# Evaluating Early Childhood Policies: An Estimable Model of Family Child Investments

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**Abstract**

In this paper, I develop and estimate a technology of skill formation nested within a collective model of household behavior to evaluate the effect of various early childhood interventions. The model incorporates different channels of parental investments in children such as time, material investments, and childcare services. I estimate the model in a novel dataset from Chile and evaluate the effects on child development of three policies currently operating in the country: cash transfers, childcare subsidies, or subsidies to child-specific goods. In Chile, as is common in various countries implementing cash transfers to poor households, women are the recipient of cash transfers in bi-parental households with the idea that cash in the hands of women translate into better child outcomes. To allow for different outcomes depending on the recipient of cash transfers, in the model, household decisions are the outcome of a bargaining process between parents with different preferences. I find that cash transfers to women have limited effect on their bargaining power and that subsidies to child-specific goods are much more effective than childcare subsidies or cash transfers.

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# 1 Introduction

Research in medicine, psychology, and economics shows that skills shaped during the first years of life have significant consequences for adult life outcomes. [1] This have motivated a large number of policies aimed at enhancing the skills of children in disadvantage. However, we still have no certainty about what are the most cost-effective policies to close the gaps of skills between rich and poor children. Furthermore, although the question of what are the key inputs and the most sensitive periods of child skills formation has been asked previously in the literature[2], family investments have been proved to be key inputs in the skills production function, and they might react as a consequence of introducing new policies. The goal of this paper is to asses which policies are most effective to close the gaps in skills between rich and poor children, taking into account that family investments change as a consequence of public policy.

To analyze how early childhood policies affect resources allocated to children and skill formation, I develop and estimate a skill production function nested within a collective model of household behavior. In the dynamic model, parents care about the skills of their child and make investments to increase the stock of skills. Such investments can take the form of time investments -such as playing, reading, or signing to the child-, material investments -toys, puzzles, music or adequate food, among others- and childcare services.

Family investments in children might react as a consequence of introducing child development policies. Moreover, there is no reason to believe that all family members will react in a similar manner. Cash transfers to children with two parents present in the household, for example, are often targeted to women with the idea that cash in the hands of women might translate into better child outcomes than cash in the hands of men. Additionally, childcare subsidies might have a stronger effect on female rather than male labor supply. To allow policies to have different effects in household members, I allow parents to have different preferences in the model. The allocation of parental investments in child skills - a public good- is mediated by each member's preferences and their relative bargaining power.

I estimate the model using a novel dataset from Chile and use it to evaluate the effects of three

[1] For a review, see Conti and Heckman (2012).

[2] See, for example, Todd and Wolpin (2007), Cunha, Heckman, and Schennach (2010), Chetty et al. (2011), and J. Heckman and Mosso (2014) for a review.

policies currently implemented in the country to promote skills of children in disadvantage: cash transfers, childcare subsidies, and in-kind transfers -transfers of goods that are specifically useful for child development such as puzzles, nutritional supplements for children, among others. I find that in-kind transfers are the most cost-effective way to increase skills for children in disadvantage. Childcare do not seem to be a very effective way to promote skills, probably because of the quality of the average childcare provider. However, these policies do liberate time resources that family members can use to participate in the labor market, specially women. Cash transfers have also limited effects on skill for children as only a small fraction of it is actually invested in child development. I find that, although women have stronger preferences for children, cash transfers have a very limited effect in the process of decision making within the household. For such a reason, switching the recipients from mothers to fathers would have limited effects on the process of child development.

There are few papers estimating structural models of household behavior and child outcomes with the goal of understanding how family behavior affects child skill formation (Bernal, 2008; Del Boca, Flinn, & Wiswall, 2014; Gayle, Golan, & Soytas, 2015; Griffen, 2018). This is the first paper that empirically evaluates a collective model of household behavior and child investments incorporating decisions of time investments, monetary investments and childcare-preschool services. Taking into account these three channels of investments is relevant since we are able to asses how each policy affects different dimensions of parental investments in their children. The results of this paper allow us to have a better idea of what policies are most effective in promoting skills of young children and the mechanisms through which each policy affects such a process.

By modeling household behavior through the collective approach, parents are allowed to have different preferences. Incorporating the collective model of household behavior in the process of skills formation for children is a relevant contribution for various reasons. First, modeling household behavior through the collective approach has proven to result in better empirical predictions than the unitary framework (Chiappori & Donni, 2009). Second, from a policy perspective, it is common to see interventions targeting individual household members. For instance, most cash transfer programs in developing countries state as an explicit condition that, in households with children, mothers should be the sole recipients of such subsidies (Fiszbein,

Schady, & Ferreira, 2009). It is often argued that mothers have stronger preferences for meeting the needs of children and therefore cash in the hands of mothers translates into better child outcomes (Blundell, Chiappori, & Meghir, 2005). Moreover, the empirical regularity that there is a positive correlation between women's empowerment and child development (Haddad, Hoddinott, Alderman, et al., 1997) cannot be explained by considering the household as a single entity with one utility function. The collective approach provides a framework that allows us to assess the extent to which targeting individual members as beneficiaries of policies, such as cash transfers, actually have consequences on child development. Furthermore, it provides an ideal framework to test the effects of female empowerment on child development.

The dataset used in this paper is the Early Childhood Longitudinal Survey from Chile (ECLS). This dataset contains detailed information regarding the skill formation process in children and allows me to overcome some empirical limitations that the literature has previously faced. For instance, studies have shown that parental skills largely determine children's skills (J. Heckman & Mosso, 2014). By having information on parental IQ tests and personality assessments, I am able to incorporate parental skills into my estimation strategy. Additionally, we know that there is a multiplicity of skills that are relevant to determining adult life outcomes (Cunha et al., 2010). I incorporate multiple measures of skills across various dimensions, such as motor, communication, cognitive and behavioral abilities in children. Additionally, the dataset contains detailed information about the time and material investments that parents make in their children, such as the weekly frequency with which each parent reads to the child, or the availability of toys, books for children and the consumption of different types of foods. This allows me to incorporate the quantity and quality of investments that families make in their children.

Moreover, this is the first paper in the literature of household choices and child development that estimates a technology of skill formation through a dynamic latent-factor approach a-là Cunha et al. (2010). This allows me to obtain non-parametric identification of the skill production technology by using a large number of skill measures. Because of that, the results of the estimation are less sensitive to the specific parametric form assumed for the skill formation technology, and the bias arising from measurement error is reduced, making the results more robust. This, along with the fact that a latent factor structure can be interpreted as unobserved hetero-

geneity (Carneiro, Hansen, & Heckman, 2003) and potentially improves the accuracy of the estimates, has made factor analysis a popular tool to get accurate estimates of the skill production function (Cunha et al., 2010; Cunha & Heckman, 2008; J. J. Heckman, Stixrud, & Urzua, 2006). This paper is the first to estimate the production function of skills via a latent-factor approach, nested within a collective model of household behavior. This paper also makes a methodological contribution to the estimation of dynamic microeconomic models with unobserved and continuous state variables. By implementing an efficient simulation-based estimator using particle filtering techniques (Murphy, 2012; Creal, 2012), I propose a feasible computational approach for dealing with the high dimensionality integration problem that arises in such models.

In this paper, I propose a new estimation strategy for collective models of household behavior. The collective model of household behavior assumes that parents have different preferences and the final allocation of resources is a Pareto efficient outcome. The extent to which the final outcome follows preferences of each member depends on the Pareto weight, or bargaining power, of each member. Traditionally, empirical applications of the collective model use data on goods that are assumed to be of private consumption such as gender specific clothing or personal care items (Cherchye, De Rock, & Vermeulen, 2012; Blundell et al., 2005). This approach imposes certain assumptions on the behavior of families such as that one member does not care about the consumption level of other members on such goods. For instance, a husband would be indifferent about the consumption level on personal care of his wife. Additionally, it assumes that the intra-household bargaining process can be fully explained by observing the consumption of such items. This approach fails in the presence of measurement error or when there are more elements in the bargaining process in addition to the goods observed to the econometrician. Rather than using information on private consumption, I use answers to questionnaires related to female empowerment and gender roles within the household, such as who makes decisions about how to spend the income. Through a latent factor approach estimation, I use these answers as noisy measures of the bargaining power of each member. This approach allows for unobserved heterogeneity, measurement error, and does not rely on the assumption that the whole bargaining process is explained by the consumption of specific elements considered to be of private consumption.

The data from test scores show significant large gaps in skills between rich and poor children at age 5. The skill gap between children in the lowest quintile of the income distribution and children in the highest quintile, is in between 0.3 and 0.7 standard deviations in tests measuring cognitive abilities, socio-emotional development, and vocabulary skills, among others. These inequalities are mostly explained by differences in parental skills and monetary investments. Additionally, the model parameter estimates show that fathers' time spent with children is 50% as productive as mothers' time and that mothers have stronger preferences for children.

When analyzing which policy is more effective for child skills formation, it is not clear *a priori* which one would be more effective: cash transfers, childcare subsidies, or subsidies for material investments. Cash transfers allow parents to spend the money freely: there is no guarantee that they will do it in the way that is most effective for children, as they might decide to spend it on elements of private consumption. Cash transfers could also increase time investments from parents, depending on the extent to which cash transfers decrease labor force participation. Childcare subsidies could potentially expose children to a better suited environment for skill promotion. However, there is evidence from Latin America pointing out that such centers can have negative effects on child skill formation (Behrman, Cheng, & Todd, 2004; Bernal, Fernández, Flórez, Gaviria, et al., 2009; Rosero Moncayo, Oosterbeek, et al., 2011). Childcare subsidies could also increase female labor force participation, further decreasing the amount of time that parents spend with their children. Finally, subsidies to child investments are guaranteed to end up being used for skill formation purposes. However, it is unclear how effective they are when compared to other inputs such as parental time or childcare services.

Regarding the targeting aspect of cash transfers, the extent to which children would benefit more by having mothers as beneficiaries is also unclear. This depends on how effective cash transfers are in empowering women in households, how different are preferences for child skills between parents, and also on the marginal willingness to pay for skills from each parent. This last point is related to the fact that both parents need to make private investments of time and money for child skills. However, skills are ultimately a public good, since both parents get benefits from it. The extent to which each member contributes to skill formation in children depends on the marginal willingness to pay. For instance, even if fathers cared less for their children,

they might be at a relatively low level of marginal utility of consumption such that for each additional dollar earned, most of it would end up in children investment.

The results of the counterfactual policy analysis suggest that, taking into account the aforementioned features about the three different programs considered, subsidies for child-specific investments are the most effective way to promote child development. At any point, they provide the highest marginal return, implying that the optimal policy would not be a mixture between programs but rather devoting all resources to such a policy.

The remainder of this article is structured as follows: In section 2 I introduce a collective model of household behavior and child skill formation. I describe the data in Section **??**. I discuss the estimation and identification of the economic model in Section **??**. The main results of the paper are included in Section **??** and finally I conclude in Section **??**.

# 2 A Collective Model of Household Behavior and Child Outcomes

In this section I describe the economic model used to rationalize investments in children together with household behavior. Each household, indexed by $(h)$, is composed of two agents $(j)$, namely the father $(f)$ and the mother $(m)$. In each household, there is also one child[3] with a level of skills denoted by $(s)$, who is not a decision maker.[4] There are two periods $t$ in the model corresponding to age 3 of the child $(t = 1)$ and age 5 $(t = 2)$. In each period, parents make decisions of monetary investments for the child $(I_t)$ and private consumption $(c_t^j)$. Additionally, parents decide how much effort to invest in the quality of the interactions with their child $(e_t^j)$. I use a measure of quality of interactions to acknowledge the fact that it is not only time investments in children what will ultimately affect their skills but also the nature of their interactions.

[3] I include only one child in the economic model as allowing for multiple children in the economic model would imply solving additional questions that are not the main goal of this paper. For instance, I would need to identify or take a stance on whether parents have the same preferences for boys and girls, or whether they have preferences for equality of skills among children, as opposed to devoting more resources to the most promising child. Moreover, we also would need to understand to what extent there is a quality-quantity tradeoff in fertility decisions: do parents prefer to have more children and devote fewer resources to each of them or to terminate their childbearing early and devote most resources to a limited number of children.

[4] The assumption of having the child not as a decision maker is common in the literature (Del Boca et al., 2014; Bernal, 2008). That seems reasonable given the little influence that children under six years of age can have on the resource allocation of the household.

The effort, monetary investments, and consumption decisions can take any positive real value $(e_t^j, c_t^j, I_t) \in \mathbb{R}^+$. Additionally, parents decide wether or not to participate in the labor market $(h_t^j) \in \{0,1\}$[5]. During the first period, parents need to decide whether or not use childcare services $(a_t)$ and then $a_t$ can take the value of zero or one depending on whether the child goes or not to these services. The utility function for the first period is described in Equation 1:

$$u_1^j(c_1^j, h_1^j, e_1^j, d_1^j, s_1) = \alpha_{1,1}^j \ln(c_1^j) + \alpha_{2,1}^j \ln(s_1) - \alpha_{3,1}^j(h_1^j) - \alpha_{4,1}^j e_1^j - \alpha_{5,1}^j e_1^j h_1^j - \alpha_{6,1}^j h_1^j(1-a_1) + \sum_{m=0}^{3} q_{1,m}\varepsilon_{1,m} \tag{1}$$

In addition to $(c_1^j)$, skills of the child $(s_1)$, and labor force participation $(h^j)$, note that the the utility also depends on the quality-effort variable$(e_1^j \in \mathbb{R}^+)$ reflecting the fact that it is costly to provide quality time for children, and such efforts are costlier for parents who participate in the labor market, by the term $(\alpha_{5,1}^j e_1^j h_1^j)$, as time resources become scarcer. The term $-\alpha_{6,1}^j h_1^j(1-a_1)$ reflects the fact that childcare can liberate time resources and thus it might be less costlier for parents to participate in the labor market. Finally, the last term is preference shock associated to each combination of labor supply and childcare decision: $\varepsilon_{t,d_t^j}$ where $d_t^j$ indicates the action taken by agent $j$ according to the following mapping:

$$d_1^j = \begin{cases} 0 & \text{if } h_1^j = 0 \text{ and } a_1 = 0 \\ 1 & \text{if } h_1^j = 1 \text{ and } a_1 = 0 \\ 2 & \text{if } h_1^j = 0 \text{ and } a_1 = 1 \\ 3 & \text{if } h_1^j = 1 \text{ and } a_1 = 1 \end{cases} \tag{2}$$

There is no uncertainty for individuals about the preference shocks. $q_{1,m}$ is an indicator function if decision $m$ is taken. That is: $q_{1,m} := \mathbb{1}\{d_1^j = m\}$ where $\mathbb{1}\{\}$ is the indicator function taking the

[5]The assumption that labor market participation is made only at the extensive margin is reasonable for the case of Chile since there is very low incidence of part-time work: the distribution of hours worked is unimodal for men and bimodal for women around zero and 45 hours a week. I provide evidence of this in the online appendix, in Section A and Figure A.1. Additionally, unemployment levels are very low compared to international standards, at about 5%.

value of 1 if the statement inside {} is true and zero otherwise. The coefficients of Equation 1 are normalized so that their sum is equal to one.

Preferences for the second period are represented in the utility function represented in Equation 3:

$$u_2^j(c_2^j, h_2^j, e_2^j, d_2^j, s_2) = \alpha_{1,2}^j \ln(c_2^j) + \alpha_{2,2}^j \ln(s_2) - \alpha_{3,2}^j(h_2^j) - \alpha_{4,2}^j e_2^j - \tag{3}$$

$$\alpha_{5,2} e_2^j h_2^j + \sum_{m=0}^{1} q_{2,m} \varepsilon_{2,m} \tag{4}$$

Note that parents do not make decisions about preschool/daycare during the second period, when children are five years old[6]. This implies that in the second period there is no decision regarding preschool/childcare attendance, $d_2^j = h_2^j$.

Table 1: Estimates: Utility function. Mother's preferences

| Parameter | Estimate | Standard Error |
|---|---|---|
| $\alpha^m_{1,12}$ | 0.6312 | 0.0028 |
| $\alpha^m_{2,12}$ | 0.0517 | 0.0001 |
| $\alpha^m_{3,12}$ | 0.3035 | 0.2208 |
| $\alpha^m_{4,0,12}$ | 0.0136 | 0.0001 |
| $\alpha^m_{4,1,12}$ | 0.0012 | 0.0001 |
| $\alpha^m_{1,10}$ | 0.0554 | 0.0003 |
| $\alpha^m_{2,10}$ | 0.0038 | 0.0001 |
| $\alpha^m_{3,10}$ | 0.1026 | 0.2437 |
| $\alpha^m_{4,0,10}$ | 0.0001 | 0.0001 |
| $\alpha^m_{4,1,10}$ | 0.0001 | 0.0001 |
| $\alpha^m_{5,10}$ | 0.8381 | 0.3831 |

Table 2: Estimates: Utility function. Father's preferences

| Parameter | Estimate | Standard Error |
|---|---|---|
| $\alpha^f_{1,12}$ | 0.1587 | 0.0026 |
| $\alpha^f_{2,12}$ | 0.0339 | 0.0001 |
| $\alpha^f_{3,12}$ | 0.8042 | 0.3610 |
| $\alpha^f_{4,0,12}$ | 0.0032 | 0.0001 |
| $\alpha^f_{4,1,12}$ | 0.0016 | 0.0001 |
| $\alpha^f_{1,10}$ | 0.6157 | 0.0026 |
| $\alpha^f_{2,10}$ | 0.1407 | 0.0005 |
| $\alpha^f_{3,10}$ | 0.8042 | 0.4496 |
| $\alpha^f_{4,0,10}$ | 0.0114 | 0.0001 |
| $\alpha^f_{4,1,10}$ | 0.0001 | 0.0001 |
| $\alpha^f_{5,10}$ | 0.0057 | 1.0415 |

Table 3: Estimates: Preference shock

| Parameter | Estimate | Standard Error |
|---|---|---|
| $\sigma^m_{W,A}$ | 3.6627 | 0.8352 |
| $\sigma^m_{NW,A}$ | 0.9095 | 0.1140 |
| $\sigma^m_{NW,NA}$ | 0.0794 | 0.2469 |
| $\sigma^f_{W,A}$ | 0.5020 | 0.4519 |
| $\sigma^f_{NW,A}$ | 0.0851 | 0.4550 |
| $\sigma^f_{NW,NA}$ | 0.0020 | 0.0777 |

Preference shocks for work-no childcare are standardized to zero

Table 4: Estimates: Mothers wages

| Parameter | Estimate | Standard Error |
|---|---|---|
| $\beta^m_0$ | 5.7874 | 0.4394 |
| $\beta^m_1$ | 0.2757 | 0.0251 |
| $\beta^m_2$ | 0.0732 | 0.0379 |
| $\beta^m_3$ | -0.0006 | 0.0006 |
| $\sigma_{w_m}$ | 0.8280 | 0.0606 |

Table 5: Estimates: Fathers wages

| Parameter | Estimate | Standard Error |
|---|---|---|
| $\beta^f_0$ | 5.8103 | 0.2997 |
| $\beta^f_1$ | 0.1260 | 0.0055 |
| $\beta^f_2$ | 0.1875 | 0.0156 |
| $\beta^f_3$ | -0.0022 | 0.0002 |
| $\sigma_{w_f}$ | 0.6894 | 0.0130 |

[6] Five year olds children all attend to preschool services in our sample.

Table 6: Estimates: Production of Skills

| Parameter | Estimate | Standard Error |
|---|---|---|
| $\theta_0$ | 0.2128 | 0.0011 |
| $\theta_1$ | 0.2673 | 0.0017 |
| $\theta_2$ | 0.5199 | 0.0032 |
| $\phi$ | 0.4688 | 0.0007 |
| $\gamma_f$ | 0.3647 | 0.0006 |
| $\gamma_m$ | 0.6353 | 0.0016 |
| $\delta_0$ | -0.8000 | 0.0051 |
| $\delta_1$ | -0.0000 | 0.0001 |
| $\delta_2$ | 0.0010 | 0.0004 |
| $\delta_{3,10}$ | 3.5038 | 0.0172 |
| $\delta_{3,12}$ | 5.3000 | 0.0408 |
| $\delta_4$ | 0.0130 | 0.0001 |
| $\sigma_s$ | 1.5754 | 0.0065 |

Table 7: Estimates: Distribution of latent factors

| Parameter | Estimate | Standard Error |
|---|---|---|
| $\sigma_{ef}^m$ | 2.5133 | 0.0039 |
| $\sigma_{ef}^f$ | 3.3754 | 0.0025 |
| $\sigma_{inv}$ | 2.1896 | 0.0144 |

Table 8: Estimates: Prices

| Parameter | Estimate | Standard Error |
|---|---|---|
| $\text{Price}_{I_0}$ | 966.2378 | 1.8225 |
| $\text{Price}_{I_1}$ | 1.0537 | 0.0019 |
| $\text{Pchildcare}_0$ | 2440.6020 | 1.1684 |
| $\text{Pchildcare}_1$ | 622.6098 | 1.2417 |

Table 9: Estimates: Pareto weight

| Parameter | Estimate | Standard Error | Description |
|---|---|---|---|
| $\lambda_0$ | -2.7321 | 0.0136 | Intercept |
| $\lambda_1$ | 0.0023 | 0.0143 | Wage ratio |
| $\lambda_2$ | 0.0527 | 0.0006 | Non-labor income ratio |
| $\lambda_3$ | -0.1194 | 0.0001 | Age difference |
| $\lambda_4$ | 0.0036 | 0.0026 | Educational difference |
| $\lambda_5$ | -2.5325 | 0.0039 | Gender ratio |
| $\lambda_6$ | -0.0069 | 0.0328 | Unemployment ratio |
| $\lambda_7$ | -0.7722 | 0.0006 | Wage ratio (region) |
| $\sigma_\mu$ | 0.5179 | 0.0074 | Standard deviation |

Table 10: Model Fit - Demand for childcare

| Childcare Attendance | Predicted | Data |
|---|---|---|
| Working Mothers | 68.4% | 67.7% |
| Not-working Mothers | 41.6% | 42.9% |

Table 11: Effects of Policy Counterfactuals on Employment

| | Change in Female labor force participation (%) | Change in Male labor force participation (%) |
|---|---|---|
| Cash transfer to mother | -2.37 | -1.05 |
| Cash transfer to father | -2.37 | -1.05 |
| Childcare subsidy | 3.16 | -2.11 |
| Child-investments subsidy | 0.00 | 0.00 |

Effects on policy beneficiaries. The reported effect is the average between the first and the second period.

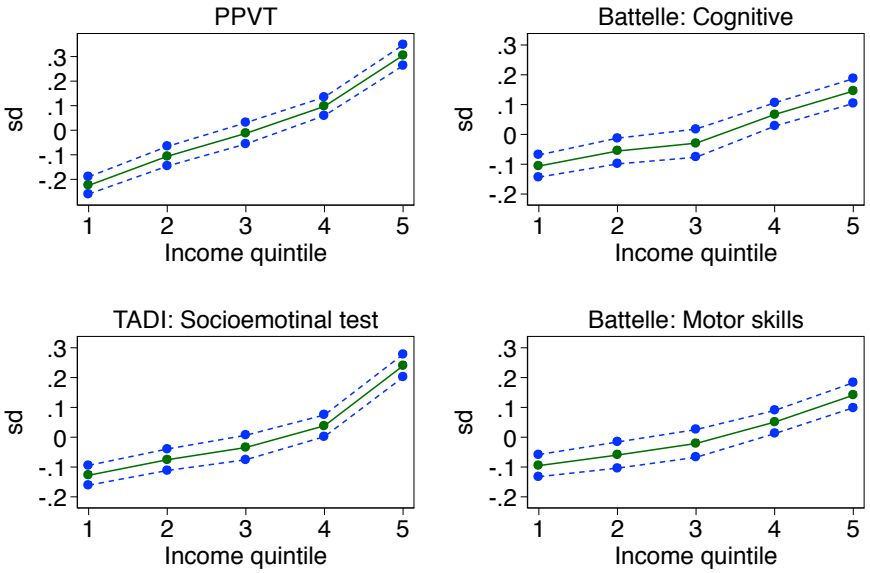
Table 12: Effects of Policy Counterfactuals on Children's Skills

| | Maternal effort* | Paternal effort* | Child investments (CLP)* | Skills of children$^+$ |
|---|---|---|---|---|
| Cash transfer to mother | 4.71 | 7.07 | 139.41 | 0.40 |
| Cash transfer to father | 4.71 | 2.08 | 139.21 | 0.40 |
| Childcare subsidy | -1.05 | 8.68 | 155.71 | 0.05 |
| Child-investments subsidy | 0.00 | 0.00 | 3252.93 | 3.00 |

Effects on policy beneficiaries. The effect corresponds to difference between policy change and baseline situation. For maternal and paternal effort, as well as skills, The effects are given in standard deviations with respect to baseline. Child investments are given in CLP. ,

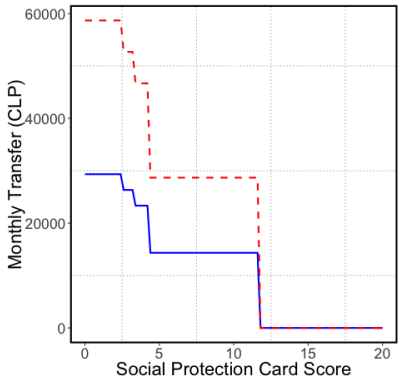
* Average effect between 2010 and 2012. For childcare subsidies, effect considered is in 2010.+ Total effect in 2012

Figure 1: Gaps in skills at age 5




The green (solid) line is the mean score, the blue (dashed) line is the 95% confidence interval. All test scores and parental assessments are normalized to have mean zero and variance one. PPVT stands for Peabody Picture Vocabulary Tests. Battelle is an instrument containing different scales to measures development of children. TADI is a test of learning and child development -"Test de Aprendizaje y Dessarollo Infantil" in Spanish-. In all tests, differences between the scores of children in the lowest quintile of the income distribution is statistically different to those children who are in the highest quintile of the income distribution.

Figure 2: Monetary Transfers to Families in Chile




This figure shows how monetary transfers to families are scheduled to families according to their score in the Social Protection Card. The total value of the transfer for each family corresponds to three different programs: "Unique Family Subsidies", "Family Assignments and "Social Protection Transfer". The conditions to be eligible for these programs are to have a score in the Social Protection Card below 11.734 and for those who work, having a monthly income of less than $187,515 CLP. The final amount being transferred to the household also depends on the size of the household and the time they have been beneficiaries of such programs. The solid line represents the schedule for a bi-parental household with one child that has been in the program for 50 months. The dashed line corresponds to a bi-parental household with three children under 18 that has been in the program for less than six months.

Figure 3: Distribution of skills by Income
Smoothing distribution

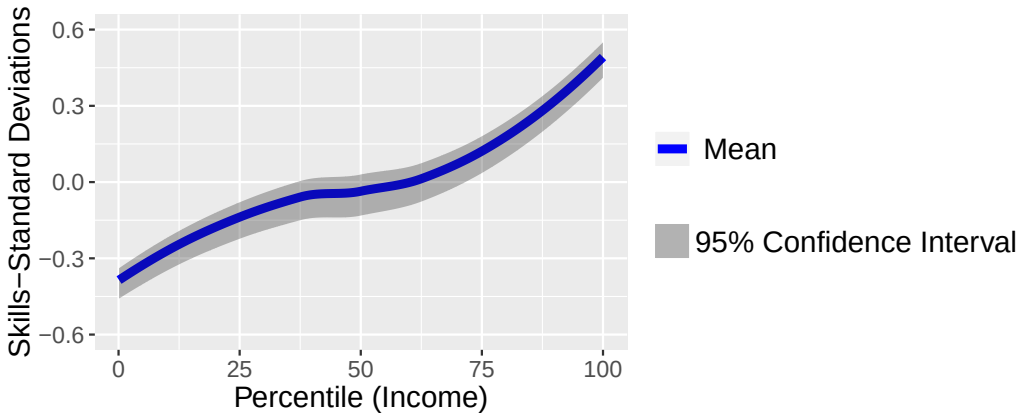



Figure 4: Model fit: Female labor force participation according to education

Figure 5: Model fit: Male labor force participation according to education

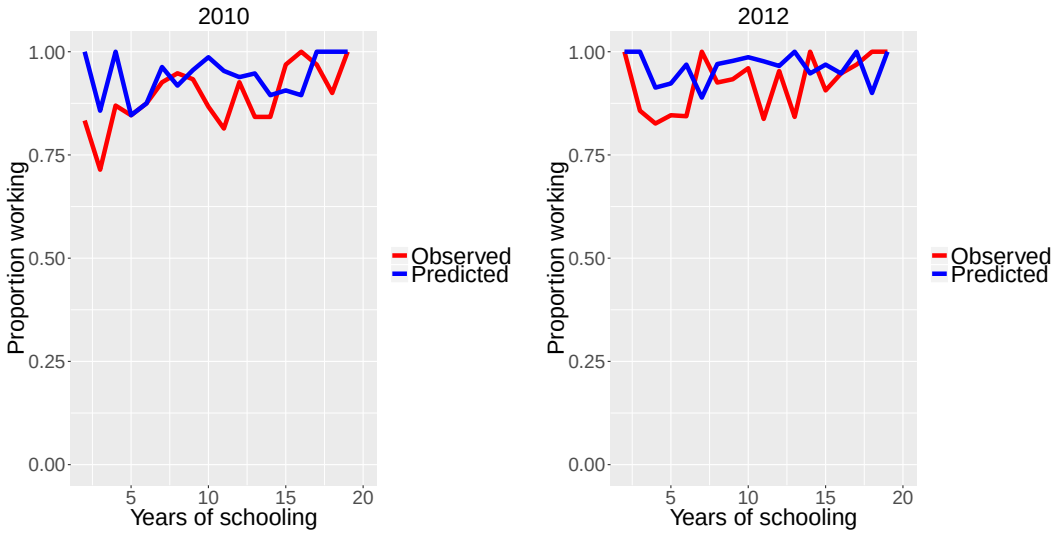
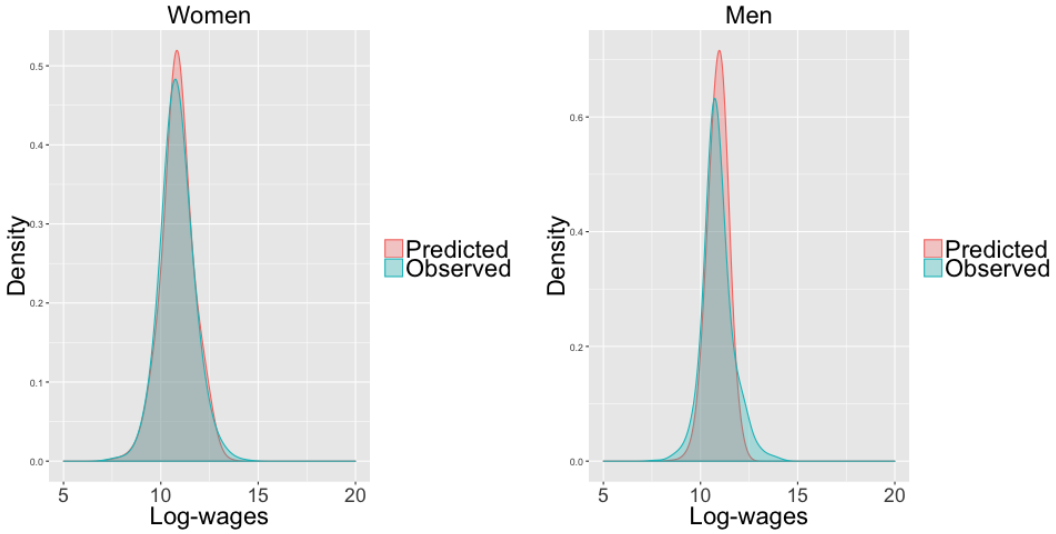


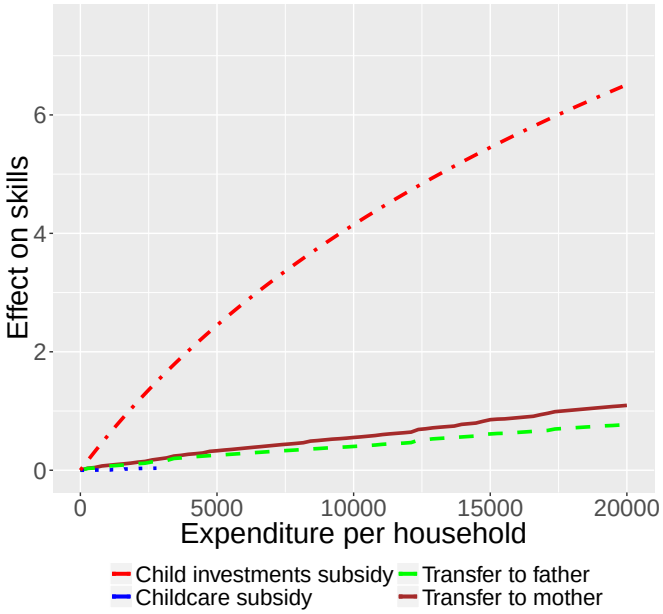

Figure 6: Model fit: distribution of wages




Kernel density estimates of predicted and observed wages.

Bandwidth chosen is 3.

Figure 7: Policy Effects on Children's Skills




The figure shows the effect of various policy counterfactuals on the skills of children located in the lowest quintile of the income distribution. The effect is measured as the number of standard deviations from the mean that the average level of skills for children in the lowest quintile of the income distribution is shifted.

# A Appendix

## A.1 Derivation of likelihood function

In this section I describe in detail how the likelihood function is constructed. The expressions will be left in terms of elements defined in Section **??**.

$$\int_{D_0} f_0\left(O_0, K_0 | X; \Theta\right) dK_0 = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} f\left(\{\{Z_m^{\ln(PG)}\}_{m=1}^{N_{\ln(PG)}}, \{Z_m^{\ln(s_0)}\}_{m=1}^{N_{s_0}}\} | \ln\left(s_0\right), \ln\left(PG\right)\right) \times f\left(\ln(s_0), \ln(PG)\right)$$

$$= \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \prod_{k \in \{\ln(s_0), \ln(PG)\}} \prod_{m=1}^{N_k} f_{\varepsilon_m^k}\left(Z_m^k - \iota_{m,0}^k - \iota_{m,1}^k k\right) f\left(\ln(s_0) | \ln(PG)\right) f\left(\ln(PG)\right) d\ln(s_0) d\ln(PG) \tag{5}$$

For the second period, the likelihood is:

$$\int_0^{\infty} \int_{D_2} f_2(O_2, K_2, K_1 | O_1, X; \Theta) dK_2 d\ln(s_1) =$$

$$\int \ldots \int \underbrace{\prod_{k \in K_2} \prod_{m=1}^{N_k} f_{\varepsilon_m^k}\left(Z_m^k - \iota_{m,0}^k - \iota_{m,1}^k k\right)}_{\text{Measurement system}} \times \underbrace{\prod_{j=m,f} f(\varepsilon_{w_2^j})^{\mathbb{1}\{h_j==1\}}}_{\text{wages}} \times \underbrace{f_{(\nu_2|\mu_2)}\left(\nu_t | \mu_2\right)}_{\text{Pareto weight}} \times$$

$$\underbrace{f_{\left(\eta_{s_2} | K_2, \ln(s_1)\right)}}_{\text{Skills of child}} \times \underbrace{\prod_{k \in \{\ln\left(e_2^{f,*}\right), \ln\left(e_2^{m,*}\right), \ln\left(I_2^*\right)\}} f_{\eta_k}(\eta_k)}_{\text{density of first set of factors}} \times \underbrace{P_{\boldsymbol{\epsilon}}\left(d_2^{m,*}, d_2^{*,f}\right)}_{\text{Preference shock}} dK_2 d\ln(s_1) \tag{6}$$

where the term $P_{\boldsymbol{\epsilon}}\left(d_2^{m,*}, d_2^{f,*}\right)$ is the cdf of the preference shocks for the observed decisions taken by the household $\left(d_2^{m,*}, d_2^{f,*}\right)$ given by the cdf of a normal distribution. Note that we also integrate with respect to skills in the first period $\ln\left(s_1\right)$ since skills in the second period depend on skills in the first period.

## A.2 Particle filter algorithm

### Filtering Algorithm

1. Set t=0.
   (a) For rr=1....RR:
      i. draw $(\ln(s_0), \ln(PG))^{\{rr\}}$ from proposal distribution
      $g((\ln(s_0), \ln(PG)|\Theta, X)$
      ii. Compute the weights $\hat{w}_0^{\{rr\}} = \frac{1}{RR}$
   (b) Compute likelihood for measurement system in $t = 0$:
   $\frac{1}{RR}\sum_{rr=1}^{RR} f\left(\{\{Z_m^{PG}\}_{m=1}^{N_{PG}}, \{Z_m^{s_0}\}_{m=1}^{N_{s_0}}\}|\left(\ln\left(s_0\right), \ln\left(PG\right)\right)^{\{rr\}}\right)$
2. Set t=t+1
   (a) For rr=1....RR:
      i. Draw $K_t^{\{rr\}}$ from proposal distribution (transition equation): $p(K_t^{\{rr\}}|K_{t-1}^{\{rr\}}, \Theta, X)$
      ii. For each factor, compute the corresponding weights given by the measurement system
      $\tilde{w}_t^{\{rr\}} = \prod_{m=1}^{N_k} f_{\varepsilon_m^k}\left(Z_m^k - \iota_{m,0}^k - \iota_{m,1}^k k\right)$
      iii. Define $w_t^{\{rr\}} = \hat{w}_{t-1}^{\{rr\}}\tilde{w}_t^{\{rr\}}$
   (b) For rr=1...RR
      i. Define $\hat{w}_t^{\{rr\}} = \frac{w_t^{\{rr\}}}{\sum_{rr=1}^{RR} w_t^{rr}}$
   (c) Compute the likelihood for period $t$: $\sum_{rr=1}^{RR} \tilde{w}_t^{rr}\hat{w}_{t-1}^{rr}$
   (d) For rr=1....RR
      i. Re-sample $RR$ particles $K_t^{\{rr\}}$ from step $(2.i)$ with probabilities $\hat{w}_t^{\{rr\}}$
      ii. Set $w_t^{rr} = \frac{1}{RR}$

In this application, I use as proposal $g((\ln(s_0), \ln(PG)|\Theta, X)$ the distribution characterized by the joint density of factors for period zero. The transition density from which factors in $t = 1, 2$ are drawn is characterized by the distribution of heterogeneity and the characterization of the factors given by the optimal solution of effort and investment in equations, the skill production specified and the Pareto weight specification.

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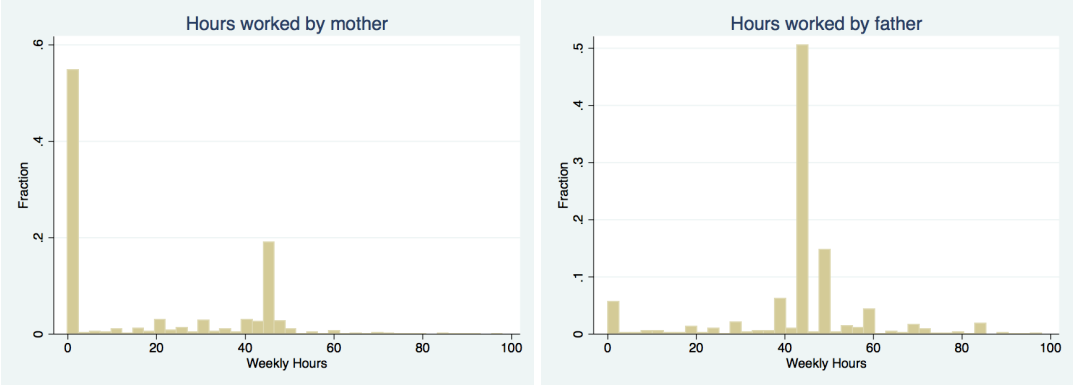
# Online Appendix (Not for Publication)

## A Labor force participation

Figure A.1: Distribution of work hours in Chile




I report the distribution of hours worked in Figure A.1. As can be seen, there is very little incidence of part-time work, most people work 45 hours a week or do not work at all. The information is taken from the ECLS. Similar results are found using the information from the national household survey of Chile, CASEN.

## B Preschool Availability as Cost Shifter of Child Investments

In this section I provide evidence suggesting that the distance to the nearest childcare provider ($DChihldcare$) and the number of childcare providers within 5km of the household ($Dens$) can be used as shifters in the cost of childcare and monetary investments for children, respectively. I estimates the coefficients of the following equation:

$$y_i = \beta_0 + \beta_1 DChildcare_i + \beta_2 Dens_i + \beta_3 X_i + \varepsilon_i \tag{7}$$

where $y_i$ is a given outcome and $X_i$ is a vector including additional controls. As can be seen in the results of the estimates, in Table B.1, distance to the nearest childcare center is negatively related with preschool attendance and availability of music for children. The number of childcare providers in the neighborhood is positively related with availability of music for children, toys, and vegetable consumption. Additionally, I use different measures of availability of childcare

centers to the household, including centers within 1, 2, and 10km. These results are reported in Table B.2. We see that all coefficients are significant except for availability of childcare centers at 1km.

Table B.1: Cost Shifters

| VARIABLES | (1) Attends preschool | (2) Music for children | (3) Toys FE | (4) Vegetable Consumption |
|---|---|---|---|---|
| Childcare providers | 0.00 | 0.01** | 0.01** | 0.03*** |
| | (0.01) | (0.00) | (0.01) | (0.01) |
| Distance to childcare | -0.01** | -0.02*** | -0.01 | -0.01 |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| Observations | 4,827 | 4,827 | 4,827 | 4,827 |
| Adjusted R-squared | 0.25 | 0.15 | 0.29 | 0.12 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

ToysFE: Toys for free expression

Childcare providers: Number of childcare providers within 5km to the household (hundreds)

Vegetable consumption: weekly frequency. Standardized (mean 0, sd 1)

Distance to childcare: Distance to nearest childcare-preschool service provider (km)

Additional controls: grades of schooling of both parents, WAIS verbal and numerical test scores for the mother, big-five personality traits test score for the mother, age of child, number of members living in the household, age of both parents, total income, activities that parents perform with their children and other investments done by parents

Table B.2: Distance: Robustness

| VARIABLES | (1) Toys FE | (2) Toys FE | (3) Toys FE | (4) Toys FE |
|---|---|---|---|---|
| Within 1km | 1.09 | | | |
| | (0.87) | | | |
| Within 2km | | 0.55** | | |
| | | (0.28) | | |
| Within 5km | | | 0.12** | |
| | | | (0.05) | |
| Within 10km | | | | 0.03** |
| | | | | (0.01) |
| Observations | 4,827 | 4,827 | 4,827 | 4,827 |
| Adjusted R-squared | 0.29 | 0.29 | 0.29 | 0.29 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Additional controls: grades of schooling of both parents, WAIS verbal and numerical test

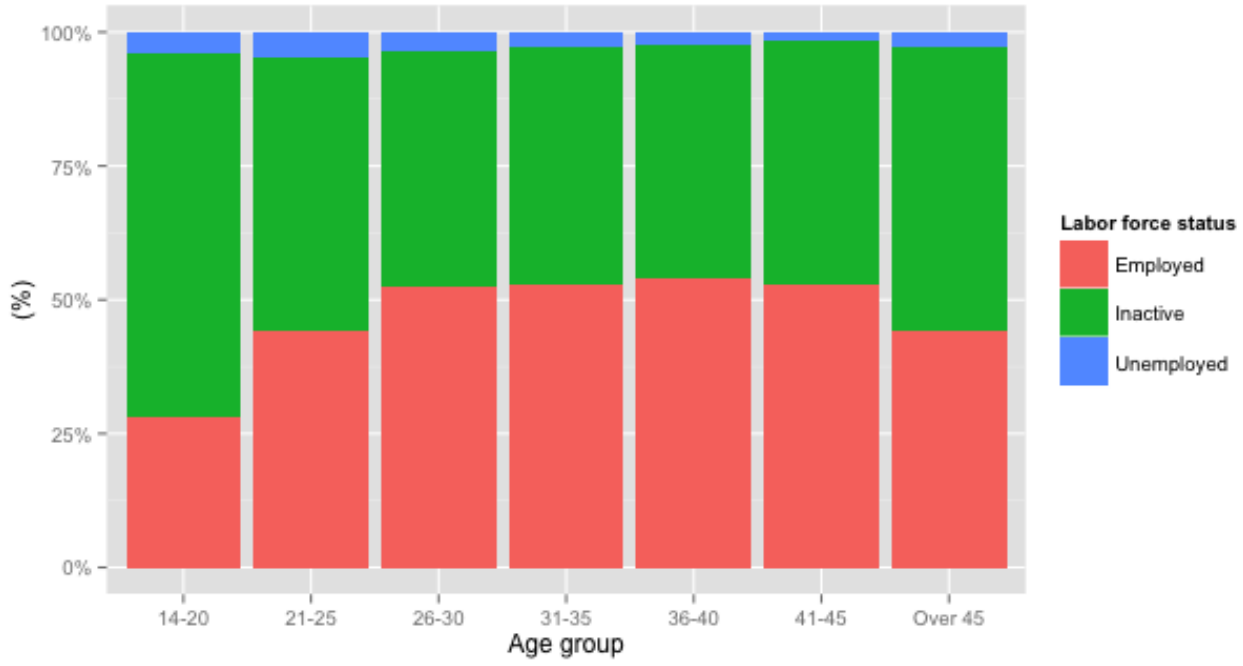
scores for the mother, big-five personality traits test score for the mother, age of child, number of members living in the household, age of both parents, total income, activities that parents perform with their children and other investments done by parents

## C Female Labor Force Participation

As mentioned before, mothers participate in the labor market , on average, for18 hours a week. The corresponding figure for fathers is 44 hours. One plausible explanation can be due to involuntary unemployment: it is harder for women to find a job offering a wage higher than their reservation wage, and because of that they do not actively participate in the labor market. However, it turns out to be the case that female unemployment in the population analyzed is low, below 5%. The main reason for observing these low levels of female participation in the labor market is due to voluntary unemployment: women with young children decide not to participate in the labor market. As can be seen in Figure C.1, this is characteristic of women across all age groups. Most of them are not working or looking for a job and 83% of them state that the main reason is that they do not do it is because they are taking care of children.

The fact that unemployment plays a small role in explaining the low levels of female activity in the labor market should guide the economic model as to how to approach the problem of deciding whether or not to work. Including frictions in the model, as is usually done in the literature in order to explain unemployment and variation in earnings for observationally equivalent agents, would complicate the model and the gains from doing so might not be significant. Because of this, I will simplify the usual decision about labor force participation, as is usually done in the neoclassical model of household behavior, where people decide whether or not to work at a given wage determined by the market.

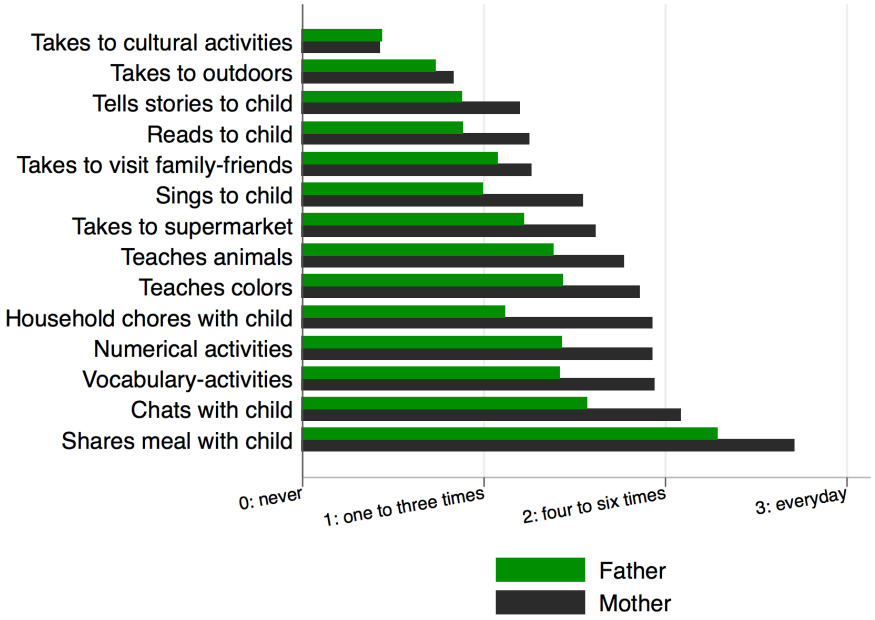
Figure C.1: Female Labor Force Participation (%)




## D Parental Activities with Children

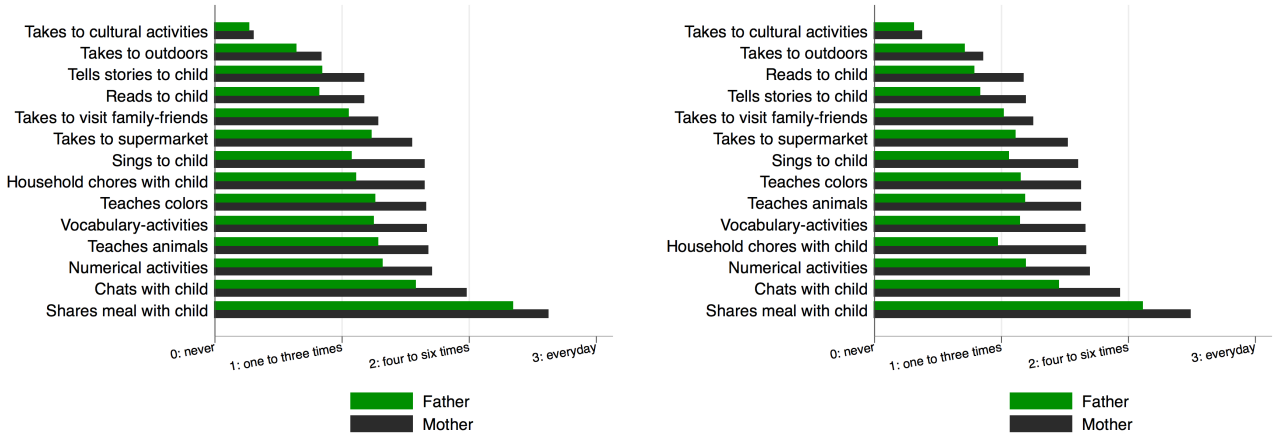
As shown in Figure D.1, mothers spend more time with their children, in every activity, than fathers do. This happens even when taking into account differences in labor supplies, as seen in Figures D.2. In Tables D.1 and D.2, I analyze the relationship between labor supply of both spouses and time spent with the child. In order to simplify the analysis, I construct a measure of time investment via principal component analysis and I regress the predicted factor with other covariates of the family. We observe that there is a negative correlation between time spent with the child and labor supply decisions for both fathers and mothers, in the two waves of the dataset being used, as can be seen in Tables D.1 and D.2.

Figure D.1: Weekly frequency of activities between parents and children




For each activity there are possible answers: 0: never, 1: one to three times a week; 2: four to six times a week; 3: everyday.

Figure D.2: Frequency of activities by parental labor supply




For each activity there are possible answers: 0: never, 1: one to three times a week; 2: four to six times a week; 3: everyday.

Additionally, we observe a positive correlation between each parent's own effort and the labor supply of his/her spouse. This might be evidence of compensating behavior by parents. For example, when one parent increases his/her labor supply, that parent decreases the amount of time spent with the child and thus the other parent might react by increasing the amount of time spent interacting with the child. This compensating behavior might diminish the plausible

negative impact on child development of an increase in female labor force participation.

The evidence from these regressions is complemented with the estimates of regressions in differences reported in Table D.3. The results again seem to suggest that, as members participate more in the labor market, they decrease the amount of time spent with their child, but this is compensated by an increase in the spouse's time with their child.

Table D.1: Time investments and labor supply (2010)

| VARIABLES | (1) Mother's effort (2010) | (2) Father's effort (2010) |
|---|---|---|
| Mother: hours worked weekly | -0.00*** | 0.00*** |
| | (0.00) | (0.00) |
| Father: hours worked weekly | 0.00*** | -0.00*** |
| | (0.00) | (0.00) |
| Total household income | 0.00 | 0.00*** |
| | (0.00) | (0.00) |
| Age of child (months) | 0.01*** | 0.00* |
| | (0.00) | (0.00) |
| BFI-Extraversion | 0.05*** | 0.07*** |
| | (0.02) | (0.02) |
| BFI-Kindness | 0.05** | 0.04* |
| | (0.02) | (0.02) |
| BFI-Responsibility | 0.06*** | 0.05** |
| | (0.02) | (0.02) |
| BFI-Neuroticism | -0.05*** | -0.02 |
| | (0.01) | (0.02) |
| BFI-Openness | 0.15*** | 0.02 |
| | (0.02) | (0.02) |
| Wais-digits | 0.01 | 0.01* |
| | (0.01) | (0.01) |
| Wais-Vocabulary | -0.00 | -0.00 |
| | (0.00) | (0.00) |
| Number of siblings | -0.07*** | -0.06*** |
| | (0.01) | (0.01) |
| Observations | 7,058 | 7,058 |
| Adjusted R-squared | 0.07 | 0.04 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Additional controls include age of child, race, age of both parents and test scores of primary caregiver.

The measure of effort is constructed via Principal component analysis, extracting one factor for the variables used as measures of time investments by parents. The measures of parental effort, together with the big five personality test scores and the Wais cognitive assessments are all standardized to have mean zero and one standard deviation. In the regression the measure of effort is in hundreds.

Table D.2: Time investments and labor supply (2012)

| VARIABLES | (1) Mother's effort (2012) | (2) Father's effort (2012) |
|---|---|---|
| Mother: hours worked weekly | -0.01*** | 0.00*** |
| | (0.00) | (0.00) |
| Father: hours worked weekly | 0.00 | -0.01*** |
| | (0.00) | (0.00) |
| Total household income | 0.00 | 0.00 |
| | (0.00) | (0.00) |
| Age of child (months) | 0.01*** | 0.00*** |
| | (0.00) | (0.00) |
| BFI-Extraversion | 0.01 | 0.05* |
| | (0.03) | (0.03) |
| BFI-Kindness | 0.06 | -0.00 |
| | (0.04) | (0.03) |
| BFI-Responsibility | 0.11** | 0.11*** |
| | (0.04) | (0.03) |
| BFI-Neuroticism | -0.05 | -0.04 |
| | (0.03) | (0.03) |
| BFI-Openness | 0.19*** | 0.05* |
| | (0.04) | (0.03) |
| Wais-digits | -0.02 | -0.00 |
| | (0.01) | (0.01) |
| Wais-Vocabulary | 0.01*** | 0.01*** |
| | (0.00) | (0.00) |
| Number of siblings | -0.09*** | -0.06*** |
| | (0.02) | (0.02) |
| Observations | 8,020 | 7,956 |
| Adjusted R-squared | 0.04 | 0.03 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Additional controls include age of child, race, age of both parents and test scores of primary caregiver.

The measure of effort is constructed via Principal component analysis, extracting one factor for the variables used as measures of time investments by parents. The measures of parental effort, together with the big five personality test scores and the Wais cognitive assessments are all standardized to have mean zero and one standard deviation. In the regression the measure of effort is in hundreds.

Table D.3: Regressions of effort in differences

| VARIABLES | (1) ΔEffort father | (2) ΔEffort mother |
|---|---|---|
| ΔHours worked mother | 0.03*** | -0.02*** |
| | (0.01) | (0.01) |
| ΔHours worked father | -0.03*** | 0.01** |
| | (0.01) | (0.01) |
| ΔEffort mother | 0.37*** | |
| | (0.01) | |
| ΔEffort father | | 0.36*** |
| | | (0.01) |
| Observations | 4,531 | 4,531 |
| R-squared | 0.14 | 0.15 |

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

$\Delta X = X_{2012} - X_{2010}$. The measure of effort is the same used as in Table D.2 but in differences. The same controls as in Table D.2 are used.

Although labor market behavior might explain part of the differences in the time investments between mothers and fathers, there are other stories consistent with such a result. The differ-

ences might be due to preferences, as mothers find it less costly to invest time in their children, or due to differences in productivity, as the amount of time that mothers spend with their children might be more efficient in enhancing children's skills than that of fathers. Moreover, there is a possible explanation related to the fact that the utility derived from children's skills is a public good but the time investments are privately exerted. As women are relatively less empowered than men, the cost of effort exerted by women is less than the cost of effort exerted by men. This implies that, even with the same preferences and resources, women would spend more time taking care of children. In the economic model, I allow all these aforementioned factors to be a possible explanation of the differences in time investment between fathers and mothers.

## E Distribution of Childcare providers

Figure E.1 reports the distribution of institutions within a neighborhood (within 5km from household) as well as the distance to the nearest preschool provider from households.

Figure E.1: Information on Preschool Providers

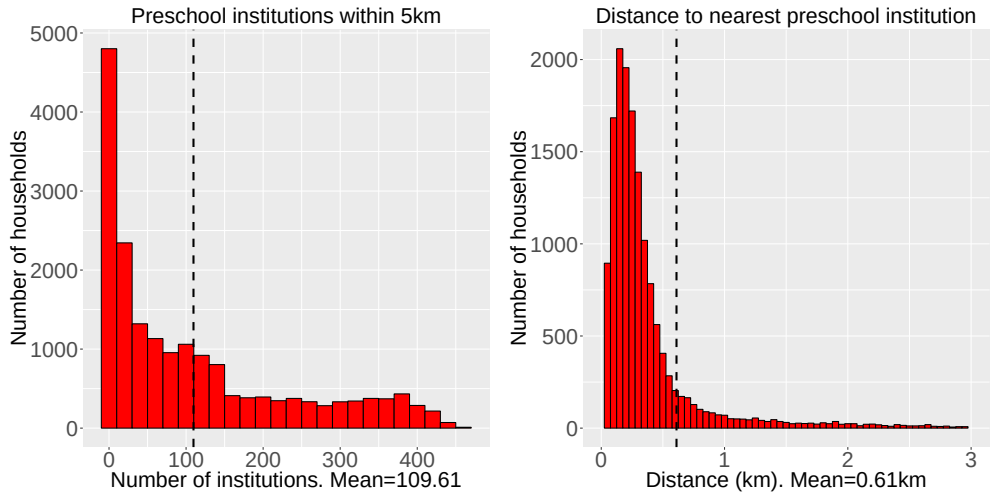



Figure E.2 is an example of the distribution of childcare and preschool providers in the City of La Serena, Chile.

Figure E.2: Example of distribution of childcare providers. City of "La Serena", Chile


## F Cash Transfer Programs in Chile

The basic program through which poor families receive cash transfers from the central government is the "Unique Family Subsidy".[7] Such program established a monthly transfer of $14,340 CLP in 2012, for a family in conditions of vulnerability[8] with one child.[9] The recipient of the transfer is always set to be the mother of the children who generate the transfer. In addition to be within the 40% most vulnerable, in order for the mother should be economically inactive in order to receive the transfer. However, the alternate program "Family Assignment" cash transfers of the same value for those mothers who were working, with a fadeout scheme.[10]

In 2016, the basic amount of a transfer in the programs "Unique Family subsidy" and "Family Assignments" corresponded to $10,577. When compared to the $7,170 CLP of 2012, this represents an increase of 29% in real terms. Additionally, in 2014 the government of Michelle Bachelet

[7] Subsidio Unico familiar in Spanish.

[8] The condition of vulnerability corresponds to a score below 11.734 in the "Ficha de ProtecciÛn Social". Approximately 40% of Chilean families lie below this threshold

[9] The $14,340 CLP were generated by the mother and the child, each generating a transfer of $7,170 CLP.

[10] The transfer scheme consisted of $7,179CLP for women with monthly wages below $187,515 CLP; $5,054 CLP for women whose wages was in between $187,515 CLP and $307,863 CLP; and $1,600 CLP for women whose wages was between $307,863 CLP and $480,163.

implemented the implemented the "Permanent Family Contribution Program". In 2016, those families who were eligible to either "Unique Family Subsidy" or "Family Assignments" were automatically eligible to be part of the "Permanent Family Contribution Program". which consisted in a transfer of $43,042 anually for each children and one for the family as a whole. Thus, a family one child would be eligible to receive $86,084 CLP.

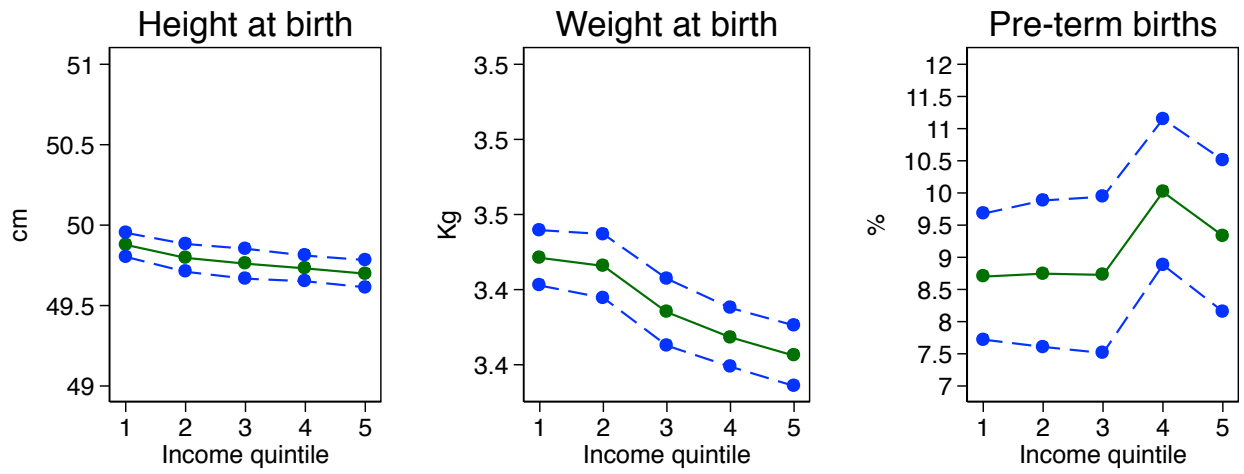
Overall, a family of one child that was receiving transfers from the "Unique Family Subsidy" program in 2012, would see an increase in the monetary transfers from the central government equivalent to 72.8% in real terms.

## G Reduced-form Evidence

In this section, I present four facts found in the dataset that motivate the economic model developed in the next section.

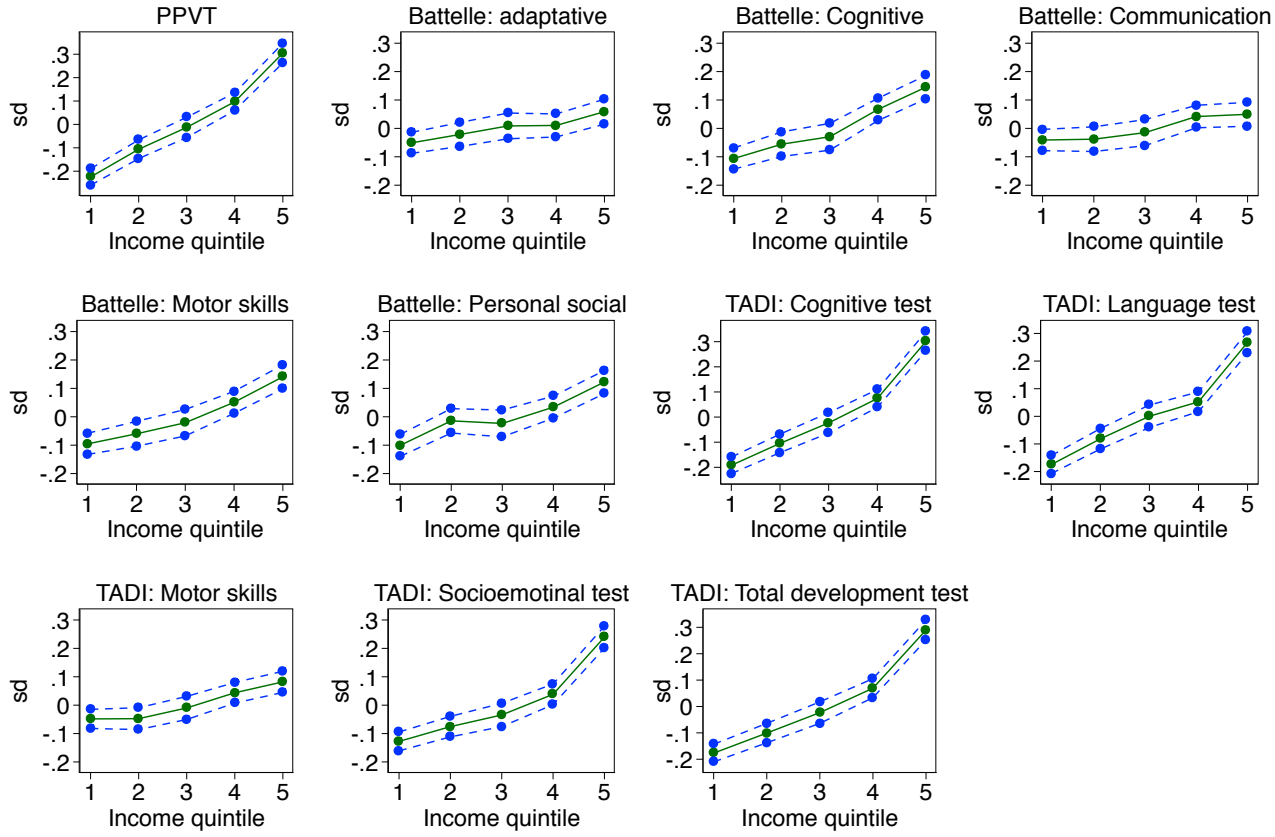
## G.1 Gaps in skills emerge early in life

Figure G.1: Gaps in health at birth




The green (solid) line is the mean score, the blue (dashed) line is the 95% confidence interval.

Figure G.2: Gaps in skills at age 5




The green (solid) line is the mean score, the blue (dashed) line is the 95% confidence interval. All test scores and parental assessments are normalized to have mean zero and variance one. PPVT stands for Peabody Picture Vocabulary Tests. Battelle is an instrument containing different scales to measures development of children. TADI is a test of learning and child development[a]. In all tests, differences between the scores of children in the lowest quintile of the income distribution is statistically different to those children who are in the highest quintile of the income distribution.

[a] "Test de Aprendizaje y Dessarollo Infantil" in Spanish.

When analyzing height at birth, weight at birth and the incidence of pre-term births[11], for different income groups, we do not observe dramatic differences between poor and rich children, as can be seen in Figure G.1. However, we do observe differences in various dimensions of development, such as vocabulary, communication skills, motor skills and cognitive achievement, when children are five years old. This can be seen in Figure G.2. The figure reports the scores in different tests and parental assessments. All of them are standardized to be mean zero and

[11] These are variables that have often been used as a measure of health at birth (Sørensen et al., 1999).

variance one. We see, for instance, that children in the lowest income quintile score 0.1 of a standard deviation below the mean on the Battelle test score for Motor Skills, whereas children in the richest quintile score 0.15 of a standard deviation above the mean. The most dramatic case is vocabulary, where children in the lowest income quintile score 50% of a standard deviation below children located in the richest income quintile. This early emergence of gaps in the development of children is consistent with the literature (Schady et al., 2015; Cunha et al., 2010).

### G.2 Female empowerment and child outcomes

The last point to be mentioned in the Reduced-form evidence section is the correlation between female empowerment and child outcomes. There is evidence in the literature pointing to the fact that women's empowerment is associated with better child outcomes in various contexts (Attanasio & Lechene, 2014; Thomas, Contreras, & Frankenberg, 2002).

We do observe evidence of a positive relationship between female empowerment and child outcomes. Table G.1 presents the results of various regressions showing positive correlations between child outcomes and the share of income earned by women. Even after controlling for variables such as the IQ level of the primary caregiver, total household income, grades of schooling of both parents and their ages, we observe a positive relationship between the share of the total household income earned by mothers and children's outcomes.

When analyzing the responses to the female empowerment questionnaires, we also observe a positive relationship between female empowerment and investments in children. In Table G.2, some regressions of child investments and female empowerment are presented. I show again that, even after controlling for the same variables as mentioned before, those households where women are relatively less empowered make fewer investments in their children. Those households where the woman manages the income are more likely to have toys for the development of children, and the frequency of consumption of fruits and vegetables is higher whereas that of bread is smaller. Similarly, households that are more accepting of the opinion that women should not work and should exclusively take care of their children are more likely to have the children sharing their bed with someone else, which might be an indicator of lower investments in children.

The results of these regressions cannot be interpreted as incorruptible evidence of a causal relationship between female empowerment and child outcomes. Nonetheless, they suggest that there are either some unobservables that are not captured in the regressions, which are also correlated with female empowerment, and which positively affect child outcomes, or that it is indeed female empowerment that improves the conditions of children in the households. In order to incorporate such findings in the economic model, I allow parents to have different preferences regarding leisure, consumption, and skills of children, among other preferences, so that we can understand whether the relationship between female empowerment and child outcomes arises from such patterns or either due to unobserved heterogeneity.

Table G.1: Child outcomes in 2012 and share of income earned by women

| VARIABLES | (1) Motor skills 2 (B3) | (2) Cognitive test (B5) | (3) Batelle Total |
|---|---|---|---|
| Mother's income share | 0.09* | 0.09* | 0.10** |
| | (0.05) | (0.05) | (0.05) |
| Total household income | 0.00 | 0.00** | 0.00** |
| | (0.00) | (0.00) | (0.00) |
| Mother's years of schooling | 0.01** | 0.02*** | 0.03*** |
| | (0.01) | (0.01) | (0.01) |
| Father's years of schooling | 0.02*** | 0.01** | 0.02*** |
| | (0.01) | (0.01) | (0.00) |
| Number of siblings | 0.02 | -0.00 | -0.03* |
| | (0.01) | (0.01) | (0.01) |
| Age of child (months) | 0.00*** | 0.00*** | 0.01*** |
| | (0.00) | (0.00) | (0.00) |
| BFI-Extraversion | 0.06*** | 0.04** | 0.04*** |
| | (0.02) | (0.02) | (0.02) |
| BFI-Kindness | -0.00 | 0.09*** | 0.02 |
| | (0.02) | (0.02) | (0.02) |
| BFI-Responsibility | 0.10*** | 0.08*** | 0.07*** |
| | (0.02) | (0.02) | (0.02) |
| BFI-Neuroticism | -0.02 | -0.03* | -0.01 |
| | (0.02) | (0.02) | (0.02) |
| BFI-Openness | 0.07*** | 0.03 | 0.03 |
| | (0.02) | (0.02) | (0.02) |
| Wais-digits | 0.01 | 0.01 | 0.02*** |
| | (0.01) | (0.01) | (0.01) |
| Wais-Vocabulary | 0.00 | 0.00*** | 0.00*** |
| | (0.00) | (0.00) | (0.00) |
| Observations | 6,823 | 6,823 | 6,822 |
| Adjusted R-squared | 0.03 | 0.05 | 0.08 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Additional controlsi include age of child, race, age of both parents, test scores of primary caregiver and number of siblings. +: lower scores indicate lower incidence of behavioral problems.

Table G.2: Female empowerment and Child outcomes

| VARIABLES | (1) Toys for development | (2) Fruits and vegetables | (3) People sharing bedroom with child |
|---|---|---|---|
| Total household income | 0.00*** | 0.00 | -0.00*** |
| | (0.00) | (0.00) | (0.00) |
| Mother's years of schooling | 0.01*** | 0.01** | -0.03*** |
| | (0.00) | (0.01) | (0.00) |
| Father's years of schooling | 0.01*** | 0.01** | -0.02*** |
| | (0.00) | (0.00) | (0.00) |
| Number of siblings | 0.00 | 0.04** | 0.08*** |
| | (0.01) | (0.01) | (0.01) |
| People in household | -0.01** | 0.01 | 0.13*** |
| | (0.01) | (0.01) | (0.01) |
| Woman administers+ | 0.03** | 0.09*** | -0.00 |
| | (0.01) | (0.02) | (0.02) |
| Gender roles -Woman++ | -0.01 | -0.03** | 0.02* |
| | (0.01) | (0.01) | (0.01) |
| Gender roles - Man++ | -0.01 | -0.05* | 0.06** |
| | (0.01) | (0.03) | (0.02) |
| Observations | 6,344 | 8,245 | 8,246 |
| Adjusted R-squared | 0.04 | 0.03 | 0.19 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Consumption of bread, fruits and vegetables and cookies and candies is related to the frequency of consumption of this food on a weekly basis. + dummy variable indicating whether the mother is the person in charge of administering the resources of the household (1) or no (0). ++ opinion of gender roles according to the man and the woman. A value of one indicates that the person agrees with the sentence "Women should not work and should only take care of children".

## H Smoothing distribution

The smoothing distribution is useful if we are interested in making inference about the state of the unobserved factors. In this case, it is particularly interesting to make inference about the skills of children. The following procedure describes how to use the information provided in the model and in the data in order to derive the smoothing distribution of the unobserved latent factors. This procedure is adapted from Klaas et al. (2006):

I use as main input for this file the article "Fast Particle Smoothing: If I had a Million Particles". I translate the notation in the one used in the paper. Define $O_{0:t} = \{O_0, O_1..., O_t\}$. Let $f$ be a generic probability density function. Then, the smoothed density is:

$$f(K_t|O_{0:2}) \tag{8}$$

where we basically condition on all the measures we have. Note that we can write Equation 8 as:

$$f(K_t|O_{0:2}) = f(K_t|O_{0:t}) \int \left( \frac{f(K_{t+1}|O_{0:2}) f(K_{t+1})}{\int f(K_{t+1}) f(K_1|O_{0:t}) dK_t} \right) dK_{t+1} \tag{9}$$

And then we can approximate this distribution $\hat{f}(K_t|O_{0:2})$ by getting $rr = 1..RR$ draws according to:

$$\hat{f}(K_t|O_{0:2}) = \sum_{rr=1}^{RR} w_{t|T}^{(rr)} \delta_{K_t^{(rr)}}(K_t) \tag{10}$$

where $\delta_{K_t^{(rr)}}(K_t)$ is the Dirac distribution and

$$w_{t|T}^{(mm)} = w_t^{(mm)} \left[ \sum_{rr=1}^{RR} w_{t+1|T}^{(rr)} \left( \frac{f\left(K_{t+1}^{(rr)}|K_t^{(mm)}\right)}{\sum_{kk=1}^{KK} w_t^{(kk)} f\left(K_{t+1}^{(rr)}|K_t^{(kk)}\right)} \right) \right] \tag{11}$$

where $w_{T|T} = w_T$

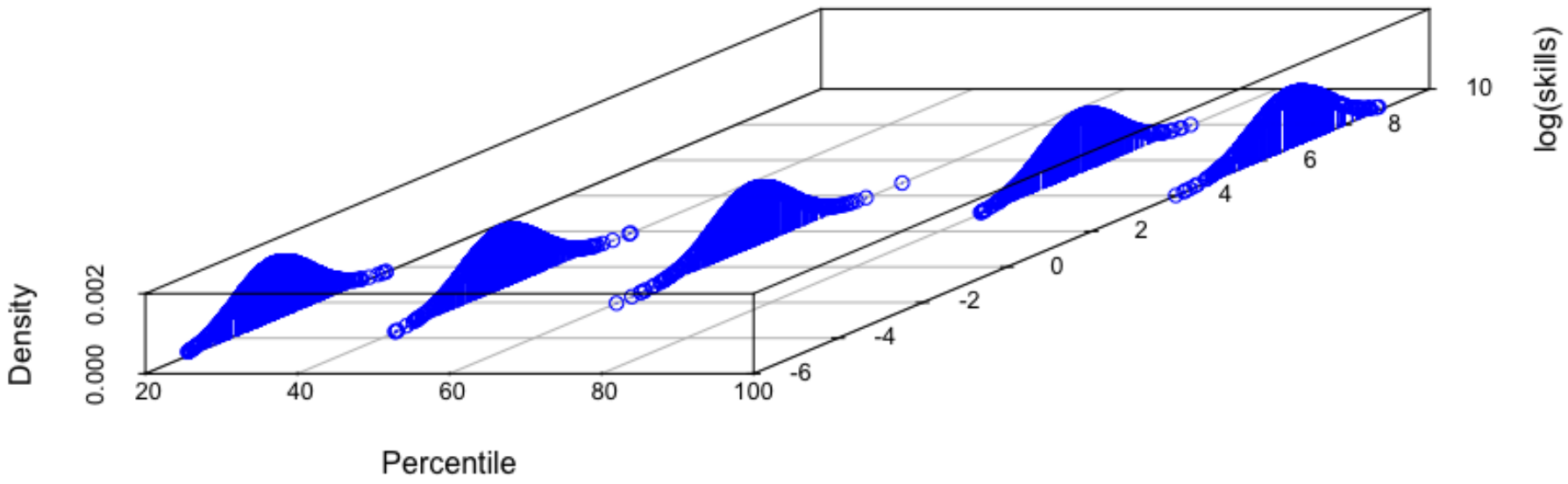
## Smoothing algorithm

1. For t=0,1,2 perform the particle filtering to obtain $\{K_t^{rr}, w_t^{rr}\}_{rr=1}^{RR}$

2. Set $w_{2|2}^{rr} = w_2^{rr}$ for $rr = 1...RR$

3. For t=1,0 define $w_{t|2}^{(mm)} = w_t^{(mm)} \left[ \sum_{rr=1}^{RR} w_{t+1|2}^{(rr)} \left( \frac{f\left(K_{t+1}^{(rr)} | K_t^{(mm)}\right)}{\sum_{kk=1}^{KK} w_t^{(kk)} f\left(K_{t+1}^{(rr)} | K_t^{(kk)}\right)} \right) \right]$

Figure H.1: Smoothing Distribution of Skills According to Household's Income Percentile




The distribution of $log(skills)$ is plotted for representative households. Households located in the 20th, 40th, 60th, 80th and 100th percentile of total household income. The smoothed distribution of all the households is presented in Figure 3

# I Signal to Nose ratio

Table I.1: Maternal effort 2012

| Measure | Signal (%) |
|---|---|
| Teaches her words | 95.94 |
| numerical activities | 95.73 |
| Teaches colors | 35.58 |
| Teaches animals and their sounds | 32.52 |
| chatting or drawing | 13.67 |
| household chores | 12.41 |
| Sings to child | 10.32 |
| supermarket | 9.24 |
| Visit friends-family | 8.93 |
| Reads to child | 7.28 |
| Shares a meal | 7.07 |
| Tells her stories | 6.47 |
| Takes her to parks | 3.85 |
| Takes her to museums-zoo-park | 2.56 |

Table I.2: Paternal effort 2012

| Measure | Signal (%) |
|---|---|
| Teaches her words | 96.94 |
| numerical activities | 96.78 |
| Teaches colors | 42.59 |
| Teaches animals and their sounds | 39.29 |
| chatting or drawing | 17.53 |
| household chores | 15.99 |
| Sings to child | 13.39 |
| supermarket | 12.02 |
| Visit friends-family | 11.64 |
| Reads to child | 9.54 |
| Shares a meal | 9.27 |
| Tells her stories | 8.50 |
| Takes her to parks | 5.10 |
| Takes her to museums-zoo-park | 3.41 |

Table I.3: Maternal effort 2010

| Measure | Signal (%) |
|---|---|
| Spends time with her talking or drawing | 66.43 |
| Plays with her | 30.33 |
| Sings to her | 20.86 |
| Reads Childre's storybooks or drawing books | 19.01 |
| Tells her stories | 14.37 |
| Takes her to parks, museums, zoos, libraries or other cultural activities | 13.96 |

Table I.4: Paternal effort 2010

| Measure | Signal (%) |
|---|---|
| Spends time with her talking or drawing | 72.66 |
| Plays with her | 36.90 |
| Sings to her | 26.14 |
| Reads Childre's storybooks or drawing books | 23.97 |
| Tells her stories | 18.40 |
| Takes her to parks, museums, zoos, libraries or other cultural activities | 17.89 |

## Table I.5: Investments 2010

| Measure | Signal (%) |
|---|---|
| Child has at least one toy that involves muscular activity | 83.50 |
| Child has at least one toy with wheels | 75.78 |
| Child has toys to pull and push | 72.95 |
| Child has a special place where to store toys and belongings | 49.40 |
| Availability of musical or literary toys | 38.25 |
| Availability of plush toys-stuffed animals | 32.57 |
| Child has three or more books of his own | 19.19 |
| Availability of mobiles for child | 9.98 |

## Table I.6: Investments 2012

| Measure | Signal (%) |
|---|---|
| There are two or more toys in the household that can help with learning numbers | 99.98 |
| There are two or more toys for free expression or impersonations such as tools and customs | 99.97 |
| Child has three or more puzzles | 26.37 |
| At first sight, there is very little evidence that there is a child living in the household | 24.39 |
| There are two or more toys in the household where child can learn colors, sizes and shapes | 20.76 |
| There are at least ten books for adults | 18.49 |
| There is a music device where child can listen children's music | 16.27 |
| There are at least ten children's books available in the house | 4.35 |
| Number of people with whom child shares bed | 1.40 |
| Number of people with whom child shares room | 1.26 |
| Consumption of juice* | 1.25 |
| Consumption of milk* | 0.53 |
| Consumption of fruits and vegetables* | 0.34 |
| Consumption of Chocolate-Candy* | 0.26 |
| Consumption of legumes* | 0.22 |
| Consumption of cookies* | 0.19 |
| Consumption of Fish-Beef-Chicken* | 0.16 |
| Consumption of water* | 0.10 |
| Consumption of hamburger-pizza-fries* | 0.04 |
| Consumption of bread-rice-pasta | 0.00 |
| Consumption of snacks in bags* | 0.00 |

*: The possible answers are 1: never, 2: one to two times a month; 3: one to three times a week; 4: four to six times a week; 5: once a day; 6: two or more times a day.

## Table I.7: Health at birth

| Measure | Signal (%) |
|---|---|
| Cigarrettes consumed during pregnancy | 100.00 |
| Substance abuse during pregnancy* | 100.00 |
| Alcohol consumption during pregnancy* | 99.98 |
| Cigarrettes consumed during the first six months of life of child | 99.97 |
| Mother diagnosed with Depression during pregnancy | 98.68 |
| Mother diagnosed with Obsesive compulsive D. during pregnancy | 98.13 |
| Mother diagnosed with Fobia during pregnancy | 97.07 |
| Mother diagnosed with Hemorrages during pregnancy | 94.94 |
| Mother diagnosed with Toxoplasmosis during pregnancy | 94.26 |
| Mother diagnosed with Preeclampsia during pregnancy | 94.17 |
| Mother diagnosed with Placenta Previa during pregnancy | 93.93 |
| Mother diagnosed with Cholestasis during pregnancy | 93.43 |
| Child was born pre-term | 91.73 |
| Mother diagnosed with Anemia during pregnancy | 88.98 |
| Mother diagnosed with Anxiety D. during pregnancy | 86.66 |
| Mother diagnosed with Urinary infections during pregnancy | 83.93 |
| Mother diagnosed with Panic D. during pregnancy | 82.63 |
| Mother diagnosed with PTSD during pregnancy | 82.33 |
| Mother diagnosed with Hipertension during pregnancy | 76.81 |
| Mother diagnosed with Bipolar D. during pregnancy | 71.58 |
| Mother diagnosed with Diabetes G during pregnancy | 68.55 |
| Weight at birth (grams) | 13.80 |
| Height at birth (cm) | 1.81 |

*Possible answers are never (0), rarely (1) and often (2).

Table I.8: Skills 2010

| Measure | Signal (%) |
|---|---|
| CBCL-Aggressive behavior | 99.84 |
| CBCL-Emotional intelligence | 9.66 |
| CBCL-Attention deficit | 7.13 |
| CBCL-anxiety -depression | 6.34 |
| CBCL-Isolation | 3.83 |
| CBCL-Sleeping disorder | 2.90 |
| CBCL-somatic complaints | 2.33 |
| TEPSI-Coordination subdomain | 0.67 |
| TEPSI-Language subdomain | 0.41 |
| TEPSI-Motor skills subdomain | 0.31 |

Table I.9: Skills 2012

| Measure | Signal (%) |
|---|---|
| Battelle-Cognitive | 52.09 |
| Battelle-Motor | 50.07 |
| Battelle-Comunication | 44.71 |
| Tadi-Language | 42.30 |
| Tadi-Cognitive | 37.89 |
| Tadi-Socioemotional | 36.73 |
| Battelle-Personal-Social | 32.98 |
| Tadi-Motor | 30.89 |
| Battelle-Adaptative | 29.45 |
| PPVT-Vocabulary | 27.63 |

Table I.10: Pareto weight

| Measure | Signal (%) |
|---|---|
| Women should work full time and delegate childcare to a third party | 81.27 |
| Men are the best suited to take care of children | 81.14 |
| Women should take care of chidlren and work part time | 44.08 |
| Both, father and mother, decide how to spend income | 34.80 |
| Mothers should take care of children | 32.66 |
| Women's only activity should be taking care of children | 29.47 |
| Father decides how to spend income | 12.05 |
| A woman who is in charge of most part of tasks of the household has no time to work* | 5.77 |
| Fathers should take care of chidlren | 5.75 |
| After having children, the best for a woman is to develop her carreer* | 2.23 |
| If my spouse earned enough there is no reason for me to work* | 1.85 |
| Having a payed job is very important in life* | 1.36 |
| Fathers time is as important as mothers time for child development* | 1.12 |
| Both spouses should contribute to household income* | 0.98 |
| Mother decides how to spend income | 0.76 |
| Men should go to work and women should stay home* | 0.62 |
| It is better to have a bad marriage than to remain single* | 0.11 |
| Men should participate in household chores more actively than they actually do* | 0.03 |
| Having a payed job is the best way for a woman to become independent* | 0.03 |

*: For each question the woman provides an answer between 1 to 5 with the following scale: Disagrees very much; disagrees; doesn't know; agrees; agrees very much.

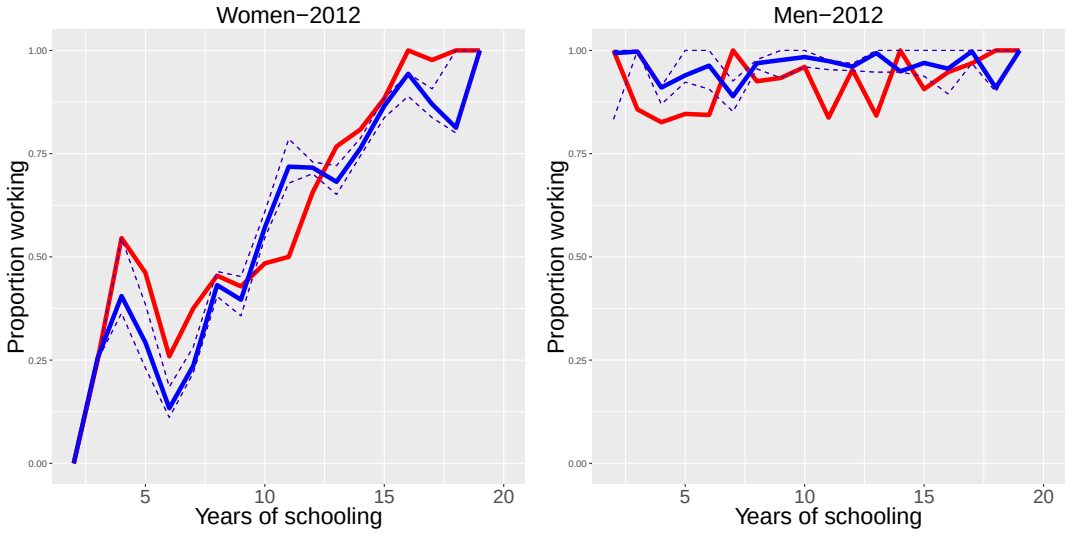
Table I.11: Skills of primary caregiver

| Measure | Signal (%) |
|---|---|
| BFI-Openness | 23.60 |
| BFI-Extroversion | 22.94 |
| BFI-Neuroticism | 21.76 |
| WAIS-Vocabulary test | 18.70 |
| BFI-Conscientiousness | 17.24 |
| BFI-Agreeableness | 12.73 |
| WAIS-Numerical test | 10.71 |

# J Bootstrap model fit

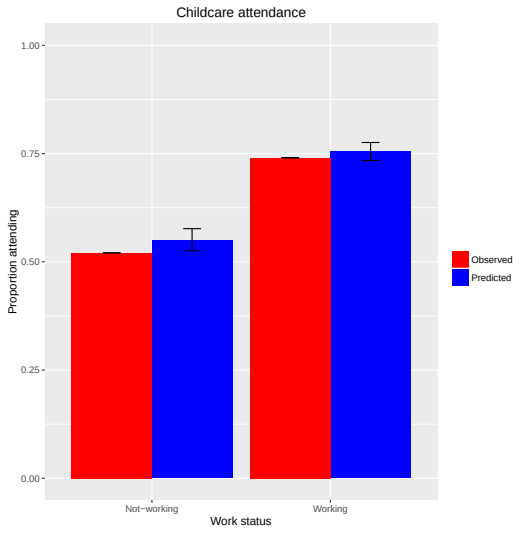
The model fit presented in the main body of the paper is done by setting all the shock levels equal to their mean value. Alternatively, a model fit can be reported by getting the corresponding draws from the distribution of the shocks. In this subsection, I report the results of the model fit when, rather than setting the shocks at their mean values, I draw from their distribution. This allows me to obtain a distribution of the relevant variables for the model fit. Figure J.1 I report the bootstrap fit of labor force participation for women and men in 2012. Figure J.2 reports the corresponding distribution for childcare demand. As can be seen from both figures, in the case of the bootstrap fit, the model does a good job fitting the observed levels.

Figure J.1: Bootstrap fit: Parents' Labor Force Participation in 2012




Dashed lines represent the 95% confidence interval

Figure J.2: Bootstrap fit: Childcare decisions (%)




Brackets include the 95% confidence interval

## K Child Investments and Bargaining Power

As shown in the Reduced-form evidence, women spend more time with their children even when controlling for labor supply. This, together with the evidence that cash in the hands of women translates into better child outcomes than cash in the hands of men, is often used as evidence that women have stronger preferences for children and thus monetary transfers should be given to women if the objective is to invest more in children. Nonetheless, this evidence is explained by several other factors.

First of all, mothers' time seems to be more productive than fathers' time, as shown by the estimation results of the model. Additionally, mothers have stronger preferences for children and the utility penalty of time investments is lower for mothers than for fathers. However, in addition to these facts, the relative empowerment of each member distorts time decisions, which explains part of the differences in time investments. Given that both parents are making investments in a public good (skills of their child) and that effort is costly and privately exerted, the fact that women spend more time with children is also a consequence of their relative disempowerment in the household rather than simply a result of different preferences.[12]

[12] Doepke and Tertilt (2014) develop a non-cooperative model of household behavior to answer the question of how female empowerment might promote economic development. The authors argue that the reason to develop a non-cooperative model of household behavior lies in the fact that the only mechanism capable of generating

The allocation of time investments is a result of maximizing the household's welfare, which includes the skills of children, taking into account the utility penalty of time investments. The time cost of each member is not equally weighted, it depends on the relative empowerment of each household member. If the mother is relatively less empowered, the cost of her time is lower than that of the father. This difference in empowerment levels distorts the cost of providing effort and implies inefficiencies in the allocation of resources for children. Put it differently, with the same amount of total effort being provided, we can find an alternative allocation of time investments that would make the child better off.

Consider the centralized problem of choosing the effort levels for the second period in order to maximize the skills of children -taking all other inputs as fixed- subject to the fact that the total amount of effort exerted should not exceed the total amount of effort found in the problem of the household described in **??**-**??**. We are basically asking whether or not it is possible to find an alternative allocation of time that would make children better off, whitout modifying the total amount of effort exerted by both parents. The problem is formally defined as:

$$\max_{e^f, e^m} s_2(e^f, e^m, .) \text{ subject to } e^f + e^m = e^{f,*} + e^{m,*} \tag{12}$$

where $e^{j,*}$ is the optimal solution to the maximization of the household welfare problem described in Equation **??**. Define the solution to the problem in 12 as $\left(e^{f,c_1}, e^{m,c_1}\right)$.

Similarly, we can define an alternate centralized problem where we maximize skills subject to the fact that the total time-cost exerted in the production of skills should not exceed that found in the household's problem defined in 1-**??**. Formally:

$$\max_{e^f, e^m} s_2(e^f, e^m, .) \text{ subject to } c\left(e^f\right) + c\left(e^m\right) = c\left(e^{f,*}\right) + c\left(e^{m,*}\right) \tag{13}$$

differences in investments in children in a collective approach would be that of preferences. However, in this paper I present a collective model of household behavior where differences in investment can arise for a variety of reasons other than preferences.

where the cost of effort is given by $c^j(e^j) = \alpha_{4,2}^j e^j(1+h^j)$. I call the solution to 13 $\left(e^{f,c_2}, e^{m,c_2}\right)$. In both cases, for $l = 1,2$, we do find that:

$$\frac{\left(\frac{e^{f,c_l}}{e^{m,c_l}}\right)}{\left(\frac{e^{f,*}}{e^{m,*}}\right)} \propto \left[\frac{(1-\mu)}{\mu}\right]^{\phi/(1-\phi)} \tag{14}$$

The difference of ratios of effort in the centralized solutions and in the household problem depends on the Pareto weight and the degree of substitutability between parental efforts. If the Pareto weight heavily favors one member, and if there is some degree of substitutability between parental effort, there would be an inefficient allocation in time investments given that we can find an alternative allocation with the same amount of cost, or the same amount of total effort, that will yield better child outcomes. I find that this mechanism explains 15% of the differences in time investments between mothers and fathers.

It is often argued in the literature that, in a collective model of household behavior, observing different child outcomes when there is a shift in the bargaining power can only be explained by differences in preferences or productivities between parents (Doepke & Tertilt, 2014). Nonetheless, if we take into account that child skills are a public good produced with effort, the cost of which is privately exerted, shifts into bargaining power can translate in changes in child skills even when parents are identical in terms of preferences and productivities.

This result can be interpreted as an additional argument for female empowerment within households, not invoking an argument of equality but one of efficiency: disparities in bargaining power lead to inefficient allocations within the household. Taking this into account, and with the estimates of the economic model, we can quantify the extent to which the differences observed in time spent with children are due to productivity, preferences or empowerment differences.