. The relevant income moments to identify the variance of permanent and transitory shock are given by

$$\begin{aligned} E[\Delta^2 y_t(\Delta^2 y_{t-2} + \Delta^2 y_t + \Delta^2 y_{t+2})] &= 2\sigma_\eta^2 \\ E[\Delta^2 y_t \Delta^2 y_{t+2}] &= E[\Delta^2 y_t \Delta^2 y_{t-2}] = -\sigma_\varepsilon^2. \end{aligned}$$

Variance and covariance of parental inputs The variance and autocovariance for the index of parental inputs is given by:

$$E\left[\left(\Delta^2 g_t\right)^2\right] = 2\phi^2\sigma_\eta^2 + 2\psi^2\sigma_\varepsilon^2 + 2\sigma_\xi^2 \tag{C.6}$$

$$E\left[\left(\Delta^2 g_t\right)\left(\Delta^2 g_{t-j}\right)\right] = E\left[\left(\Delta^2 g_t\right)\left(\Delta^2 k_{t+j}\right)\right] = 0, j > 1. \tag{C.7}$$

The covariances between income and the index of parental investment in children are given by

$$E\left[\Delta^2 g_t \Delta^2 y_t\right] = 2\phi\sigma_\eta^2 + \psi\sigma_\varepsilon^2$$

$$E\left[\Delta^2 g_t \Delta^2 y_{t+2}\right] = -\psi\sigma_\varepsilon^2 \tag{C.8}$$

$$E\left[\Delta^2 g_t \Delta^2 y_{t-2}\right] = 0 \tag{C.9}$$

$$E\left[\Delta^2 g_t \Delta^2 y_{t+j}\right] = 0, j > 2 \tag{C.10}$$

Then, the parameters for partial insurance are identified by the following moments

$$\frac{E\left[\Delta^2 g_t\left(\Delta^2 y_{t-2} + \Delta^2 y_t + \Delta^2 y_{t+2}\right)\right]}{E\left[\Delta^2 y_t\left(\Delta^2 y_{t-2} + \Delta^2 y_t + \Delta^2 y_{t+2}\right)\right]} = 2\phi \tag{C.11}$$

$$\frac{E\left[\Delta^2 g_t \Delta^2 y_{t+2}\right]}{E\left[\Delta^2 y_t \Delta^2 y_{t+2}\right]} = \psi. \tag{C.12}$$

As Blundell, Pistaferri and Preston, 2008, show, σ_ξ^2 can be identified using the following condition

$$E\left(\Delta^2 g_t\right)^2 - \frac{\left\{E\left[\Delta^2 g_t\left(\Delta^2 y_{t-2} + \Delta^2 y_t + \Delta^2 y_{t+2}\right)\right]\right\}^2}{E\left[\Delta^2 y_t\left(\Delta^2 y_{t-2} + \Delta^2 y_t + \Delta^2 y_{t+2}\right)\right]} - \frac{\left\{E\left[\Delta^2 g_t \Delta^2 y_{t+2}\right]\right\}^2}{E\left[\Delta^2 y_t \Delta^2 y_{t+2}\right]} = \sigma_\xi^2.$$

Measurement error in income and parental inputs As Meghir and Pistaferri, 2004, and Blundell et al., 2008, show if income and the index of parental inputs are measured with error, we can write them as

$$\begin{aligned} y_{it}^* &= y_{it} + u_{it}^y \\ g_{it}^* &= g_{it} + u_{it}^g \end{aligned}$$

where x^* denotes the observed measure and x is true measure. Measurement error in consumption/parental inputs induces serial correlation in consumption/parental inputs growth so that in the context of the CNLSY where we can only second differences can be constructed we have

$$\Delta^2 g_{it}^* = \Delta g_{it}^* + \Delta g_{it-1}^* = \Delta g_{it} + \Delta g_{it-1} + u_{it}^g - u_{it-2}^g.$$

Then σ_{ug}^2 is identified by

$$E\left[\Delta^2 g_t \Delta^2 g_{t-2}\right] = -\sigma_{ug}^2 = E\left[\Delta^2 g_t \Delta^2 g_{t+2}\right].$$

If income is measured with error, then σ_ε^2 and σ_{uy}^2 cannot be separately identified. Also, only a lower bound for ψ is identified. Notice that the variance for parental inputs is given by

$$E\left[\left(\Delta^2 g_t\right)^2\right] = 2\phi^2\sigma_\eta^2 + 2\psi^2\sigma_\varepsilon^2 + 2\sigma_\xi^2 + 2\sigma_{ug}^2.$$

The variances and autocovariances of income are given by:

$$E[(\Delta^2 y_t)^2] = 2\sigma_\eta^2 + 2\sigma_\varepsilon^2 + 2\sigma_{uy}^2$$
$$E[\Delta^2 y_t \Delta^2 y_{t-2}] = -\sigma_\varepsilon^2 - \sigma_{uy}^2 = E[\Delta^2 y_t \Delta^2 y_{t+2}].$$

Timing of investments matter This is the case in which the response of parental inputs to permanent and transitory income shocks varies with the age of the child. In this case the following moments can be used to identify the variance of the permanent shock

$$E[\Delta y_t^2(\Delta y_{t-2}^2 + \Delta y_t^2 + \Delta y_{t+2}^2)] = \sigma_{\eta,a}^2$$

for $t = 3, ..., T-1$. The variance of the transitory shock is identified using

$$E[\Delta y_t^2 \Delta y_{t+2}^2] = -\sigma_{\varepsilon,a}^2$$

for $t = 2, ..., T-1$. The insurance parameters are identified by:

$$\frac{E[\Delta g_t^2(\Delta y_{t-2}^2 + \Delta y_t^2 + \Delta y_{t+2}^2)]}{E[\Delta y_t^2(\Delta y_{t-2}^2 + \Delta y_t^2 + \Delta y_{t+2}^2)]} = \psi_t$$

for $t = 3, ..., T-1$, and

$$\frac{E[\Delta g_t^2 \Delta y_{t+2}^2]}{E[\Delta y_t^2 \Delta y_{t+2}^2]} = \phi_t$$

for $t = 2, ..., T-1$.

C.2 One type of parental inputs and non-separability across periods

This is the case in which parental inputs respond to past shocks. Then we write:

$$\Delta^2 g_t = \phi^0(\eta_t + \eta_{t-1}) + \phi^1(\eta_{t-1} + \eta_{t-2}) + \psi^0(\varepsilon_t + \varepsilon_{t-1}) + \psi^1(\varepsilon_{t-1} + \varepsilon_{t-2}). \tag{C.13}$$

Then, the (auto)variance of parental investments is then given by:

$$E\left[\left(\Delta^2 g_t\right)^2\right] = 2\sigma_\eta^2\left((\phi^0)^2 + (\phi^1)^2\right) + 2\sigma_\varepsilon^2\left((\psi^0)^2 + (\psi^1)^2\right) + 2\sigma_{ug}^2. \tag{C.14}$$

$$E\left[\Delta^2 g_t \Delta g_{t-2}\right] = E\left[\Delta^2 g_t \Delta y_{t+2}\right] = \phi^0\phi^1\sigma_\eta^2 + \psi^0\psi^1\sigma_\varepsilon^2 \tag{C.15}$$

The covariance between income and measures of parental investment in children are given by

$$\begin{aligned}
E\left[\Delta^2 g_t \Delta^2 y_t\right] &= \left(2\phi^0 + \phi^1\right)\sigma_\eta^2 + \psi^0\sigma_\varepsilon^2 - \psi^1\sigma_\varepsilon^2 && \text{(C.16)}\\
E\left[\Delta^2 g_t \Delta y_{t-2}\right] &= \phi^1\sigma_\eta^2 + \psi^1\sigma_\varepsilon^2 && \text{(C.17)}\\
E\left[\Delta^2 g_t \Delta^2 y_{t+2}\right] &= -\psi^0\sigma_\varepsilon^2 \\
E\left[\Delta^2 g_t \Delta y_{t-j}\right] &= E\left[\Delta^2 g_t \Delta y_{t+j}\right] = 0, j > 1 && \text{(C.18)}
\end{aligned}$$

Then the variances of permanent and transitory shocks $(\sigma_\eta^2, \sigma_\varepsilon^2)$ are still identified by the same conditions as in the basic case. It is still true that $\frac{E\left[\Delta^2 g_t \Delta^2 y_{t+2}\right]}{E\left[\Delta^2 y_t \Delta^2 y_{t+2}\right]} = \psi^0$. With lagged shocks

$$\frac{E[\Delta^2 g_t(\Delta^2 y_{t-2} + \Delta^2 y_t + \Delta^2 y_{t+2})]}{E[\Delta^2 y_t(\Delta^2 y_{t-2} + \Delta^2 y_t + \Delta^2 y_{t+2})]} = 2\left(\phi^0 + \phi^1\right). \tag{C.19}$$

C.3 Assumptions: Two types of parental inputs and non-separability within periods

As we mention in the main text, we have two sets of parental inputs: time and consumption related. Here we present a generalization of the setup above which allows for interaction between the two sets of investments. To keep the exposition simpler we abstract from measurement error issues, but we consider them in the empirical implementation. Consider the following set of equations

$$\begin{aligned}
\Delta^2 e_t &= \phi_e\eta_t + \phi_e\eta_{t-1} + \psi_e\varepsilon_t + \psi_e\varepsilon_{t-1} + \varphi_e\Delta^2 g_t && \text{(C.20)}\\
\Delta^2 g_t &= \phi_g\eta_t + \phi_g\eta_{t-1} + \psi_g\varepsilon_t + \psi_g\varepsilon_{t-1} + \varphi_g\Delta^2 e_t && \text{(C.21)}
\end{aligned}$$

where e and g represent time and goods inputs, respectively. This is a system that can be solved to write $\Delta^2 e_t$ and $\Delta^2 g_t$ as functions of the permanent and persistent shocks and the degree of substitution/complementarity between the two sets of inputs. Then,

$$\begin{aligned}
\Delta^2 e_t &= \frac{(\phi_e + \varphi_e \phi_g)(\eta_t + \eta_{t-1}) + (\psi_e + \varphi_e \psi_g)(\varepsilon_t + \varepsilon_{t-1})}{1 - \varphi_e \varphi_g} \\
\Delta^2 g_t &= \frac{(\phi_g + \varphi_g \phi_e)(\eta_t + \eta_{t-1}) + (\psi_g + \varphi_g \psi_e)(\varepsilon_t + \varepsilon_{t-1})}{1 - \varphi_e \varphi_g}
\end{aligned}$$

The variance of investments is then given by:

$$E\left[\left(\Delta^2 e_t\right)^2\right] = \frac{2\sigma_\eta^2 (\phi_e + \varphi_e \phi_g)^2 + 2\sigma_\varepsilon^2 (\psi_e + \varphi_e \psi_g)^2}{(1 - \varphi_e \varphi_g)^2} \quad \text{(C.22)}$$

$$E\left[\left(\Delta^2 g_t\right)^2\right] = \frac{2\sigma_\eta^2 (\phi_g + \varphi_g \phi_e)^2 + 2\sigma_\varepsilon^2 (\psi_g + \varphi_g \psi_e)^2}{(1 - \varphi_e \varphi_g)^2}. \quad \text{(C.23)}$$

The covariance between the two sets of investment is given by:

$$\begin{aligned}
E\left[\Delta^2 e_t \Delta^2 g_t\right] &= \frac{2(\phi_e + \varphi_e \phi_g)(\phi_g + \varphi_g \phi_e)\sigma_\eta^2 + 2(\psi_e + \varphi_e \psi_g)(\psi_g + \varphi_g \psi_e)\sigma_\varepsilon^2}{(1 - \varphi_e \varphi_g)^2} \\
E\left[\Delta^2 e_t \Delta^2 g_{t-k}\right] &= 0, k \geq 2
\end{aligned}$$

The contemporanous covariance between the two set of inputs is used to identify φ. We show below how this moment is essential to identify φ and all other parameters $\phi_1, \phi_2, \psi_1, \psi_2$.

The covariances between income and parental inputs are given by:

$$E\left[\Delta^2 e_t \Delta^2 y_t\right] = \frac{2(\phi_e + \varphi_e \phi_g)\sigma_\eta^2 + (\psi_e + \varphi_e \psi_g)\sigma_\varepsilon^2}{1 - \varphi_e \varphi_g} \quad \text{(C.24)}$$

$$E\left[\Delta^2 g_t \Delta^2 y_t\right] = \frac{2(\phi_g + \varphi_g \phi_e)\sigma_\eta^2 + (\psi_g + \varphi_g \psi_e)\sigma_\varepsilon^2}{1 - \varphi_e \varphi_g} \quad \text{(C.25)}$$

$$E\left[\Delta^2 e_t \Delta^2 y_{t+2}\right] = -\frac{(\psi_e + \varphi_e \psi_g)\sigma_\varepsilon^2}{1 - \varphi_e \varphi_g} \quad \text{(C.26)}$$

$$E\left[\Delta^2 g_t \Delta^2 y_{t+2}\right] = -\frac{(\psi_g + \varphi_g \psi_e)\sigma_\varepsilon^2}{1 - \varphi_e \varphi_g} \quad \text{(C.27)}$$

$$E\left[\Delta^2 g_t \Delta^2 y_{t-2}\right] = E\left[\Delta^2 e_t \Delta^2 y_{t-2}\right] = 0 \quad \text{(C.28)}$$

And

$$E\left[\Delta^2 g_t \Delta^2 y_{t+j}\right] = E\left[\Delta^2 e_t \Delta y_{t+1}\right] = E\left[\Delta^2 g_t \Delta^2 y_{t-j}\right] = E\left[\Delta^2 e_t \Delta y_{t-1}\right] = 0, j > 2 \quad \text{(C.29)}$$

Then, σ_η^2 and σ_ε^2 are identified as before. Then, we are left with the 5 equations below to identify 6 parameters: $\phi_e, \phi_g, \psi_e, \psi_g, \varphi_e \varphi_g$.

$$\frac{E[\Delta^2 e_t(\Delta^2 y_{t-2} + \Delta^2 y_t + \Delta^2 y_{t+2})]}{E[\Delta^2 y_t(\Delta^2 y_{t-2} + \Delta^2 y_t + \Delta^2 y_{t+2})]} = \frac{2\left(\phi_e + \varphi_e \phi_g\right)}{1 - \varphi_e \varphi_g} \tag{C.30}$$

$$\frac{E[\Delta^2 g_t(\Delta^2 y_{t-2} + \Delta^2 y_t + \Delta^2 y_{t+2})]}{E[\Delta^2 y_t(\Delta^2 y_{t-2} + \Delta^2 y_t + \Delta^2 y_{t+2})]} = \frac{2\left(\phi_g + \varphi_g \phi_e\right)}{1 - \varphi_e \varphi_g} \tag{C.31}$$

$$\frac{E\left[\Delta^2 e_t \Delta^2 y_{t+2}\right]}{E[\Delta^2 y_t \Delta^2 y_{t+2}]} = -\frac{\psi_e + \varphi_e \psi_g}{1 - \varphi_e \varphi_g} \tag{C.32}$$

$$\frac{E[\Delta^2 g_t \Delta^2 y_{t+2}]}{E[\Delta^2 y_t \Delta^2 y_{t+2}]} = -\frac{\psi_g + \varphi_g \psi_e}{1 - \varphi_e \varphi_g} \tag{C.33}$$

$$E\left[\Delta^2 e_t \Delta^2 g_t\right] = \frac{2\left[\begin{array}{c} \left(\phi_e + \varphi_e \phi_g\right)\left(\phi_g + \varphi_g \phi_e\right)\sigma_\eta^2 + \\ \left(\psi_e + \varphi_e \psi_g\right)\left(\psi_g + \varphi_g \psi_e\right)\sigma_\varepsilon^2 \end{array}\right]}{\left(1 - \varphi_e \varphi_g\right)^2}. \tag{C.34}$$

Since this system is under-identified, we impose the restriction that $\varphi_e = \varphi_g = \varphi$ in the results presented in the main text. Estimates with $\varphi_e \neq \varphi_g$ proved to be too unstable, but the results are available from the authors.

D Data

D.1 The Panel Study of Income Dynamics

The PSID is a longitudinal study that began in 1968 with a nationally representative sample of about 5,000 American families, with an oversample of black and low-income families. In 1997, the PSID began collecting data on a random sample of the PSID families that have children 12 years old or younger in the Child Development Supplement (CDS). Data were collected for up to two children per family for approximately 3,500 children residing in 2,400 households. The CDS includes information on child development and family dynamics, including parent-child relationships, home environment, indicators of childrens health, cognitive achievements, social-emotional development and time use, among other variables. A follow-up study with these children and families was conducted in 2002-03 (CDS-II). These children were then between the ages of 8-18. No new children were added to the study.

Starting in 1997, children's time diaries were collected along with detailed assessments of childrens cognitive development. For 2 days per week (one weekday and one weekend day),there is a detailed time diary which records all activities during the day and who else (if anyone) participated with the child in these activities. Namely, mothers and fathers can actively participate or engage with the child ("primary activity") or simply be around the child but not actively involved ("secondary activity"). We construct a daily measure of active time for the mother and father summing the total minutes for each category of time.

We consider two possible uses of the time: total time and in leisure related activities. Leisure includes watching television, socializing (relaxing with friends and family, playing games with friends and family, etc.), exercise/sports (playing sports, attending sporting events, exercising, and running), reading (books and magazines, personal mail, and personal email), entertainment (going to the movies or theatre, listening to music, using the computer for leisure, doing arts and crafts, playing a musical instrument), sleeping and eating (see Aguiar and Hurst, 2007).

References

[1] Aguiar, Mark and Erik Hurst, 2007, "Lifecycle Prices and Production", American Economic Review, December 2007, 97(5), 1533-59.