Government Transfers, Parental Incentives and Child Development

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September 2026
JEL Classification J13, D1
Keywords: Child development, Parenting styles, Social Policy
PRELIMINARY AND INCOMPLETE - DO NOT CIRCULATE

Abstract

We leverage a model of parental and child investments in the cognitive and non-cognitive development of children, to explore the impact of various government income transfer policies. We find that if the planner's objective is to improve the distribution of cognitive skills, the most effective set of policies are *(external) conditional cash transfers*, in which the household receives an income transfer when the child's cognitive ability exceeds a prespecified threshold. We find that the possibility of parents using their own extrinsic reward schemes to incentivize their child (or *internal conditional cash transfers*) greatly increases the cost effectiveness of external conditional cash transfer policies in fostering cognitive skills, but that they also create non-trivial negative feedback effects of monetary transfers (both internal or external) on children's discount factors.

1 Introduction

This paper builds on the recent work by Del Boca, Flinn, Verriest and Wiswall, 2025 (hereafter DFVW) in which the authors develop and estimate a dynamic model of parental and child investments, and their effects on children's skills. These skills include a measure of cognitive ability (as proxied through test scores) as well as a specific type of non-cognitive skills (as proxied through the child's intertemporal discount factor). The model is estimated using rich U.S. household panel data from the Panel Study of Income Dynamics (PSID) and its Child Development Supplement (CDS), supplemented with other representative survey data on time preferences among U.S. adolescents and adults. Besides choosing labor supply, parental and child consumption, and how much time and money to invest in their child, parents also periodically choose whether to use an extrinsic incentive scheme to increase the child's self-investment time, which is optimally chosen by the child in response to the parents' own choices. From now on, we will refer to these parent-designed incentive mechanisms as "internal conditional cash transfers" or "ICCTs". Crucially, DFVW find that

while ICCTs lead to increased child efforts - and hence higher cognitive ability - in the short run, they also (stochastically) reduce the child's future intrinsic motivation to self-invest by reducing the child's intertemporal discount factor. Consistent with the broader literature on developmental psychology, the authors thus find that the use of extrinsic rewards by parents (e.g., by explicitly tying the child's allowance or private consumption to their productive self-investment time) may entail large costs in terms of the child's future incentives to invest in themselves. As such, the model rationalizes why higher-educated households - whose members, on average, tend to be more forward-looking - are less inclined to use such incentive devices, all else equal.

Our analysis centers on the interaction between parents, children, and actors external to the household (which we will often refer to as a social planner) during the child development process. The interaction between parents and children has been frequently studied and is deemed to have important consequences for the welfare and development of children.[1] Relatively recent contributions by economists to this topic include Weinberg (2001), Hotz and Pantano (2015), Hao et al. (2008), Akabayashi (1996, 2006) and Lizzeri and Siniscalchi (2008). Weinberg (2001) develops a model in which altruistic parents provide for their child's consumption and attempt to influence behaviors of the child that lead to long-term beneficial outcomes for her. Weinberg shows that poor parents, i.e., those for whom the floor on their child's consumption is binding, have less scope for influencing the actions of their children. As a result, Weinberg's analysis predicts that less well-off parents are more likely to resort to non-pecuniary incentive mechanisms, such as corporal punishment, to influence their children. Akabayashi (1996, 2006) develops an incentive model of the parent-child relationship showing the potential for child-abuse. Although our paper does not include consumption floors that inhibit some parents' ability to positively influence their child's behavior, we do allow for a mechanism that restricts the ability of some households to use (positive) incentive schemes for their children, and households that do not use them will generally experience lower growth in the child's ability. As we shall show, wealthier households are more likely to use this incentivize device, which tends to further increase disparities in child outcomes at the end of the development period.

What we refer to as an Internal Conditional Cash Transfer (ICCT) allows the parents to offer the child a consumption compensation schedule contingent on the child's self-investment time, with a cost incurred because the parents need to monitor the amount of time that the child studies. We view our model of parental incentives as a stand-in for a wide variety of different incentive schemes used in practice. Although it is difficult to have direct evidence on the use of all such mechanisms, in our data there are measures of child allowances paid by the parents and additional information about whether these allowances are conditioned on the completion of school work. Allowances are received by about 55 percent of children across all ages (6-16), with 75 percent receiving an allowance at age 12. Conditional on giving an

[1] Other related studies focus on adolescents' risky behaviors. Hao et al. (2008) show that all parents, including the very altruistic, have incentives to penalize older children for their risky behaviors in order to dissuade their younger ones from engaging in such behaviors. Hotz and Pantano (2015) consider a model in which parents impose more stringent disciplinary environments in response to their earlier-born children's poor performance in school in order to deter such outcomes for their later-born offspring. They provide evidence that the school performance of children in the NLSY-C declines with birth order as does the stringency of their parents' disciplinary restrictions.

allowance, depending on age, around 40 to 50 percent of parents report that the allowance is tied to completion of school work by the child. Although this particular mechanism is not the only way that parents incentivize children, these data provide some evidence that these incentives are used in practice by many households.

Given that at least some households actively employ incentive systems, it is of interest to investigate how conditional or unconditional transfers offered to the household by agents external to it modify household behavior, including the use of ICCTs. In terms of designing effective conditional cash transfers systems (CCTs), households enjoy considerable advantages with respect to external agents that have the objective of increasing cognitive ability within a population of households. First of all, the parents can be assumed to know their own child's characteristics, in terms of both ability and preferences. This is a substantial advantage with respect to an external agent who may only know the distributions of ability and preferences of children and their parents in the population. A second advantage is in terms of the potential observability of the effort of the child, which is a direct input to the production process. While no parent can say with certainty how much "effective time" their child spends in study or other activities designed to increase her cognitive ability, they clearly have more information than does an agent external to the household. External agents will largely be constrained to offer outcome-based incentives, at least in more developed societies, and outcomes are likely to contain substantial amounts of noise which further complicates the design of effective mechanisms (Del Boca et al. (2016)).

It is helpful to think of the parents as the "agents" within a standard principal-agent setting, with the social planner playing the role of the principal. The principal's objective is to increase the level of the cognitive ability of children in the population by incentivizing the household members, parents and child, to provide more productive inputs than they would in baseline. All three parties value the child's cognitive ability to different degrees, and the problem the social planner faces is to design simple policies to achieve its goal given knowledge of the distributions of preferences and resources within the target population. We only consider very simple transfer policies of the type that have been implemented in various forms in the past. The most sophisticated policy we consider is a CCT policy in which the planner pays any household a fixed amount if their child's ability increases by a prespecified amount between ages t and $t+1$.

Relatively few theoretical models or field experiments have examined the important role that parents play in producing child cognitive outcomes, and the potential payoffs in terms of child cognitive outcomes for effectively incentivizing parental behavior. In terms of large scale experiments in the U.S. that incentivized parents, there is only Opportunity NYC-Family Rewards. This experiment, generously funded by Bloomberg Philanthropies and other charitable foundations, offered substantial payments to families based on the successful satisfaction of any items from a menu of requirements, involving "inputs" (e.g., school attendance, visits to doctors) and "outputs" (e.g., school grades, performance on standardized tests). The general findings of the study were that input-based incentives performed poorly in terms of increasing cognitive outcomes, while output-based incentives were more effective.[2] The authors of the final report interpret this as suggesting there was little scope

[2]The overview of the results from Opportunity New York is taken from Riccio et al. (2013). See also Fryer (2011) on earlier studies.

for improvement in school attendance or visits to doctors, for example, because these were already high, even in this low-income population. The "output-based" incentives seemed to have more potential for increasing cognitive outcomes, although this is predicated on the reward structure being set in an optimal fashion (Del Boca et al. (2016)).

There have been smaller-scale field experiments conducted on the incentivization of parents as well. At least since the time of the Perry School project, it has been recognized that involving parents in programs designed to increase the cognitive and non-cognitive development is crucial to the success of the program. In spite of this, few interventions in school environments seek to involve and incentivize parental participation. One exception is Fryer et al. (2015), which demonstrates the potential for the incentivization of parents. The authors conduct a CCT experiment involving children and parents in Chicago Heights, Illinois, a low-performing urban school district. The parents were incentivized to attend a Parent Academy (where parents were taught effective parenting practices), complete homework with their children, and the children's performance on benchmark examinations. The authors found quite large positive effects on both cognitive and non-cognitive development for Hispanic and White children, but no effect for Black students.

In addition to developing an estimable model of parent-child interactions in the cognitive development of the child, our aim is to investigate the relationship between external policies offered to parents designed to increase the cognitive development of their child and the behavior of parents and their children within the household. Our belief is that only by merging theoretical and econometric research on the subject with the results of field studies informed by this research can effective policies for child cognitive and non-cognitive development be designed.

The plan of the paper is as follows. In Section X, we discuss the design of efficient mechanisms to increase the cognitive outcomes of children, given the model estimates presented in DFVW (2025). We also explore the manner in which transfers and ECCTs impact household decisions and welfare.

2 Summary of model

We now reconsider the model after allowing the parents to offer the children contracts that have the possibility of increasing parental welfare. We can think of these "contracts" as a kind of "parental style." These policies, to a limited extent, mimic the kind of policies that an external social actor may offer the household. They will differ in important ways, however, which may give the parents an advantage over a social planner in implementing effective conditional cash transfer (CCT) schemes.

There are essentially two major advantages enjoyed by the parents. First, a conditional cash transfer offered by an external agent, who is assumed to be unable to observe the investments of the household members, must be based on an output measure.[3] This means

[3]It is true that a number of well-known CCT experiments, such as PROGRESA in Mexico, provide payments to households for what may be considered as inputs into the production technology of cognitive development. In that experiment, most payments to parents were given for keeping their children in school. Even in more developed settings, inputs may be incentivized. One prominent example is Opportunity NYC-Family Rewards, which incentivized parents to take children to doctors and dentists. However, the largest

that there is a delay between the investment costs of the household and the reward. While some parents may have a fairly high discount factor, so that such a delay in receiving payment is not a major disincentive to effort choices, children may have low discount factors, and the prospect of a delayed reward may reduce their incentive to increase current period investments. If the child could be paid immediately for increases in their current period investments, this will make it less costly to incentivize children to reach any given targeted "quality" level.

Second, the parents have more information concerning the child's preferences and actions (and their own) than does an external agent. This allows them potentially to design more effective CCTs than can an external agent. In the model estimated by DFVW, the parents are able to design an internal CCT (ICCT) that allows them to align the child's action with the (altruistic) parents' preferences, albeit at a cost to the child's stochastic discount factor. In particular, the optimal ICCT parameters chosen by the parents, which consist of a consumption floor, denoted by b_t, and a reward elasticity, denoted by r_t, depend on both the child's and the parents' individual utility parameters, as well as other primitives that may be unobserved by the planner. However, the choices of the planner and the parents in incentivizing child development cannot be directly compared, since, in general, they have different objectives. In the case of the external agent, we will assume that their only concern is with some function of the distribution of child skills in the targeted population, which clearly differs from the objective of the parents, which is to maximize their discounted stream of payoffs. These payoffs are only partially a function of their own child's skills.

DFVW demonstrate how the use of an ICCT allows the household to achieve a cooperative, meaning efficient, outcome. The mechanism they use is a mapping from the observed effort choice of the child, which is their study time $\tau_{c,t}$ in period t, into the private consumption of the child in the period, x_t. We first observe that the parents can formulate a simple mapping that allows them to manipulate the child to choose any $\tau_{c,t}$ that they desire, for any given (feasible) value of child consumption x_t. This incentive scheme is not unique. DFVW utilize the incentive function,

$$x_t = \exp(b_t + r_t \ln \tau_{c,t}),\ t = 1, ..., M.$$

which contains the two parameters, b_t and r_t, and has some appealing features from the point of view of characterization of the household equilibrium and computation. For any choice of b_t and r_t, and for any strictly positive $\tau_{c,t}$, this function restricts the consumption of the child to be positive in all periods, which is required under the functional form assumptions regarding parental and child utility. Under the functional form assumptions regarding the preferences of the parents and the child (Cobb-Douglas), and given the functional form of the cognitive ability production function (also Cobb-Douglas), the incentive function we assume is without loss of generality. This is because it allows parents to obtain their first best outcome (on the Pareto frontier).

We refer to DFVW for more details on the parents' optimal choice of whether to use an ICCT and, if so, their optimal consumption floor and reward elasticity parameters (b_t and r_t), respectively.

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incentives were targeted towards outputs, such as a child's grades and examination performance in school.

To recap, the parents collectively have two choices regarding behavior. By paying the utility cost ω_t in period t, they are able to implement an efficient household allocation of resources in which the child's reaction function is aligned with the parents' own altruistic preferences. If they do not pay this utility cost, they obtain a welfare level generated in the Stackelberg (inefficient) equilibrium. However, due to the detrimental impact of the ICCT on the child's future discount factor (and thus the continuation values of both the child and the parents), the parents' welfare when using an ICCT does not necessarily exceed their welfare level in the absence of an ICCT. Thus, the parents' choice of whether or not to use an ICCT in any given period depends on the relative magnitudes of (1) the cognitive and welfare gains created by the ICCT, which to some extent persist over time, and depend on how misaligned the child's preferences are to those of the parents; and (2) the costs associated with using an ICCT, which include a short-run disutility cost as well as a persistent cost to the child's discount factor (or intrinsic motivation level).

A social planner solely concerned with improving the distribution of children's cognitive ability in the population would generally prefer that all households utilize ICCTs in all periods. This is illustrated in Table 13 of DFVW, which shows that final-period child skills are maximized when ICCT use is 100 percent. However, since ICCTs are costly, this will never be optimal for all parents in all periods. Conversely, if the planner only cares about improving the distribution of children's discount factors, the planner would want to minimize the use of ICCTs by parents, since the DFVW estimates suggests that ICCTs are detrimental to children's future delayed gratification. Clearly, the planner's optimal policy - both cash transfers and external CCTs - will depend not only on the planner's objective function, but also on how each type of policy affects the parents' behavior, and their use of ICCTs in particular. We shall return to this point in Section 3, below.

3 The Impact of External Policies on Household Behavior and Welfare Outcomes

We now study the effect of external resource transfers made to the parents on the behavior of household members and household outcomes, with particular reference to child development. There are two important problems that a social planner faces in attempting to improve aspects of the child cognitive ability distribution by making monetary transfers to households. The planner does not know the preferences of the household members, but rather is only assumed to know the distribution of preferences in the population. Since we assume that the social planner's preferences are only defined with respect to the distribution of child cognitive ability, that gives this problem a principal-agent structure, in that there is asymmetric information regarding household preferences and actions and because the preferences of household members and the planner are different. By making a transfer to the parents (the agents), the planner attempts to influence the distribution of cognitive outcomes in the most cost-efficient way while taking the actions of the household into account.

The planner is limited in terms of the types of goods that can be transferred, which are restricted to money or in-kind transfers of child investment goods, e_t. We restrict attention to non-coercive policies, which we define as any policy under which the welfare of the parents

(assumed to be the recipients of all transfers) is no less than it would be in the absence of the policy. In the case of policies that take the form of income transfers to the household contingent on its behavior, these triggering events must be observable to the social planner. Since we assume that the internal actions of the household are not directly observable by the planner, this means that any external CCT, or ECCT in what follows, must be based on observed child quality in the period(s) before and after the one-period policy intervention.

In the case of ECCTs, we will consider only threshold-based policies, which specify a threshold $\underline{k}_{t+1}(k_t)$, that is the lowest level of child quality in period $t+1$ for which the parents receive the reward ϕ_C. We allow this threshold to be a function of the child's cognitive ability when the policy is announced, so that we can consider growth-based policies, such as $\underline{k}_{t+1}(k_t) = (1+\rho_C)k_t$, where ρ_C is the growth rate required of a household with current child quality k_t to receive the transfer ϕ_C.

Before proceeding, we mention a few restrictive features of our analysis. The potential policy space for the planner is enormous, and we only consider a small set of policies within this space. We do not consider explicit targeting of sub-populations based on potentially observable characteristics, such as family income or demographic characteristics. The reader can think of this targeting as having already been done, with the population we consider being the restricted sub-population of interest to the planner. Within this group of households with children, we only consider policies that transfer an identical amount of resources to each household. This may clearly be inefficient if there is substantial variation in resources across households within the target population. We can think of the initial targeting in terms of observable characteristics, such as household income or wage rates, as having substantially reduced the variability in these characteristics within the targeted population.

We will also only consider policies that are targeted to households containing a child of age t. We limit our attention to "one-shot" policies of this form primarily because of the complications that arise when examining household behavior when there are multi-period ECCT policies. It is well known (e.g., Weitzman (1980)) that when facing a sequence of incentive contracts of this form, the household will engage in strategic behavior by altering its investments so as to enhance its ability to receive the reward in future periods. A nice example of this phenomenon in the case of incentive contracts offered to educators can be found in Macartney (2016). Although there are no complications in extending unrestricted and restricted transfer policies to a multi-period setting, since our primary interest is in comparing the performance of these three types of policies, we limit our attention to a single period for all policy types. The age upon which we primarily focus is age 15, so that $t = 15$. We will be examing the impact of these various policies on child cognitive ability at age 16.

3.1 Unrestricted Income Transfers

The most basic type of transfer that we consider consists of a money transfer of ϕ_U to parents of a child of age t. There are no restrictions on how the parents can spend the money, so that in the period within which it is received, the transfer increases household non-labor income to $I_t + \phi_U$. Since we do not allow for savings and borrowing in the model, this additional income must be spent in period t. Since child cognitive ability is a normal good to the parents, this will result in an increase in child ability in the following period with respect to its level if the transfer had not be received. From the viewpoint of maximizing

household welfare (from the point of view of the parents), this is the (weakly) preferred type of transfer policy by the household of the ones that we will consider.[4]

Using the point estimates of the model parameters, we focus on the growth in child quality between ages 15 and 16 in the baseline and under the unrestricted transfer policy, while varying the level of the transfers.[5] Let g_t denote the average growth rate in child latent human capital between age t and $t+1$, which is given by

$$g_t = \frac{1}{N \times R} \sum_{r=1}^{R} \sum_{h=1}^{N} \frac{k_{h,t+1}^r - k_{h,t}^r}{k_{h,t}^r}$$

where $k_{h,t+1}^r$ is the optimal level of child quality at age $t+1$ in household h in simulation round r (which is after the transfer has been received in period t), N is the number of households, and R is the number of simulation rounds. Given our estimates, the growth rate in child quality between the ages of 15 and 16 in the absence of policy intervention has a mean of approximately 12.3 percent (see part (a) in Table 1).

In Table 1 we examine the results of an unrestricted transfer of \$170 dollars to week per sample household on a variety of household outcomes, most importantly, the cognitive ability of the child. Given our emphasis on the use of ICCTs, we also analyze the impact of this transfer in our baseline model with costly ICCTs and in the case when ICCTs are not available to any household, which can be thought of as the case in which the cost of their use is indefinitely large. In the baseline case, the unrestricted transfer has a relatively small positive effect on the level of child quality at age 16, 0.32 percent. This is in spite of the fact that the investment time of both parents individual and jointly increases noticeably, as do child expenditures. However, at this age, the impacts of parental time investments on the growth in the child's cognitive ability are modest at best. Expenditures on child investment goods have increased by 3.13 percent in response to the transfer, but child time investments actually decrease by a small amount.

The most striking impact of the transfer is on the labor supply of the parents, which falls by almost 8 percent for mothers and by 5.3 percent for fathers. Most of this time is spent on leisure consumption by the parents, which increases by 2.8 percent for mothers and 3.8 percent for fathers. Household consumption also increases markedly, with the parents' consumption increasing by 3.15 percent and the child's by 3.1 percent. The current period utility of both sets of agents increases by a small amount at ages 15 and 16. We see that the proportion of households using an ICCT is unchanged, and the reward elasticity r_{15} set when an ICCT is used is also essentially unchanged.

The impact of an unconditional transfer of $\phi_U = 170$ in the case in which no households utilize an ICCT is largely the same. The increase in the growth rate in child quality is slightly greater, but this is largely explained by the fact that the average level of k_{15} is much lower

[4]This comparison is with a restricted transfer policy that offers an in-kind transfer of ϕ_U of child-investment goods and with a conditional cash transfer policy that pays ϕ_U when the household satisfies the requirements for receiving the transfer.

[5]Recall that we are assuming that all households receive the same amount of the transfer, ϕ_U. A more effective policy given the planner's objective may be to vary the transfer amount by the observable characteristics of the household.

if households are precluded from using ICCTs. The proportional drop in child investment time is greater than in the case with costly ICCTs, but smaller in absolute terms since the average level of study time is so much lower in the no-ICCT case than in the costly ICCT case (2.71 hours versus 6.59 hours).

3.2 Restricted Income Transfers

A restricted income transfer can be thought of as an in-kind transfer in which the planner transfers child investment goods (e) directly to the household. This is a restricted transfer since the method in which it can be used by the household is (potentially) limited, unlike in the case of an unrestricted transfer. In this case, the parents can still re-optimize their entire set of choices, but under the additional constraint that the total expenditures on child goods cannot be less than the amount of the targeted transfer of ϕ_R. Such directed transfers are "restrictive" in the sense that they limit the parents' ability to increase their private consumption or leisure. The only impact on the household's period t problem is that (1) the period t non-labor income is now equal to $I_t + \phi_R$, and (2) the constraint that $e_t \geq \phi_R$. At the household's period t solution, this constraint may be binding for some households but not for others, depending on the parents' preferences, other primitive parameters of the model, and the period t values of the state variables, Γ_t. If the parents are not using an Internal CCT, the optimal child expenditures in the presence of a restricted transfer policy can be defined as follows:

$$e_t^* = \max\{\frac{\beta_p \psi_{p,t+1} \delta_{4,t}}{\tilde{\alpha}_3 + \tilde{\alpha}_6 + \beta_p \psi_{p,t+1} \delta_{4,t}} Y_t,\ \phi_R\}$$

where $Y_t = w_{1,t}h_{1,t} + w_{2,t}h_{2,t} + I_t + \phi_R$. If the parents are using an Internal CCT, we use a numerical solver to find the optimal child expenditures. Computationally, we treat the restrictive transfer ϕ_R as an unrestrictive transfer (as described in the previous subsection), and then verify whether the expenditure constraint is satisfied.

No household can be worse off in terms of parental welfare by accepting such a transfer. When the constraint that $e_t^* \geq \phi_R$ is not binding, then the unrestricted transfer is equivalent to an unrestricted transfer. When it is binding, the household must still be better off than in the absence of the transfer, since even at the pre-transfer choices, if all of the transfer is spent on additional investment in the child, child quality will increase relative to its pre-transfer level, and this will increase parental welfare since child quality is a normal good. Although these transfers will never lead to a decrease in the level of child expenditures, there can still be significant crowding-out by the parents in the sense that a large portion of the transfer may be diverted to other goods valued by the household. In comparison to an unrestricted transfer policy, this type of policy would be expected to be more costly to administer due to the monitoring required to ensure that the money transfer is spent on child investment, or making in-kind transfers directly.

In Table 2 we examine the impacts of a restricted transfer $\phi_R = 170$, the same amount of transfer income upon which we focused in Table 1 when the transfer was unrestricted (i.e., $\phi_U = 170$). There are extremely large differences between the two tables. In the case of costly ICCTs, child quality at age 16 increases by 1.13 percent with respect to the case of no transfer. The growth rate in child quality increases by over 12 percent. The time investments

of the parents increase in a similar way as in the case of the unrestricted transfers, albeit a bit more markedly except for the joint time investment of the parents. The most noticeable change with respect to the earlier table is in terms of the money expenditures on the child, which increases by over 50 percent. If baseline expenditure on e_{15} had been greater than or equal to 170 for all households, then there is no difference between a restricted transfer of 170 or an unrestricted transfer of 170. We see instead, that average expenditures on e_{15} were 122.51 dollars before the policy intervention, and this is what accounts for the extreme large increase in e_{15}. Child self-investment time also rises markedly, under the policy, by 4.21 percent relative to the baseline case.

The impact of the transfer ϕ_R on household consumption is not as large as the similar money transfer of ϕ_U due to the fact that the parents are constrained in terms of how the transfer can be spent. Although the labor supply of both parents declines relative to baseline, the decrease is not as large as in the unrestricted transfer case due to the restriction on the use of the transfer. As in the case of an unrestricted cash transfer, the restricted transfer has (almost) no impact on the proportion of households using an ICCT. However, it has a very large impact on the size of the reward elasticity, r_{15}. In the case of a transfer of ϕ_R, the reward elasticity increases by 11.68 percent relative to baseline, in comparison to no change in the unrestricted transfer of ϕ_U. This is what accounts for the large increase in τ_c under the ϕ_R policy.

When ICCTs are not available to the household, the impacts on child quality at age 16 are roughly the same as in the costly ICCT case. There are smaller increases in parental time investments than in the ϕ_U case, and a slightly smaller decrease in child investment time. In comparison with the costly ICCT environment, the impact on parental labor supply and the leisure of household members is slightly more muted. This is also true regarding consumption and utility levels, although the child has a slightly higher utility level at age 15 when the parents are unable to offer an ICCT.

3.3 External Conditional Cash Transfers

An External Conditional Cash Transfer (ECCT) specifies a requirement for a household to receive a monetary reward of ϕ_C. In the case of an internal incentive scheme (or ICCT), the parents specify a reward function $x_t^*(\tau_{c,t}; \Gamma_t)$, which is a function of the child's time input into the development process, $\tau_{c,t}$, and the set of characteristics describing the household environment when the child is of age t, Γ_t. As in DFW (2016), we will only consider a few simple types of these reward systems, although the ones we do consider could be (and have been) implemented in real world settings. We assume that the requirement that a household must meet in order to receive the cash award of ϕ_C in period $t+1$ can be written in terms of a function of the form $\underline{k}_{t+1}(k_t)$, and that the household will receive the reward if and only if $k_{t+1} \geq \underline{k}_{t+1}(k_t)$. The two leading examples of the function $\underline{k}_{t+1}(k_t)$ are $\underline{k}_{t+1}(k_t) = \underline{k}_{t+1}$ and $\bar{k}_{t+1}(k_t) = (1+\rho_C)k_t$. In the first case, the reward is assumed to be a constant quality level specific to age $t+1$ children, one which is independent of the history of the child's abilities, $\{k_s\}_{s \leq t}$. In the second case, all households are required to achieve a growth rate of at least ρ_C in child ability between ages t and $t+1$ in order to receive the reward.

Since two sets of agents are involved in producing child quality, it is natural to consider whether the payoff ϕ_C should be paid to a single agent (parents or the child) or whether

it might be optimally divided between the two. We restrict our attention to the case in which parents receive the entire award. This is somewhat of a natural choice under our informational assumptions. Since the external agent can only observe child cognitive ability at each age $t = 1, ..., M$, it cannot utilize input-based CCTs, as the parents potentially can. Therefore it cannot design a CCT that would remunerate both parents and the child individually for the quantities of inputs they supply to the development process.

We will be particularly interested in the manner in which the existence of external output-based CCTs paid to the parents affects the parental decision to use an ICCT. Given our model estimates, virtually all parents in our sample use ICCTs to incentivize their children to self-invest more (rather than less), so that ICCTs produce higher levels of child ability at age $t + 1$. Since the parents are responsible for the ICCT decision, it seems natural for the external agent to make the payments ϕ_C to the parents, in order to increase the likelihood that the household uses an ICCT. Given our model estimates, we are able to evaluate the extent to which external and internal CCTs are complements in the production of child cognitive ability. If we interpret the use of an ICCT as a "parenting style," our results illustrate the manner in which the policies of external agents can influence the pattern of interaction between parents and children inside the household. Therefore, the possibility of using ICCTs has the potential to greatly amplify the impact of government policy on child development.

3.3.1 No Internal CCTs

We begin by considering the impact of an ECCT on household decisions in the absence of ICCTs, so that each household behaves in an inefficient manner. We have already seen that the scope for the parents to influence the choices of the child in this setting is limited. In particular, we know that they only influence the child's choice of their time input through their crowd-out effect on her available time, which is given by $\tilde{T}_t - \tau_{p,t}$. Thus, the only way that the parents can increase the child's time input is by reducing their own, that is, any increase in their own total time input in child production leads to a decrease in the child's study time. Their only other avenue to increase child quality is through increased expenditures on child investment goods, e_t.

In order to examine the impact of an external CCT in this case, we utilize the framework developed in DFW (2016). If the reward of ϕ_C is received in period $t + 1$, the parents' non-labor income in that period is increased from I_{t+1} to $I_{t+1} + \phi_C$. The first case to consider is when the parents' choices in period t, and the child's response in terms of her choice of $\tau_{c,t}$ in the absence of the external CCT would result in a level of child quality in period $t+1$, k^*_{t+1}, that is no less than the threshold required to receive ϕ_C, so that $k^*_{t+1} \geq \underline{k}_{t+1}$. In this case, the household essentially receives an unrestricted income transfer in period $t + 1$ without changing any of their original period t decisions.

The more interesting case is when $k^*_{t+1} < \underline{k}_{t+1}$. In this situation, the parents face a binary choice. First, they can make their original choices (and the child hers) so as to produce the quantity k^*_{t+1}, which means that they will not receive the reward. Second, assuming no uncertainty in the production process, they can alter their decisions (and the child's response) so as to receive the reward ϕ_C in the following period. This requires them to suffer a utility loss in period t for an increase in the continuation value of the parents in

period $t+1$, since in that period they will have a higher level of non-labor income and a higher level of child quality than in the absence of the policy. We define the maximum value of period t utility subject to the constraint that the household produce k_{t+1} units of child quality in period $t+1$ (without using an ICCT) as

$$\begin{aligned} J^0_{p,t}(\Gamma_t, k_{t+1}) &= \max_{a_{p,t}} \tilde{\alpha}_1 \ln l_{1,t} + \tilde{\alpha}_2 \ln l_{2,t} + \tilde{\alpha}_3 \ln c_t + \tilde{\alpha}_4 \ln k_t + \tilde{\alpha}_5 \ln l_{c,t} + \tilde{\alpha}_6 \ln x_t \\ \text{subject to: } k_{t+1} &= f_t(k_t, \tau_{1,t}, \tau_{2,t}, \tau_{12,t}, e_t, \tau^*_{c,t}(\tau_{p,t})) \\ T &= l_{i,t} + h_{i,t} + \tau_{i,t} + \tau_{12,t}, \ i = 1, 2 \\ c_t + e_t + x_t &= w_{1,t} h_{1,t} + w_{2,t} h_{2,t} + I_t, \\ \tau^*_{c,t}(\tau_{p,t}) &= \gamma_t(\tilde{T}_t - \tau_{1,t} - \tau_{2,t} - \tau_{12,t}). \end{aligned}$$

This formulation of the problem can be used to define the household's problem when there is no External CCT, since

$$V^0_{p,t}(\Gamma_t) = \max_{k_{t+1}} J^0_{p,t}(\Gamma_t, k_{t+1}) + \beta_p V^0_{p,t+1}(\Gamma_{t+1})$$

and

$$k^*_{t+1}(\Gamma_t) = \arg\max_{k_t} J^0_{p,t}(\Gamma_t, k_{t+1}) + \beta_p V^0_{p,t+1}(\Gamma_{t+1}),$$

where the period $t+1$ vector of state variables, Γ_{t+1}, includes k_{t+1}. The value $k^*_{t+1}(\Gamma_t)$ is the baseline level of period $t+1$ child quality in the absence of the ECCT program.

When $k^*_{t+1} < \underline{k}_{t+1}$, the value of increasing child quality to $\underline{k}_{t+1}$ is given by

$$V^0_{p,t}(\Gamma_t, \underline{k}_{t+1}) = J^0_{p,t}(\Gamma_t, \underline{k}_{t+1}) + \beta_{p,t} V^0_{p,t+1}(\Gamma'_{t+1}),$$

where the state variable vector Γ'_{t+1} includes the value of child quality $\underline{k}_{t+1}$ and non-labor income level of $I_{t+1} + \phi_C$. Then, in the absence of internal CCTs, the household will increase child quality to $\underline{k}_{t+1}$ if and only if

$$\begin{aligned} V^0_{p,t}(\Gamma_t, \underline{k}_{t+1}) &> V^0_{p,t}(\Gamma_t) \\ \Rightarrow J_{p,t}(\Gamma_t, \underline{k}_{t+1}) + \beta_p V^0_{p,t+1}(\Gamma'_{t+1}) &> J^0_{p,t}(\Gamma_t, k^*_{t+1}) + \beta_p V^0_{p,t+1}(\Gamma_{t+1}) \\ \Rightarrow V^0_{p,t+1}(\Gamma'_{t+1}) - V^0_{p,t+1}(\Gamma_{t+1}) &> \beta_p^{-1}[J^0_{p,t}(\Gamma_t, k^*_{t+1}) - J^0_{p,t}(\Gamma_t, \underline{k}_{t+1})]. \end{aligned}$$

Both sides of the last line are strictly positive when $\underline{k}_{t+1} > k^*_{t+1}$.

3.3.2 Relationship between External CCTs and the Use of Internal CCTs

In order for a household facing the requirement to produce more child quality in period $t+1$ than it would in the absence of the external CCT, it is obviously the case that its use of one or more of the inputs in the period t production process must be increased relative to its baseline level. In the single agent case considered in DFW (2016), the parents would increase all inputs in an efficient manner (i.e., with minimum loss in period t utility). In the two-agent case considered here, and in the absence of an internal CCT, an increase in total parental time investments in the child will mechanically lead to a reduction in the time the child spends investing in herself. Of course, if the value of the child's own time

investments are low, this may not be a major impediment to reaching the target $\underline{k}_{t+1}$ with minimal loss of current period utility. However, when this is not the case, increasing parental time investments and decreasing child time investments may require a significant increase in purchased inputs in period t, e_t.

Under an ICCT, the parents are able to influence the input chosen by the child, $\tau_{c,t}$ by choosing a reward function. In this case, the parents are not subject to the same mechanical crowd-out effect that is in effect when there is no ICCT. This allows them to increase the time investments of the child as they increase their own in any situation where it is optimal to do so. The period utility cost of implementing an internal CCT is given by $\omega_t > 0$ in period t. [6] In order to clarify the decisions in this case, it will be useful to distinguish between the payoff values to the household (1) whether they produce the $\underline{k}_{t+1}$ required to receive ϕ_C in period $t+1$ and (2) whether they use an ICCT in period t. Let the value of the parents' problem when using an ICCT be given by $V^1_{p,t}(\Gamma_t)$, where this value does not include the fixed (to the parents) implementation cost ω_t (in utils). As we discussed previously, we know that $V^1_{p,t}(\Gamma_t) > V^0_{p,t}(\Gamma_t)$ for all Γ_t. Then in the absence of an external CCT, the household implements an ICCT if and only if

$$V^1_{p,t}(\Gamma_t) - V^0_{p,t}(\Gamma_t) > \omega_t.$$

In the case for which no internal CCT is used, we defined $V^0_{p,t}(\Gamma_t, \underline{k}_{t+1})$ as the value of the households' problem when it produced $\underline{k}_{t+1}$ over the course of period t. Analogously, we define $V^1_{p,t}(\Gamma_t, \underline{k}_{t+1})$ as the value of the households' problem when it produces $\underline{k}_{t+1}$ during period t and utilizes an ICCT in period t; as above, this does not include the utility cost, ω_t. We know that $V^1_{p,t}(\Gamma_t, \underline{k}_{t+1}) > V^0_{p,t}(\Gamma_t, \underline{k}_{t+1})$ for all target levels $\underline{k}_{t+1}$. In period t, the household makes choices along two dimensions: (1) whether to use an internal CCT and (2) whether to produce a level of child quality exactly equal to the required amount, $\underline{k}_{t+1}$. We will now discuss the conditions required for the various outcomes to be observed. We will not explicitly condition on the fact that $k^*_{t+1} < \underline{k}_{t+1}$, where k^*_{t+1} is the unconstrained choice in the absence of an ECCT, when parents endogenously choose whether to use an ICCT. Whenever this inequality is not satisfied, the household can never be better off producing the quantity $\underline{k}_{t+1}$, that is, the targeted value of $\underline{k}_{t+1}$ will never be chosen by those households who will receive ϕ_C next period with no change in their period t decisions. If a household receives ϕ_C in period $t+1$, either $k_{t+1} = \underline{k}_{t+1}$ or $k_{t+1} > \underline{k}_{t+1}$, and in the latter case, we say that ϕ_C received in period $t+1$ is an unrestricted transfer. [7]

Each household must fall into one of the following four distinct cases.

1. (No ICCT, $k_{t+1} \neq \underline{k}_{t+1}$) In this case, we have

$$\begin{aligned} V^1_{p,t}(\Gamma_t) - V^0_{p,t}(\Gamma_t) &\leq \omega_t \\ V^0_{p,t}(\Gamma_t, \underline{k}_{t+1}) - V^0_{p,t}(\Gamma_t) &< 0 \\ V^1_{p,t}(\Gamma_t, \underline{k}_{t+1}) - V^0_{p,t}(\Gamma_t) &\leq \omega_t \end{aligned}$$

[6] In the estimation of the model, we will assume that the cost of running an ICCT is fixed over time within a household, so that $\omega_1 = ... = \omega_M$. There is a distribution of these time invariant costs across households.

[7] It is, in principle, possible for a household to freely choose exactly $\underline{k}_{t+1}$ with no ECCT present, but since preferences are continuous random variables, this is a zero-probability event.

The first line is the condition that, in the absence of the ECCT, the parents would not implement an ICCT. The second line is the condition that the household, in the absence of an ICCT, would choose not to produce the level $\underline{k}_{t+1}$ required to receive ϕ^{CCT}. The last line is the condition that value of the household producing $\underline{k}_{t+1}$ using an ICCT relative to not using an ICCT and not receiving the reward is less than the cost of the ICCT.

2. (ICCT, $k_{t+1} \neq \underline{k}_{t+1}$) In this case, we have

$$\begin{aligned} V^1_{p,t}(\Gamma_t) - V^0_{p,t}(\Gamma_t) &> \omega_t \\ V^1_{p,t}(\Gamma_t, \underline{k}_{t+1}) - V^1_{p,t}(\Gamma_t) &< 0 \end{aligned}$$

The first line is the condition that the unconstrained choice of k_{t+1} yields a higher value using an ICCT than when not using one. The second line is the condition that producing exactly $\underline{k}_{t+1}$ using an ICCT yields a lower value than not producing $\underline{k}_{t+1}$. Recall that this condition covers also those individuals for whom $k^*_{t+1} > \underline{k}_{t+1}$, for which the reward of ϕ_C is the same as an unrestricted transfer of the same amount, $\phi_U = \phi_C$.

3. (No ICCT, $k_{t+1} = \underline{k}_{t+1}$) Here we have the conditions

$$\begin{aligned} V^0_{p,t}(\Gamma_t, \underline{k}_{t+1}) - V^0_{p,t}(\Gamma_t) &\geq 0 \\ V^1_{p,t}(\Gamma_t, \underline{k}_{t+1}) - V^0_{p,t}(\Gamma_t, \underline{k}_{t+1}) &\leq \omega_t. \end{aligned}$$

The first condition is that, in the no ICCT state, the value of producing $\underline{k}_{t+1}$ exceeds the value of producing k^*_{t+1}. The second condition is that the value of producing $\underline{k}_{t+1}$ using the ICCT is less than the value of producing $\underline{k}_{t+1}$ without using the ICCT.

4. (ICCT, $k_{t+1} = \underline{k}_{t+1}$) The conditions are

$$\begin{aligned} V^1_{p,t}(\Gamma_t, \underline{k}_{t+1}) - V^1_{p,t}(\Gamma_t) &\geq 0 \\ V^1_{p,t}(\Gamma_t, \underline{k}_{t+1}) - V^0_{p,t}(\Gamma_t, \underline{k}_{t+1}) &> \omega_t \\ V^1_{p,t}(\Gamma_t, \underline{k}_{t+1}) - V^0_{p,t}(\Gamma_t) &> \omega_t \end{aligned}$$

The first condition is that, when using an ICCT, the value of producing $\underline{k}_{t+1}$ is no less than the value of not producing it. The second condition is that the value of producing $\underline{k}_{t+1}$ is greater when using an ICCT than when not. The third condition is that the value of producing $\underline{k}_{t+1}$ using the ICCT exceeds the value of not using an ICCT and not producing $\underline{k}_{t+1}$ units of quality.

3.3.3 Quantitative Results: Growth-based ECCTs

In what follows, we let k^*_{t+1} and k^{**}_{t+1} denote the equilibrium levels of latent child capital at age $t+1$ in the baseline and in the presence of an ECCT, respectively. In a growth-based ECCT, the planner specifies a triple of policy parameters (t, ρ_C, ϕ_C). The first parameter denotes the age at which the policy is announced and implemented. As mentioned above, to avoid having to consider issues of intertemporal strategic behavior, we restrict the ECCT

policies to be limited to one period and to be unanticipated by the population of households. Throughout the empirical exercise, we set $t = 15$. At this age the child's time investment is more valuable in producing cognitive ability, and from our estimates, a large proportion of parents are employing ICCTs. The second parameter denotes the target growth rate of the child's (latent) human capital, with the target for a family with age t child quality of k_t given by

$$\underline{k}_{t+1} = (1 + \rho_C)k_t$$

The last parameter, ϕ_C, denotes the financial reward received by the household in period $t + 1$ if $k_{t+1} \geq \underline{k}_{t+1}$.

We will be especially interested in comparing the efficiency of the three transfer programs: unrestricted, restricted, and conditional, where efficiency will be defined as the increase in average child ability relative to baseline for a given per capita transfer payment, with all of our comparisons involving a one-time policy involving families of 15 year-olds. Thus, we will be comparing the values of k_{16} in the baseline with its value under the policy. The payoff to the unrestricted and restricted policies is relatively straightforward to determine. Since child quality is a normal good in all households, the average child quality in the targeted households is a continuous and increasing function of ϕ_U or ϕ_R.

In the case of an ECCT, it is somewhat more complicated to determine the cost of a program because of the variability in the take-up rate. In this case, we begin by positing a given desired improvement in average growth with respect to baseline. If baseline average growth in cognitive ability between year t and year $t + 1$ among our target population of size N is defined as $g_t = N^{-1} \sum_{h=1}^{N} \frac{k^*_{h,t+1} - k_{h,t}}{k_{h,t}}$, then we specify a desired growth rate of $g^{**}_t = N^{-1} \sum_{h=1}^{N} \frac{k^{**}_{h,t+1} - k_{h,t}}{k_{h,t}}$, so that we look for the program parameters that minimize average per capita cost and that produce an average child quality growth of g^{**}_t, where the planner restricts himself to choosing $g^{**}_t \geq g_t$. It is important to note that the program parameters that are chosen are those that satisfy

$$(\rho_C, \phi_C)^*(g) = \arg \min_{\substack{\rho_C, \phi_C \\ \text{s.t. } g^{**}_{t+1}(\rho_C, \phi_C) = g}} \frac{N_C(\rho_C, \phi_C)}{N} \phi_C, \tag{1}$$

where N_C is the number of households that receive ϕ_C, N is the size of the target population, and $g^{**}_{t+1}(\rho_C, \phi_C)$ is the average growth in child cognitive ability in the target population under the ECCT. The minimand is average per capita cost. The take-up rate is $N_C(\rho_C, \phi_C)/N$.

Because it is difficult to determine the per capita cost of an optimally-designed ECCT chosen to achieve a growth rate of g, we have solved (1) for a variety of values of g, and then interpolated the relationship between per capita cost and g in the figures described below, which examine the relationship between per capita cost and the growth in child quality in period $t + 1$ relative to baseline.

In Table 3 we examine the impact of an ECCT offering $\phi_C = 250$ dollars in the event that the growth in child quality between ages 15 and 16 is at least $\rho_C = 20$ percent, for the benchmark model of a costly ICCT. In the comparison with the situation of no ICCT, the growth requirement is reduced to $\rho_C = 17.5$ percent because of the lower baseline growth rate when ICCTs are excluded. In comparison with the $\phi_U = \phi_R = 170$ cases in Tables 1 and 2, we see dramatic increases in the average level of k_{16} under the ECCT policy. With

respect to the baseline, the proportional increases in the time investments of the parents and the child are approximately an order of magnitude larger under the ECCT than under restricted transfers. Because of the restriction on the use of the transfer, the expenditures on child investment are higher under the restricted transfer case.

The parents' time spent in leisure and at work decline markedly, unlike the situation under restricted or unrestricted transfers to the household. The child's time investment increases by 30.6 percent, as parents are increasingly likely to use ICCTs and to increase the reward elasticity. The proportion of households using an ICCT increases by 21.7 percent, and the average reward elasticity of all households using an ICCT increases by 103.59 percent. The consumption of parents and the child fall significantly at age 15, but recall that meeting the requirement of the ECCT increases household income when the child is 16 and increases the terminal value of both parents and the child by increasing the terminal value of child quality. We see that the utility of both parents and the child at age 16 are increased under the policy.

When there is no possibility of using an ICCT, the ECCT policy still has a substantial impact on average child quality at age 16, increasing it by 2.92 percent. This is less than what is achieved when it is possible to utilize an ICCT, largely because it expands the parents' ability to influence the investment decision of the child. With no ICCT, increases in the parents' time investments in the child only serve to crowd out the child's time investments. With an ICCT, the parents can counteract this by increasing the incentive offered to their child to study. In the baseline case of a costly ICCT, child study time increased by over 30 percent even in the face of dramatic increases in the parents' own investment time. Instead, in the situation with ICCTs, the child's time investment falls by 4.84 percent in response to the large increase in the parents' time investments. Other responses of the parents and the child in the no ICCT case are not as dramatically different from the baseline situation of costly ICCTs.

In Table 4 we compare the impacts of various ECCTs that vary in their per capita cost and have been designed to meet a particular target gain in average k_{t+1} with respect to the baseline of no ECCT. Column (0) contains the baseline situation for the costly ICCT case. The average growth in latent child ability between ages 15 and 16 is 12.3 percent, with a standard deviation of 4.1 percent. We find that 72 percent of households are using an ICCT when their child is 15 years of age. Among households using an ICCT at age 15, the average reward elasticity is 0.239.

Column (1) contains the results from imposing an ICCT that produces a gain in the average child quality growth of of 2.1 percentage points relative to baseline, or $g^{**}_{t+1} = 14.4$ percent. This gain is substantially greater than what was realized under either the unrestricted or restricted transfers of $\phi_U = \phi_R = 170$, and yet the per capita cost of this gain is only 36, or 21 percent of the amount given to all families under the unconditional transfers. The optimal combination of ρ_C and ϕ_C in this case is $\rho_C = 0.185$ and $\phi_C = 75$, so that even those families who qualify for the transfer receive 95 less than under the unconditional transfers that we examined in Tables 1 and 2. We see that the standard deviation of child quality at age 16 slightly increases under this particular ECCT.

The threshold-based CCT pays all parents whose child's latent ability at age 16 satisfies $k_{16} \geq \underline{k}_{16}$. In some cases, the child would have met the requirement even in the absence of the program, that is, whenever $k^*_{16} \geq \underline{k}_{16}$. In this case, the transfer is the same as an

unrestricted transfer $\phi_U = 75$. In other cases, when $k_{16}^* < \underline{k}_{16}$, the parents may decide to devote additional resources to child investment so as to meet the threshold, and in this case we have $k_{16}^{**} = \underline{k}_{16}$. In order to judge the effectiveness of the incentive device, it is important to separate these two cases when we examine the overall take-up rate. In panel (c) of Table 4, we see that the take-up rate for this program is 48 percent. In order to receive the transfer, 42.1 percent of the target population have to increase their pre-policy levels of investment so as to qualify for the transfer. Under this metric, the incentives built into the program are quite effective.

Our main interest is in the relationship between ECCTs and parents' decisions to employ ICCTs. In panel (d), we see that there is an increase in the proportion of households using an ICCT of 6.1 percentage points with respect to baseline, even with the rather low transfer amount of $\phi_C = 75$. Prior to the policy, among the subset of households who would adjust their baseline level of k_{16}^* in order to qualify for the transfer, 81.6 percent were using an ICCT. However, in the presence of the ECCT, the proportion of these households that use an ICCT in order to receive the reward, in which case $k_{16}^{**} = \underline{k}_{16}$, is 96.7 percent. We see that the ICCT is a crucial element of reducing the current period utility loss to the parents of qualifying for the reward through the incentivization of their child to spend more time studying. This is also reflected in changes in the average reward elasticity among those households using an ICCT. In the baseline, this average was 0.239, while under the policy the average reward elasticity increases to 0.309.

In columns (2) through (4) of Table 4, we report results for more expensive ECCTs. In column (2), the gain in average growth relative to baseline is 3.2 percentage points, or $g_{t+1}^{**} = 15.5$ percent, and the per capita cost of this program is 72.2. The optimal target growth rate for this targeted increase in average quality is $\rho_C = 0.195$, and the reward is $\phi_C = 135$. In comparison with the baseline of no program, we see that besides increasing the average level of k_{16} by 2.39 percent, the standard deviation of k_{16} decreases slightly from 5.493 to 5.480. The take-up rate increases to 53.5 percent, with 93.5 percent of the households receiving the transfer increasing k_{16}^* to $\underline{k}_{16}$. Of the individuals who would increase k_{16}^* to $\underline{k}_{16}$ in order to receive the transfer, 78.2 percent were using an ICCT before the policy. After the policy, the use of ICCTs among this subset of incentivized households increases to 97.8 percent. The reward elasticity also increased substantially among households using an ICCT, to 0.347 from 0.309 under the less ambitious and costly ECCT in column (1).

These patterns continue to be observed as we increase the size of the targeted change in average child quality. In columns (3) and (4), the increase in the average growth rate g_t with respect to baseline is 4.2 and 4.8 percentage points, respectively. The per capita costs of these programs are 115.4 and 146.3, still far less than the unconditional policies that we considered. We see that under both of these policies, the substantial increase in average child quality also occurs with a small reduction in inequality, as measured by the standard deviation of k_{16}. As was noted when discussing the less ambitious ECCTs, the increased utilization of ICCTs is crucial in producing a relatively high take-up rate for modest program costs. As the reward threshold increases, we also see substantial increases in the reward elasticities, as noted earlier.

3.4 Comparison of the Effectiveness of the Policies

We conclude our policy analysis by examining the cost effectiveness of the unrestricted, restricted, and conditional cash transfer programs in terms of the gain in the average growth rate in child quality with respect to baseline (i.e., $g_t^{**} - g_t$) by per capita cost. The results are summarized in Figure 1.

In the Figure, we plot six curves, which correspond to the three types of policies with and without costly ICCTs. As we have seen previously, the existence of an unrestricted transfer of $\phi_U = 170$ had no impact on the proportion of households using an ICCT. In the case of a restricted cash transfer of $\phi_R = 170$, we saw that there was a negligible impact on the proportion of households using an ICCT. In contrast, conditional cash transfer programs of various types, in terms of ρ_C and ϕ_C, increased the usage of ICCTs markedly. Therefore we expect that the cost-effectiveness advantage of the conditional cash transfer policy to decrease when ICCTs are not available to households.

We see large differences between the programs in terms of cost effectiveness, whether or not ICCTs are available to be utilized by households. For example, for a per capita expenditure of 100, an unconditional cash transfer produces well less than an 0.3 percentage point average gain in child quality at age 16, whereas a restricted transfer of 100 produces an average gain of approximately 0.5 percentage points. Instead, the average gain for an optimally-designed ECCT is approximately 3.8 percentage points . This advantage decreases if households do not have access to ICCTs, but is still substantial even in that case.

We have considered very expensive programs as well, up to a per capita cost of 400. In this case, unrestricted transfers yield an average gain in child cognitive ability at age 16 of less than 1 percentage point, while restricted transfers of that amount are able to produce slightly more than a 3 percentage point gain. An ECCT of that amount is able to produce more than a 6 percentage point gain in our baseline model (with ICCTs available). However, in all cases, we should note that the gains with respect to increased per capita expenditures are decreasing rapidly at high levels of transfers. This indicates the limits of these types of programs in a setting in which the social planner must face intermediaries (parents) with very different objectives.

We have been comparing policies almost exclusively in terms of their impacts on average child cognitive ability, but inequality is an important consideration, as well. Even if the superiority of ECCT programs was clearly established in terms of average quality improvements, we might feel differently about such programs if they greatly increased inequality in the child cognitive ability distribution. In Figure 2, we plot the standard deviation of k_{16} under the various programs with respect to the standard deviation without any policy. We find that the ECCT program actually acquits itself well under this criterion, as well. The ECCT decreases variability at any reasonably costly program level with respect to baseline. Restricted cash transfers actually tend to increase inequality in k_{t+1}, whereas unrestricted cash transfers have little effect on inequality. Therefore, the case in favor of ECCTs (especially when ICCTs are available) is strengthened. In addition to be the most cost-effective way to increase average child quality (among the small set of policies that we have considered), they also seem to reduce inequality in the distribution of cognitive ability.

4 Conclusion

We show that the choice of parenting styles, in terms of the use of ICCTs, is important when considering the design of transfers to households that are designed to increase investments in child cognitive ability. In threshold-based reward systems, in which the parents are given a monetary transfer if their child exhibits an increase in cognitive ability greater than some predetermined amount, the use of an ICCT can alleviate the utility cost of reaching the threshold and receiving the reward. In our policy experiments, we show that the increase in the use of ICCTs in the presence of these types of external reward systems can be substantial. Without the potential to use such rewards, these programs would be less cost effective from the perspective of the social planner.

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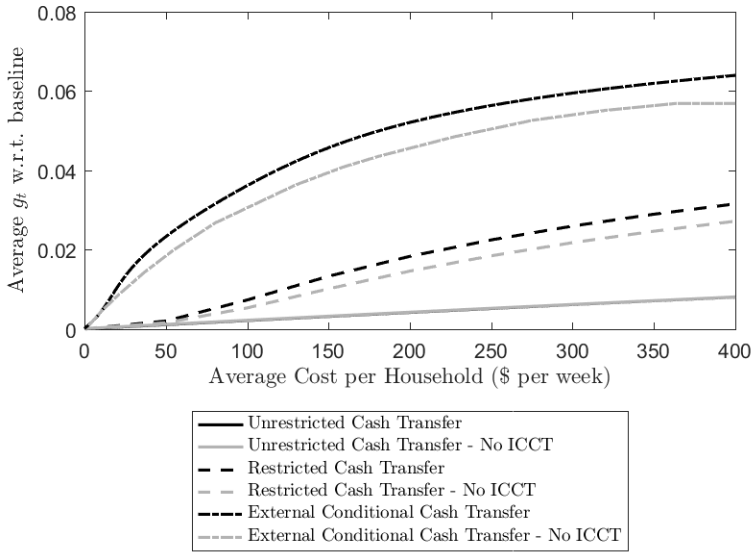
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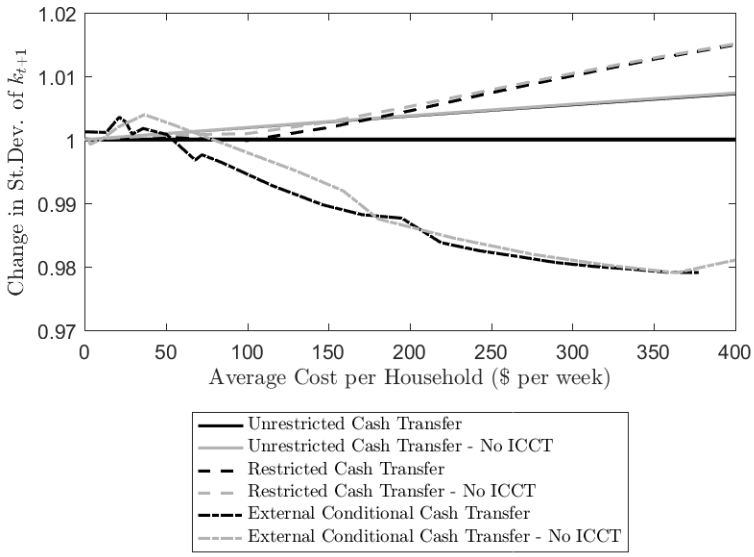
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Figure 1: Counterfactual Simulations: Cost-effectiveness of each policy



Notes: Each line plots the increase in the average growth rate in the child's latent value of child quality between the ages of 15 and 16, under a variety of counterfactual policy experiments where each household receives a one-time transfer at the start of either period $t = 15$ (for the UCT and RCT) or $t = 16$ (for the ECCT). The horizontal axis shows the average cost per household, in dollars per week. For the ECCT, this is equal to the product of the transfer amount and the take-up rate. The solid lines correspond to pure income transfers, where the subsidy simply accrues to the household's non-labor income (I_t), without any restrictions on how the money should be spent. The dashed lines correspond to targeted transfers, where the subsidy can only be spent directly on child goods during the period in which the transfer occurs (e_t). The dash-dotted lines correspond to External CCTs, where we only plot the convex hull created by the "optimal" policies, i.e. those achieving the largest gains in average growth of child quality at every average cost level. In order to see how the presence of Internal CCTs affects the effectiveness of each type of policy, we compare policy results for the benchmark model with endogenous (costly) Internal CCTs (i.e. the black lines) to those implied by the model where Internal CCTs are not available (i.e. the grey lines). Note that the baseline growth in child quality is lower for the model without Internal CCTs. For comparison, the vertical axis therefore plots the increase in the average growth rate relative to the respective baseline growth rate for each of the two models. All experiments were done using $R = 10$ simulated data sets.

Figure 2: Counterfactual Simulations: Distributional effects of each policy ($\sigma(k_{t+1})$)



Notes: Each line plots how the standard deviation of the child's latent value of child quality at the age of 16 (i.e. $\sigma(k_{16})$) changes under a variety of counterfactual policy experiments, where each household receives a one-time transfer at the start of either period $t = 15$ (for the UCT and RCT) or $t = 16$ (for the ECCT). The horizontal axis shows the average cost per household, in dollars per week. For the ECCT, this is equal to the product of the transfer amount and the take-up rate. The solid lines correspond to pure income transfers, where the subsidy simply accrues to the household's non-labor income (I_t), without any restrictions on how the money should be spent. The dashed lines correspond to targeted transfers, where the subsidy can only be spent directly on child goods during the period in which the transfer occurs (e_t). The dash-dotted lines correspond to External CCTs, where we only plot the results for the "optimal" policies, i.e. those achieving the largest gains in average growth of child quality at every average cost level. In order to see how the presence of Internal CCTs affects the effectiveness of each type of policy, we compare policy results for the benchmark model with endogenous (costly) Internal CCTs (i.e. the black lines) to those implied by the model where Internal CCTs are not available (i.e. the grey lines). Note that the baseline standard deviation of child quality is different for the model without Internal CCTs. For comparison, the vertical axis therefore plots the proportional change in the standard deviation relative to the respective baseline standard deviation for each of the two models. All experiments were done using $R = 10$ simulated data sets.

Table 1: Comparing Models with and without Internal CCTs: Unrestricted Cash Transfer at age 15

	Benchmark Costly ICCT		**Special Case No ICCT**	
	Baseline	Policy	Baseline	Policy
(a) Child Quality				
Level k_{t+1}	10.56	+0.32	10.02	+0.32
Growth rate g_t in %	12.27	+2.90	10.52	+3.37
(b) Investments				
Mother's Active Time τ_1	5.61	+1.33	5.73	+1.35
Father's Active Time τ_2	3.00	+2.10	3.04	+2.14
Joint Parental Time τ_{12}	7.83	+2.52	7.90	+2.55
Child Expenditures e	122.51	+3.13	121.40	+3.13
Child Self-Investment Time τ_c	6.59	-0.88	2.71	-1.01
(c) Labor Supply and Leisure				
Mother's Hours Work h_1	29.03	-7.87	28.50	-8.01
Mother's Leisure l_1	70.57	+2.81	70.91	+2.78
Father's Hours Work h_2	45.07	-5.28	44.58	-5.38
Father's Leisure l_2	55.37	+3.80	55.75	+3.80
Child's Leisure l_c	51.61	-0.50	55.27	-0.54
(d) Consumption and Welfare				
Parents' Consumption c	1695.07	+3.15	1707.52	+3.16
Child Consumption x	509.68	+3.10	471.55	+3.13
Parents' Utility $\widetilde{u}_{p,t}$	4.40	+0.49	4.40	+0.49
Parents' Utility $\widetilde{u}_{p,t+1}$	4.45	+0.02	4.45	+0.02
Child's Utility $u_{c,t}$	3.67	+0.12	3.67	+0.12
Child's Utility $u_{c,t+1}$	3.75	+0.04	3.74	+0.04
(e) Internal CCT Use				
Prop. Using Internal CCT	0.72	+0.00	-	-
Reward Elasticity r	0.17	+0.05	-	-

Notes: This table summarizes the effects of an unrestricted cash transfer of 170 dollars per week to all households at age $t = 15$. Columns 1-2 present results for the (benchmark) model where households choose whether to use an ICCT at a given cost. Columns 3-4 present results for the special case where ICCTs are infinitely costly. For each model, the "Baseline' column shows averages taken across all households and simulation rounds, at child age $t = 15$, in the absence of policy. The "Policy' column contains average percentage deviations from the respective baseline column. All experiments were done using $R = 10$ simulated data sets.

Table 2: Comparing Models with and without Internal CCTs: Restricted Cash Transfer at age 15

	Benchmark Costly ICCT		**Special Case No ICCT**	
	Baseline	Policy	Baseline	Policy
(a) Child Quality				
Level k_{t+1}	10.56	+1.13	10.02	+0.92
Growth rate g_t in %	12.27	+12.55	10.52	+11.32
(b) Investments				
Mother's Active Time τ_1	5.61	+2.46	5.73	+0.82
Father's Active Time τ_2	3.00	+2.51	3.04	+1.27
Joint Parental Time τ_{12}	7.83	+2.28	7.90	+1.51
Child Expenditures e	122.51	+50.63	121.40	+51.67
Child Self-Investment Time τ_c	6.59	+4.21	2.71	-0.68
(c) Labor Supply and Leisure				
Mother's Hours Work h_1	29.03	-5.60	28.50	-4.34
Mother's Leisure l_1	70.57	+1.86	70.91	+1.51
Father's Hours Work h_2	45.07	-3.69	44.58	-2.91
Father's Leisure l_2	55.37	+2.54	55.75	+2.02
Child's Leisure l_c	51.61	-1.21	55.27	-0.33
(d) Consumption and Welfare				
Parents' Consumption c	1695.07	+2.47	1707.52	+2.02
Child Consumption x	509.68	-2.44	471.55	+2.12
Parents' Utility $\widetilde{u}_{p,t}$	4.40	+0.23	4.40	+0.27
Parents' Utility $\widetilde{u}_{p,t+1}$	4.45	+0.07	4.45	+0.05
Child's Utility $u_{c,t}$	3.67	-0.29	3.67	+0.07
Child's Utility $u_{c,t+1}$	3.75	+0.13	3.74	+0.11
(e) Internal CCT Use				
Prop. Using Internal CCT	0.72	+0.84	-	-
Reward Elasticity r	0.17	+11.68	-	-

Notes: This table summarizes the effects of a restricted cash transfer of 170 dollars per week to all households at age $t = 15$. Columns 1-2 present results for the (benchmark) model where households choose whether to use an ICCT at a given cost. Columns 3-4 present results for the special case where ICCTs are infinitely costly. For each model, the "Baseline' column shows averages taken across all households and simulation rounds, at child age $t = 15$, in the absence of policy. The "Policy' column contains average percentage deviations from the respective baseline column. All experiments were done using $R = 10$ simulated data sets.

Table 3: Comparing Models with and without Internal CCTs: External CCT at age 15

	Benchmark Costly ICCT		**Special Case No ICCT**	
	Baseline	Policy	Baseline	Policy
(a) Child Quality				
Level k_{t+1}	10.56	+3.55	10.02	+2.92
Growth rate g_t in %	12.27	+42.26	10.52	+38.74
(b) Investments				
Mother's Active Time τ_1	5.61	+20.88	5.73	+21.70
Father's Active Time τ_2	3.00	+21.83	3.04	+23.20
Joint Parental Time τ_{12}	7.83	+23.23	7.90	+24.91
Child Expenditures e	122.51	+25.97	121.40	+32.19
Child Self-Investment Time τ_c	6.59	+30.62	2.71	-4.84
(c) Labor Supply and Leisure				
Mother's Hours Work h_1	29.03	-2.72	28.50	-2.67
Mother's Leisure l_1	70.57	-3.32	70.91	-3.83
Father's Hours Work h_2	45.07	-1.63	44.58	-1.50
Father's Leisure l_2	55.37	-3.26	55.75	-3.90
Child's Leisure l_c	51.61	-11.17	55.27	-7.32
(d) Consumption and Welfare				
Parents' Consumption c	1695.07	-3.01	1707.52	-3.80
Child Consumption x	509.68	-5.10	471.55	-3.64
Parents' Utility $\widetilde{u}_{p,t}$	4.40	-1.01	4.40	-0.81
Parents' Utility $\widetilde{u}_{p,t+1}$	4.45	+0.60	4.45	+0.64
Child's Utility $u_{c,t}$	3.67	-1.62	3.67	-1.09
Child's Utility $u_{c,t+1}$	3.75	+0.63	3.74	+0.46
(e) Internal CCT Use				
Prop. Using Internal CCT	0.72	+21.70	-	-
Reward Elasticity r	0.17	+103.59	-	-

Notes: This table summarizes the effects of an external conditional cash transfer which offers a reward of 250 dollars per week at age 16, conditional on the growth rate in child quality between age 15 and 16 being at least 20 percent for the benchmark model, and 17.5 percent for the no-ICCT model. Columns 1-2 present results for the (benchmark) model where households choose whether to use an ICCT at a given cost. Columns 3-4 present results for the special case where ICCTs are infinitely costly. For each model, the "Baseline' column shows averages taken across all households and simulation rounds, at child age $t = 15$, in the absence of policy. The "Policy' column contains average percentage deviations from the respective baseline column. All experiments were done using $R = 10$ simulated data sets.

Table 4: External CCTs: Comparing Optimal Policies at Age 15

	(0)	(1)	(2)	(3)	(4)
	Baseline	**ECCT Policy**			
Avg. Cost per Household	-	36.0	72.2	115.4	146.3
(a) Policy Parameters					
Target growth rate ρ^{CCT}	-	0.185	0.195	0.200	0.200
Reward ϕ^{CCT}	-	75	135	195	225
(b) Child Capital					
Growth Rate g_t, Average	0.123	0.144	0.155	0.165	0.171
Growth Rate g_t, St.dev.	0.041	0.050	0.052	0.052	0.049
Level k_{t+1}, Average	10.562	10.734	10.814	10.878	10.915
Level k_{t+1}, St.dev.	5.493	5.503	5.480	5.454	5.437
(c) Take-up Rate					
Fraction receiving transfer: $Pr(k^{**}_{t+1} \geq \overline{k}_{t+1})$	-	0.480	0.535	0.592	0.650
Fraction affected by policy: $Pr(k^{**}_{t+1} \geq \overline{k}_{t+1} > k^{*}_{t+1})$	-	0.421	0.500	0.564	0.623
(d) Fraction using ICCT at time t					
All Households	0.720	0.781	0.814	0.845	0.864
Baseline, given $k^{**}_{t+1} \geq \overline{k}_{t+1} > k^{*}_{t+1}$	-	0.816	0.782	0.757	0.745
Policy, given $k^{**}_{t+1} \geq \overline{k}_{t+1} > k^{*}_{t+1}$	-	0.967	0.978	0.980	0.979
(e) ICCT reward elasticity (r_t) at time t					
All Households	0.172	0.241	0.282	0.317	0.339
Given $r_t > 0$	0.239	0.309	0.347	0.375	0.392

Notes: All results are obtained for a growth-based External CCT policy administered when each child is $t = 15$ years old, where the parents receive a transfer of ϕ^{CCT} if the child's optimal level of latent human capital at age $t+1$ under the ECCT policy (denoted by k^{**}_{t+1}) is at least $(1 + \rho^{CCT})$ times the baseline level at age t, k_t. The optimal $t+1$ level of child quality in the baseline (in the absence of an ECCT policy) is denoted by k^{*}_{t+1}.