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Links between maternal employment and child nutrition in rural Tanzania

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Abstract

Child undernutrition remains a widespread problem in many developing countries. The empowerment of women, and mothers in particular, was shown to improve child nutrition in various geographical contexts. One important avenue to empower women is fostering female employment. However, maternal employment can influence child nutrition through different mechanisms; it is not clear under what conditions the overall effect will be positive. We develop a theoretical model to show that maternal employment can affect child nutrition through changes in (i) income, (ii) intra-household bargaining power, and (iii) time available for childcare. The links are empirically analyzed using panel data from rural Tanzania and regression models with maternal fixed effects. Maternal employment has non-linear effects on child height-for-age z-scores (HAZ), the standard indicator of long-term child nutritional status. Off-farm employment reduces child HAZ at low levels of labor supply. The effect turns positive at higher levels of off-farm labor supply and negative again at very high levels. The child nutrition effects of maternal time allocation to agricultural work on the own family farm are weaker than those of off-farm employment and statistically insignificant. These findings can help to better design development interventions that foster synergies and avoid potential tradeoffs between female empowerment and child nutrition goals.

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1. Introduction

Child undernutrition remains a widespread problem and a major development challenge in many low- and middle-income countries. Especially during early childhood, nutritional deficiencies contribute to high mortality, morbidity, and impaired physical and cognitive development (Black et al., 2013; Hoddinott et al., 2013; Horton and Steckel, 2013; Headey et al., 2018). Although recent development efforts have put strong emphasis on tackling this problem, rates of child undernutrition remain high, especially when measured in terms of child stunting (low height-for-age) (Development Initiatives, 2018). Even though stunting is only one symptom of child undernutrition, it is often associated with other negative nutrition and health outcomes that are less straightforward to measure (Leroy and Frongillo, 2019). Reducing child stunting has therefore become a global health priority during the past decade (The Lancet, 2013; de Onis and Branka, 2016). Considerable research has been devoted to the question as to what types of interventions can help to reduce child stunting (Webb, 2013; Ruel and Alderman, 2013; Leroy and Frongillo, 2019). One important leverage point is women empowerment, which was shown to have positive effects on child nutrition in various geographical contexts (Lepine and Strobl, 2013; Sraboni et al., 2014; Malapit et al., 2015). Women empowerment is also a goal in itself on the sustainable development agenda, generally pointing at welcome synergies.

Women empowerment is often related to improving access to productive resources and employment (UN, 2018). Female employment tends to increase total household income and also the part of the income that is controlled by women. The latter is particularly relevant for the status and decision-making power of women within the household and has positive effects of child nutrition and health (Hoddinott and Haddad, 1995; Chowdhury et al. 2003; Rangel, 2006; Majlesi, 2016). However, beyond income and income control, female employment can also affect child wellbeing through changes in time allocation. Especially in rural areas of developing countries women have heavy workloads, as they are often involved in agricultural work on the family farm in addition to being responsible for household work and child nurturing (Ferrant et al., 2014). Additional involvement in off-farm employment further adds to the workload and may possibly reduce the time available for childcare, including breastfeeding and food preparation (Popkin and Solon, 1976; Rivera-Pasquel et al., 2015). In other words, female off-farm employment may have a negative partial effect on child nutrition and health through this time reallocation mechanism. Similar tradeoffs may also occur for new on-farm activities that further increase the workload of women. For instance, the promotion of homestead gardens has become a popular intervention to improve nutrition through higher vegetable consumption (World Bank, 2007; Masset et al., 2012), but – as homestead gardens are primarily managed by women – the time available for childcare may shrink. Better understanding these mechanisms is important to envisage under what conditions female off-farm and on-farm employment will have positive or negative effects on child nutrition, but the evidence is scant. This research gap is addressed here, both conceptually and empirically.

Relatively few studies have analyzed the complex relationship between female employment and child nutrition in developing countries. Early studies with data from the Philippines (Popkin and Solon, 1976; Senauer and Garcia, 1991; Blau et al., 1996), Panama, (Tucker and Sanjur, 1988) and Guinea (Glick and Sahn, 1998) showed mixed results. A few more recent studies also exist. Several have focused only on women's time use in agriculture, confirming that severe time constraints can be negatively associated with child nutrition (Komatsu et al., 2015; Johnston et al., 2018). Rashad and Sharaf (2019) used cross-section data from Egypt to suggest that maternal employment has negative effects on child nutrition. In contrast, Ngenzebuke and Akachi (2017) used data from Nigeria and found that maternal employment is positively associated with child nutrition. While Ngenzebuke and Akachi (2017) used two rounds of data for their analysis, the observations were pooled without controlling for unobserved heterogeneity, so causal inference is hardly possible. The only related study that used panel data econometric techniques to control for unobserved heterogeneity is by Jain and Zeller (2015). They found no significant impact of maternal labor supply on child food intake in Bangladesh. Effects on child nutritional status were not analyzed. Moreover, as the different survey rounds used by Jain and Zeller (2015) were all collected during one year, the observed variations primarily reflect seasonality and the estimates cannot be interpreted as longer-term effects.

Our contribution to this body of literature is twofold. First, we develop a model to conceptualize the effects of maternal employment on child nutrition with a particular focus on the underlying mechanisms. Second, we use panel data covering a time period of several years and econometric techniques to control for unobserved heterogeneity, thus being able to draw more robust causal inference on longer-term nutrition effects. In particular, we use three rounds of data from the Tanzanian Living Standard Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) to analyze the effects of off-farm and on-farm maternal employment on child height-for-age z-scores (HAZ).

2. Conceptual framework

2.1. Theoretical model

We develop a simple model in order to formalize the mechanisms through which maternal employment may affect investments in children – and child nutrition in particular. For simplicity, we assume that each household consists of husband and wife, and two children, a boy and a girl. Investment decisions are made repeatedly over multiple periods. In each period, the decision process consists of a two-stage game. In the first stage, the mother (i) faces a set of employment opportunities at different wages and she decides if and how much labor to offer on the labor market. In the second stage, the father (j) and the mother (i) bargain over how their income is spent. Male wages are treated as fixed in this model. Since male labor force participation stayed largely constant over the past decades, while female labor force participation increased, it seems reasonable to assume that female wages but not male wages change in the theoretical framework.

Each parent derives utility from consumption(C^m) and from the human capital stock of each child, the boy's (H_b) and the girl's $\left(H_g\right)$. We focus on nutrition as one key component of child human capital.

$$U\left(C^m, H_b, H_g\right). \qquad (1)$$

The wage each mother receives depends on the set of available jobs (J_i), and her personal characteristics (X_i), such that $w_i = w_i(J_i, X_i)$. For simplicity, we assume that she always chooses the best paying job and – in that job and at that particular wage – decides how much to work. Labor supply of the mother (l_i) is thus determined as follows:

$$l_i = argmax\ U_i(C_i^m, H_b, H_g) \qquad (2)$$

Whatever time the woman does not spend on the labor market is devoted to childcare. And the stock of human capital of each child increases in the time that the mother allocates to childcare (which is non-rival to both children) and in the monetary investment in the child:

$$H_{b,g} = f[(T_i - l_i), i_{b,g}] \tag{3}$$

where T_i denotes the total time endowment of the mother, and $i_{b,g}$ the monetary investment in the boy or girl. In the second stage, husband and wife (or mother and father) bargain over how to spend their income. For simplicity, the father's income is held constant. The bargaining process between parents is treated as cooperative Nash Bargain, also termed as "collaborative model" by Chiappori (1992):

$$max \;\; \left(U_i\left(C_i^m, H_b, H_g\right) - V_i\right)^{\gamma_i}\left(U_j\left(C_j^m, H_b, H_g\right) - V_j\right)^{\gamma_j} \tag{4}$$

$$s.t.$$

$$C_i^m + C_j^m = w_i l_i + Y_j - i_b - i_g \tag{5}$$

$$H_{b,g} = f[(T_i - l_i), i_{b,g}] \tag{6}$$

where γ is each parent's bargaining weight within the household, and V the outside option. The bargaining weights of both parents depend on their personal characteristics and wage incomes:

$$\gamma_i = f(X_i, w_i), \tag{7}$$

and

$$\gamma_j = f\left(X_j, w_j\right). \tag{8}$$

Likewise, the outside option depends on each parent's personal characteristics and income. As in Atkin (2009), the utility functions of each parent have different parameters, such that

(i) the mother has greater utility of investing in her children than the father, and (ii) the relative utility of investing in girls (respective to boys) is greater for the mother than the father (see Behrman, 1997, for a review). The following utility functions are sufficiently general to capture these ideas:

$$U_i = \left[(1 - \alpha_i - \beta_i)C_i^{\rho} + \alpha_i {H_b}^{\rho} + \beta_i {H_g}^{\rho}\right]^{1/\rho}, \qquad (9)$$

$$U_j = \left[(1 - \alpha_j - \beta_j)C_j^{\rho} + \alpha_j {H_b}^{\rho} + \beta_j {H_g}^{\rho}\right]^{1/\rho}, \qquad (10)$$

with $\alpha > 0$, and $\beta > 0$. The above mentioned preferences imply that $\alpha_i > \alpha_j$, $\beta_i > \beta_j$, and $\alpha_i/\beta_i < \alpha_j/\beta_j$.

Such a model can be solved recursively for each period. A mother decides how much time to allocate to the labor market, anticipating how this will affect her relative bargaining power in the second stage. Solving the model leads to the following reduced form equations for investment in each child:

$$H_b = b(J_i, Y_j, X_i, X_j, \gamma_i, V_i, \gamma_j, V_j), \qquad (11)$$

and

$$H_g = g(J_i, Y_j, X_i, X_j, \gamma_i, V_i, \gamma_j, V_j), \qquad (12)$$

where the preference parameters α and β are captured in X, and female wages are determined by J_i and X_i. These equations could be further simplified by dropping the bargaining weight (γ) and the outside option (V) as they are themselves functions of X_i and J_i for the mother, and of X_j and Y_j for the father. However, these parameters are retained here for expositional purposes.

2.2. Model implications

Equations (11) and (12) highlight how an increase in the set of employment options (J_i), and therewith w_i, affects the investment in each child via different mechanisms. The three main mechanisms are the (i) income effect, the (ii) bargaining power (or female empowerment) effect, and (iii) the time allocation effect. These effects are discussed in more detail in the following.

The income effect is due to the increase in female wage earnings, which expands the set of possible consumption outcomes. To the extent that both parents' utility increases in investments in their children, they will spend more on both of them. Holding other things constant, higher investments in food and healthcare will result in improved child nutrition (Leslie, 1988; Oddo et al., 2018).

The bargaining power (female empowerment) effect comes from the increase in mother's income relative to father's income. This improves her outside option and increases her bargaining weight and decision-making power within the household. As women derive greater utility than men from investing in their children, an increase in female decision-making power shifts expenditures towards female preferences, thus further raising household investments in child nutrition and health beyond the overall income effect. Indeed, several empirical studies showed that female empowerment has positive effects on food and healthcare expenditures and child nutrition also after controlling for total household income (Hoddinott and Haddad, 1995; Chowdhury et al., 2003; Rangel, 2006; Majlesi, 2016).

The time allocation effect arises from the fact that maternal time is a direct input in the production of child human capital and nutrition. Holding other things constant, less time for childcare will reduce child human capital and nutrition (Berger et al., 2005; Rivera-Pasquel et al., 2015). However, the different effects overlap. Therefore, the mother faces a tradeoff between spending time with her child (and increasing the utility from child human capital) and working on the labor market (and increasing utility from own consumption). The direction of the combined effect depends on the shape of the utility function and the degree of complementarity between maternal time and monetary inputs in the production of child human capital. If the complementarity between maternal time and monetary investments in the production of child human capital is high, and maternal consumption and child human capital are substitutes in maternal utility, then an increase in maternal wages can decrease time allocation to childcare and worsen child human capital and nutrition. Indeed, empirical evidence from developing countries suggests that the substitution effect dominates in maternal utility, implying that women work more as wages increase (e.g., Atkin, 2009; Heath and Mobarak, 2015).

Depending on the relative strength of these three mechanisms, an increase in maternal employment can have positive or negative effects on child nutrition. This may depend on the type of employment. For instance, work on the family farm near the homestead may be more compatible with child nurturing than off-farm work further away from home. We also expect the effects of maternal employment on child nutrition to be non-linear, as the relative importance of the mechanisms may vary with the actual amount of labor supplied by the mother. The time allocation mechanism may not be so relevant when the mother only works for a few hours per week, but may increase in importance when the number of hours worked rises.

3. Data

3.1. Household survey

Data for the empirical analysis come from the World Bank's Living Standard Measurement Study –Integrated Surveys on Agriculture (LSMS-ISA) for Tanzania. We use three rounds of this survey, namely those for 2008, 2010, and 2012. During these three rounds the same households were surveyed, so the data have a panel structure. While a fourth round of the LSMS-ISA survey was carried out in Tanzania in 2014, many households were newly sampled for this latest round, attenuating their use in panel data models with household or individual fixed effects.

The LSMS-ISA data are representative for Tanzania as a whole. For this study, we only use observations from rural areas in order to be able to differentiate between off-farm and on-farm employment for the same set of women. The dataset contains comprehensive information on the household composition, asset ownership, agricultural production, other economic activities, consumption expenditures, and other socioeconomic variables. The survey also contains detailed data on the time allocation of all household members which is particularly useful for our study. Finally, in all survey rounds, child anthropometric measures were taken. For our study, we use the data from children under five years of age (0-60 months) matched with their respective mothers. For the three survey rounds, we have complete observations for 5,096 children (1,136, 1,750 and 2,210 from 2008, 2010, and 2012, respectively) residing with 3,598 unique mothers.

3.2. Measuring child nutrition

Child nutrition is the main outcome variable in this study. We measure child nutrition in terms of height-for-age z-scores (HAZ), which we calculate using WHO's child growth standard (WHO, 2006; O'Donnell et al., 2008). HAZ for child *i* is computed as follows:

$$HAZ_i = \frac{h_i - \bar{h}}{\sigma_h} \tag{13}$$

where h_i is the child's height, $\bar{h}$ is the median height of the well-nourished reference population with the same age and gender, and σ_h is the standard deviation of the reference population's height. HAZ reflects the long-term nutritional status of children, which is influenced by the child's development during gestation, the dietary and health conditions during early childhood, and other factors (O'Donnell et al., 2008; Shively, 2017). A child with low HAZ suffers from chronic undernutrition due to continued nutritional deficiencies. If the individual HAZ is below -2.0, the child is categorized as stunted (WHO, 2006).

In the literature, stunting is considered the best indicator of chronic undernutrition, mainly because it accurately reflects children's growth faltering and wellbeing (de Onis and Branka, 2016). Low HAZ and stunting are also associated with many other adverse nutrition-related health outcomes, although impaired linear growth does not necessarily cause these other health outcomes (Leroy and Frongillo, 2019). We consider HAZ the most suitable indicator of child nutrition in our study, as it reflects long-term nutritional inadequacies, as opposed to weight-based indicators that rather capture short-term changes in undernutrition (O'Donnell et al., 2008). HAZ allows us to examine the child's biological response to continued nutrition and health conditions that may result from maternal labor supply. Put differently, HAZ is better than alternative indicators since it can reflect possible longer-term effects of maternal labor supply, rather than effects of any acute shocks that could affect maternal labor supply and short-term child nutrition measures simultaneously.

3.3. Measuring maternal employment

Our main explanatory variable of interest is maternal employment. We use two dummy variables that capture the mother's involvement in off-farm wage and on-farm agricultural work, respectively. In addition, we capture employment intensity through the number of hours that the mother spent in off-farm wage work and on-farm agricultural work during the past 7 days. We acknowledge that these maternal employment variables do not capture the entire spectrum of activities, as women might also engage in self-employment and various other household activities. However, the number of hours spent in off-farm wage and on-farm agricultural work are the only time allocation variables consistently measured in the three survey rounds.

4. Estimation strategy

4.1. Panel regression models

We aim to examine how maternal employment affects child nutrition. Using mothers as the panel identifier, we run multi-period regression models taking the following general form:

$$HAZ_{imt} = \beta_0 + \beta_1 L_{mt} + \beta_2' \boldsymbol{C}_{it} + \beta_3' \boldsymbol{X}_{ht} + \beta_4' \boldsymbol{M}_{mt} + \beta_5' \boldsymbol{D}_{\boldsymbol{t}} + a_i + \varepsilon_i \qquad (14)$$

where HAZ_{imt} refers to the height-for-age z-score of child i that belongs to mother m at time t. L_{mt} represents maternal employment with two separate variables for off-farm wage work and on-farm agricultural work. As mentioned above, we use dummy variables and continuous variables measuring the time spent in both activities in separate regressions. We run specifications where we separately include off-farm and on-farm work, as well as specifications with both employment variables jointly included in the same model, in order to examine possible changes in the coefficient estimates. We expect the effect of maternal time spent in off-farm wage work and on-farm agricultural work to be different, because work on the own family farm may be easier to combine with childcare activities than off-farm work further away from the homestead. In addition, on-farm agricultural work is directly related to food production and may therefore affect child nutrition also through higher food availability at the household level (Shively and Sununtnasuk, 2015). In variants of equation (14), we will also include higher-degree polynomial terms of L_{mt}, as we expect the effects of maternal employment on child nutrition to differ between low and high numbers of hours allocated to off-farm and on-farm work.

$\boldsymbol{C}_{it}$ in equation (14) is a vector of child-level characteristics (age and gender), $\boldsymbol{X}_{ht}$ is a vector of household characteristics (age and gender of the household head etc.), and $\boldsymbol{M}_{mt}$ is a vector of maternal characteristics (age, education, and height). As one component of $\boldsymbol{M}_{mt}$ we also include the number of non-working female adults living in the household, as other female adults could take on childcare roles and thus reduce the relevance of the time allocation mechanism of maternal employment. $\boldsymbol{D}$ represents a vector of time fixed effects, a_i is time-invariant mother specific unobserved heterogeneity, which is expected to correlate with L_{mt}. ε_i is an idiosyncratic error term. By including mother fixed effects we are able to account for time-invariant heterogeneity, but not for time-variant shocks that might also affect both the decision to work and child nutritional outcomes. To minimize concerns of unobserved time-variant shocks driving our results, we control for weather shocks in all specifications.

4.2. Mundlak estimator

We use the Mundlak (1978) approach, also called pseudo fixed effects estimator. The Mundlak approach uses a random effects specification but includes time averages of the time-variant explanatory variables in addition to the regular controls. This inclusion of time averages takes care of time-invariant unobserved heterogeneity similar to the regular fixed effects specification (Wooldridge, 2002). But the Mundlak approach is more efficient than the regular fixed effects estimator when the within variation in the data is smaller than the between variation, which is the case at least in some variants of our regression models. Further, the coefficient estimates for the time averages are interesting in themselves, as they reveal long-term relationships between the respective covariates and the outcome variable (Andress et al., 2015). The Mundlak regressions take the form:

$$HAZ_{imt} = \beta_0 + \beta_1' L_{mt} + \beta_2' \boldsymbol{C}_{it} + \beta_3' \boldsymbol{X}_{ht} + \beta_4' \boldsymbol{M}_{mt} + \beta_5' \widetilde{\boldsymbol{X}}_h + \beta_6' \widetilde{\boldsymbol{M}}_h + \beta_7' \boldsymbol{D_t} + a_i + \varepsilon_i \qquad (15)$$

where $\widetilde{\boldsymbol{X}}_h$ and $\widetilde{\boldsymbol{M}}_h$ are the time averages of household and maternal characteristics, including the number of hours worked by the mother.[1] Since mothers belonging to the same household share similar characteristics in terms of economic status of the household and the overall environment shaping child nutrition, we cluster standard errors at the household level. In a robustness check, we also use the regular fixed effects estimator.

[1] Time averages of the higher-degree polynomials of hours worked are not included as this leads to high multicollinearity.

4.3. Exploring effect mechanisms

In the theoretical model above we identified three mechanisms of how maternal employment could affect child nutrition, namely (i) the income effect, (ii) the bargaining power (or female empowerment) effect, and (iii) the time allocation effect. If the income effect were the only effect that matters, the coefficient for maternal employment in the regression models should turn insignificant after controlling for total household income. We test this by comparing model specifications with and without total household income (consumption expenditures) included as control variable.

To analyze the role of the time allocation mechanism the higher-degree polynomials of maternal employment are of particular interest. Especially in the specifications where we control for total consumption expenditures, the effects of maternal employment on child nutrition will primarily consist of the bargaining effect and the time allocation effect. The bargaining effect may increase with the number of hours worked, but very likely in a diminishing way, so that at very high levels of hours worked the time allocation effect will dominate. Using squared and cubed terms of hours worked will help to shed light on these relationships in the empirical setting.

In addition to estimating the models for the full sample of children under the age of 5 years, we will also estimate separate models for children below and above 2 years of age. Nutrition and health conditions during the first 1000 days of life (including 9 months of pregnancy and the first two years after birth) are known to be particular crucial for the child's long-term physical and cognitive development (Ruel and Alderman, 2013). This could mean that the observed effects are bigger for the subsample of children under two. On the other hand, even when the conditions during the first 1000 days are particularly critical, effects on the child's nutrition and health status are sometimes only visible in subsequent years, especially when using HAZ as a long-term nutrition indicator (Alderman and Headey, 2018). This could lead to partial exposure bias when including all children under five. In that case, we would expect the effects to increase when only including children between 2 and 5 years of age.

4.4. Dose-response model

The main explanatory variables of interest – the number of hours spent by the mother in off-farm wage and on-farm agricultural work – are continuous and may have non-linear effects on child nutrition. As explained, possible non-linearities will be explored by using higher-degree polynomial terms in the regression models. An alternative approach that we also employ is the dose-response model proposed by Cerulli (2015). This dose-response model does not depend on the assumption of a normally distributed treatment variable, which is an advantage in our case because the two variables for the number of maternal hours worked are both truncated at zero. The dose-response model takes the following form:

$$w_i = 1: \quad HAZ_{1i} = \mu_1 + g_1(\mathbf{x}_i) + h(s_i) + e_1 \qquad (16)$$

$$w_i = 0: \quad HAZ_{0i} = \mu_1 + g_0(\mathbf{x}_i) + e_0$$

where w_i is a treatment indicator which takes a value of one if child i lives with a working mother (treated) and zero otherwise (untreated). $g_1(\mathbf{x}_i)$ and $g_0(\mathbf{x}_i)$ are functions of the vector of control variables for the treated and untreated groups, respectively. s_i represents the continuous treatment, namely the number of hours worked by the mother, where we use a range of [0,100]. $\mathrm{h}(s_i)$ is the function for the continuous treatment taking a value of 0 when $w_i = 0$. The average treatment effect (ATE) can be calculated as:

$$ATE(x, s) = E(HAZ_{1i} - HAZ_{0i} | x, s) \tag{17}$$

The dose response function (DRF) is equal to the average treatment effect (ATE) given the level of treatment s [$ATE(x, s)$]. That is, the DRF is a function of the treatment intensity and is calculated by averaging $ATE(x, s)$ over x (Cerulli, 2015). We show a graphical representation of the DRF, which is calculated by using the predicted value of the ATE on the treated, $\widehat{ATET}\ (s_i) = \ \widehat{ATE}\ (s_{i,\ \ s_i > 0})$. As there are no panel data approaches available for estimating the dose-response model, we pool the data from all three survey rounds and use year dummies and Mundlak time-averages to account for the temporal dimension of the data.

5. Empirical results

5.1. Descriptive statistics

Table 1 presents descriptive statistics of the nutrition status of children in rural Tanzania, by survey year, age group, and sex of the child, as well as by maternal employment status. The average HAZ is -1.53 across all three survey rounds. HAZ was particularly low in 2008 and then increased in 2010 and 2012. Correspondingly, the rate of child stunting fell from 45% in 2008 to around 37% in 2010 and 2012. In spite of this improvement, child stunting remains high, pointing at widespread chronic undernutrition in rural Tanzania. Stunting is higher among boys than girls, which is consistent with earlier studies in other countries of sub-Saharan Africa (Christiaensen and Alderman, 2004; Webb and Block, 2004). And, as expected, child stunting is more widespread in poorer than in richer households. Interestingly, Table 1 also shows that stunting is higher among children with working mothers than among children whose mothers do not work either on-farm or off-farm. Many but not all of these differences are statistically significant.

Table 2 shows descriptive statistics of maternal employment. Around 11 percent of the mothers are employed in the off-farm sector and 70 percent work on their own family farm. Across all mothers in the sample (including those working and not working), the average number of hours worked during the 7 days prior to the survey was 2.8 in off-farm employment and 18.8 in on-farm agricultural activities. These average numbers of hours worked did not show much variation across the three survey rounds.

Prior to the regression analysis, we examine the bivariate relationship between maternal working hours and child linear growth. Figure 1 displays Kernel density plots of child HAZ by the work status of the mother in off-farm employment (panel A) and on-farm agricultural activities (panel B). For both types of employment, child HAZ is systematically higher if the mother does not work, and the distributions between children with mothers that do and do not work are statistically different at the 1 percent level (Table A1 in the Appendix).

In Figure 2, we plot the link between maternal hours worked off-farm and on-farm and child HAZ using a quadratic prediction plot. These predictions only use the sample with working mothers. Panel A of Figure 2 shows that there is a positive association between maternal hours spent in off-farm wage work and child HAZ up to a certain point. However, beyond approximately 55 hours of maternal off-farm work per week, child HAZ starts to decline. Panel B shows a different relationship for on-farm agricultural work. Child HAZ is highest if the mother only spends little time working on the family farm and consistently decreases with an increasing number of hours worked on-farm. However, these relationships in Figures 1 and 2 do not control for any confounding factors. The net effects of maternal off-farm and on-farm employment on child nutrition are analyzed with regression models below.

5.2. Effects of maternal employment on child nutrition

Table 3 shows results of the regression models where maternal off-farm and on-farm employment are represented by two dummy variables. The coefficient estimate for maternal off-farm employment in model (1) is negative and statistically significant. The mother's involvement in off-farm work reduces child HAZ by 0.185. Model (2) also looks at the effect of off-farm work but additionally controls for household consumption expenditures. The coefficient for maternal employment is hardly affected, implying that the income mechanism of female employment does not play a major role.[2] The negative effect of maternal off-farm employment on child nutrition seems to be mainly driven by the time allocation mechanism, as this is the only one for which we expect a negative direction.

The coefficient for maternal on-farm work is not statistically significant (model 3 in Table 3). However, the coefficient for the time average of maternal involvement in on-farm agricultural work is negative and statistically significant, suggesting a negative long-term relationship between maternal work in agriculture and child nutrition. These findings also

[2] The coefficient of total household expenditure itself is not statistically significant, which may surprise as household living standard should have a positive effect on child nutrition. However, the mean of household expenditure, which is included in the Mundlak specification and shown in the lower part of Table 3, is positive and statistically significant, confirming that living standard is positively associated with child HAZ.

hold after controlling for total household expenditures (model 4). Models (5) and (6) include the off-farm and on-farm employment variables simultaneously, without any major changes to the main results.

Tables 4 and 5 show results of the models where maternal employment is represented by the number of hours worked in the off-farm sector and on the own family farm, respectively. In model (1) of Table 4, the number of hours spent in off-farm work is only included in linear form. The coefficient is negative but not statistically significant. In models (2) and (3), the squared and cubed terms of hours worked are additionally included. In model (3), the coefficients of the first, second, and third degree polynomials are all statistically significant and with switching signs. The estimates suggest that a relatively small amount of time allocated to off-farm work has a negative effect on child nutrition. If the mother works more than 12 hours per week in off-farm employment, the child nutrition effect turns positive, and then negative again if she works more than 60 hours per week in the off-farm sector. A graphical presentation of predicted child HAZ at various levels of maternal hours worked off-farm is shown in Figure A1 in the Appendix.

The decline in child HAZ beyond 60 hours is of little practical relevance in Tanzania, as only about 0.5 percent of the mothers (around 5 percent of all mothers working off-farm) work more than 60 hours per week in off-farm activities. Nevertheless, the estimated non-linear effects clearly underline the changing relevance of the different underlying mechanisms as the number of hours worked by the mother increases. At low and very high numbers of maternal hours worked in off-farm activities, the negative time allocation effect on child nutrition dominates, whereas at moderate numbers of hours worked this negative time allocation effect is overcompensated by positive income and bargaining effects. These relationships do not change much also when controlling for total household expenditures (model 4 in Table 4).

Table 5 shows results for the number of hours worked in on-farm agricultural activities. The coefficients of the linear, squared, and cubed terms of hours worked are all statistically insignificant,[3] suggesting that maternal on-farm work does not affect child nutrition in a measurable way. Only the mean of hours worked on-farm has a negative and significant coefficient, pointing at a negative long-term association between maternal on-farm work and child HAZ. These effects do not change much when controlling for total household expenditures (model 3), or for the number of hours spent in off-farm work (models 4 and 5). Comparing results between Tables 4 and 5 reveals that also the effects of maternal off-farm employment do not change much when additionally controlling for the time spent in on-farm activities.

5.3. Effects by age group of children

We now subdivide the total sample of children into two subsamples, those below and above 2 years of age, and estimate separate models in order to examine whether the effects of maternal employment vary by age group. Results are shown in Table 6. All models shown control for total household expenditures. We first concentrate on the effects of maternal off-farm employment. For children below 2 years of age (model 1), the signs of the coefficients for the linear, squared, and cubed terms of hours worked in off-farm activities are the same as those for the whole sample (compare with Table 4), but none of the estimates is

[3] The cubed term of the number of hours worked on-farm was dropped from the models shown in Table 5, as it was statistically insignificant in all specifications.

statistically significant. In contrast, for children above 2 years of age (model 4 in Table 6) all three coefficients are statistically significant. This suggests that both the positive and negative effects of maternal off-farm employment on child nutrition are stronger for older than for younger children. This may surprise given that the conditions during the first 1000 days of life are known to be particularly crucial for long-term child development (Ruel and Alderman, 2013). One possible explanation could be that some of the mothers may carry their younger children with them to the off-farm workplace, thus reducing the negative time allocation mechanism. This is less possible with older children. However, as already discussed above, it is also possible that some of the longer-term effects on child nutritional status that result from conditions under the age of 2 years are only fully reflected in the HAZ of children in later years, simply because HAZ is a long-term measure of child nutrition. This is consistent with other recent studies showing that the observed influence of many factors on HAZ are larger and stronger for children above 2 years of age (Alderman and Headey, 2018; Headey et al. 2018).

For maternal on-farm work and children under the age of 2 years, the linear and squared terms of hours spent on-farm, and also the mean hours spent over time, are all statistically insignificant (model 2 in Table 6). In contrast, for older children we find a small but positive and significant estimate for the square term of hours worked on-farm (model 5 in Table 6), suggesting that a high agricultural labor input of the mother may have positive effects on child nutrition. In Africa, women are often responsible for growing subsistence food crops, including staple foods and vegetables, so that a higher female involvement in agriculture may be associated with better food and nutrient availability. The cubed term of the hours spent in on-farm agricultural work was not statistically significant in any of the specifications, meaning that child HAZ does not decline at very high levels of maternal agricultural work. This is different from the effects of off-farm work, probably because childcare is easier to combine with on-farm work than with off-farm work further away from the homestead.

5.4. Robustness checks

In this subsection, we carry out a few robustness checks in order to see whether the results change when we use different model or variable specifications. In a first robustness check, we run the regressions with maternal hours spent in off-farm and on-farm activities but using the standard fixed effects estimator rather than the Mundlak approach. The results are very similar to those discussed above (see Table A6 in the Appendix).

In a second robustness check, we use the Mundlak approach but only consider children that were surveyed in at least two of the three survey rounds. That is, we exclude those that were only observed in one survey round. The motivation for this is to examine whether the results change when we exclude children for which no within variation over time is observed. The results are very similar to those with the full sample of children included (see Table A7 in the Appendix), underlining the robustness of the findings.

A last robustness check refers to the data used for the construction of the maternal employment variables. In the models discussed above, we used the number of hours worked in off-farm and on-farm activities during the 7 days prior to the survey. While the relatively short recall period used for these questions in the survey probably leads to quite precise response data, it does not account for seasonality that may be relevant for both agricultural and non-agricultural activities in rural areas. Other time allocation variables were not consistently measured over the three survey rounds. However, in the 2010 and 2012 survey rounds, the time spent in off-farm activities over a 12-months period was also captured. We use the data from these two survey rounds to run alternative regressions with the average weekly number of hours that the mother worked off-farm (average calculated over the 12-months period). Results are shown in Table A8 in the Appendix. The non-linear effects on child nutrition are very similar to those discussed above.

For agricultural production during the last 12 months, the survey captured labor inputs of different household members, which we used to calculate the total number of labor days spent by the mother in on-farm activities. Results are shown in Table A9 in the Appendix. In these models, maternal on-farm labor days have no significant effect on child nutrition, which is also consistent with the estimates above.

5.5. Dose-response model results

The estimation result of the dose-response regressions are shown in Table A10 in the Appendix. They are graphically represented in Figure 3. Panel A of Figure 3 illustrates the treatment effects of maternal off-farm employment on child HAZ at different levels of hours worked. The function clearly shows the non-linearity of the treatment effects that was already pointed out above. Low levels of hours worked off-farm have a negative average treatment effect on child HAZ. The effect increases with more hours worked and turns positive beyond about 38 hours of weekly off-farm work. Then the treatment effect reaches a maximum at 55 hours, after which it declines and turns negative again. Also consistent with the findings above, the treatment effects are somewhat stronger when confining the analysis to children 2 years and older (Figure A2 in the Appendix).

Panel B of Figure 3 illustrates the treatment effects of maternal on-farm work on child HAZ. While the average treatment effect is positive at low and moderate levels of on-farm work, and then turns negative at larger numbers of hours worked, the estimates are small in magnitude and not statistically significant.

6. Conclusions

We have analyzed the effects of maternal employment on child nutrition conceptually and empirically with panel data from rural Tanzania. Based on a theoretical model and a review of the literature on gender relations within traditional households we have shown that maternal employment can affect child nutrition through changes in (i) income, (ii) intra-household bargaining power, and (iii) time available for childcare.

The effects and the underlying mechanisms were evaluated empirically with panel regression models and the Mundlak estimator to control for time-invariant heterogeneity. We also tried to control for time-variant heterogeneity by including a broad set of covariates, including child, maternal, and household characteristics, as well as variations in local rainfall conditions. We have differentiated between maternal work in off-farm employment and in on-farm agricultural activities, as the effects on child nutrition may differ. Around 11 percent of the mothers with small children in rural Tanzania are involved in off-farm employment. Off-farm employment has a negative effect on child height-for-age z-scores (HAZ), when employment is represented as a dummy variable. However, the effect varies with the amount of time that the mother spends in off-farm activities. Maternal off-farm employment reduces child HAZ at low levels of labor supply. This suggests that – at low levels of labor supply – the negative partial effect from reducing the time for childcare is stronger than the positive partial effects from rising income and female bargaining power. The effect of maternal off-farm employment turns positive at higher levels of labor supply, and negative again at very high levels.

We do not find statistically significant effects of maternal on-farm work on child nutrition. While on-farm agricultural work of the mother can have a direct positive effect on food availability, it is probably associated with a smaller gain in female intra-household bargaining power than off-farm employment. Another difference between the two types of work is that on farm-agricultural activities are easier to combine with childcare than off-farm work that is typically located further away from the homestead. Hence, the negative partial time allocation effect likely plays a less relevant role for on-farm activities.

These findings have important policy implications, especially in rural Africa where the role of off-farm employment is increasing rapidly. Reducing child undernutrition and empowering women are both important goals on the sustainable development agenda. And empowering women is often related to improving female employment opportunities. Our results suggest that there can be tradeoffs between the child nutrition and women empowerment goals, because increased maternal off-farm employment can worsen child nutrition under specific circumstances. At the same time, our results also suggest that there can be positive synergies between maternal off-farm employment and child nutrition under different circumstances. Hence, understanding the non-linear effects and the role of the underlying mechanisms is important for the appropriate design of development interventions.

It should be stressed that the strength of the mechanisms underlying the effects of maternal employment on child nutrition can also evolve. For instance, improved female education and better access to lucrative employment opportunities can strengthen the positive income and intra-household bargaining mechanisms. Improving women's access to profitable self-employed activities that can be carried out at home or near the homestead could reduce tradeoffs between female cash income generation and time available for childcare. In the same vein, sharing responsibilities in household work and childcare between different family members can reduce the negative child nutrition effect of maternal time reallocation to off-farm work.

Our concrete empirical results are specific for rural Tanzania, but the general finding that maternal employment can have non-linear effects on child nutrition is probably also true more broadly. We acknowledge that the survey recall data on time allocation used for the empirical analysis may suffer from measurement error, even though the results were robust to using alternative measures. Follow-up research with more precise data – perhaps collected with digital time recording devices – in different geographical and cultural contexts could be useful to better understand the complex links between maternal employment and child nutrition.

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Table 1. Nutritional status of children in rural Tanzania

	All years		2008		2010		2012	
	HAZ	Stunted (%)	HAZ	Stunted (%)	HAZ	Stunted (%)	HAZ	Stunted (%)
All children (below 5 years)	-1.53 (0.02)	38.9	-1.79 (0.04)	45.3	-1.44 (0.04)	36.5	-1.47 (0.03)	37.7
By age group								
Below 2 years	-1.21	35.4	-1.70	43.9	-1.07	31.7	-1.10 (0	34.6
	(0.04)	(1.05)	(0.07)	(2.44)	(0 .06)	(1.69)	.06)	(1.58)
2-4 years	-1.76***	41.4***	-1.83	46.0	-1.72***	40.1***	-1.74***	39.8**
	(0.02)	(0.90)	(0.05)	(1.86)	(0.04)	(1.56)	(0.04)	(1.36)
By sex								
Female	-1.45	37.1	-1.71	43.6	-1.42	35.7	-1.35	34.7
	(0.03)	(1.00)	(0.06)	(2.06)	(0.05)	(1.63)	(0.05)	(1.43)
Male	-1.61***	40.8**	-1.87*	46.9	-1.46	37.2	-1.60***	40.6***
	(0.03)	(1.00)	(0.06)	(2.12)	(0.06)	(1.63)	(0.05)	1.48
By off-farm employment								
Mother worked off-farm	-1.69	44.8	-2.07	54.8	-1.56	38.6	-1.60	45.2
	(0.07)	(2.13)	(0.11)	(4.66)	(0.11)	(3.43)	(0.11)	(3.30)
Mother did not work off-farm	-1.51**	38.2***	-1.75**	44.2**	-1.42	36.2	-1.46	36.8**
	(0.02)	(0.72)	(0.05)	(1.55)	(0.04)	(1.22)	(0.04)	(1.08)
By on-farm work								
Mother worked on-farm	-1.60	41.1	-1.81	46.6 1.73	-1.51	38.94	-1.55	39.9
	(0.03)	(0.82)	(0.05)		(0.04)	(1.40)	(0.04)	(1.25)
Mother did not work on-farm	-1.38***	33.7***	-1.72	41.6	-1.28 ***	30.94***	-1.30***	32.3***
	(0.04)	(1.22)	(0.08)	(2.84)	(0.07)	(1.99)	(0.06)	(1.82)
By living standard								
First expenditure tercile	-1.74	44.9	-1.95	48.0	-1.66	43.5	-1.69	44.4
	(0.04)	(1.21)	(0.07)	(2.57)	(0.07)	(2.05)	(0.06)	(1.83)
Second expenditure tercile [a]	-1.54	39.1	-1.81	46.7	-1.48	38.5	-1.44	35.8
	(0.04)***	(1.18)***	(0.08)	(2.57)	(0.06)*	(2.01)*	(0.06)***	(1.76)***
Third expenditure tercile [a]	-1.32	32.7	-1.61	41.0	-1.18	27.4	-1.30	32.7
	(0.04)***	(1.14)***	(0.08)***	(2.53)*	(0.06)***	(1.85)***	(0.06)***	(1.73)***
Observations of children	5096		1136		1750		2210	

Notes: Standard errors are shown in parentheses. Tests for significant differences between mean values for children in different categories are carried out. [a] Second and third tercile mean values are both compared with first tercile mean. * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Table 2. Maternal employment and hours worked off-farm and on-farm

	All years	2008	2010	2012
Mother worked during last 7 days in				
Off-farm wage work (%)	10.9	10.8	11.9	10.1
On-farm agricultural work (%)	69.6	72.6	68.8	68.7
Average hours worked during last 7 days in				
Off-farm wage work	2.8 (10.2)	2.3 (8.6)	3.1 (11.1)	2.8 (10.3)
On-farm agricultural work	18.8 (17.9)	19.1 (17.3)	18.7 (18.1)	18.7 (18.1)
Observations of unique mothers	3598	806	1231	1561

Notes: Standard deviations are shown in parentheses.

Table 3. Effect of maternal employment on child HAZ (Mundlak regressions)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Mother worked off-farm (1/0)	-0.185**	-0.184**			-0.185**	-0.183**
	(0.092)	(0.093)			(0.093)	(0.093)
Mother worked on-farm (1/0)			0.018	0.021	0.012	0.015
			(0.063)	(0.063)	(0.063)	(0.063)
Child age (months)	-0.112***	-0.112***	-0.112***	-0.112***	-0.112***	-0.112***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Age squared	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female child (1/0)	0.243***	0.241***	0.244***	0.242***	0.243***	0.241***
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
No. of non-working female adults	-0.042	-0.042	-0.048	-0.046	-0.049	-0.047
	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)
Year 2010	0.296***	0.296***	0.293***	0.294***	0.293***	0.293***
	(0.049)	(0.049)	(0.049)	(0.049)	(0.049)	(0.049)
Year 2012	0.273***	0.274***	0.267***	0.271***	0.266***	0.269***
	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)
Total expenditure per adult equivalent (log)		0.054		0.057		0.055
		(0.056)		(0.057)		(0.057)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-9.819***	-14.235***	-9.732***	-13.858***	-9.735***	-13.861***
	(0.682)	(0.898)	(0.677)	(0.904)	(0.677)	(0.904)
Mundlak variables						
Mean of mother worked off-farm	0.193	0.181			0.189	0.179
	(0.130)	(0.128)			(0.130)	(0.128)
Mean of mother worked on-farm			-0.275***	-0.221**	-0.269***	-0.215**
			(0.094)	(0.094)	(0.094)	(0.094)
Mean no. of non-working female adults	0.129**	0.132**	0.102*	0.110*	0.103*	0.111*
	(0.058)	(0.057)	(0.060)	(0.058)	(0.060)	(0.058)
Mean of total expenditure		0.324***		0.295***		0.297***
		(0.079)		(0.079)		(0.079)
Observations	5,096	5,096	5,096	5,096	5,096	5,096
Number of groups	2,117	2,117	2,117	2,117	2,117	2,117
R-squared	0.16	0.18	0.17	0.18	0.17	0.18

Notes: Coefficient estimates are shown with cluster-corrected standard errors in parentheses. Expenditures deflated using the consumer price index. Only selected control and Mundlak variables shown for brevity. Full estimation results are shown in Table A2 in the Appendix. * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Table 4. Effect of maternal hours worked off-farm on child HAZ (Mundlak regressions)

	Model 1	Model 2	Model 3	Model 4
Mother worked off-farm (hours)	-0.004	-0.007	-0.036***	-0.034***
	(0.003)	(0.006)	(0.012)	(0.012)
Hours worked squared		5.8E-05	0.001***	0.001***
		(0.000)	(0.000)	(0.000)
Hours worked cubed			-1.2E-05***	-1.2E-05***
			(0.000)	(0.000)
Child age (months)	-0.112***	-0.112***	-0.112***	-0.112***
	(0.005)	(0.005)	(0.005)	(0.005)
Age squared	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Female child (1/0)	0.243***	0.243***	0.243***	0.242***
	(0.043)	(0.043)	(0.043)	(0.043)
Rainfall deviation (annual)	-0.209	-0.208	-0.195	-0.193
	(0.140)	(0.140)	(0.140)	(0.140)
Rainfall deviation squared	0.068	0.068	0.057	0.059
	(0.115)	(0.115)	(0.115)	(0.115)
No. of non-working female adults	-0.043	-0.043	-0.041	-0.042
	(0.045)	(0.045)	(0.045)	(0.045)
Year 2010	0.297***	0.296***	0.297***	0.297***
	(0.049)	(0.049)	(0.049)	(0.049)
Year 2012	0.274***	0.274***	0.270***	0.272***
	(0.054)	(0.054)	(0.054)	(0.054)
Total expenditure per adult equivalent				0.053
(log)				(0.056)
Other control variables	Yes	Yes	Yes	Yes
Constant	-9.828***	-9.824***	-9.770***	-14.106***
	(0.681)	(0.682)	(0.682)	(0.899)
Mundlak variables				
Mean of hours in off-farm	0.009**	0.009**	0.009**	0.008*
	(0.004)	(0.004)	(0.004)	(0.004)
Mean no. of non-working female adults	0.134**	0.134**	0.130**	0.133**
	(0.058)	(0.058)	(0.058)	(0.057)
Mean of rainfall deviation	-0.306	-0.305	-0.299	-0.223
	(0.227)	(0.227)	(0.227)	(0.226)
Mean of rainfall deviation squared	0.534**	0.533**	0.522*	0.467*
	(0.269)	(0.269)	(0.269)	(0.279)
Mean of total expenditure				0.319***
				(0.078)
Observations	5,096	5,096	5,096	5,096
Number of groups	2,117	2,117	2,117	2,117
R-squared	0.16	0.16	0.17	0.18

Notes: Coefficient estimates are shown with cluster-corrected standard errors in parentheses. Expenditures deflated using the consumer price index. Only selected control and Mundlak variables shown for brevity. Full estimation results are shown in Table A3 in the Appendix. * p<0.1; ** p<0.05; *** p<0.01

Table 5. Effect of maternal hours worked on-farm on child HAZ (Mundlak regressions)

	Model 1	Model 2	Model 3	Model 4	Model 5
Mother worked on-farm (hours)	0.001	-0.003	-0.002	-0.003	-0.002
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Hours worked on-farm squared		6.3E-05	5.2E-05	6.1E-05	5.0E-05
		(0.000)	(0.000)	(0.000)	(0.000)
Mother worked off-farm (hours)				-0.035***	-0.033***
				(0.012)	(0.012)
Hours worked off-farm squared				0.001***	0.001***
				(0.000)	(0.000)
Hours worked off-farm cubed				-1.2E-05***	-1.2E-05***
				(0.000)	(0.000)
Child age (months)	-0.112***	-0.112***	-0.112***	-0.112***	-0.112***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Age squared	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female child (1/0)	0.244***	0.244***	0.243***	0.244***	0.242***
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
No. of non-working female adults	-0.044	-0.047	-0.045	-0.046	-0.045
	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)
Year 2010	0.294***	0.292***	0.293***	0.293***	0.294***
	(0.050)	(0.050)	(0.049)	(0.050)	(0.049)
Year 2012	0.267***	0.266***	0.270***	0.262***	0.266***
	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)
Total expenditure per adult equivalent (log)			0.057		0.053
			(0.057)		(0.057)
Other control variables	Yes	Yes	Yes	Yes	Yes
Constant	-9.762***	-9.751***	-13.932***	-9.710***	-13.833***
	(0.677)	(0.677)	(0.902)	(0.678)	(0.903)
Mundlak variables					
Mean hours worked on-farm	-0.006***	-0.006**	-0.005*	-0.005**	-0.004*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Mean hours worked off-farm				0.008*	0.007*
				(0.004)	(0.004)
Mean no. of non-working female adults	0.114*	0.112*	0.119**	0.114*	0.120**
	(0.060)	(0.060)	(0.058)	(0.059)	(0.057)
Mean total expenditure			0.300***		0.299***
			(0.079)		(0.079)
Observations	5,096	5,096	5,096	5,096	5,096
Number of groups	2,117	2,117	2,117	2,117	2,117
R-squared	0.17	0.17	0.18	0.17	0.18

Notes: Coefficient estimates are shown with cluster-corrected standard errors in parentheses. Expenditures deflated using the consumer price index. Only selected control and Mundlak variables shown for brevity. Full estimation results are shown in Table A4 in the Appendix. * p<0.1; ** p<0.05; *** p<0.01.

Table 6. Effect of maternal hours worked on HAZ of children below and above 2 years of age

	Children below 2 years			Children 2-4 years		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Mother worked off-farm (hours)	-0.027		-0.027	-0.029**		-0.027**
	(0.023)		(0.023)	(0.012)		(0.012)
Hours off-farm squared	0.001		0.001	0.001***		0.001**
	(0.001)		(0.001)	(0.000)		(0.000)
Hours in off-farm cubed	-3.9E-06		-3.8E-06	-1.2E-05**		-1.1E-05**
	(0.000)		(0.000)	(0.000)		(0.000)
Mother worked on-farm (hours)		0.005	0.005		-0.003	-0.003
		(0.006)	(0.006)		(0.003)	(0.003)
Hours on-farm squared		-6.2E-05	-6.0E-05		9.6E-05*	9.1E-05
		(0.000)	(0.000)		(0.000)	(0.000)
Child age (months)	-0.166***	-0.167***	-0.167***	0.032**	0.033**	0.033**
	(0.024)	(0.023)	(0.023)	(0.015)	(0.015)	(0.015)
Age squared	0.002**	0.002**	0.002***	-1.6E-04	-1.8E-04	-1.7E-04
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	0.000)
Female child (1/0)	0.306***	0.307***	0.305***	0.153***	0.151***	0.152***
	(0.072)	(0.072)	(0.072)	(0.044)	(0.044)	(0.044)
No. of non-working female adults	-0.145*	-0.134	-0.139	0.033	0.028	0.030
	(0.087)	(0.088)	(0.088)	(0.040)	(0.040)	(0.040)
Total expenditure (log)	-0.045	-0.041	-0.045	0.133**	0.126**	0.128**
	(0.109)	(0.109)	(0.109)	(0.052)	(0.052)	(0.052)
Year 2010	0.542***	0.541***	0.541***	0.140**	0.133**	0.130**
	(0.092)	(0.093)	(0.093)	(0.057)	(0.057)	(0.057)
Year 2012	0.492***	0.486***	0.486***	0.113**	0.118**	0.116**
	(0.095)	(0.095)	(0.095)	(0.057)	(0.057)	(0.057)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-14.326***	-14.323***	-14.226***	-16.879***	-16.525***	-16.453***
	(1.306)	(1.307)	(1.316)	(1.046)	(1.045)	(1.045)
Mundlak variables						
Mean of hours off-farm	0.015*		0.015	0.003		0.002
	(0.009)		(0.009)	(0.004)		(0.004)
Mean of hours on-farm		-0.005	-0.004		-0.008***	-0.008***
		(0.004)	(0.004)		(0.002)	(0.002)
Mean no. of non-working females	0.135	0.118	0.128	0.103*	0.083	0.080
	(0.108)	(0.110)	(0.110)	(0.057)	(0.055)	(0.055)
Mean of total expenditure	0.479***	0.478***	0.471***	0.215**	0.179**	0.180**
	(0.135)	(0.135)	(0.136)	(0.084)	(0.085)	(0.084)
Observations	2,088	2,088	2,088	3,008	3,008	3,008
Number of groups	1,555	1,555	1,555	1,628	1,628	1,628
R-squared	0.23	0.23	0.23	0.15	0.16	0.16

Notes: Coefficient estimates are shown with cluster-corrected standard errors in parentheses. Expenditures deflated using the consumer price index. Only selected control and Mundlak variables shown for brevity. Full estimation results are shown in Table A5 in the Appendix. * p<0.1; ** p<0.05; *** p<0.01.

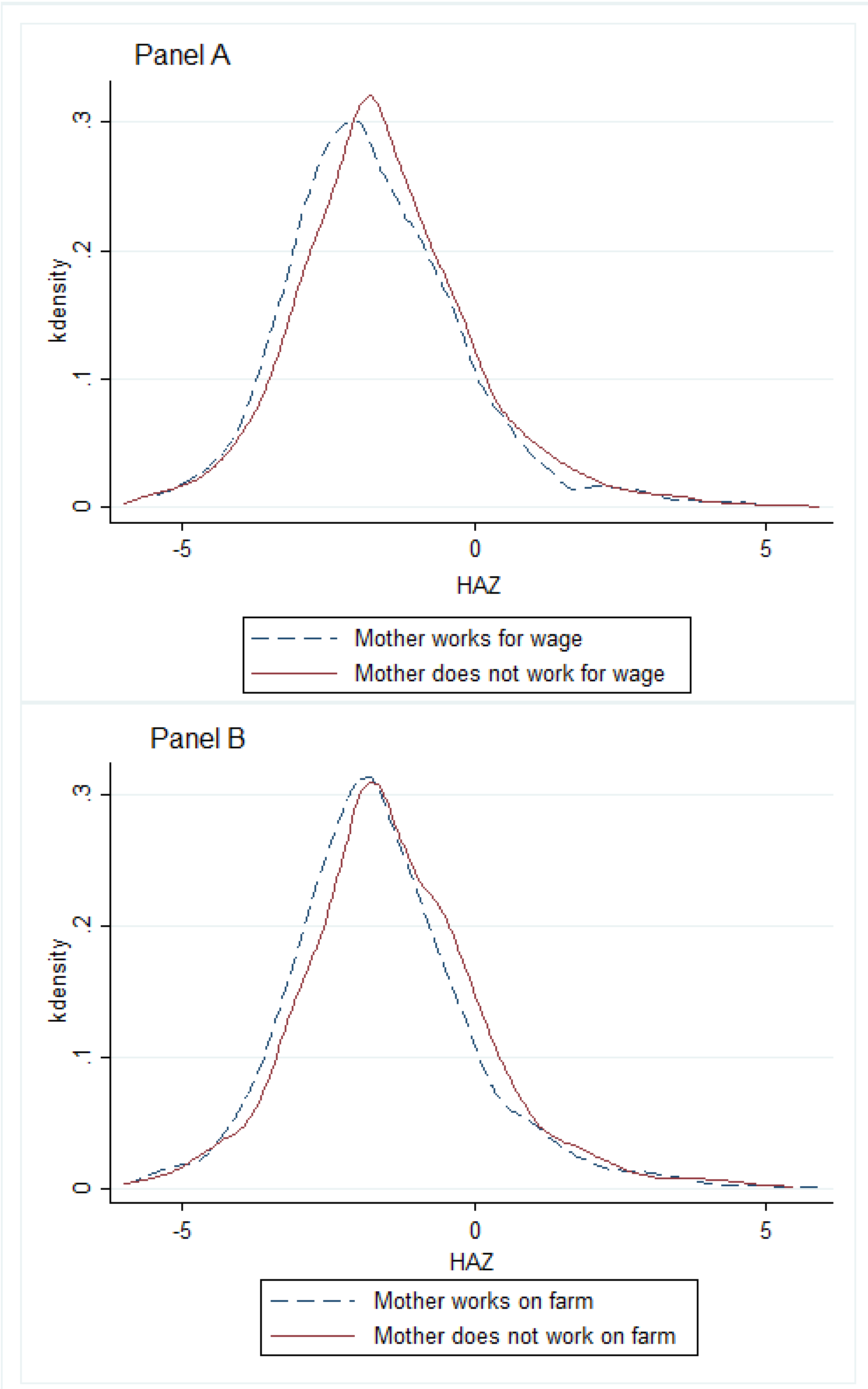

Figure 1. Kernel density of HAZ for children with working and non-working mothers. Panel A refers to mothers working off-farm. Panel B refers to mothers working on-farm.

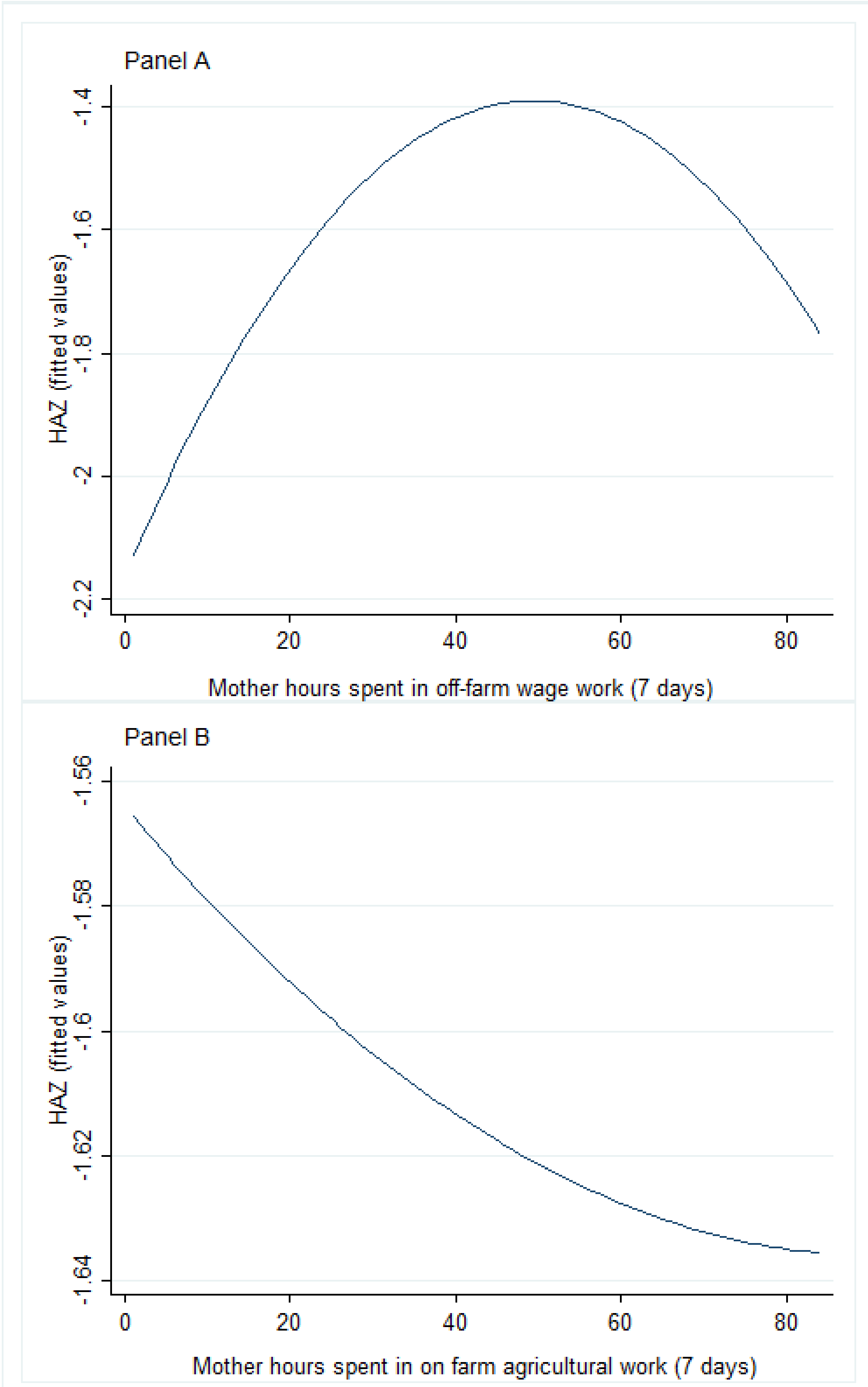

Figure 2. Relationship between the number of hours worked by the mother and child HAZ (quadratic fit). Panel A refers to mothers working off-farm. Panel B refers to mothers working on-farm. Both panels only include children with working mothers.

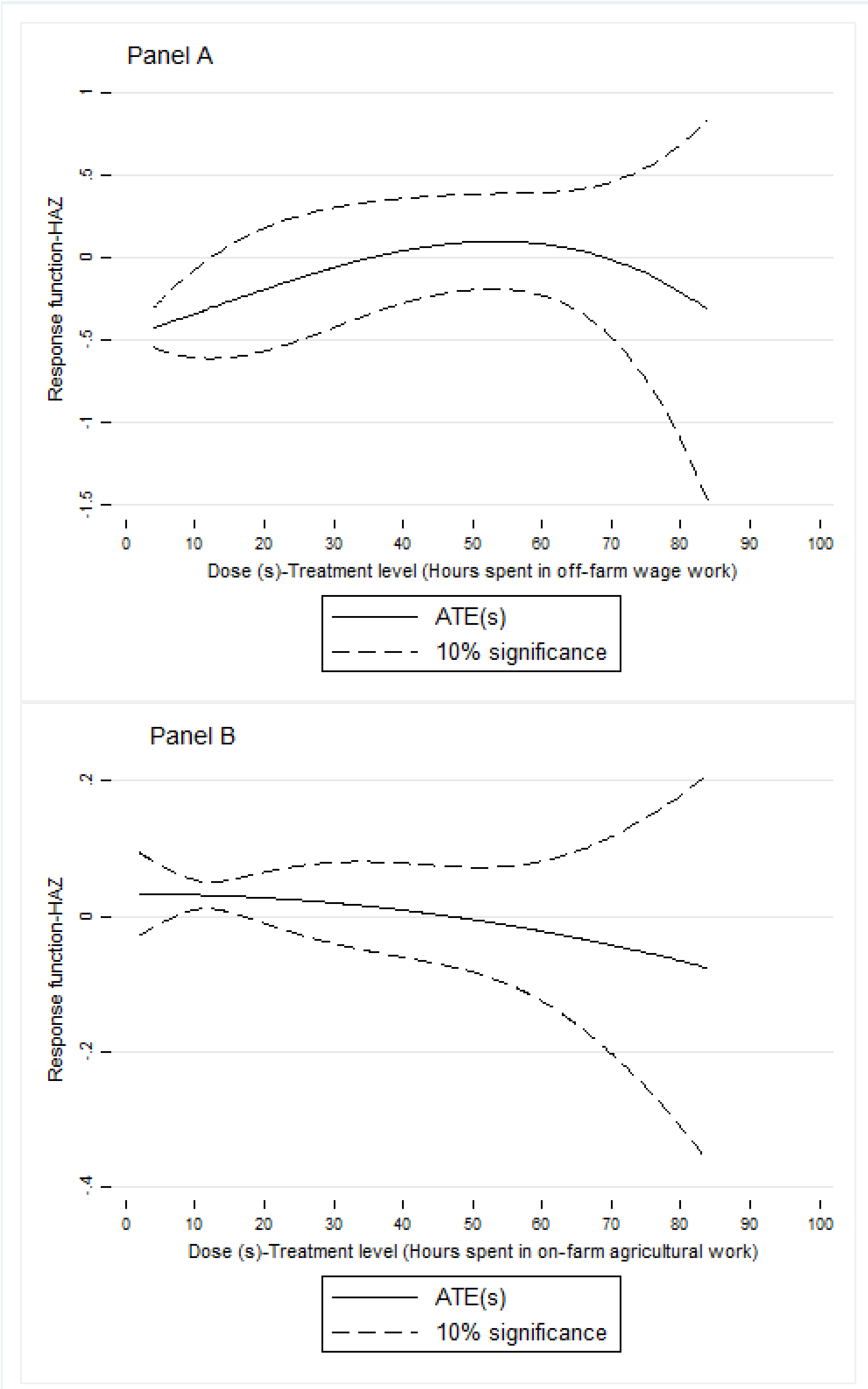

Figure 3. Dose-response functions for effects of maternal employment on child HAZ. Panel A shows effects of maternal off-farm work. Panel B shows effects of maternal on-farm work.

APPENDIX

Table A1. Kolmogorov-Smirnov test for equality of HAZ distributions by maternal work status

	D	*p*-value	Number of observations
Off-farm wage work			
Mother works off-farm	-0.085	0.001	535
Mother does not work off-farm	0.007	0.958	4561
Combined	0.085	0.002	
On-farm agricultural work			
Mother works on-farm	-0.078	0.000	3588
Mother does not work on-farm	0.004	0.968	1508
Combined	0.078	0.000	

Table A2. Effect of maternal employment on child HAZ (full result)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Mother worked off-farm	-0.185**	-0.184**			-0.185**	-0.183**
(1/0)	(0.092)	(0.093)			(0.093)	(0.093)
Mother worked on-farm			0.018	0.021	0.012	0.015
(1/0)			(0.063)	(0.063)	(0.063)	(0.063)
Child age (months)	-0.112***	-0.112***	-0.112***	-0.112***	-0.112***	-0.112***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Age squared	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female child (1/0)	0.243***	0.241***	0.244***	0.242***	0.243***	0.241***
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
Height of mother (cm)	0.014	0.014	0.014	0.014	0.014	0.014
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Educated mother (1/0)	-0.083	-0.085	-0.092	-0.093	-0.091	-0.092
	(0.092)	(0.092)	(0.093)	(0.092)	(0.093)	(0.093)
Female-headed	0.046	0.052	0.036	0.042	0.050	0.055
household (1/0)	(0.089)	(0.089)	(0.089)	(0.089)	(0.089)	(0.089)
Age of household head	-0.001	-4.9E-04	-2.6E-04	2.9E-05	-4.1E-04	-1.3E-04
(years)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Rainfall deviation	-0.205	-0.201	-0.206	-0.204	-0.198	-0.195
(annual)	(0.140)	(0.140)	(0.140)	(0.140)	(0.140)	(0.140)
Rainfall deviation	0.065	0.067	0.064	0.066	0.062	0.064
squared	(0.115)	(0.115)	(0.116)	(0.116)	(0.115)	(0.116)
No. of non-working	-0.042	-0.042	-0.048	-0.046	-0.049	-0.047
female adults	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)
Year 2010	0.296***	0.296***	0.293***	0.294***	0.293***	0.293***
	(0.049)	(0.049)	(0.049)	(0.049)	(0.049)	(0.049)
Year 2012	0.273***	0.274***	0.267***	0.271***	0.266***	0.269***
	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)
Total expenditure per		0.054		0.057		0.055
adult equivalent (log)		(0.056)		(0.057)		(0.057)
Mundlak variables						
Mean of mother worked	0.193	0.181			0.189	0.179
off-farm	(0.130)	(0.128)			(0.130)	(0.128)
Mean of mother worked			-0.275***	-0.221**	-0.269***	-0.215**
on-farm			(0.094)	(0.094)	(0.094)	(0.094)
Mean female-headed	-0.148	-0.121	-0.150	-0.124	-0.165	-0.137
household	(0.116)	(0.115)	(0.114)	(0.114)	(0.115)	(0.114)
Mean age of household	0.001	0.003	0.002	0.003	0.002	0.003
head	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Mean no. of non-working	0.129**	0.132**	0.102*	0.110*	0.103*	0.111*
female adults	(0.058)	(0.057)	(0.060)	(0.058)	(0.060)	(0.058)
Mean of maternal height	0.045***	0.042***	0.045***	0.042***	0.045***	0.042***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Mean educated mother	0.129	0.051	0.123	0.052	0.122	0.051
	(0.111)	(0.111)	(0.112)	(0.112)	(0.112)	(0.112)
Mean of rainfall deviation	-0.302	-0.224	-0.258	-0.196	-0.267	-0.204
	(0.228)	(0.228)	(0.227)	(0.227)	(0.228)	(0.228)
Mean of rainfall deviation	0.536**	0.479*	0.578**	0.516*	0.579**	0.516*
squared	(0.271)	(0.282)	(0.272)	(0.284)	(0.271)	(0.282)
Mean of total expenditure		0.324***		0.295***		0.297***
		(0.079)		(0.079)		(0.079)
Constant	-9.819***	-14.235***	-9.732***	-13.858***	-9.735***	-13.861***
	(0.682)	(0.898)	(0.677)	(0.904)	(0.677)	(0.904)
Observations.	5,096	5,096	5,096	5,096	5,096	5,096
R-squared	0.16	0.18	0.17	0.18	0.17	0.18

Notes: Coefficient estimates are shown with cluster-corrected standard errors in parentheses. Expenditures deflated using the consumer price index. * p<0.1; ** p<0.05; *** p<0.01

Table A3. Effect of maternal hours worked off-farm on child HAZ (full results)

	Model 1	Model 2	Model 3	Model 4
Mother worked off-farm (hours)	-0.004	-0.007	-0.036***	-0.034***
	(0.003)	(0.006)	(0.012)	(0.012)
Hours worked squared		5.8E-05	0.001***	0.001***
		(0.000)	(0.000)	(0.000)
Hours worked cubed			-1.2E-05***	-1.2E-05***
			(0.000)	(0.000)
Child age (months)	-0.112***	-0.112***	-0.112***	-0.112***
	(0.005)	(0.005)	(0.005)	(0.005)
Age squared	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Female child (1/0)	0.243***	0.243***	0.243***	0.242***
	(0.043)	(0.043)	(0.043)	(0.043)
Height of mother (cm)	0.014	0.014	0.014	0.014
	(0.010)	(0.010)	(0.010)	(0.010)
Educated mother (1/0)	-0.083	-0.082	-0.080	-0.083
	(0.092)	(0.092)	(0.093)	(0.093)
Female-headed household	0.040	0.040	0.053	0.058
	(0.089)	(0.089)	(0.088)	(0.088)
Age of household head (years)	-0.001	-0.001	-0.001	-3.1E-04
	(0.004)	(0.004)	(0.004)	(0.004)
Rainfall deviation (annual)	-0.209	-0.208	-0.195	-0.193
	(0.140)	(0.140)	(0.140)	(0.140)
Rainfall deviation squared	0.068	0.068	0.057	0.059
	(0.115)	(0.115)	(0.115)	(0.115)
No. of non-working female adults	-0.043	-0.043	-0.041	-0.042
	(0.045)	(0.045)	(0.045)	(0.045)
Year 2010	0.297***	0.296***	0.297***	0.297***
	(0.049)	(0.049)	(0.049)	(0.049)
Year 2012	0.274***	0.274***	0.270***	0.272***
	(0.054)	(0.054)	(0.054)	(0.054)
Total expenditure per adult equivalent (log)				0.053
				(0.056)
Mundlak variables				
Mean of hours in off-farm	0.009**	0.009**	0.009**	0.008*
	(0.004)	(0.004)	(0.004)	(0.004)
Mean female-headed household	-0.152	-0.151	-0.154	-0.127
	(0.115)	(0.116)	(0.115)	(0.114)
Mean age of household head	0.001	0.001	0.001	0.002
	(0.004)	(0.004)	(0.004)	(0.004)
Mean of maternal height	0.045***	0.045***	0.045***	0.042***
	(0.011)	(0.011)	(0.011)	(0.011)
Mean educated mother	0.129	0.128	0.123	0.046
	(0.111)	(0.112)	(0.112)	(0.111)
Mean no. of non-working female adults	0.134**	0.134**	0.130**	0.133**
	(0.058)	(0.058)	(0.058)	(0.057)
Mean of rainfall deviation	-0.306	-0.305	-0.299	-0.223
	(0.227)	(0.227)	(0.227)	(0.226)
Mean of rainfall deviation square	0.534**	0.533**	0.522*	0.467*
	(0.269)	(0.269)	(0.269)	(0.279)
Mean of total expenditure				0.319***
				(0.078)
Constant	-9.828***	-9.824***	-9.770***	-14.106***
	(0.681)	(0.682)	(0.682)	(0.899)
Observations	5,096	5,096	5,096	5,096

Notes: Coefficient estimates are shown with cluster-corrected standard errors in parentheses. Expenditures deflated using the consumer price index. * p<0.1; ** p<0.05; *** p<0.01

Table A4. Effect of maternal hours worked on-farm on child HAZ (full results)

	Model 1	Model 2	Model 3	Model 4	Model 5
Mother worked on-farm (hours)	0.001	-0.003	-0.002	-0.003	-0.002
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Hours worked on-farm squared		6.3E-05	5.2E-05	6.1E-05	5.0E-05
		(0.000)	(0.000)	(0.000)	(0.000)
Mother worked off-farm (hours)				-0.035***	-0.033***
				(0.012)	(0.012)
Hours worked off-farm squared				0.001***	0.001***
				(0.000)	(0.000)
Hours worked off-farm cubed				-1.2E-05***	-1.2E-05***
				(0.000)	(0.000)
Child age (months)	-0.112***	-0.112***	-0.112***	-0.112***	-0.112***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Age squared	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female child (1/0)	0.244***	0.244***	0.243***	0.244***	0.242***
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
Height of mother (cm)	0.015	0.014	0.014	0.014	0.014
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Educated mother (1/0)	-0.084	-0.086	-0.087	-0.082	-0.084
	(0.092)	(0.093)	(0.092)	(0.093)	(0.093)
Female-headed household	0.032	0.030	0.037	0.052	0.057
	(0.089)	(0.090)	(0.089)	(0.089)	(0.088)
Age of household head (years)	-0.001	-2.9E-04	-1.3E-07	-2.7E-04	8.5E-06
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Rainfall deviation (annual)	-0.207	-0.211	-0.208	-0.194	-0.192
	(0.140)	(0.140)	(0.140)	(0.140)	(0.140)
Rainfall deviation squared	0.063	0.064	0.066	0.055	0.057
	(0.116)	(0.115)	(0.115)	(0.115)	(0.115)
No. of non-working female adults	-0.044	-0.047	-0.045	-0.046	-0.045
	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)
Year 2010	0.294***	0.292***	0.293***	0.293***	0.294***
	(0.050)	(0.050)	(0.049)	(0.050)	(0.049)
Year 2012	0.267***	0.266***	0.270***	0.262***	0.266***
	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)
Total expenditure per adult equivalent (log)[1]			0.057		0.053
			(0.057)		(0.057)
Mundlak variables					
Mean of hours in on-farm	-0.006***	-0.006**	-0.005*	-0.005**	-0.004*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Mean of hours in off-farm				0.008*	0.007*
				(0.004)	(0.004)
Mean female-headed household	-0.143	-0.143	-0.117	-0.163	-0.136
	(0.115)	(0.115)	(0.114)	(0.115)	(0.114)
Mean age of household head	0.002	0.002	0.003	0.002	0.003
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Mean no. of non-working female adults	0.114*	0.112*	0.119**	0.114*	0.120**
	(0.060)	(0.060)	(0.058)	(0.059)	(0.057)
Mean of maternal height	0.045***	0.045***	0.042***	0.045***	0.042***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Mean educated mother	0.117	0.118	0.047	0.112	0.042
	(0.112)	(0.112)	(0.112)	(0.112)	(0.112)
Mean of rainfall deviation	-0.258	-0.249	-0.188	-0.257	-0.195
	(0.226)	(0.226)	(0.226)	(0.226)	(0.226)
Mean of rainfall deviation square	0.515*	0.527**	0.476*	0.515*	0.466*
	(0.268)	(0.268)	(0.280)	(0.266)	(0.276)
Mean of consumption expenditure			0.300***		0.299***
			(0.079)		(0.079)
Constant	-9.762***	-9.751***	-13.932***	-9.710***	-13.833***
	(0.677)	(0.677)	(0.902)	(0.678)	(0.903)
Observations	5,096	5,096	5,096	5,096	5,096

Notes: Coefficient estimates are shown with cluster-corrected standard errors in parentheses. * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Table A5. Effect of maternal hours worked on HAZ of children below and above 2 years (full results)

	Children below 2 years			Children 2-4 years		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Mother worked off-farm (hours)	-0.027		-0.027	-0.029**		-0.027**
	(0.023)		(0.023)	(0.012)		(0.012)
Hours off-farm squared	0.001		0.001	0.001***		0.001**
	(0.001)		(0.001)	(0.000)		(0.000)
Hours off-farm cubed	-3.9E-06		-3.8E-06	-1.2E-05**		-1.1E-05**
	(0.000)		(0.000)	(0.000)		(0.000)
Mother worked on-farm (hours)		0.005	0.005		-0.003	-0.003
		(0.006)	(0.006)		(0.003)	(0.003)
Hours on-farm squared		-6.2E-05	-6.0E-05		9.6E-05*	9.1E-05
		(0.000)	(0.000)		(0.000)	(0.000)
Child age (months)	-0.166***	-0.167***	-0.167***	0.032**	0.033**	0.033**
	(0.024)	(0.023)	(0.023)	(0.015)	(0.015)	(0.015)
Age squared	0.002**	0.002**	0.002***	-1.6E-04	-1.8E-04	-1.7E-04
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	0.000)
Female child (1/0)	0.306***	0.307***	0.305***	0.153***	0.151***	0.152***
	(0.072)	(0.072)	(0.072)	(0.044)	(0.044)	(0.044)
Height of mother (cm)	0.028	0.027	0.029	0.016*	0.017**	0.016*
	(0.045)	(0.045)	(0.045)	(0.008)	(0.008)	(0.008)
Educated mother (1/0)	-0.079	-0.083	-0.077	-0.045	-0.050	-0.047
	(0.144)	(0.143)	(0.144)	(0.092)	(0.093)	(0.093)
Female-headed household	0.274	0.257	0.277	-0.158	-0.186*	-0.170*
	(0.174)	(0.175)	(0.175)	(0.098)	(0.098)	(0.099)
Age of household head (years)	0.005	0.005	0.005	-0.002	-0.002	-0.002
	(0.006)	(0.007)	(0.007)	(0.004)	(0.004)	(0.004)
Rainfall deviation (annual)	-0.087	-0.094	-0.079	-0.295**	-0.308**	-0.290**
	(0.305)	(0.305)	(0.305)	(0.137)	(0.136)	(0.136)
Rainfall deviation squared	0.329	0.292	0.309	0.043	0.050	0.042
	(0.447)	(0.442)	(0.447)	(0.161)	(0.160)	(0.160)
No. of non-working female adults	-0.145*	-0.134	-0.139	0.033	0.028	0.030
	(0.087)	(0.088)	(0.088)	(0.040)	(0.040)	(0.040)
Total expenditure (log)	-0.045	-0.041	-0.045	0.133**	0.126**	0.128**
	(0.109)	(0.109)	(0.109)	(0.052)	(0.052)	(0.052)
Year 2010	0.542***	0.541***	0.541***	0.140**	0.133**	0.130**
	(0.092)	(0.093)	(0.093)	(0.057)	(0.057)	(0.057)
Year 2012	0.492***	0.486***	0.486***	0.113**	0.118**	0.116**
	(0.095)	(0.095)	(0.095)	(0.057)	(0.057)	(0.057)
Mundlak variables						
Mean of hours off-farm	0.015*		0.015	0.003		0.002
	(0.009)		(0.009)	(0.004)		(0.004)
Mean of hours on-farm		-0.005	-0.004		-0.008***	-0.008***
		(0.004)	(0.004)		(0.002)	(0.002)
Mean female-headed household	-0.365*	-0.333	-0.371*	0.116	0.119	0.112
	(0.203)	(0.202)	(0.204)	(0.130)	(0.129)	(0.129)
Mean age of household head	-0.002	-0.001	-0.001	0.005	0.005	0.005
	(0.007)	(0.007)	(0.007)	(0.004)	(0.004)	(0.004)
Mean no. of non-working females	0.135	0.118	0.128	0.103*	0.083	0.080
	(0.108)	(0.110)	(0.110)	(0.057)	(0.055)	(0.055)
Mean of maternal height	0.026	0.027	0.025	0.045***	0.045***	0.045***
	(0.045)	(0.046)	(0.046)	(0.010)	(0.010)	(0.010)
Mean educated mother	-0.087	-0.091	-0.094	0.078	0.081	0.075
	(0.167)	(0.167)	(0.168)	(0.115)	(0.116)	(0.116)
Mean of rainfall deviation	-0.153	-0.149	-0.153	-0.260	-0.216	-0.217
	(0.444)	(0.444)	(0.445)	(0.225)	(0.224)	(0.224)
Mean of rainfall deviation square	0.093	0.085	0.083	0.652**	0.656**	0.649**
	(0.494)	(0.491)	(0.490)	(0.259)	(0.261)	(0.261)
Mean Total expenditure	0.479***	0.478***	0.471***	0.215**	0.179**	0.180**
	(0.135)	(0.135)	(0.136)	(0.084)	(0.085)	(0.084)
Constant	-14.326***	-14.323***	-14.226***	-16.879***	-16.525***	-16.453***
	(1.306)	(1.307)	(1.316)	(1.046)	(1.045)	(1.045)
Observations	2,088	2,088	2,088	3,008	3,008	3,008

Notes: Coefficient estimates are shown with cluster-corrected standard errors in parentheses. * p<0.1; ** p<0.05; *** p<0.01.

Table A6. Effect of maternal hours worked on child HAZ (fixed effects estimates)

	Model 1	Model 2	Model 3	Model 4	Model 5
Mother worked off-farm	-0.034**	-0.034**			-0.033**
(hours)	(0.015)	(0.015)			(0.015)
Hours off-farm squared	0.001**	0.001**			0.001**
	(0.001)	(0.001)			(0.001)
Hours off-farm cubed	-1.1E-05**	-1.1E-05**			-1.1E-05**
	(0.000)	(0.000)			(0.000)
Mother worked on-farm			1.0E-04	1.3E-04	-2.2E-04
(hours)			(0.004)	(0.004)	(0.004)
Hours on-farm squared			1.4E-05	1.4E-05	-2.2E-04
			(0.000)	(0.000)	(0.000)
Child age (months)	-0.111***	-0.111***	-0.111***	-0.111***	-0.111***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Age squared	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female child (1/0)	0.299***	0.298***	0.298***	0.298***	0.298***
	(0.057)	(0.057)	(0.057)	(0.057)	(0.057)
Height of mother (cm)	0.012	0.012	0.013	0.013	0.013
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Educated mother (1/0)	-0.084	-0.084	-0.086	-0.087	-0.083
	(0.148)	(0.148)	(0.147)	(0.147)	(0.148)
Female-headed household	0.020	0.023	-0.015	-0.012	0.022
(1/0)	(0.106)	(0.106)	(0.107)	(0.108)	(0.106)
Age of household head	-0.008*	-0.008*	-0.008*	-0.008*	-0.008*
(years)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Rainfall deviation (annual)	-0.165	-0.164	-0.182	-0.181	-0.164
	(0.146)	(0.146)	(0.147)	(0.147)	(0.146)
Rainfall deviation squared	0.078	0.080	0.087	0.089	0.080
	(0.113)	(0.113)	(0.114)	(0.114)	(0.114)
Year 2010	0.300***	0.303***	0.298***	0.301***	-0.010
	(0.055)	(0.055)	(0.055)	(0.055)	(0.045)
Year 2012	0.283***	0.287***	0.285***	0.290***	0.303***
	(0.067)	(0.067)	(0.068)	(0.068)	(0.055)
No. of non-working female	-0.012	-0.012	-0.010	-0.010	0.286***
adults	(0.044)	(0.044)	(0.045)	(0.045)	(0.068)
Total expenditure per		0.037		0.041	0.037
adult equivalent (log)		(0.059)		(0.059)	(0.059)
Constant	-2.063	-2.531	-2.202	-2.729	-2.578
	(1.540)	(1.705)	(1.544)	(1.713)	(1.714)
Observations	5,096	5,096	5,096	5,096	5,096
Number of groups	2,117	2,117	2,117	2,117	2,117
R-squared	0.10	0.10	0.10	0.10	0.10

Notes: Coefficient estimates are shown with cluster-corrected standard errors in parentheses. Expenditures deflated using the consumer price index. * p<0.1; ** p<0.05; *** p<0.01

Table A7. Effect of maternal hours worked on child HAZ (excluding children only observed once)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Mother worked off-farm	-0.031**	-0.029**			-0.029**	-0.027*
(hours)	(0.014)	(0.014)			(0.014)	(0.014)
Hours off-farm squared	0.001**	0.001**			0.001**	0.001**
	(0.001)	(0.001)			(0.001)	(0.001)
Hours off-farm cubed	-1.2E-05**	-1.2E-05**			-1.2E-05**	-1.1E-05**
	(0.000)	(0.000)			(0.000)	(0.000)
Mother worked on-farm			0.001	0.001	-4.2E-05	7.7E-05
(hours)			(0.004)	(0.004)	(0.004)	(0.004)
Hours on-farm squared			2.6E-05	2.5E-05	3.5E-05	3.3E-05
			(0.000)	(0.000)	(0.000)	(0.000)
Child age (months)	-0.100***	-0.100***	-0.101***	-0.101***	-0.101***	-0.100***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Age squared	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female child (1/0)	0.221***	0.216***	0.223***	0.217***	0.220***	0.214***
	(0.064)	(0.063)	(0.064)	(0.063)	(0.064)	(0.063)
Height of mother (cm)	0.010	0.010	0.011	0.011	0.011	0.011
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Educated mother (1/0)	-0.060	-0.056	-0.065	-0.061	-0.063	-0.058
	(0.132)	(0.131)	(0.130)	(0.130)	(0.132)	(0.132)
Female-headed	-0.052	-0.050	-0.099	-0.096	-0.058	-0.056
household (1/0)	(0.100)	(0.100)	(0.103)	(0.103)	(0.101)	(0.101)
Age of household head	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
(years)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Rainfall deviation	-0.388***	-0.387***	-0.413***	-0.410***	-0.391***	-0.390***
(annual)	(0.148)	(0.148)	(0.148)	(0.147)	(0.148)	(0.147)
Rainfall deviation	0.243**	0.245**	0.254**	0.255**	0.243**	0.244**
squared	(0.113)	(0.113)	(0.114)	(0.114)	(0.113)	(0.113)
No. of non-working	-0.026	-0.027	-0.017	-0.018	-0.019	-0.020
female adults	(0.044)	(0.044)	(0.045)	(0.045)	(0.045)	(0.045)
Year 2010	0.458***	0.460***	0.455***	0.457***	0.459***	0.462***
	(0.071)	(0.071)	(0.072)	(0.071)	(0.072)	(0.071)
Year 2012	0.518***	0.519***	0.521***	0.522***	0.519***	0.519***
	(0.100)	(0.100)	(0.100)	(0.100)	(0.100)	(0.100)
Total expenditure (log)		0.047		0.055		0.051
		(0.060)		(0.061)		(0.061)
Mundlak variables						
Mean of hours off-farm	0.005	0.003			0.003	0.002
	(0.005)	(0.005)			(0.005)	(0.005)
Mean of hours on-farm			-0.008***	-0.008***	-0.008***	-0.007**
			(0.003)	(0.003)	(0.003)	(0.003)
Mean female-headed	-0.0004	0.036	0.026	0.057	-0.004	0.031
household	(0.145)	(0.144)	(0.146)	(0.146)	(0.144)	(0.144)
Mean age of household	0.005	0.006	0.005	0.006	0.005	0.006
head	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Mean no. of non-	0.079	0.088	0.062	0.072	0.058	0.067
working female adults	(0.066)	(0.067)	(0.063)	(0.063)	(0.063)	(0.063)
Mean of maternal height	0.051***	0.048***	0.051***	0.048***	0.051***	0.048***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Mean educated mother	0.036	-0.016	0.047	-0.002	0.037	-0.013
	(0.154)	(0.153)	(0.155)	(0.154)	(0.155)	(0.154)
Mean of rainfall	-0.071	-0.010	-0.015	0.038	-0.021	0.032
deviation	(0.294)	(0.292)	(0.294)	(0.291)	(0.294)	(0.291)
Mean of rainfall	0.216	0.158	0.198	0.144	0.193	0.141
deviation square	(0.225)	(0.230)	(0.222)	(0.228)	(0.222)	0.228)
Mean of total		0.283***		0.261***		0.266***
expenditure		(0.099)		(0.100)		(0.099)
Constant	-10.410***	-14.155***	-10.374***	-13.967***	-10.364***	-13.964***
	(0.975)	(1.266)	(0.971)	(1.255)	(0.972)	(1.261)
Observations	2,650	2,650	2,650	2,650	2,650	2,650
Number of groups	944	944	944	944	944	944
R-squared	0.15	0.16	0.16	0.17	0.16	0.17

Notes: Coefficient estimates are shown with cluster-corrected standard errors in parentheses. Expenditures deflated using the consumer price index. * p<0.1; ** p<0.05; *** p<0.01

Table A8. Robustness check using mother's average weekly hours spent in off-farm work

	Model 1	Model 2	Model 3	Model 4	Model 5
Mother worked off-farm (average	-0.002	-0.007	-0.029***	-0.026**	
weekly hours during last year)	(0.002)	(0.005)	(0.010)	(0.011)	
Average weekly hours off-farm		7.9E-05	0.001***	0.001**	
squared		(0.000)	(0.000)	(0.000)	
Average weekly hours off-farm			-9.6E-06***	-8.7E-06**	
cubed			(0.000)	(0.000)	
Mother worked off-farm last year					-0.106
(1/0)					(0.094)
Child age (months)	-0.124***	-0.124***	-0.123***	-0.124***	-0.124***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Age squared	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female child	0.241***	0.241***	0.241***	0.238***	0.238***
	(0.048)	(0.048)	(0.048)	(0.048)	(0.048)
Height of mother (cm)	0.002	0.002	0.001	1.3E-04	0.001
	(0.010)	(0.010)	(0.011)	(0.011)	(0.011)
Educated mother (1/0)	-0.058	-0.054	-0.052	-0.055	-0.058
	(0.096)	(0.096)	(0.097)	(0.097)	(0.097)
Female-headed household (1/0)	0.163	0.167	0.180*	0.196*	0.191*
	(0.103)	(0.103)	(0.104)	(0.104)	(0.103)
Age of household head (years)	0.001	0.001	0.001	0.002	0.002
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Rainfall deviation (annual)	-0.361**	-0.362**	-0.360**	-0.359**	-0.360**
	(0.182)	(0.182)	(0.182)	(0.181)	(0.181)
Rainfall deviation squared	0.190	0.193	0.187	0.187	0.191
	(0.132)	(0.132)	(0.132)	(0.132)	(0.132)
No. of non-working female adults	-0.032	-0.033	-0.029	-0.029	-0.031
	(0.054)	(0.054)	(0.055)	(0.055)	(0.055)
Year 2012	-0.002	3.8E-04	-0.002	2.0E-04	0.003
	(0.043)	(0.044)	(0.043)	(0.043)	(0.043)
Total expenditure per adult				0.097	0.101
equivalent (log)				(0.067)	(0.067)
Mundlak variables					
Mean of average weekly hours	0.005	0.005	0.005	0.005	
	(0.003)	(0.003)	(0.003)	(0.003)	
Mean of mother worked off-farm					0.085
last year					(0.123)
Mean female-headed household	-0.256**	-0.260**	-0.263**	-0.242*	-0.232*
	(0.131)	(0.130)	(0.131)	(0.130)	(0.130)
Mean age of household head	-0.002	-0.002	-0.001	-2.8E-04	-0.001
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Mean no. of non-working female	0.120*	0.120*	0.110*	0.115*	0.117*
adults	(0.066)	(0.066)	(0.066)	(0.065)	(0.065)
Mean of maternal height	0.057***	0.057***	0.058***	0.056***	0.055***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Mean educated mother	0.093	0.089	0.086	0.016	0.019
	(0.116)	(0.116)	(0.116)	(0.116)	(0.116)
Mean of rainfall deviation	0.018	0.030	0.035	0.090	0.092
	(0.289)	(0.290)	(0.289)	(0.287)	(0.288)
Mean of rainfall deviation square	0.066	0.056	0.040	0.015	0.023
	(0.248)	(0.248)	(0.248)	(0.251)	(0.253)
Mean of consumption expenditure				0.246***	0.248***
				(0.086)	(0.086)
Constant	-9.270***	-9.251***	-9.240***	-13.269***	-13.328***
	(0.747)	(0.748)	(0.745)	(0.956)	(0.958)
Observations	3,957	3,957	3,957	3,957	3,957
Number of groups	1,934	1,934	1,934	1,934	1,934
R-squared	0.18	0.18	0.18	0.19	0.19

Notes: Coefficient estimates are shown with cluster-corrected standard errors in parentheses. Only 2010 and 2012 survey rounds used. Expenditures deflated using the consumer price index. * p<0.1; ** p<0.05; *** p<0.01

Table A9. Robustness check using mother's annual labor days spent in on-farm work

	Model 1	Model 2	Model 3	Model 4
Mother worked on-farm (labor days in agriculture	-3.2E-04	-0.001	-0.001	
during last year) [a]	(0.001)	(0.001)	(0.001)	
Labor days on-farm squared		2.7E-06	9.6E-07	
		(0.000)	(0.000)	
Mother worked on-farm (1/0)				-0.108
				(0.099)
Child age (months)	-0.113***	-0.113***	-0.113***	-0.112***
	(0.005)	(0.005)	(0.005)	(0.005)
Age squared	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Female child (1/0)	0.256***	0.256***	0.253***	0.253***
	(0.043)	(0.043)	(0.043)	(0.043)
Height of mother (cm)	0.016	0.016*	0.016	0.016*
	(0.010)	(0.010)	(0.010)	(0.010)
Educated mother (1/0)	-0.106	-0.108	-0.109	-0.108
	(0.093)	(0.093)	(0.093)	(0.093)
Female-headed household	0.013	0.009	0.019	0.015
	(0.093)	(0.093)	(0.093)	(0.092)
Age of household head (years)	0.001	0.001	0.001	0.001
	(0.004)	(0.004)	(0.004)	(0.004)
Rainfall deviation (annual)	-0.204	-0.203	-0.197	-0.193
	(0.142)	(0.142)	(0.142)	(0.142)
Rainfall deviation squared	0.077	0.075	0.076	0.073
	(0.114)	(0.115)	(0.115)	(0.115)
No. of non-working female adults	-0.020	-0.021	-0.020	-0.020
	(0.050)	(0.050)	(0.050)	(0.050)
Year 2010	0.279***	0.278***	0.284***	0.280***
	(0.051)	(0.051)	(0.051)	(0.051)
Year 2012	0.276***	0.274***	0.279***	0.270***
	(0.055)	(0.055)	(0.054)	(0.055)
Total expenditure per adult equivalent (log)			0.070	0.066
			(0.058)	(0.059)
Mundlak variables				
Mean of labor days on-farm	-0.001	-0.001	-2.8E-04	
	(0.001)	(0.001)	(0.001)	
Mean of dummy for mother worked on-farm				-0.027
				(0.128)
Mean female-headed household	-0.125	-0.124	-0.101	-0.093
	(0.119)	(0.119)	(0.119)	(0.118)
Mean age of household head	2.9E-04	2.2E-04	0.001	0.001
	(0.004)	(0.004)	(0.004)	(0.004)
Mean of rainfall deviation	-0.226	-0.225	-0.173	-0.166
	(0.229)	(0.229)	(0.229)	(0.229)
Mean of rainfall deviation square	0.487*	0.485*	0.438	0.449
	(0.265)	(0.266)	(0.276)	(0.275)
Mean no. of non-working female adults	0.097	0.097	0.105	0.101
	(0.073)	(0.073)	(0.072)	(0.071)
Mean of maternal height	0.043***	0.043***	0.040***	0.040***
	(0.011)	(0.011)	(0.011)	(0.011)
Mean educated mother	0.123	0.122	0.058	0.053
	(0.113)	(0.113)	(0.114)	(0.114)
Mean of consumption expenditure			0.276***	0.271***
			(0.082)	(0.081)
Constant	-9.789***	-9.765***	-13.813***	-13.656***
	(0.691)	(0.693)	(0.926)	(0.934)
Observations	4,935	4,935	4,935	4,935
Number of groups	2,055	2,055	2,055	2,055
R-squared	0.17	0.17	0.18	0.18

Notes: Coefficient estimates are shown with cluster-corrected standard errors in parentheses. Expenditures deflated using the consumer price index. [a] Labor days are total days spent by the mother for harvesting, weeding, and land preparation * p<0.1; ** p<0.05; *** p<0.01

Table A10. Dose-response model regression results

	Model 1	Model 2
Mother worked off-farm (1/0)	-0.447**	
	(0.194)	
Mother worked on-farm (1/0)		0.023
		(0.073)
Child age (months)	-0.113***	-0.113***
	(0.005)	(0.005)
Age squared	0.002***	0.002***
	(0.000)	(0.000)
Female child (1/0)	0.205***	0.205***
	(0.040)	(0.039)
Height of mother (cm)	0.014	0.014
	(0.024)	(0.024)
Educated mother (1/0)	-0.083	-0.091
	(0.088)	(0.088)
Female-headed household	0.052	0.047
	(0.101)	(0.101)
Age of household head (years)	0.001	0.002
	(0.003)	(0.003)
Rainfall deviation (annual)	-0.227	-0.231
	(0.161)	(0.160)
Rainfall deviation squared	0.056	0.067
	(0.153)	(0.153)
No. of non-working female adults	-0.052	-0.059
	(0.044)	(0.044)
Total expenditure per adult equivalent (log)	0.063	0.070
	(0.061)	(0.061)
Year 2010	0.297***	0.297***
	(0.053)	(0.053)
Year 2012	0.277***	0.280***
	(0.053)	(0.053)
Mundlak variables		
Mean of mother worked off-farm	0.129	
	(0.131)	
Mean of mother worked on-farm		-0.213**
		(0.091)
Mean female-headed household	-0.093	-0.106
	(0.118)	(0.118)
Mean age of household head	0.001	0.001
	(0.004)	(0.004)
Mean no. of non-working female adults	0.126**	0.115*
	(0.059)	(0.059)
Mean of total expenditure per adult equivalent	0.323***	0.298***
	(0.075)	(0.075)
Mean of maternal height	0.044*	0.044*
	(0.024)	(0.024)
Mean educated mother	0.040	0.044
	(0.102)	(0.102)
Mean of rainfall deviation	-0.136	-0.136
	(0.218)	(0.217)
Mean of rainfall deviation square	0.395	0.431*
	(0.244)	(0.245)
Tw_1	0.013	0.000
	(0.025)	(0.005)
Tw_2	0.000	-0.000
	(0.001)	(0.000)
Tw_3	-0.000	
	(0.000)	
Constant	-14.582***	-14.319***
	(0.731)	(0.736)
Observations	5,096	5,096
R-squared	0.19	0.19
ATE	-0.45	0.02
ATET	-0.18	0.02

Notes: Coefficient estimates are shown with robust standard errors in parentheses Regressions based pooled data with time averages included to account for the panel structure. Expenditures deflated using the consumer price index. * p<0.1; ** p<0.05; *** p<0.01

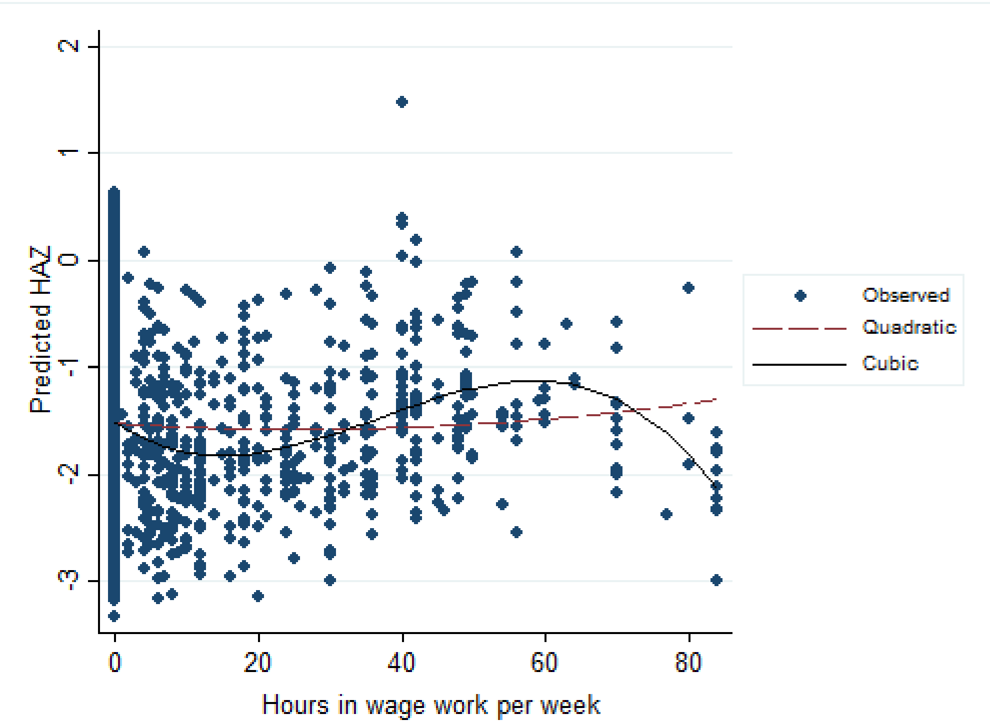

Figure A1. Predicted child HAZ at various levels of maternal off-farm employment
Note: Predictions based on estimates shown in Table 4 of the main paper.

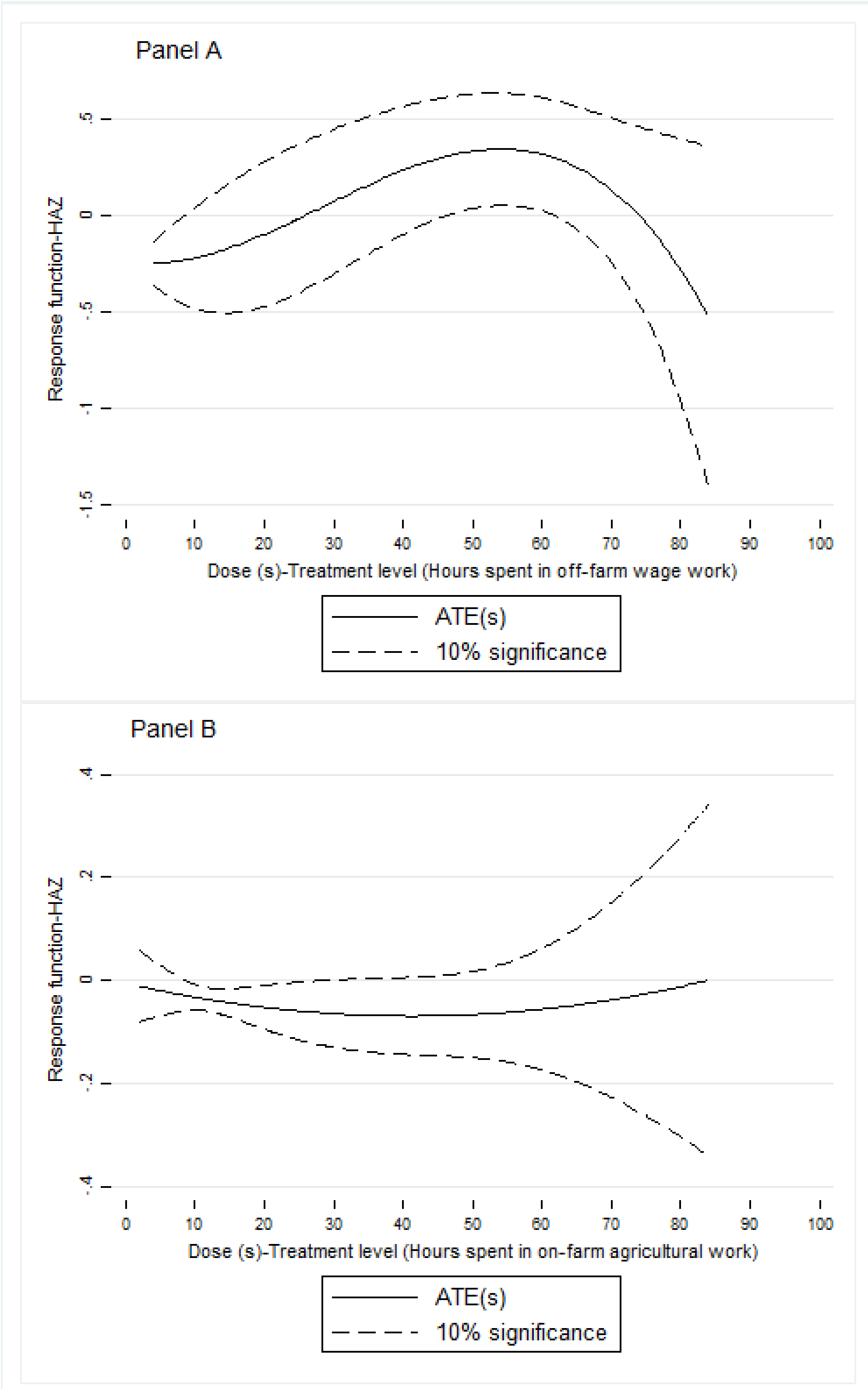

Figure A2. Dose-response functions for effects of maternal employment on HAZ of children 2 years and older. Panel A shows effects of maternal off-farm work. Panel B shows effects of maternal on-farm work.