From Quantity to Quality: Delivering a Home-based Parenting Intervention through China's Family Planning Cadres

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Abstract

We present the results of a randomised experiment evaluating the effects of a home-based parenting program delivered by cadres in China's Family Planning Commission (FPC) – the former enforcers of the one-child policy. We find that the program significantly increased infant cognitive skills after six months. Effects on infant skill development were accompanied by increases in both parental investment and parenting skills. Household participation in the program was associated with the degree to which participants had a favorable view of the FPC, which also increased due to the program.

JEL Classification: J13, I21, I28, H11

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1 Introduction

A growing body of cross-disciplinary research highlights the importance of a child's environment in the first years of life for skill development and outcomes over the life course (Knudsen et al., 2006). This period is thought to be important for human capital accumulation both because very young children are sensitive to their environment and because deprivation during this period can have long-term consequences. Research in cognitive science suggests that malleability of cognitive ability is highest in infancy and decreases over time (Nelson and Sheridan, 2011). Due to the hierarchical nature of brain development – whereby higher level functions depend and build on lower level ones – cognitive deficiencies in early life can permanently hinder skill development. The nature of cognitive development may further lead to important dynamic complementarities in the production of human capital where early skills increase the productivity of later human capital investments and encourage more investment as a result (Cunha et al., 2010; Attanasio et al., 2015).

These mechanisms may explain findings of large long-run effects of early childhood interventions (Cunha and Heckman, 2007). Long-term follow-up studies of early childhood interventions to improve nutrition and create stimulating environments have found large and wide-ranging effects into adulthood. These studies found programs to have increased college attendance, employment, and earnings as well as cause reductions in teen pregnancy and criminal activity (Heckman et al., 2010; Walker et al., 2011; Gertler et al., 2014).

Findings from this body of research provide strong support for investments in early childhood programs (Carneiro and Heckman, 2003). Particularly in low and middle-income countries, the social returns to early intervention could be substantial due to the large number of children that are at risk of becoming developmentally delayed. Estimates indicate that 250 million children (43%) younger than 5 years old living in low-income and middle-income countries are at risk of not reaching their full development potential

(Lu et al., 2016). While there are several reasons that so many children are at risk in developing countries, a significant factor is that children often lack a sufficiently stimulating environment (Black et al., 2017). Partly as a result of this evidence, Early Childhood Development (ECD) has been the subject of substantial policy advocacy, as evidenced by its inclusion in the United Nation's Sustainable Development Goals (Nations, 2015).

A key practical challenge facing policy makers, however, is how to deliver ECD programs cost effectively at scale (Berlinski et al., 2016; Richter et al., 2017). Providing ECD interventions at scale is challenging largely due to the infrastructure required to deliver services effectively to families in need, many of whom live in hard-to-reach communities such as urban slums and sparsely populated rural areas. Because building a new infrastructure to support ECD services alone would be costly, some have suggested integrating ECD programs into existing public service infrastructures (Richter et al., 2017). For example, international agencies including the World Bank, the Inter-American Development Bank, the United Nations and the World Health Organization have called for ECD to be integrated into health and nutrition programs (Chan, 2013; Black and Dewey, 2014). Whether such a strategy can be successful is an open question. It is unclear, for example, if existing personnel who have been working in other areas and have little or no background in early childhood education can be trained to effectively deliver an ECD program. Moreover, it is often the case that public sector agencies resist new tasks, particularly if they are perceived as misaligned with the organisation's existing mission (Wilson, 1989; Dixit, 2002).

We study the promotion of ECD in rural China through a home-based parent training intervention implemented by one of the world's largest bureaucracies, the China Family Planning Commission (FPC). In recent years, the Chinese government has relaxed its family planning laws and, since January 2016, has allowed all parents to conceive two children without penalty. Relaxation of the One Child Policy (OCP) and changing fertility preferences have greatly diminished the need for enforcement, and the FPC has begun to shift focus to other areas including ECD (Wu et al., 2012). Delivering ECD policies through

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the infrastructure of the FPC has promise but also potentially significant challenges. It is therefore unclear – even if an intervention itself is efficacious – whether it can be effectively delivered through the apparatus of the FPC.[1] This study investigates whether it is possible to re-train cadres formerly responsible for enforcing the OCP into effective parenting teachers. In other words, can the local knowledge and infrastructure of the FPC – which has been responsible for managing the quantity of human capital – be used to effectively raise the quality of human capital in China?

To study the effects of an FPC-delivered home-based parenting intervention, we conducted a cluster-randomised controlled trial across 131 villages in Shaanxi Province, located in northwestern China. We worked with the FPC to re-train 70 cadres (local officials) to deliver a structured curriculum aimed at improving parenting practices in early childhood through weekly home visits. Loosely modeled on the Jamaican Early Childhood Development Intervention (Grantham-McGregor et al., 1991), the curriculum was designed with ECD experts in China and aimed to train and encourage caregivers to engage in stimulating activities with their children.

We find that the intervention substantially increased the development of cognitive skills in children assigned to receive weekly home visits. Effects on infant skill development were accompanied by increases in both parental investment and parenting skills. Children who lagged behind in their cognitive development and received little parental investment at the onset of the intervention benefited most from the program. Although the average effect of the program was diminished by imperfect compliance, we find evidence that one of the primary factors hindering compliance – unfavorable public perception of the FPC – was also significantly reduced as a result of the program. This suggests that compliance may improve overtime if implemented by the FPC.

Our findings add to an emerging literature studying how ECD can be integrated into existing infrastructure in developing countries to facilitate delivery at scale. Attanasio et al.

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[1]See China Central Television (CCTV) News report: How will a Million Family Planning Workers Transition? https://youtu.be/84WIe1C3XTM

([2014](#)) found that a parenting intervention integrated into an existing conditional cash transfer program in Colombia and delivered by local volunteers successfully improved cognitive development outcomes, and, like the program we study in China, did so primarily through increased parental investments (Attanasio et al., 2015). Again in Colombia, Attanasio et al. (2018) analyse the impact of a stimulation intervention implemented within an existing programme promoted by the Colombian government and show that it has a sizable impact on children developmental outcomes. In Pakistan, Yousafzai et al. (2014) find significant improvements in early childhood outcomes of children enrolled in a parenting intervention integrated in a community-based health service and find that effects persist 2 years after termination of the parenting intervention (Yousafzai et al., 2016). Our study adds to the literature by providing evidence on the effectiveness of an ECD intervention integrated into local government services in China: specifically whether the infrastructure and personnel of the FPC can effectively implement a home-based parenting program and reduce the high prevalence of cognitive delay among infants and toddlers in rural China.

The remainder of the paper is structured as follows. In the next section we discuss the FPC and how their role is changing with the abolishment of the One Child Policy. In section 3 we describe the experimental design and data collection. In section 4 we report findings of the impact evaluation of the parenting intervention. Section 5 concludes.

2 Background: The Changing Role of the FPC

The Family Planning Commission (FPC)[2] is the entity responsible for the implementation of population and family planning policies in China. From 1980, a large part of the agency's mandate included enforcement of the One Child Policy – a policy comprised of a set of

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[2]In March 2013, the National Population and Family Planning Commission was merged with the Ministry of Health to form the current National Health and Family Planning Commission. Since March 2018, the ministry is called the National Health Commission.

regulations governing family size.[3] Although there were several, now well-documented, unintended consequences of the policy, the government at the time considered population containment necessary to improve living standards as the country faced an impending baby boom (Hesketh et al., 2005).

The implementation of China's One China Policy required close interaction between families and local FPC cadres to ensure universal access to contraceptive methods, to monitor for violations, and to enforce penalties. Although details of how the policy was implemented varied across regions and time, at its most intense phase of implementation families were required to obtain birth permits before pregnancy and births were to be registered with the local FPC cadre. Once families met their number of allowed children, FPC officers often encouraged or forced sterilisation (Greenhalgh, 1986). If women became pregnant without a birth permit, FPC facilities were used for abortions (both voluntary and not). The FPC also enforced penalties for out-of-plan births which included substantial fines and loss of employment.

Given the numerous and complicated set of policy instruments, and the close interaction with families that this entailed, implementation of the One Child Policy required a large bureaucracy. As of 2005, the FPC had more than 500,000 administrative staff and more than 1.2 million village-level FPC operatives.[4] In 2016, the budget supporting the FPC's activities exceeded 8.85 billion dollars.[5] However, after debates in recent years about the necessity of the One Child Policy's continuation, the government announced in October 2015 that the policy would be formally terminated as of January 1, 2016.[6]

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[3]Despite its name, most families were not restricted to having only one child. In many rural areas, families were allowed two children and there were a number of other exemptions including for minority groups and for parents who worked in high-risk occupations. See Hesketh et al. (2005) and Hesketh et al. (2015) for good overviews of the policy and implementation.

[4]See NPFPC, 2006, Statistical Bulletin of Forth National Population and Family Planning System Statistical, http://www.nhfpc.gov.cn/guihuaxxs/s10741/201502/f68e73331a9147e78209ab81bd156a39.shtml

[5]Includes funding for health and family planning activities. See NHFPC, 2016, The Departmental budget report of National Health and Family Planning commission of the PRC, http://www.nhfpc.gov.cn/caiwusi/s3574/201604/3582098e060144148a1e3b4f3f1a4fe0.shtml

[6]The Central Committee of the Communist Party of China, 2015. Bulletin of Fifth Plenary Session of 18th CPC Central Committee.

Termination of the policy also has called into question the future role of the FPC.[7]

Some have argued that an appropriate future focus of the FPC would include early childhood care and education, which falls within the technical purview of the agency (Wu et al., 2012). Currently, responsibility for providing these services is spread across multiple entities, which in practice has led to a gap in service provision (Wu et al., 2012). Whether the FPC would be able to effectively fill this role is an open question, however. On one hand, the FPC has the ideal infrastructure to provide early childhood services: a large, well-functioning organisation with representation in every village and community in the country; a relatively well-educated work force; and the ability to maintain information on every family and child. On the other hand, it may be difficult for FPC cadres to retrain and effectively deliver ECD services. More significantly, the agency's history and reputation could limit its effectiveness. Although the enforcement of the policy relaxed over time, the agency's at times draconian measures may have created lasting social animosity toward the family planning commission that could hinder its effective delivery of ECD services.[8]

3 Experimental Design and Data Collection

3.1 Sampling and Randomisation

The study sample was selected from one prefecture located in a relatively poor province located in Northwest China. The province ranks in the bottom half of provinces nationally in terms of GDP per capita. The prefecture chosen for the study is located in a mountainous and relatively poor region of the province.

To identify the sample, we first selected townships from four nationally-designated poverty counties in the chosen prefecture. All townships in each county were included

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[7]See Sonmez, F., Wall Street Journal, 2015. After the One-Child Policy: What Happens to China's Family-Planning Bureaucracy? http://blogs.wsj.com/chinarealtime/2015/11/12/after-the-one-child-policy-what-happens-to-chinas-family-planning-bureaucracy/

[8]See China Central Television (CCTV) News report: How will a Million Family Planning Workers Transition? https://youtu.be/84WIe1C3XTM

except the one township in each county that housed the county seat. Within each township, government data was used to compile a list of all villages reporting a population of at least 800 people. We then randomly selected two villages from the list in each township. These exclusion criteria were chosen to ensure a rural sample and increase the likelihood that sampled villages had a sufficient number of children in the target age range. Our final sample consisted of 131 villages total. All children in sample villages between 18 and 30 months of age were enrolled in the study. At baseline, a total of 592 children were sampled.

Following baseline data collection (described below), 65 villages were randomly assigned to the parenting intervention group and the remaining 66 to a control group. The randomisation procedure was stratified by county, child cohort, and experimental group of an earlier trial.[9]

Each trainer was assigned a maximum of four families chosen randomly from treatment villages to be enrolled in the program. In treatment villages, a total of 212 children were enrolled and the remaining 79 were not. In the analysis, we test for spillover effects on these children in treatment villages who were not selected to participate.

3.2   Parenting Program

Parenting trainers, selected by the FPC from among their cadres in each township, delivered a structured curriculum through weekly home visits to households in treatment villages for a period of six months (from November 2014 to April 2015). Based loosely on the Jamaican home visiting model (Grantham-McGregor et al., 1991) and adapted by child development psychologists in China to the local setting, the goal of the inter-

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[9]The children included in this study were previously part of the sample for a randomised trial testing the effect of micronutrient powders aimed at reducing anemia. For that trial, children were recruited when they were between 6 and 12 months of age. Recruitment was done in two six-month cohorts. The findings of that trial, reported in Luo et al. 2016, show no effect of micronutrient powder on haemoglobin or anemia at 18 months. The treatment assignment for the parenting intervention evaluated in this study was stratified on the arms of the earlier trial. There is no evidence that effects of the parenting intervention vary across arms of the earlier trial. In all analysis we additionally control for past nutrition assignment status.

vention was to train caregivers to interact with their children through stimulating and developmentally-appropriate activities.

The curriculum delivered by the parenting trainers was developed by the research team in collaboration with the FPC and outside ECD experts in China. The curriculum was stage-based and fully scripted. Weekly age-appropriate sessions were developed targeting children from 18 months of age to 36 months of age. Each weekly session contained modules focused on two of four total developmental areas: cognition, language, socio-emotional, and (fine and gross) motor skills. Every two weeks, caregivers would encounter one activity from each category. In addition to developmental activities, the curriculum also included one weekly module on child health/nutrition.

During sessions, parent trainers were trained to introduce caregivers to the activity and assist caregivers to engage in the activity with their child. Typically the only caregiver that participated was the primary caregiver (usually mother or grandmother), though other caregivers sometimes observed. At the end of each weekly session, the materials used for that week's activities (toys and books) were left in the household to be returned at the next visit.

Parenting trainers were selected and deployed by the FPC office in each township. Summary statistics on trainer characteristics are shown in Appendix Table A1. Around 60 percent of the parenting trainers deployed by the FPC office were men. The majority of parenting trainers were married and had children themselves. The parenting trainers were well educated with most of them having enjoyed a community college higher education and around 30 percent had obtained a bachelor degree. On average, parenting trainers were 34 years old and had worked 12 years for the Family Planning Commission. FPC offices assigned parent trainers to enrolled families in their township. Most trainers were assigned families in only one village.

Fully scripting the curriculum eliminated the need for extensive training of parent trainers. All parenting trainers underwent an initial, centralised one-week intensive training at

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the beginning of the program which covered theories and principles of early childhood development, parenting skills, and the curriculum. This initial training consisted of both classroom-based instruction as well as field practice. Throughout the program, trainers received periodic training by phone on curriculum activities which would vary according to the ages of children to whom they were assigned.

3.3 Data Collection

We conducted our baseline survey in October 2014 and our follow-up survey in May 2015. Teams of enumerators collected detailed information on children, caregivers and households. Each child's primary caregiver was identified and administered a survey on child, parent and household characteristics including each child's gender, birth order, maternal age and education. Each child's age was obtained from his or her birth certificate. The primary caregiver was identified by each family as the individual most responsible for the infant's care (typically the child's mother or grandmother).

Children's cognitive, psychomotor and social-emotional development were assessed in each round. At baseline, all children were assessed using the Bayley Scales of Infant Development (BSID) Version I, a standardised test of infant cognitive and motor development (Bayley, 1969). The test was formally adapted to the Chinese language and environment in 1992 and scaled according to an urban Chinese sample (Yi et al., 1993; Huang et al., 1993). Following other published studies that use the BSID to assess infant development in China (Li et al., 2009; Chang et al., 2013; Wu et al., 2011), it was this officially adapted version of the test that was used in this study (Yi, 1995). All BSID enumerators attended a week-long training course on how to administer the BSID, including a 2.5 day experiential learning program in the field. The test was administered in the household using a standardised set of toys and detailed scoring sheet. The BSID takes into consideration each child's age in days, as well as whether he or she was premature at birth. These two factors, combined with the child's performance on a series of tasks using the standardised toy kit, are used

to construct two sub-indices: the Mental Development Index (MDI), which evaluates memory, habitation, problem solving, early number concepts, generalisation, classification, vocalisation and language to produce a measure of cognitive development; and the Psychomotor Development Index (PDI), which evaluates gross motor skills (rolling, crawling and creeping, sitting and standing, walking, running and jumping) and fine motor skills to produce a measure of psychomotor development (Bayley, 1969).

Because the BSID-I is not designed to assess outcomes for children older than 30 months, only children aged 30 months or under at follow-up (approximately half of the sample) were administered the BSID in the follow-up survey. Older children were assessed using the Griffith Mental Development Scales (GMDS-ER 2-8) (Luiz et al., 2006), which has been shown to be comparable in its assessment of early childhood development to the BSID-I (Cirelli et al., 2015).[10]

Enumerators were trained for two days on how to administer the Griffith Mental Development Scales. As with the BSID, a standard activity kit is used to test different skill sets of children and enumerators score children on a standardised form based on their performance on tested activities. The GMDS-ER 2-8 comprises six sub scales: locomotor, personal-social, language (receptive and expressive), hand and eye coordination, performance, practical reasoning.[11]

For the analysis, raw scores are standardised separately by sub-index. Since raw scores are increasing in age, we compute age-adjusted z-scores using age-conditional means and standard deviations estimated by non-parametric regression. This non-parametric standardisation method is less sensitive to outliers and small sample size within age-category and yields normally distributed standardised scores with mean zero across the age range (in months)(Attanasio et al., 2015).[12]

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[10]The Pearson correlation coefficient between the BSID and GMDS is found to be higher than 0.8.

[11]The last sub-scale of the GMDS-ER, practical reasoning, is only used to assess development of older children, hence was not registered to this particular age group. Furthermore, in the analysis we ommit the GMDS-ER language subscale as receptive and expressive language skills are not explicitly tested by the BSID I and we want to have comparable measures across the two age cohorts.

[12]The non-parametric method is described further in the Web Appendix B.4. of Attanasio et al. (2015).

In each wave we also assessed children's social-emotional behavior using the Ages and Stages Questionnaire: Social Emotional (ASQ:SE) (Squires et al., 2003). The items in this questionnaire (which vary by age) measure a child's tendency towards a set of behaviors such as ability to calm down, accept directions, demonstrate feelings for others (empathy), communicate feelings, initiate social responses to parents and others, and respond without guidance (move to independence). Main caregivers were asked to indicate whether the child exhibits these behaviors *most of the time*, *sometimes*, or *never*. Depending on the desirability of the behavior, answered are scored either 0, 5, or 10 points. Children who score 60 or more are considered to require further assessment for social-emotional problems.

The parenting curriculum was designed to affect child development by increasing parenting skills and investment of caregivers in the development of their children. We measured parenting skills at baseline and follow up by asking the primary caregiver a series of questions on parenting knowledge and confidence. These included questions about the importance of different activities such as reading and playing with their children and caregiver confidence in engaging in these activities. Caregivers responded to these questions using a 7-point likert scale. Parental investment was measured by asking whether the main caregiver engaged in a set of child-rearing activities, such as story-telling and playing with toys, the previous day and how many children's books they have in the house.

Information on compliance – including whether the weekly parenting sessions took place and, if not, the reason they did not take place – as well as details of the interaction were collected on a monthly basis from caregivers and on a weekly basis from parenting trainers through telephone interviews. In our analysis, we use parenting trainer reports as these data are more complete. The difference in average compliance for these two measures is insignificant and the two measures are highly correlated (correlation of 0.69).

3.4 Baseline Characteristics, Balance, and Attrition

Summary statistics and tests for balance across control and treatment groups are shown in Table 1. Differences between study arms in individual child and caregiver characteristics are insignificant. A joint significance test across all baseline characteristics also confirms the study arms are balanced.[13] Appendix Table A2 shows that characteristics of untreated children in treatment villages (the "spillover group") are also balanced with those of children in the treatment and control groups.

Children in our sample are on average just over 24 months old at the start of the program. Less than 5% of children are born with low birth weight. A large part of the children in our sample are first born in the family (60%). More than 80% of children were ever breastfed and around 35% were breastfed for more than one year. More than 20% percent of sample children were anemic according to the WHO-defined threshold of 110 g/L. On average children were reported to be ill 4 days over the previous month.[14] At baseline, around 40 percent of the sample is cognitively delayed with Bayley MDI scores below 80 points, but few (10%) were delayed in their motor development. Around 30 percent of the children are at risk of social-emotional problems at baseline.

We also collected information on caregivers and families. Around 26 percent of the sample receives social security support through the *dibao*, China's minimum living standard guarantee program, as reported in Panel B of Table 1. The biological mother is the primary caregiver in only 60 percent of households, with grandmothers often taking over child rearing when mothers out-migrate to join the labour force in larger cities. We find that slightly more than 70 percent of primary caregivers in the sample (mothers or grandmothers as appropriate) have at least 9 years of formal schooling. On average households report being somewhat indifferent in their feelings toward the FPC at

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[13]We test this by regressing treatment status on all baseline characteristics reported in Table 1 and test that the coefficients on all characteristics were jointly zero. The p-value of this test is 0.529.

[14]Caregivers were asked whether the child had suffered from fever, cough, diarrhea, indigestion or respiratory cold over the previous month.

baseline.[15]

Baseline statistics on parental inputs shown in Panel C of Table 1 show that caregivers engage in few stimulating activities with their children. Only 11% of caregivers told a story to their child the previous day. Less than 5% read a book to their child (on average households have only 1.6 books). Only around 1 in 3 caregivers report playing or singing to their child the previous day.

Overall attrition between November 2014 and May 2015 was less than 1 percent and insignificantly correlated with treatment status. We define attrition as missing a Bayley's or Griffith outcome (depending on the age-cohort) measure at endline for children with a Bayley baseline measure.

3.5 Estimation of Program Effects

Given random assignment of households into treatment and control groups, comparison of outcome variable means across treatment arms provides unbiased estimates of the effect of the parenting intervention on outcomes. However, to increase power (and to account for our stratified randomisation procedure) we condition our estimates on randomisation strata (Bruhn and McKenzie, 2009) and baseline values of the outcome variable.

We use ordinary least-squares (OLS) to estimate the intention-to-treat (ITT) effects of the parenting intervention with the following ANCOVA specification:

$$Y_{ijt} = \alpha_1 + \beta_1 T_{jt} + \gamma_1 Y_{ij(t-1)} + \tau_s + \epsilon_{ij} \tag{1}$$

where Y_{ijt} is an outcome measure for child i in village j at follow-up; T_{jt} is a dummy variable indicating the treatment assignment of village j; $Y_{ij(t-1)}$ is the outcome measure for child i at baseline, and τ_s is a set of strata fixed effects. We adjust standard errors

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[15]We asked caregivers to rate their perception of local Family Planning Commission on a 5-point scale (1 *very much like*; 2 *like*; 3 *Neither like nor dislike*; 4 *dislike*; 5 *very much dislike*).

for clustering at the village level using the Liang-Zeger estimator. To estimate spillover effects we use the same specification but replace treated children with untreated children in treatment villages in the estimation sample. Because we estimate treatment effects on multiple outcomes, we present p-values adjusted for multiple hypotheses using the step-down procedure of Romano and Wolf (2005) which controls for the familywise error rate (FWER).

We estimate program effects both separately by age cohort and on the full sample pooling both cohorts together. Because different assessments were used for the cohorts at endline, we construct a combined index of infant skill development that allows us to estimate effects on the full sample. To construct this index, we follow Heckman et al. (2013) and develop a dedicated measurement system relating the observed infant development outcome measures in both cohorts to a latent infant skill factor. We assume that the measurement system is invariant to treatment assignment which implies that any observed treatment effect on measured development outcomes results from a change in the latent skill and not from a change in the measurement system.[16] Hence, for each cohort we estimate following dedicated measurement system at baseline and follow-up:

$$y_{im}^{\theta} = \mu_m^{\theta} + \theta_i' \lambda_m^{\theta} + \delta_{im}^{\theta} \tag{2}$$

with y_{im}^{θ} the observed m^{th} measure for child i; μ_m^{θ} the mean of the mth measure and λ_m^{θ} the loadings of the factor for measure m. The measurement error δ_{im}^{θ} is the remaining proportion of the variance of the outcome measures m that is not explained by the factor and is assumed to be independent of the latent infant skill factor θ and to have a zero mean.[17]

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[16]More formally, this assumption implies that the measurement system intercept, factor loadings and distribution of measurement errors are the same for the control and the treatment group

[17]Table A4 in the appendix shows the measurement system for the latent infant skill factor at baseline and follow-up. The first column in this table reports factor loadings. We normalised the factor loading of the first measure in both periods and cohorts to one. Hence, at baseline, the scale of the latent infant skill factor is determined by the Bayley Mental Development Index. At follow up, the scale of the latent infant skill factor is determined by the Bayley Mental Development Index for the younger cohort, and by the Griffith

After estimating the measurement system for each cohort separately we use the estimated means and factor loadings to predict a factor score for each child i in the sample using the Bartlett scoring method (Bartlett, 1937)[18]. The predicted infant skill factors are standardised non-parametrically for each age-month group by cohort and we control for cohort fixed effects in our pooled regression specification.

In the same spirit as the creation of a latent infant skill factor, we estimate a dedicated measurement system relating all observed measures of parental investment behaviour and parenting skills to latent factors. We estimate following system of equations for baseline and follow-up:

$$y_{im}^P = \mu_m^P + P_i' \lambda_m^P + \delta_{im}^P \tag{3}$$

$$y_{im}^I = \mu_m^I + I_i' \lambda_m^I + \delta_{im}^I \tag{4}$$

with y_{im}^P and y_{im}^I the observed m^{th} measure of parenting skill or parental investment of child i; μ_m^P and μ_m^I the mean of the mth measure and λ_m^P and λ_m^I the loadings of the factor for measure m. The measurement system for the latent parenting skill factor and parental investment factor at baseline and follow-up can be found in Appendix Table A4. The predicted parenting skill factor and parental investment factor are standardised by the distribution of the control group.

Performance scale for the older age cohort. The second column of the table shows estimates for how much of the variance is driven by signal relative to noise. The signal-to-noise ratios for the mth measure of child development is calculated as:

$$S_m^\theta = \frac{\lambda_m^2 Var(\theta)}{\lambda_m^2 Var(\theta) + Var(\delta_m)}$$

These calculations show that Bayley and Griffith measures derived form objective testing by trained enumerators have relatively high signal-to-noise ratios while the signal of the *ASQ: Social-Emotional*, a measure based on caregiver response, is relatively poor.

[18]Bartlett's scoring method is based on GLS estimation with measures as dependent variables and factor loadings as regressors.

4 Impact of the Parenting Intervention

4.1 Average Treatment Effects on Infant Skills

Pooling the two cohorts, Figure 1 plots the kernel density estimates of the latent infant skill distribution at baseline and follow-up by treatment assignment. At baseline, the infant skill distribution of infants in treatment and control villages overlap and a Kolmogorov-Smirnov (K-S) test indicates that the two distributions are similar (p-value = 0.828). At follow-up, the infant skill distribution is shifted to the right in the treatment group. A K-S test rejects the equality of distributions in the treatment and control groups with a p-value of 0.029.

Table 2 presents the average treatment effects on infant skills are shown in Table 2. Pooling cohorts, we estimate that the parenting program led to an overall average increase of 0.23 standard deviations in infant skill (bottom row). Estimating effects separately by cohort, we find that the parenting intervention significantly increased cognitive skills as measured by the Mental Development Index of the Bayley assessment scale for the younger age-cohort and by the Griffith assessment scales of Performance and Personal-Social for the older age-cohort. The 6-month intervention led to a significant increase of 0.24 standard deviations in cognitive development in the younger cohort and an increase of 0.27 standard deviations for the older cohort. We find no significant program effects on child psychomotor development or on social-emotional outcomes. These results are similar to the finding of Attanasio et al. (2014), who report that their home-based parenting intervention in Colombia led to an increase of 0.26 standard deviations in cognitive development but no significant improvement in psychomotor development. Despite similar effect sizes of both programs, the Colombia study lasted one year longer (18 months in total) and enrolled younger children (12-24 months).

4.2 Mechanisms: Effects on Parenting Skills and Investment

To motivate the mechanisms through which the parenting intervention may have affected infant skills, consider the following general production function of early skill formation:

$$\theta_{t+1} = f_{t+1}(\theta_t, I^T_{t+1}, I^P_{t+1}, P_{t+1}, X_t). \tag{5}$$

Here, θ_t and θ_{t+1} are vectors of infant skills at baseline and follow-up respectively, I^T_{t+1} are direct investments from the treatment (i.e. time spent with the child during weekly visits), I^P_{t+1} are parental investments during the intervention period, P_{t+1} are parenting skills during the intervention period, and X_t a vector of household characteristics.

This production function illustrates several mechanisms through which the intervention may have affected infant skill. First, the intervention could have a *direct* impact on infant skill formation through the weekly interactions with the parenting trainers (investment from the treatment itself, a shift in I^T_{t+1}). Alternatively, the intervention may have *indirect* effects by affecting either (a) parental investment (I^P_{t+1}) or (b) the effectiveness of parental investment through an increase in parenting skills (P_{t+1}). Although the intervention was designed to improve the quantity and quality of infant-caregiver interactions it is not a priori clear that parents would spend more time with their children. Parental investment could be crowded-out as a result of the intervention if parents see the intervention as an in-kind transfer and hence re-optimise the allocation of the household resources.[19]

Our data allow us to estimate the causal effect of the intervention on two of these four mechanisms: parental investments and on parenting skills. Assuming measurement error

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[19]An additional potential mechanisms is that the intervention could change the production technology by shifting the productivity parameter. Attanasio et al. (2014) use data from an intervention in Colombia to explicitly test for this mechanism and do not find evidence for this channel. Following this result, we do not test for this mechanism here (as we focus on reduced-form results), but assume that this channel is negligible in our interpretation of mechanisms.

is sufficiently small, no treatment effects on parental investment would suggest that the main mechanism for program effects is through a direct effect of the program. Effects on these two indicators, however, would not rule these out as potential channels of impact.

Kernel density estimates of the latent parental investment factor and the latent parenting skill factor at baseline and follow-up are plotted in Figure 2 by treatment assignment. At baseline both the parental investment factor and parenting skill factor have a similar distribution for control and treatment villages (confirmed by K-S test p-values of 0.96 and 0.62 respectively). At follow-up we find that the distribution of the parental investment factor in the treatment villages has drastically shifted to the right. This visual evidence is also supported by a strong K-S test rejection of the equality of the two parenting investment factor distributions with a p-value < 0.01. We see a more moderate shift in the distribution of the parenting skill factor. Nevertheless, the distributional shift is significant (p-value=0.05) and we find again that caregivers in treatment villages have improved parenting skills along the entire ability distribution.

Average treatment effects on the secondary outcomes can be found in Table 3. We find that the program significantly increase parenting skills (Panel A). In terms of individual components, caregivers in treatment households report a stronger belief in the importance of reading for child development, more confidence in their ability to read to their children, and more confidence (less nervousness) in their ability to care for their children. The intervention had no effect on parental beliefs about the importance of play for child development or confidence.

We also find large effects on parental investment (Panel B). The parenting intervention increased the time caregivers spend with their children actively engaging in age-appropriate developmental activities such has reading and singing. Furthermore, we find that treatment households had significantly more children's books in their homes at the end of the program compared to the households in the control group. We find no evidence of crowding-out of parental investment as a result of the parenting intervention

as children in treatment households did not significantly spend more time watching tv or playing by themselves.

Overall this evidence suggests that parents are investing considerably more effort into parenting and have gained some better parenting skills as a result of the intervention. This evidence suggests that an important mechanism contributing to the effectiveness of the intervention was a change in parenting behavior, which was the aim of the parenting intervention and is in line with findings of Attanasio et al. (2015).

4.3   Compliance and Dose-Response Estimation

On average, 16.4 visits (out of 24 total planned visits) were completed for each household during the course of the study based on reports from parent trainers. To assess the drivers of incomplete compliance, we regress the number of reported household visits on child, family, and trainer characteristics as well as the distance from the village to the closest FPC office. The estimated correlates of compliance can be found in Table 4.

Compliance is most strongly correlated with four factors: whether the child is male, whether a child suffered cognitive delay at the start of the intervention, distance from the village to the FPC office in the township, and caregiver perception of the FPC. Male children receive on average slightly more household visits. Children who were cognitive delayed (measured as BSID< 80) received on average one to two household visits less compared to children who were at a more normal developmental stage at the start of the intervention. Compliance is negatively correlated with the distance to the FPC office, which may reflect supply-side compliance failure as parenting trainers chose to visit remote households less frequently, though it may also be capturing correlated demand-side characteristics of households.

Once all variables are included in the compliance regression, the most important demand-side factor associated with compliance appears to be whether households had an unfavorable view of the FPC at baseline. Households with a more unfavorable view of

the agency completed significantly fewer visits. If the program were to be implemented in the future, however, this may become less of an obstacle to implementation as we find that the program itself has a significant positive effect on public perception of the FPC as reported in Table 5. The estimated average treatment effect of the intervention on the household's reported negative perception of the FPC (on 5-point likert scale) at the end of the parenting program is -0.33 and significant at the 5% level.

Given imperfect compliance, we present estimates of the dose-response relationship between the number of completed household visits and our main outcomes of interest (infant skill, parenting skill, and parental investment) using control function methods. We do this first assuming a linear relationship and then allowing for a concave relationship by adding a squared term for household visits completed. For both of these, we instrument the number of visits with the treatment assignment, the distance between the village and the FPC township office, and the interaction between these two variables.[20]

Table 6 shows control function estimates of the dose-response relationships. In Columns (1), (3) and (5) we assume a linear relationship between the number of completed household visits and the latent infant skill, parenting skill and parental investment factors. We estimate that each session completed increases infant skill with 0.012 standard deviations, parenting skill with 0.020 standard deviations and parental investment with 0.044 standard deviations. Results from Column (2), (4) and (6) which allow for non-linearity do not suggest that these relationships are concave. Assuming a linear relationship up to 24 household visits, these estimates suggest that under full compliance we would see infant skill increase by 0.288 standard deviations, parenting skill by 0.480 deviations and parental investment by 1.008 standard deviations.

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[20]Linear estimates of the dose-response relationship between the number of completed household visits and cognitive development outcomes are similar when instrumenting compliance with only treatment assignment.

4.4 Heterogeneity

We estimate average treatment effects within subgroups defined by pre-treatment characteristics. To do so, we create dummy variables indicating treatment for each subgroup and include these, along with dummy variables indicating subgroups, in Equation (1). A t-test is used to test whether estimated treatment effects differ significantly across sub-groups.

The subgroup analysis is presented in Table 7. After adjusting for multiple hypotheses, we find that average treatment effects differ significantly for children who had low baseline infant skills (below the median) at the onset of the program. We further find significant heterogeneity in treatment effects for children with low levels of parental investment before the start of the program. Average treatment effects do not, however, differ significantly at the 10 % level or lower across any of the other subgroups examined, which could be due to insufficient power. Overall this evidence suggest that the program was most effective for children who lagged behind in their cognitive development and come from households where baseline levels of parental investments were low at the onset of the intervention. This suggests that the parenting intervention helped those children most in need of extra cognitive stimulation.

5   Conclusion

This paper reports the results of a randomised trial of a home-based parenting program delivered by cadres employed by China's Family Planning Commission. We find that the program significantly increased infant cognitive skills of children after only six months. There were no significant effects on motor development or social-emotional outcomes. The program also had corresponding positive effects on measures of parental investment and let to a significant increase in parenting skills. Children who lagged behind cognitively and received little parental investment at the onset of the intervention benefited most of the program. These effects occurred despite lackluster compliance with the program which

appears to have been driven primarily by a combination of supply-side implementation failures and an unfavorable perception of the FPC by beneficiary households. The program itself, however, had a positive effect on views of the FPC suggesting that public perception may be a less significant obstacle as the program is implemented over time. Efforts to improve supply-side compliance will likely have the greatest impact on improving program effectiveness.

Our study faces a number of limitations. First, the study took place in one poor rural area in Northwest China; results may differ in other regions and contexts. Second, children were already over 18 months of age at the start of the trial. It is possible that effects would be larger if children were enrolled at an earlier age and/or the intervention took place over a longer period of time. Finally, we estimate effects only at one point in time at the conclusion of the intervention. Longer-run follow-up of the children in the study will be necessary to determine if the gains we find are lasting or fade out over time.

Despite these limitations, our results imply that an ECD program can be effectively delivered through the existing infrastructure of the National Health and Family Planning Commission. Future research should explore alternative interventions to improve ECD outcomes and compare relative cost-effectiveness across alternative delivery models.

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Table 1: Descriptive Statistics and Balance

	(1) Control (N=301)	(2) Treatment (N=212)	(3) p-value
Panel A. Child Characteristics			
(1) Age in months	24.46	24.45	0.747
	(0.20)	(0.22)	
(2) Male	0.45	0.51	0.185
	(0.03)	(0.04)	
(3) Low birth weight	0.04	0.04	0.774
	(0.01)	(0.01)	
(4) First born	0.59	0.61	0.366
	(0.03)	(0.04)	
(5) Ever breastfed	0.85	0.87	0.974
	(0.03)	(0.04)	
(6) Breastfed ≥ 12 months	0.35	0.39	0.867
	(0.05)	(0.05)	
(7) Anemia (Hb <110 g/L)	0.23	0.27	0.849
	(0.03)	(0.04)	
(8) Days ill past month	4.32	4.55	0.620
	(0.33)	(0.37)	
(9) Cognitive Delay (BSID MDI<80)	0.46	0.39	0.206
	(0.04)	(0.03)	
(10) Motor Delay (BSID PDI<80)	0.12	0.10	0.476
	(0.02)	(0.02)	
(11) Social-Emotional Problems (ASQ:SE>60)	0.25	0.28	0.401
	(0.03)	(0.03)	
Panel B. Household Characteristics			
(1) Social security support recipient	0.28	0.25	0.832
	(0.03)	(0.03)	
(2) Mother at home	0.68	0.62	0.116
	(0.04)	(0.05)	
(3) Caregiver education ≥ 9 years	0.72	0.74	0.487
	(0.03)	(0.04)	
(4) Unfavourable perception of FPC	2.87	2.85	0.824
	(0.06)	(0.05)	
Panel C. Parental Inputs			
(1) Told story to child yesterday	0.11	0.11	0.960
	(0.02)	(0.02)	
(2) Read book to child yesterday	0.05	0.04	0.872
	(0.01)	(0.01)	
(3) Sang song to child yesterday	0.37	0.35	0.651
	(0.03)	(0.04)	
(4) Played with child yesterday	0.34	0.34	0.996
	(0.03)	(0.03)	
(5) Number of books in household	1.60	1.90	0.615
	(0.24)	(0.29)	

P-values account for clustering within villages. Unfavourable perception of FPC is measured on a 5-point likert scale.

Table 2: Program Treatment Impact on Infant Skills

	Treatment effect		
	Point estimate	Std. error	Romano-Wolf P-value
Cohort 1: Below 30 months at follow-up (N=226)			
Bayley: Mental Development Index	0.244**	(0.108)	{0.0360}
Bayley: Psychomotor Development Index	-0.011	(0.119)	{0.9168}
ASQ: Social-Emotional Problems	-0.005	(0.139)	{0.9020}
Cohort 2: Above 30 months at follow-up (N=277)			
Griffith: Performance	0.275**	(0.107)	{0.0115}
Griffith: Personal-Social	0.264***	(0.107)	{0.0092}
Griffith: Locomotor	-0.026	(0.115)	{0.8854}
Griffith: Eye-hand coordination	0.118	(0.114)	{0.2609}
ASQ: Social-Emotional Problems	0.114	(0.118)	{0.6732}
Infant Skill Factor	0.225***	(0.076)	

Note: In all regressions we control for strata (county) fixed effects, previous nutrition assignment status and baseline developmental outcomes. In the pooled factor regression we additionally control for cohort fixed effects. All development outcomes are non-parametrically standardized for each age-month group. The Griffith language subscale is omitted in the analysis for the older cohort as receptive and expressive language skills are not explicitly tested by the BSID I and we want comparable measures of infant skills across both age groups. We find a positive but insignificant treatment effect on the Griffith language subscale (point estimate: 0.023 and std. error: 0.107). All standard errors are clustered at the village level. Significance stars indicate significance after adjusting for multiple hypotheses using the step-down procedure of Romano Wolf (2005) to control for the familywise error rate (FWER). Significance levels are as follows: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Program Treatment Impacts on Parenting Skills and Parental Investment

	Treatment effect		
	Point estimate	Std. error	Romano-Wolf P-value
Panel A. Parenting Skills at follow-up (N=510)			
Parent feels duty to help baby understand the world	0.129	(0.072)	{0.2043}
Parent knows how to play with baby	0.057	(0.086)	{0.3468}
Parent knows how to read stories to baby	0.282***	(0.085)	{0.0011}
Parent finds it important to play with baby	0.062	(0.087)	{0.3633}
Parent finds it important to read stories to baby	0.303***	(0.085)	{0.0004}
Parent finds it difficult to communicate with baby	0.047	(0.095)	{0.6243}
Parent feels nervous when caring for baby	-0.168**	(0.086)	{0.0464}
Parenting Skill Factor	0.342***	(0.092)	
Panel B. Parental Investment at follow-up (N=510)			
Number of books in hh for reading to baby	0.268***	(0.088)	{0.0015}
Number of times per week family reads to baby	0.869***	(0.117)	{0.0000}
Number of times per week family sings to baby	0.274***	(0.089)	{0.0047}
Number of times per week family goes out with baby	-0.079	(0.089)	{0.5041}
Number of hours per day baby spends watching tv	0.015	(0.077)	{0.8700}
Number of hours per day baby plays by itself	0.111	(0.103)	{0.7215}
Parental Investment Factor	0.724***	(0.104)	

Note: In all regressions we control for strata (county) fixed effects, previous nutrition assignment status and baseline parental skills or investment measures. In the pooled factor regressions we additionally control for cohort fixed effects. All outcomes are standardized by the distribution of the control group. Parenting skill outcomes are measured on a 7-point likert scale. Number of times per week family reads, sings or goes out with baby are measured on a 4-point likert scale. All standard errors are clustered at the village level. Significance stars indicate significance after adjusting for multiple hypotheses using the step-down procedure of Romano Wolf (2005) to control for the familywise error rate (FWER). Significance levels are as follows: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Determinants of Compliance

	(1) HH Visits	(2) HH Visits	(3) HH Visits	(4) HH Visits	(5) HH Visits
Male	1.599*	1.965**	1.935**	1.849**	1.367
	(0.823)	(0.849)	(0.841)	(0.853)	(0.825)
Age in months	-0.083	-0.040	-0.038	0.005	-0.038
	(0.118)	(0.115)	(0.116)	(0.123)	(0.099)
Cognitive Delay (BSID MDI<80)	-1.541*	-1.691**	-1.526*	-1.548*	-1.085
	(0.851)	(0.840)	(0.834)	(0.827)	(0.733)
Motor Delay (BSID PDI<80)	-1.130	-1.573	-1.897*	-1.714	-0.449
	(1.201)	(1.089)	(1.072)	(1.113)	(0.988)
Socio-Emotional Problems (ASQ:SE> 60)	0.110	0.663	0.930	0.662	0.769
	(0.972)	(0.837)	(0.842)	(0.853)	(0.830)
Number of days ill	0.085	0.037	0.045	0.030	-0.057
	(0.132)	(0.131)	(0.130)	(0.129)	(0.125)
Mother home >2 years		0.652	0.596	0.911	0.703
		(1.067)	(1.021)	(0.984)	(0.856)
Maternal education > 9 years		1.136	0.973	1.048	0.519
		(0.961)	(0.926)	(0.886)	(0.983)
Social security support recipient		-1.582	-1.916*	-1.821*	-1.412
		(0.999)	(0.985)	(1.036)	(1.051)
Distance to FPC office		-0.326***	-0.331***	-0.339***	-0.304***
		(0.116)	(0.115)	(0.118)	(0.111)
Unfavourable perception of FPC			-1.467***	-1.562***	-1.814***
			(0.518)	(0.528)	(0.508)
Trainer is male				-1.214	-1.426
				(1.400)	(1.399)
Trainer work experience FPC				0.144	0.154
				(0.110)	(0.112)
Trainer has bachelor degree				0.045	-0.493
				(1.417)	(1.073)
County FE	No	No	No	No	Yes
Observations	211	211	211	211	211
R^2	0.04	0.13	0.16	0.18	0.27

Note: Unfavorable perception of Family Planning Commission (FPC) is measured on a 5-point likert scale. Trainer work experience is measured by the number of years worked as a cadre for the FPC. All Standard errors are clustered at the village level. Significance levels are as follows: * $p < 0.1$, ** $p < 0.05$

Table 5: Average Treatment Effect on Perception of Family Planning Commission

	(1) Unfavorable Perception FPC
Treatment	-0.332**
	(0.130)
Observations	474
R^2	0.07
Control mean	3.80

Note: We control for strata (county) fixed effects, cohort fixed effects, previous nutrition assignment status and a baseline household-reported measure of the perception of the Family Planning Commission. Both baseline and follow-up perception is measured on a 5-point likert scale. Standard errors are clustered at the village level and reported in parentheses. Significance levels are as follows: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Dose-Response Relationships

	(1) Infant Skill	(2) Infant Skill	(3) Parenting Skill	(4) Parenting Skill	(5) Parental Inv.	(6) Parental Inv.
Number of HH Visits	0.012***	0.055	0.020***	0.027	0.042***	0.011
	(0.005)	(0.037)	(0.005)	(0.042)	(0.006)	(0.044)
Number of HH Visits^2		-0.003		-0.001		0.002
		(0.002)		(0.002)		(0.003)
Observations	503	503	510	510	510	510
R^2	0.29	0.29	0.08	0.08	0.25	0.25

Note: Column (1), (3) and (5) give control function estimates of the treatment effect of one household visit on the factor outcomes of interest, assuming a linear relationship between the number of household visits and the factor outcomes up to 24 household visits. Column (2), (4) and (6) give control function estimates of the treatment effect of one household visit, assuming a concave relationship. Residuals used in the control function estimation are derived from regressing the number of household visits on treatment status, distance to the FPC office, baseline perception of the FPC and the interaction of both the distance and perception measure with treatment assignment. F-test of joint significance of the excluded instruments gives a p-value of 0.000. In all regressions we control for baseline latent factors, strata(county) fixed effects, cohort fixed effects and previous nutrition assignment status. All standard errors are clustered at the village level. Significance levels are as follows: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Program Treatment Impact on Infant Skill, Parenting Skills and Parental Investment by Subgroups

		(2) Infant Skill (N=510)	(3) Romano Wolf P-value
Child Gender			
	Male	0.292	0.471
		(0.114)	
	Female	0.174	
		(0.101)	
Baseline Infant Skill			
	Low infant skill	0.356	0.091
		(0.111)	
	High infant skill	0.090	
		(0.096)	
Maternal Migration			
	Mother at home < 2 years	0.199	0.684
		(0.102)	
	Mother at home ≥ 2 years	0.249	
		(0.118)	
Maternal Education			
	Caregiver education < 9 years	0.161	0.739
		(0.171)	
	Caregiver education ≥ 9 years	0.228	
		(0.088)	
Baseline Parenting Skills			
	Low parenting skills	.341	0.257
		(0.157)	
	High parenting skills	.182	
		(.140)	
Baseline Parental Investment			
	Low investment	.384	0.054
		(.118)	
	High investment	.0887	
		(.099)	

Note: In all regressions we control for strata (county) fixed effects, cohort fixed effects, previous nutrition assignment status and baseline developmental outcomes. All standard errors are clustered at the village level. For baseline infant skills, parenting skills and baseline parental investment dummies are constructed at the median value of the baseline latent factor. Column (2) reports p-values of a t-test of equality of treatment effects for different sub-groups controlling for the familywise error rate by using the step-down adjustment procedure of Romano Wolf (2005). All standard errors are clustered at the village level.

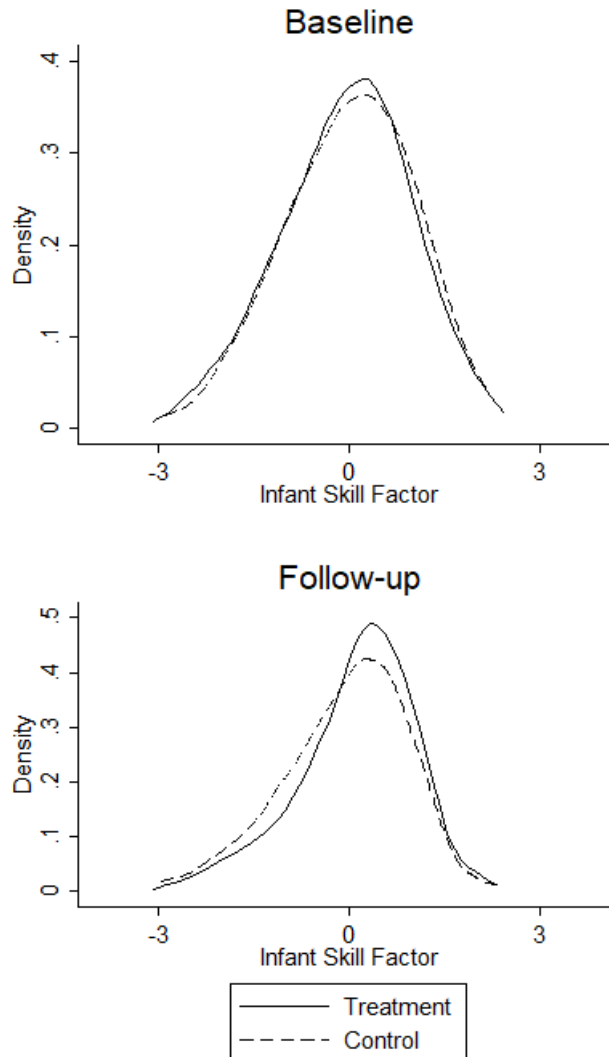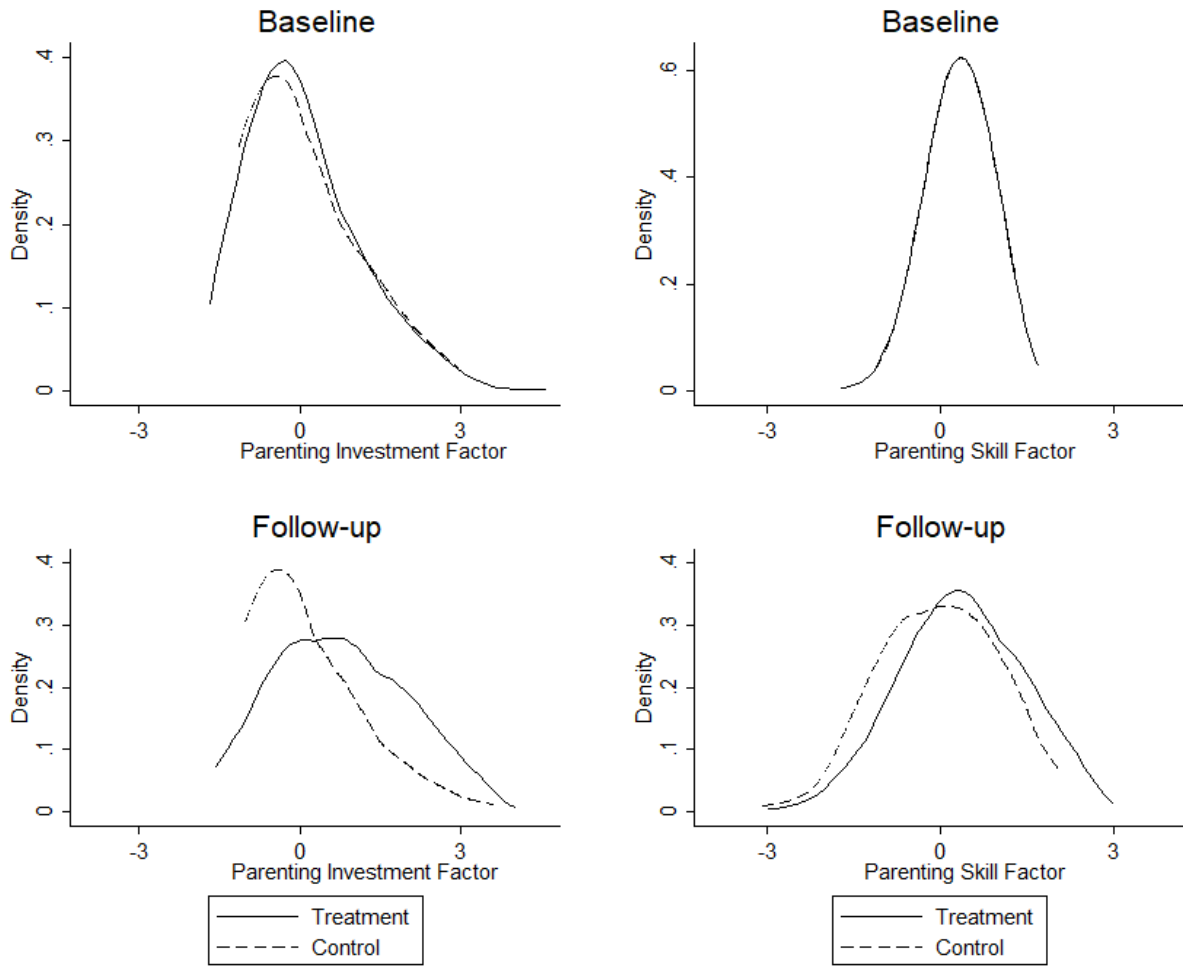Figure 1: Probability density functions of Bartlett factor scores of Infant Skill are show for baseline and follow-up by treatment assignment. The Kolmogorov-Smirnov (K-S) test of the equality of the infant skill distribution of control and treatment villages cannot be rejected at the 5% significance level (p-value:0.828) at baseline. At follow-up the K-S test rejects the equality of the two distributions (p-value:0.029).

(a) Parental Investment Factor   (b) Parenting Skill Factor

Figure 2: Probability density functions of Bartlett factor scores of Parental Investment (a) and Parenting Skill (b) are shown for baseline and follow-up by treatment assignment. The Kolmogorov-Smirnov (K-S) test of the equality of the parental investment and parenting skill distribution of control and treatment villages cannot be rejected at the 5% significance level (p-value:0.619 and 0.959) at baseline. At follow-up the K-S test rejects the equality of the control and treatment distribution for both the parental investment and parenting skill factors (p-value:0.000 and 0.053).

Table A1: Trainer Summary Statistics (N=69)

Variable	Mean	Std. Dev.
Male	0.609	0.492
Age	33.8	5.8
Married	0.884	0.323
Has child	0.841	0.369
Age of youngest child	6.731	6.074
Has bachelor degree	0.304	0.464
Monthly Salary (RMB)	3229.2	477.7
Work experience FPC (years)	11.681	6.895

Table A2: Descriptive Statistics and Balance

	(1) Control (N=300)	(2) Treatment (N=212)	(3) Spillover (N=79)	(4) P-value Control vs. Treatment	(5) P-value Control vs. Spillover	(6) P-value Treatment vs. Spillover
Panel A. Child Characteristics						
(1) Age in months	24.47	24.45	24.38	0.800	0.689	0.856
	(0.20)	(0.22)	(0.33)			
(2) Male	0.45	0.51	0.58	0.196	0.017	0.110
	(0.03)	(0.034)	(0.05)			
(3) Low birth weight	0.04	0.04	0.05	0.777	0.683	0.808
	(0.01)	(0.01)	(0.03)			
(4) First born	0.58	0.61	0.66	0.358	0.427	0.985
	(0.03)	(0.04)	(0.06)			
(5) Ever breastfed	0.85	0.87	0.87	0.997	0.502	0.562
	(0.03)	(0.04)	(0.06)			
(6) Still breastfed ≥ 12 months	0.35	0.39	0.33	0.900	0.929	0.690
	(0.05)	(0.05)	(0.08)			
(7) Anemia (Hb <110 g/L)	0.23	0.27	0.16	0.846	0.871	0.831
	(0.03)	(0.04)	(0.05)			
(8) Days ill past month	4.32	4.55	4.77	0.702	0.995	0.725
	(0.34)	(0.37)	(0.84)			
(9) Cognitive Delay (BSID MDI<80)	0.46	0.39	0.36	0.243	0.846	0.611
	(0.04)	(0.03)	(0.08)			
(10) Motor Delay (BSID PDI<80)	0.12	0.10	0.13	0.568	0.832	0.476
	(0.023)	(0.024)	(0.055)			
(11) Social-Emotional Problems(ASQ:SE>60)	0.25	0.28	0.32	0.414	0.286	0.957
	(0.03)	(0.03)	(0.05)			
Panel B. Household Characteristics						
(1) Social security support recipient	0.28	0.25	0.29	0.852	0.895	0.910
	(0.03)	(0.03)	(0.06)			
(20 Mother at home	0.68	0.62	0.66	0.120	0.481	0.102
	(0.04)	(0.04)	(0.06)			
(3) Caregiver education ≥ 9 years	0.72	0.74	0.78	0.460	0.201	0.886
	(0.03)	(0.04)	(0.04)			
(4) Unfavourable perception of FPC	2.87	2.85	2.86	0.882	0.946	0.707
	(0.06)	(0.05)	(0.09)			
Panel C. Parental Inputs						
(1) Told story to child yesterday	0.11	0.11	0.09	0.985	0.694	0.330
	(0.02)	(0.02)	(0.04)			
(2) Read book to child yesterday	0.05	0.04	0.02	0.859	0.404	0.350
	(0.01)	(0.01)	(0.02)			
(3) Sang song to child yesterday	0.37	0.35	0.46	0.653	0.400	0.082
	(0.03)	(0.04)	(0.08)			
(4) Played with child yesterday	0.33	0.34	0.38	0.952	0.296	0.756
	(0.03)	(0.03)	(0.06)			
(5) Number of books in household	1.60	1.89	2.30	0.599	0.148	0.179
	(0.24)	(0.29)	(0.64)			

P-values account for clustering within villages.

Table A3: Average Treatment Effects on Infant Skills, Parenting Skills and Parental Investment of Non-treated Children in Treatment Villages (N=79)

	Treatment effect	
	Point estimate	Std. error
Infant Skill Factor	0.073	(0.108)
Parenting Skill Factor	0.083	(0.127)
Parental Investment Factor	0.076	(0.122)

Note: In all regressions we control for strata (county) fixed effects, cohort fixed effects, previous nutrition assignment status and baseline latent factors. All standard errors are clustered at the village level. Significance levels are as follows: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A4: Measurement System

Latent Factor	Measurement	factor loading	% Signal
Infant Skill Factor at baseline			
	Bayley: Mental Development Index	1	0.56
	Bayley: Psychomotor Development Index	0.61	0.22
	ASQ: Social-Emotional Problems	-0.46	0.10
Infant Skill Factor at follow-up			
Age-Cohort 1	Bayley: Mental Development Index	1	0.29
	Bayley: Psychomotor Development Index	0.94	0.35
	ASQ: Social-Emotional Problems	-0.54	0.06
Age-Cohort 2	Griffith: Performance	1	0.35
	Griffith: Personal-Social	0.79	0.41
	Griffith: Locomotor	0.94	0.50
	Griffith: Eye-hand coordination	0.71	0.34
	ASQ: Social-Emotional Problems	-1.79	0.02
Parenting Skill Factor at baseline			
	Parent knows how to read stories to baby	1	0.45
	Parent knows how to play with baby	1.19	0.64
	Parent finds it important to read stories to baby	1.05	0.66
	Parent finds it important to play with baby	1.17	0.83
	Parent feels duty to help baby understand the world	1.39	0.79
	Parent finds it difficult to communicate with baby	0.73	0.27
	Parent feels nervous when caring for baby	0.50	0.17
Parenting Skill Factor at follow-up			
	Parent knows how to read stories to baby	1	0.45
	Parent knows how to play with baby	0.57	0.19
	Parent finds it important to read stories to baby	0.59	0.32
	Parent finds it important to play with baby	0.30	0.13
	Parent feels duty to help baby understand the world	0.23	0.09
	Parent finds it difficult to communicate with baby	-0.16	0.01
	Parent feels nervous when caring for baby	-0.22	0.03
Parental Investment Factor at baseline			
	Number of books in hh for reading to baby	1	0.18
	Number of times per week family reads to baby	0.34	0.39
	Number of times per week family sings to baby	0.47	0.42
	Number of times per week family goes out with baby	0.36	0.18
	number of times per day baby spends watching tv	0.19	0.05
	Number of times per day baby plays by itself	0.34	0.04
Parental Investment Factor at follow-up			
	Number of books in hh for reading to baby	1	0.12
	Number of times per week family reads to baby	0.38	0.51
	Number of times per week family sings to baby	0.45	0.35
	Number of times per week family goes out with baby	0.12	0.00
	Number of times per day baby spends watching tv	-0.07	0.00
	Number of times per day baby plays by itself	-0.08	0.00

Note: Table shows dedicated measurement system. For each measure factor loadings are shown
as well as the fraction of the variance in each measure that is explained by the variance in signal.