Links between Maternal Employment and Child Nutrition in Rural Tanzania

Bethelhem Legesse Debela, Esther Gehrke, and Matin Qaim

Improving child nutrition and empowering women are two important and closely connected development goals. Fostering female employment is often seen as an avenue to serve both these goals, especially if it helps to empower the mothers of undernourished children. However, maternal employment can influence child nutrition through different mechanisms, and the net effect may not necessarily be positive. We develop a theoretical model to show that maternal employment can affect child nutrition through changes in income, intrahousehold bargaining power, and time available for childcare. The links are analyzed empirically using panel data from farm households in rural Tanzania. We find that the links between maternal employment and child height-for-age Z-scores (HAZ) are non-linear. Off-farm employment is negatively associated with child HAZ at low levels of labor supply. The association turns positive at higher levels of labor supply and negative again at very high levels. The associations between maternal on-farm work and child nutrition are weaker and not statistically significant. These findings can help to better design development interventions that foster synergies and avoid potential tradeoffs between female empowerment and child nutrition goals.

Key words: Child nutrition, female employment, stunting, Tanzania, women's empowerment.

JEL codes: D13, I15, J22, O15, Q12.

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 is therefore a global health priority (de Onis and Branca 2016). Considerable research has been devoted to the question as to what types of interventions can help to reduce child stunting (Ruel and Alderman 2013; Leroy and Frongillo 2019). One important leverage point is women's empowerment, which was shown to have positive associations with child nutrition in various geographical contexts (Lepine and Strobl 2013;

Bethelhem Legesse Debela is an assistant professor in the Department of Agricultural Economics and Rural Development, University of Goettingen, Germany. Esther Gehrke is an assistant professor in the Agricultural Economics and Rural Policy Group, Wageningen University and Research, The Netherlands. Matin Qaim is a professor in the Department of Agricultural Economics and Rural Development, University of Goettingen, Germany.
Financial support for this research from the German Research Foundation (DFG) is gratefully acknowledged. The authors thank three anonymous reviewers of this journal for helpful comments received on an earlier version of this manuscript.
Correspondence to be sent to: bdebela@uni-goettingen.de

Amer. J. Agr. Econ. 00(00): 1–19; doi:10.1111/ajae.12113

Sraboni et al. 2014; Cunningham et al. 2015; Malapit et al. 2015).[1] Women's empowerment is also a goal in itself in the sustainable development agenda, generally pointing at welcome synergies (UN 2018).

Many of the interventions that aim at female empowerment try to improve women's access to productive resources and employment (Pratley 2016; UN 2018). The rationale is that female employment tends to increase total household income and also the part of the income controlled by women. The latter is particularly relevant for the status and decision-making power of women within the household and has been shown to be positively associated with 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 well-being through changes in time allocation. Women have heavy workloads—especially in rural areas of developing countries—as they are often involved in agricultural work on the family farm in addition to being responsible for household work and child nurturing (Ferrant, Pesando, and Nowacka 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, Escobar-Zaragoza, and González de Cosío 2015). In other words, female off-farm employment may have a negative 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 (Iannotti, Cunningham, and Ruel 2009). Better understanding these mechanisms is important to envisage under what conditions female off-farm and on-farm employment is positively or negatively associated with child nutrition. Yet, evidence on the links between maternal employment and child nutrition 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. A few early studies with data from the Philippines (Popkin and Solon 1976; Senauer and Garcia 1991 ; Blau, Guilkey, and Popkin 1996), Panama, (Tucker and Sanjur 1988), and Guinea (Glick and Sahn 1998) showed mixed results with positive, negative, or no linkages. However, these early studies have limitations in terms of sampling, methodology, and indicators used. Some of the early studies were only descriptive in nature (Popkin and Solon 1976) or used cross-sectional data (Tucker and Sanjur 1988; Glick and Sahn 1998), hence limiting the ability to control for possible confounding factors and time effects. Other studies used panel data to reduce potential issues of endogeneity (Senauer and Garcia 1991; Blau, Guilkey, and Popkin 1996) but had other drawbacks. Senauer and Garcia (1991) used village-level average wage rates instead of the actual time allocation of mothers. Blau, Guilkey, and Popkin (1996) only focused on small children under two years of age, so that longer term effects on child nutrition could not be fully captured. This is especially relevant when analyzing effects on stunting, because child height is an indicator that reflects nutrition and health conditions over a longer period of time (Alderman and Headey 2018). Also, none of the early studies focused on rural households and differentiated between maternal employment in on-farm and off-farm activities, as we do here.

A few more recent studies also exist. Several focused on women's time use in agriculture, finding that severe time constraints can be negatively associated with child nutrition (Johnston et al. 2018; Komatsu, Malapit, and Theis 2018). A study by Bhalotra (2010) used a large panel dataset from India to explain determinants of maternal labor supply and links with child health. Bhalotra (2010) found that income shocks result in increased maternal labor supply and this, in turn, is negatively associated with low antenatal care and disease treatment of children, due to low health seeking-behavior among working mothers. Rashad and Sharaf (2019) used cross-section data from Egypt to suggest that maternal

[1] Studies examining the link between women's empowerment and child nutrition have used various definitions and measures of women's empowerment. Most studies draw on Kabeer's (1999) definition of empowerment as expanding women's ability to make strategic life choices, particularly along three dimensions: resources, agency, and achievements. As women's empowerment is a multidimensional concept, the relationship between empowerment and other outcomes of interest depends on the specific empowerment dimension considered, as well as on the general context. Some of the studies on child nutrition cited here focus on the agency dimension of empowerment by using the Women's Empowerment in Agriculture Index (WEAI; Sraboni et al. 2014; Cunningham et al. 2015; Malapit et al. 2015). Other studies used women's bargaining power within the household as an empowerment indicator (Lepine and Strobl 2013). A recent systematic review concludes that most studies find a positive association between women's empowerment and child health, but that this might vary with the specific definition of empowerment used (Pratley 2016).

employment is negatively associated with child nutrition. In contrast, Ngenzebuke and Akachi (2017) used data from Nigeria and found that maternal employment is positively associated with child nutrition.[2] The only related study that used panel data and econometric techniques to control for time-invariant unobserved heterogeneity is by Jain and Zeller (2015). They found no significant association between maternal labor supply and child food intake in Bangladesh. Links with 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 variation primarily reflects seasonality rather than longer term nutrition 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 inference on longer-term nutrition implications. In particular, we use three rounds of data from the Tanzanian Living Standard Measurement Study—Integrated Surveys on Agriculture (LSMS-ISA) to analyze associations between maternal off-farm and on-farm employment and child height-for-age Z-scores (HAZ).

Conceptual Framework

Different approaches exist to model household decisions of maternal employment and investments in child human capital. The most basic model is a unitary household model that can be traced back to Becker (1981).[3] More recent approaches extend this model to allow for cooperative and even non-cooperative bargaining between spouses. In this section, we first develop a simple unitary model along the lines of Becker (1981) and subsequently extend it to discuss the implications of alternative bargaining processes within the household.

Investments in Children in a Unitary Household Model

Assume that each household consists of husband, wife, and two children, a boy and a girl.[4] Investment decisions are made repeatedly over multiple periods. In each period, the household maximizes utility over consumption (C) and over the human capital stock of each child, the boy's (H_b) and the girl's (H_g). Household utility is maximized subject to a budget constraint and the human capital production function[5]:

$$\begin{aligned} &max\, U\left(C, H_b, H_g\right) \\ (1)\quad &\text{s.t. } C = w_i l_i + Y_j - i_b - i_g \\ &H_{b,g} = f\left[(T_i - l_i), i_{b,g}\right]. \end{aligned}$$

In equation (1), Y_j denotes the labor income of the father (and any non-labor income of the household). For simplicity, we ignore the effects of changes in wages on male labor supply.[6] The wage each mother receives depends on the set of available jobs (J_i), and her personal characteristics (X_i), such that $w_i = w_i(J_i, X_i)$. We assume that she always chooses the best-paying job and—in that job and at that particular wage—the household determines how much she will work (l_i).[7] Whatever time the woman does not spend on the labor market is devoted to childcare. 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, where T_i denotes the

[2]Although the data used in Ngenzebuke and Akachi (2017) have a panel data structure with two rounds, the observations were pooled and no corrections for time-invariant heterogeneity were used. Further, Ngenzebuke and Akachi (2017) examined links with weight for age and not height for age as the more reliable long-term indicator of child nutrition.

[3]In his seminal work, Becker analyzed the effect of an increase in female wages on investments in children and fertility.

[4]This household setup does not perfectly represent the typical household in our setting in Tanzania, which is characterized by the cohabitation of parents or parents-in-law, as well as polygamy. In our sample, 53% of the children live in nuclear families, whereas the remaining children live in households with other relatives/non-relatives, polygamous households, or single-parent households. Our model is designed to generate predictions in the simplest setting possible. It should be stressed that we can generate identical predictions in a multi-adult household model, as long as time constraints become binding for other adult household members at some point. This assumption is generally satisfied if other cohabiting adults are already busy with household chores or other tasks in the absence of maternal labor supply.

[5]The budget constraint also highlights the financial constraints in investing in child nutrition. Household consumption expenditures do not automatically include items that are important in fostering child growth and human capital development.

[6]Male wages are treated as fixed here to simplify the analysis. Because male labor force participation largely stagnated over the past decades while female labor force participation increased, it seems reasonable to focus on the effect of changes in female wages. Fathers are found to be working on average three times as many hours as mothers also in our sample (see table A1 in the online supplementary appendix S1).

[7]We thereby abstract from a potential tradeoff between wages and work flexibility.

total time endowment of the mother, and $i_{b,g}$ the monetary investment in the boy or the girl.

Let $\rho_i = \partial H/\partial i$ be the human capital return to monetary investments, and $\rho_h = \partial H/\partial h$ denote the return to time investments. The reduced form of child human capital can thus be written as:

$$(2) \quad H_{b,g} = g(\rho_i, \rho_h, J_i, X_i, Y_j).$$

Model Implications

Equations (1) and (2) highlight how an increase in the set of employment options (J_i), and therewith w_i, affects the investment in children via two main mechanisms: an income effect and a time allocation effect.[8] The income effect is due to the increase in female wages, which expands the set of possible choices.[9] To the extent that household utility increases in child human capital, and the household could spend more on child-specific consumption goods.[10] The time allocation effect arises from the fact that maternal time is a direct input in the production of child human capital. If women increase labor supply as wages increase, they will have less time available for childcare.[11]

Essentially, the household faces a tradeoff between having the mother spend time with her children (and increasing the utility from child human capital) and having the mother work on the labor market (and increasing utility from consumption and monetary investments in children). The direction of the combined effect depends on the shape of the utility function and the degree of substitutability between maternal time and monetary inputs in the production of child human capital.[12]

It seems important to highlight that the utility of investing in the boy might not have to equal the utility of investing in the girl. Consider the following CES (constant elasticity of substitution) utility function:

$$(3) \quad U = \left[(1-\alpha-\beta)C^{\rho} + \alpha H_b{}^{\rho} + \beta H_g{}^{\rho}\right]^{1/\rho}$$

For any $\alpha \neq \beta$, the effect of an increase in wages on child human capital need not be identical for the boy and the girl. To the extent that the relative importance of these mechanisms varies with wages, the relationship between maternal employment and child nutrition may even be non-monotonic.[13]

Bargaining Models

We now extend the setup to allow for non-cooperative or cooperative bargaining between spouses. A non-cooperative bargaining process implies that each adult household member individually decides how much to work and how much to spend on consumption and child nutrition, and thus would essentially be the sum of two (or more) individual maximization processes that follow the lines of equation (1). Child nutrition would then be a function of the monetary investment of the father and the time and monetary investments of the mother.

In a cooperative household model, in contrast, the decision process can be descried as a two-stage game. In the first stage, the mother (i) 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 joint income is spent.

The bargaining process between parents is treated as a cooperative Nash Bargain, also termed "collaborative model" by Chiappori (1992). The maximization problem now becomes:

[8] The effect may, in addition, 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. At the same time, the quality of work might affect the mother's ability of taking care of herself and her children. Unfortunately, the nature of our data does not allow us to explore these mechanisms in more detail.

[9] Note that this discussion has parallels to the standard labor supply literature, in which an increase in wages can increase or decrease the demand for leisure. In contrast to this literature, the income effect here corresponds to an increase in labor supply of the mother as we abstract from the demand for leisure. As a matter of fact, empirical evidence from developing countries suggests that women work more as wages increase, implying that the substitution effect dominates the "classical" income effect (Atkin 2009; Heath and Mobarak 2015).

[10] Holding other things constant, higher investments in food and healthcare will result in improved child nutrition (Leslie 1988; Oddo et al. 2018).

[11] Holding other things constant, less time for childcare will reduce child human capital and nutrition (Berger, Hill, and Waldfogel 2005; Rivera-Pasquel, Escobar-Zaragoza, and González de Cosío 2015).

[12] If, for example, the complementarity between maternal time and monetary investments in the production of child human capital is sufficiently large, and maternal consumption and child human capital are substitutes in household utility, then an increase in maternal wages could decrease time allocated to childcare and worsen child nutrition.

[13] To illustrate this point, we simulate the relationship between labor supply and child nutrition under varying wages and for different preference parameters. Figure A1 in the online supplementary appendix S1 depicts numerical solutions. We show that the relationship between labor supply and child nutrition varies with the complementarity parameter and can change from positive to negative (or vice versa) at different levels of labor supply.

$$\max \left(U_i\left(C_i^m, H_b, H_g\right) - V_i\right)^{\gamma_i}$$
$$\left(U_j\left(C_j^m, H_b, H_g\right) - V_j\right)^{\gamma_j} s.t.$$

$$(4) \quad C_i^m + C_j^m = w_i l_i + Y_j - i_b - i_g$$
$$H_{b,g} = f\left[(T_i - l_i), i_{b,g}\right].$$

In equation (4), γ is each parent's bargaining weight within the household, and V is the outside option. The bargaining weights (and outside options) of both parents depend on their personal characteristics and (relative) wage incomes.[14]

Extending the model to allow for cooperative (and non-cooperative) bargaining highlights a third mechanism through which maternal labor supply could affect child nutrition: the female bargaining power effect. If the utility functions of each parent have different parameters, such that the mother has greater utility of investing in her children than the father, then an increase in female wages (and employment) could raise investments in child nutrition over and above the income effect.[15]

This effect comes from the increase in mother's income relative to father's income. In the non-cooperative model, this works directly through maternal expenditures: the increase in female wages directly contributes to child nutrition as the mother implements her own preferences conditional on her own income. In the cooperative model, the increase in female wages improves her outside option and increases her bargaining weight within the household. This then shifts expenditures toward female preferences.[16]

[14]Such a model can be solved recursively, because the mother decides how much time to allocate to the labor market, anticipating how this will affect her relative bargaining power in the second stage.

[15]The assumption that mothers have higher utility of investing in children than fathers has a long tradition in the literature on human capital investments. See Behrman (1997) for an early review. More recent evidence along these lines can be found in Rangel (2006), Reggio (2011), de Hoop et al. (2018), and Heggeness (2020). Assuming that utility functions are as in equation (3) and maternal (paternal) parameters are subscripted by i (j), the above-mentioned preferences imply that $\alpha_i > \alpha_j$, $\beta_i > \beta_j$, and $\alpha_i/\beta_i < \alpha_j/\beta_j$. See Atkin (2009) for a discussion.

[16]Indeed, several empirical studies showed that the share of female-controlled income has positive effects on food and healthcare expenditures and on child nutrition also after controlling for total household income (Hoddinott and Haddad 1995; Chowdhury et al. 2003; Rangel 2006; Reggio 2011; Ogutu, Gödecke, and Qaim 2020).

Data

Household Survey

Data for the empirical analysis come from the World Bank's LSMS-ISA survey 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. Although 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 article, 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 analysis. Finally, in all survey rounds, child anthropometric measures were taken. For our article, 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 children in 2008, 2010, and 2012, respectively) residing with 3,598 unique mothers.

Measuring Child Nutrition

Child nutrition is the main outcome variable in this article. 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 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).

We consider HAZ the most suitable indicator of child nutrition in our article, 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 because 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.

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 seven 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.

Estimation Strategy

General Setup

We aim to examine the link between maternal employment and child nutrition. The most general specification takes the following form:

$$(5) \qquad HAZ_{imt} = \beta_0 + \beta_1 L_{mt} + \beta_2' \boldsymbol{C}_{it} + \beta_3' \boldsymbol{M}_{mt} + \beta_4' \boldsymbol{X}_{ht} + \beta_5' \boldsymbol{X}_{jt} + \beta_6' \boldsymbol{D}_t + a_m + \varepsilon_{imt}$$

where HAZ_{imt} refers to the height-for-age Z-score of child i of 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, which measure 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 variants of equation (5), 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 (5) is a vector of child-level characteristics (age and sex), intended to approximate returns to human capital investments, $\boldsymbol{M}_{mt}$ is a vector of maternal characteristics (age, education, and height), and $\boldsymbol{X}_{ht}$ is a vector of household characteristics (such as sex of the household head etc.). $\boldsymbol{X}_{jt}$ denotes region-specific shocks (such as rainfall), $\boldsymbol{D}_t$ represents a vector of time fixed effects, and a_m is time-invariant mother specific unobserved heterogeneity, such as her ability, her preferences for child nutrition, or the time-invariant component of her outside option.[17] ε_{imt} is the idiosyncratic error term.

After adequately controlling for maternal fixed effects, the specification above implies that we are comparing children of the same mother at different points in time, keeping HAZ differences between age and sex groups fixed. Identification of equation (5) requires that no unobserved shocks simultaneously affect maternal labor supply and child nutrition. A number of threats to identification remain, which will be discussed in detail in the robustness checks.

Mundlak Estimator

While controlling for mother fixed effects seems the most straightforward way of eliminating bias from time-invariant unobserved heterogeneity, this approach has the disadvantages of producing estimates that are biased toward zero in short panels with limited

[17] We assume for now that parental characteristics that are time invariant are also captured by a_m.

variation in the explanatory variable and of exacerbating measurement error. In light of these caveats, we use Mundlak's (1978) approach, also called pseudo fixed effects estimator, to control for time-invariant omitted variables. The Mundlak approach builds on the assumption that mothers with the same time-averaged labor supply should be comparable also along unobserved characteristics and identifies treatment effects from differential variation over time in employment for a comparable group of women. The underlying assumption is that the time-varying component of labor supply is fully exogenous, once the time-invariant component has been controlled for.

The Mundlak approach has several advantages: first, it 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 of our regression models. Second, joint tests on the estimates of the time averages provide an alternative to the Hausman test and reveal whether random effects estimates would be biased (Wooldridge 2019). In all our estimations, the joint tests for the time averages are statistically significant, hence confirming that random effects estimates would be biased and that this bias is properly addressed through the Mundlak approach. We thus estimate the following specification:

$$(6) \qquad HAZ_{imt} = \beta_0 + \beta_1 L_{mt} + \beta_2' \boldsymbol{C}_{it} + \beta_3' \boldsymbol{M}_{mt} + \beta_4' \boldsymbol{X}_{ht} + \beta_5' \boldsymbol{X}_{jt} + \beta_6 \tilde{L}_m + \beta_6' \tilde{\boldsymbol{M}}_m + \beta_7' \tilde{\boldsymbol{X}}_h + \beta_8' \boldsymbol{D}_t + \varepsilon_{imt}$$

where $\tilde{L}_m, \tilde{\boldsymbol{M}}_m$ and $\tilde{\boldsymbol{X}}_h$ are the time averages of maternal labor supply and of maternal and household characteristics.[18] Because 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 with similar results.

Given that our regression results build on economic modeling, control for unobserved time-invariant heterogeneity, and survive various robustness checks, the coefficients of maternal employment on child nutrition probably reflect causal effects to a large extent. Nevertheless, as we cannot perfectly control for possible time-variant unobserved heterogeneity in our econometric specifications, we remain cautious and rather talk of associations between maternal employment and child nutrition when interpreting the results.

Dynamics in Nutritional Outcome

The specification above implies that the return to any investment in human capital is solely determined by age and sex of the child. However, given the cumulative nature of HAZ, it seems highly likely that the returns to any investment vary with lagged values of HAZ. Ignoring initial conditions would introduce bias in our estimates, if maternal labor supply responded systematically to lagged HAZ, while lagged HAZ has a direct effect on current HAZ. Such systematic responses could arise if mothers of undernourished children chose to work more in order to be able to afford more or better food. The response could however also go in a negative direction if mothers of undernourished children chose to allocate more resources to her other children. Although we cannot speak to the direction of these responses, we can try to isolate the effect of maternal employment from any underlying dynamics by conditioning on lagged values of child HAZ. Given that we only observe a small set of children in all three survey rounds, our sample size drops substantially when doing so. This is why we present results of this alternative approach only as a robustness check.

Exploring Mechanisms

In the theoretical model above, we identified three mechanisms of how maternal employment could affect child nutrition, namely (*a*) the income effect, (*b*) the bargaining power effect, and (*c*) the time allocation effect. With the data at hand it is not possible to conclusively separate all three mechanisms. Yet, we employ several tests to assess the importance of individual mechanisms. First, we test if controlling for household consumption expenditures affects our estimates. If the income effect were the only effect that matters, the coefficients on maternal employment should turn insignificant

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

Table 1. Nutritional Status of Children and Maternal Employment in Rural Tanzania

		All Years	2008	2010	2012
Panel A: Nutritional status of children					
All children	HAZ	−1.53 (1.56)	−1.79 (1.45)	−1.44 (1.56)	−1.47 (1.60)
	Stunted (%)	38.9 (48.8)	45.2 (49.8)	36.5 (48.1)	37.6 (48.5)
Below 2 years	HAZ	−1.21 (1.83)	−1.70 (1.50)	−1.07 (1.84)	−1.10 (1.93)
	Stunted (%)	35.4 (47.8)	43.9 (49.7)	31.7 (46.6)	34.6 (47.6)
2–4 years	HAZ	−1.76*** (1.29)	−1.83 (1.42)	−1.72*** (1.23)	−1.74*** (1.26)
	Stunted (%)	41.4*** (49.3)	46.0 (49.9)	40.1*** (49.0)	39.8** (49.0)
Obs. of children		5,096	1,136	1,750	2,210
Panel B: Maternal employment and hours worked					
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
Hours worked during last 7 days in					
Off-farm wage work		2.8 (10.2)	2.2 (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)
Obs. of unique mothers		3,598	806	1,231	1,561

Note: Mean values are shown with standard deviations in parentheses. Differences between children above and below 2 years of age were tested for statistical significance.
$^{**}p < 0.05$;
$^{***}p < 0.01$.

after controlling for total consumption expenditures.[19] Second, acknowledging that time constraints might matter less when there is substitutability in time investments within the household, we test if controlling for the labor supply of other household members affects our estimates. The additional control variables that we use are paternal hours in wage and agriculture and share of other (male or female) household members involved in wage labor.

To analyze the role of the time allocation mechanism, the higher degree polynomials of maternal employment are also 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 at a diminishing rate, 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.

Heterogeneity in the Links between Maternal Employment and Child Nutrition

In addition to estimating the models for the full sample of children under the age of 5 years, we also estimate separate models for children below and above 2 years of age. Nutrition and health conditions during the first 1,000 days of life (including nine 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). Nevertheless, as mentioned above, HAZ is a cumulative indicator that often detects nutrition and health deficiencies more clearly in somewhat older children (Alderman and Headey 2018). Hence, we expect the maternal employment coefficients to be larger for the children above 2 years of age than for the children below. Furthermore, we allow parental preferences to vary for the girl's and the boy's human capital by splitting the sample by sex.

Empirical Results

Descriptive Statistics

Table 1 presents descriptive statistics of the nutrition status of children and maternal employment in rural Tanzania by survey year. The average HAZ is −1.53 across all three

[19]Given that consumption expenditures might also be measured with error, we explore different alternative measures of income. None of these alternative measures alters the sign or magnitude of our main estimates (see further details below).

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.[20] In spite of this improvement, child stunting remains high, pointing at widespread chronic undernutrition in rural Tanzania.

Panel B in table 1 shows that around 11% of the mothers are employed in the off-farm sector and 70% 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 seven - 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. When considering maternal entrance to and exit from the labor market over time, the majority of the mothers do not show fluctuation in their off-farm employment status. From the mothers observed in multiple survey rounds, 18.6% changed their off-farm employment status, but 81.4% did not. For on-farm work, 38.6% of the mothers changed their participation status (table A2 in the online supplementary appendix S1).

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 significantly different at the 1% level (table A3 in the online supplementary appendix S1). However, these relationships in table 1 and figure 1 do not control for any confounding factors. We control for confounding factors in the regression analysis that follows.

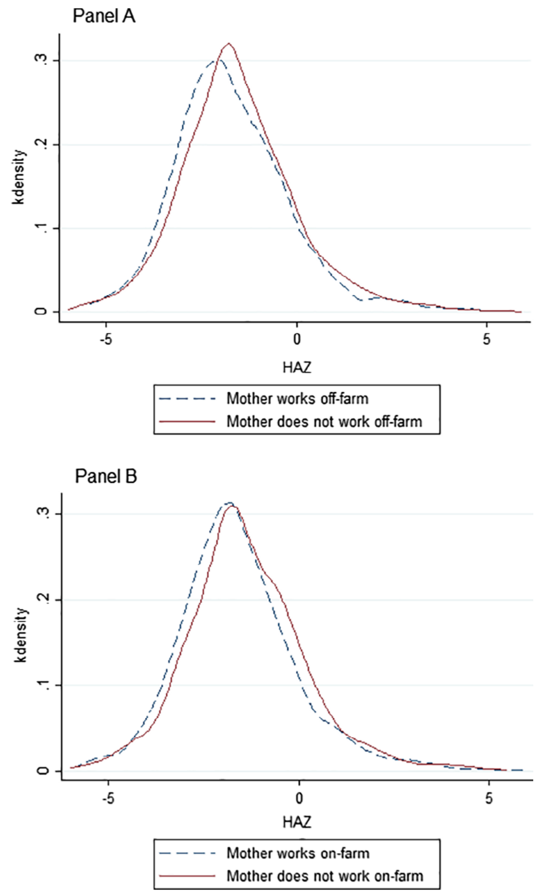

Figure 1. Kernel density of HAZ for children with working and non-working mothers

Note: Panel A refers to mothers working off-farm. Panel B refers to mothers working on-farm.

Maternal Employment and Child Nutrition

Table 2 shows results of Mundlak regressions in which child HAZ is the dependent variable and maternal off-farm employment is the main explanatory variable of interest. We add control variables step by step with the aim to examine the sensitivity of the results. Comparison of the different models reveals that our main findings are not very sensitive to the inclusion of additional control variables. The coefficient estimate for the dummy variable of maternal off-farm employment in model (4), with all controls included, is negative and statistically significant. The mother's involvement in off-farm work reduces child HAZ by 0.18.

Models (5) to (10) in table 2 measure maternal employment by the number of hours worked in the off-farm sector. In model (5), the number of hours spent in off-farm work is only included in linear form. The coefficient is negative but not statistically

[20]Although the prevalence of stunting declined considerably between 2008 and 2010, it did not further decline between 2010 and 2012. Reasons for these developments are not entirely clear. The stunting prevalence rates and trends from the LSMS-ISA data used here are consistent with WHO data reporting child stunting rates for Tanzania of 43.1%, 34.9%, and 37.1% in 2008, 2010, and 2012, respectively.

Table 2. Maternal Employment in Off-Farm Work and Child HAZ (Mundlak Regressions)

Panel A: Dummy variable for maternal off-farm work

	(1)	(2)	(3)	(4)
Mother worked off farm (1/0)	−0.249** (0.098)	−0.183** (0.092)	−0.184** (0.092)	−0.180* (0.093)
Child characteristics	No	Yes	Yes	Yes
Maternal characteristics	No	No	Yes	Yes
Household characteristics	No	No	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Mundlak variables	Yes	Yes	Yes	Yes
Observations	5,096	5,096	5,096	5,096
Number of groups	2,117	2,117	2,117	2,117
R-squared	0.01	0.09	0.16	0.16
Joint test of Mundlak variables[a]	Chi2 = 19.93 (p-value = 0.001)			

Panel B: Maternal hours in off-farm work

	(5)	(6)	(7)	(8)
Mother worked off farm (hours)	−0.004	−0.009	−0.048***	−0.043***
	(0.003)	(0.006)	(0.012)	(0.012)
Hours worked off farm squared		7.8E−05	0.002***	0.002***
		(0.000)	(0.000)	(0.000)
Hours worked off farm cubed			−1.7E−05***	−1.5E−05***
			(0.000)	(0.000)
Child characteristics	No	No	No	Yes
Maternal characteristics	No	No	No	No
Household characteristics	No	No	No	No
Year fixed effects	Yes	Yes	Yes	Yes
Mundlak variables	Yes	Yes	Yes	Yes
Observations	5,096	5,096	5,096	5,096
Number of groups	2,117	2,117	2,117	2,117
R-squared	0.01	0.01	0.01	0.09

Panel B continued

	(9)	(10)
Mother worked off farm (hours)	−0.040***	−0.038***
	(0.011)	(0.012)
Hours worked off farm squared	0.001***	0.001***
	(0.000)	(0.000)
Hours worked off farm cubed	−1.4E−05***	−1.3E−05***
	(0.000)	(0.000)
Child characteristics	Yes	Yes
Maternal characteristics	Yes	Yes
Household characteristics	No	Yes
Year fixed effects	Yes	Yes
Mundlak variables	Yes	Yes
Observations	5,096	5,096
Number of groups	2,117	2,117
R-squared	0.16	0.17
Joint test of Mundlak variables[a]	Chi2 = 22.76 (p-value = 0.000)	

Note: The dependent variable in all models is child HAZ. Coefficient estimates are shown with cluster-corrected standard errors in parentheses. Only the main independent variables of interest are shown for brevity. Full estimation results are shown in table A4 in the online supplementary appendix S1.
[a]The test statistics for the joint significance of the Mundlak variables (time averages) always refer to the models in each part with all control variables included.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

significant. In models (6) and (7), the squared and cubed terms of hours worked are included respectively. In model (7), the coefficients of the first, second, and third degree polynomials are all statistically significant and with alternating signs. These results

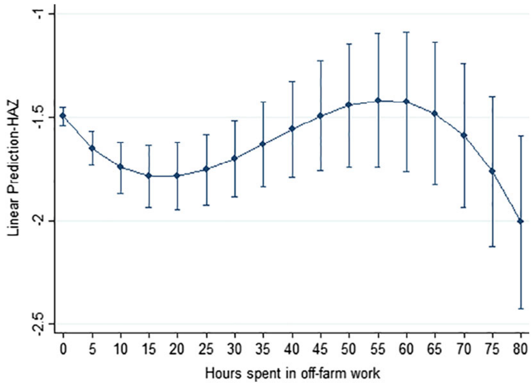

Figure 2. Relationship between maternal hours spent in off-farm and child HAZ

Note: Predictions are based on the estimates of model (10) in table 2 and 90% confidence intervals.

are robust to controlling for child, maternal, and household characteristics. The estimates in models (7) to (10) suggest that a relatively small amount of time allocated to off-farm work is negatively associated with child nutrition. If the mother works more than 12 hours per week in off-farm employment, the association with child nutrition turns positive and then negative again if she works more than 55 hours per week. A graphical presentation of predicted child HAZ at various levels of maternal hours worked off-farm is shown in figure 2.

The decline in child HAZ beyond 55 hours is of little practical relevance in Tanzania, as only about 0.9% of the mothers (around 8% of all mothers working off-farm) work more than 55 hours per week in off-farm activities. Nevertheless, the estimated non-linear association clearly underlines the changing relevance of the different underlying mechanisms when 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 mechanism for child nutrition seems to dominate. At moderate numbers of hours worked, this negative time allocation mechanism seems to be overcompensated by positive income and/or female bargaining mechanisms.

Table 3 shows estimates for the association between maternal employment in on-farm agricultural work and child nutrition. When represented through a dummy variable, the coefficient of maternal on-farm work is not statistically significant (models 1–4). The coefficient also remains insignificant when additionally controlling for maternal off-farm employment (model 5). Models (6) to (12) in table 3 show results for the number of hours worked in on-farm activities. In model (7), the coefficient for the linear term of hours worked on-farm is negative and statistically significant, whereas the squared term is positive and statistically significant. However, both coefficients turn statistically insignificant when also controlling for child, maternal, and household characteristics (models 8–10), suggesting that maternal on-farm work does not affect child nutrition considerably.[21] These results do not change much when additionally controlling for the number of maternal hours spent in off-farm work (models 11–12). Comparing the estimates in tables 2 and 3 also reveals that the coefficients for maternal off-farm employment do not change much when additionally controlling for the time spent in on-farm work.

Exploring the Underlying Mechanisms

In table 4, we look at the implications of maternal employment when additionally controlling for the labor contributions of other adult household members. Other adult household members include all persons above 14 years of age living in the household. We consider the labor contributions by these persons in on-farm and off-farm economic activities, in order to better account for possible labor and childcare substitution effects between different persons living in the same household. Models (4) and (5) in table 4 show that the non-linear relationship between maternal off-farm employment and child nutrition remains consistent also when controlling for the labor of other household members, with only a slight decline in the coefficient magnitudes.[22] This might imply that substitution effects in childcare between household members are insufficient to offset the negative influence of maternal employment on child HAZ.

In model (6) of table 4, we additionally control for household consumption expenditures. The coefficients for maternal employment are hardly affected, suggesting that the income mechanism of female employment does not

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

[22]These results also remain when using the standard fixed effects estimator instead of the Mundlak approach (table A7 in the online supplementary appendix S1).

Table 3. Maternal Employment in On-Farm Work and Child HAZ (Mundlak Regressions)

Panel A: Dummy variable for maternal on-farm work					
	(1)	(2)	(3)	(4)	(5)
Mother worked on farm (1/0)	−0.071	0.026	0.030	0.026	0.020
	(0.074)	(0.063)	(0.063)	(0.063)	(0.064)
Mother worked off farm (1/0)					−0.180*
					(0.093)
Child characteristics	No	Yes	Yes	Yes	Yes
Maternal characteristics	No	No	Yes	Yes	Yes
Household characteristics	No	No	No	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Mundlak variables	Yes	Yes	Yes	Yes	Yes
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	0.02	0.09	0.17	0.17	0.17
Joint test of Mundlak variables [a]		Chi2 = 31.63 (p-value = 0.000)			

Panel B: Maternal hours in on-farm work					
	(6)	(7)	(8)	(9)	(10)
Mother worked on farm (hours)	−0.001	−0.007*	−0.003	−0.003	−0.003
	(0.002)	(0.004)	(0.003)	(0.003)	(0.003)
Hours worked on farm squared		1.2E−04**	6.8E−05	6.9E−05	7.2E−05
		(0.000)	(0.000)	(0.000)	(0.000)
Child characteristics	No	No	Yes	Yes	Yes
Maternal characteristics	No	No	No	Yes	Yes
Household characteristics	No	No	No	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Mundlak variables	Yes	Yes	Yes	Yes	Yes
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	0.01	0.02	0.09	0.17	0.17

Panel B continued		
	(11)	(12)
Mother worked on farm (hours)	−0.003	−0.003
	(0.003)	(0.003)
Hours worked on farm squared	7.6E−05	7.0E−05
	(0.000)	(0.000)
Mother worked off farm (hours)	−0.004	−0.036***
	(0.003)	(0.012)
Hours worked off farm squared		0.001***
		(0.000)
Hours worked off farm cubed		−1.2E−05***
		(0.000)
Child characteristics	Yes	Yes
Maternal characteristics	Yes	Yes
Household characteristics	Yes	Yes
Year fixed effects	Yes	Yes
Mundlak variables	Yes	Yes
Observations	5,096	5,096
Number of groups	2,117	2,117
R-squared	0.17	0.17
Joint test of Mundlak variables [a]	Chi2 = 31.88 (p-value = 0.000)	

Note: The dependent variable in all models is child HAZ. Coefficient estimates are shown with cluster-corrected standard errors in parentheses. Only the main independent variables of interest are shown for brevity. Full estimation results are shown in table A5 in the online supplementary appendix S1.

[a]The test statistics for the joint significance of the Mundlak variables (time averages) always refer to the models in each part with all control variables included.

*$p < 0.1$;

**$p < 0.05$;

***$p < 0.01$.

Table 4. Maternal Employment and Child HAZ with Additional Controls (Mundlak Regressions)

	(1)	(2)	(3)	(4)	(5)	(6)
Mother worked off farm (1/0)	−0.170* (0.095)	−0.159* (0.096)	−0.158* (0.096)			
Mother worked on farm (1/0)	−0.016 (0.067)	−0.009 (0.068)	−0.005 (0.068)			
Mother worked off farm (hours)				−0.036*** (0.012)	−0.032*** (0.012)	−0.031*** (0.012)
Hours worked off farm squared				0.001*** (0.000)	0.001*** (0.000)	0.001** (0.000)
Hours worked off farm cubed				−1.2E−05*** (0.000)	−1.1E−05*** (0.000)	−1.1E−05** (0.000)
Mother worked on farm (hours)				−0.003 (0.003)	−0.004 (0.003)	−0.003 (0.003)
Hours worked on farm squared				6.9E−05 (0.000)	7.3E−05 (0.000)	6.6E−05 (0.000)
Total expenditure per adult equivalent (log)			0.065 (0.056)			0.064 (0.056)
Father's on-farm and off-farm labor contribution	Yes	Yes	Yes	Yes	Yes	Yes
Labor contribution other adult members	No	Yes	Yes	No	Yes	Yes
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Mundlak variables	Yes	Yes	Yes	Yes	Yes	Yes
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	0.18	0.18	0.19	0.17	0.18	0.19
Joint test of Mundlak variables[a]	Chi2 = 52.82 (p-value = 0.000)					

Note: The dependent variable in all models is child HAZ. Coefficient estimates are shown with cluster-corrected standard errors in parentheses. Only the main independent variables of interest are shown for brevity. Full estimation results are shown in table A6 in the online supplementary appendix S1. Expenditure variables were deflated using the consumer price index.

[a]The test statistic for the joint significance of the Mundlak variables (time averages) refers to the model with all control variables included.

*$p < 0.1$;

**$p < 0.05$;

***$p < 0.01$

play a major role in this context.[23] We conclude that the negative association between maternal off-farm employment and child nutrition is mainly driven by the time allocation mechanism, as this is the only mechanism for which we expect a negative direction.

Children of Different Age and Sex

We now subdivide the total sample of children into two subsamples, those below and above two years of age, and estimate separate models in order to examine whether the implications of maternal employment vary by age group. Results are shown in table A10 in the online supplementary appendix S1. For children below two years of age (models 1–3), 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, but none of the estimates are statistically significant. In contrast, for children above two years of age all three coefficients are statistically significant (models 5–7). The binary variables measuring maternal participation in off-farm and on-farm work are statistically insignificant for both age groups (models 4 and 8 in table A10, online supplementary appendix S1).

These findings by age cohort suggest that the associations between maternal hours in off-farm work and child nutrition are more visible in older than in younger children. This does not mean that maternal attention and care are less important for younger children. On the contrary, maternal care may be more important for children under two years. However, some of the longer term effects on child nutritional status resulting from early childhood conditions are often only fully reflected in the HAZ of children in later years, simply because HAZ is a cumulative, 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 two years of age (Alderman and Headey 2018; Headey et al. 2018). We further explore the dynamics of HAZ as a function of maternal employment in the robustness checks below.

In table A11 in the online supplementary appendix S1, we subdivide the child sample by sex, as parents' preferences and food and resource allocation to boys and girls may vary. Interestingly, the non-linear relationship between maternal hours in off-farm employment and HAZ is consistently observed only for girls and not for boys. A possible explanation is that differential sex preferences exist, such that girls benefit more than boys from their mother working and gaining bargaining power within the household. However, the cubed term of maternal hours in off-farm work is consistently negative and significant for both girls and boys (table A11, online supplementary appendix S1), suggesting that mothers' time constraints have negative implications for child nutrition regardless of the child's sex.

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 use the standard fixed effects estimator instead of the Mundlak approach. The results remain very similar to those discussed above (table A7 in the online supplementary appendix S1). 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 is to examine whether the results change when we exclude children for which no within variation over time is observed. Again, these results are very similar to those with the full sample of children included (table A12 in the online supplementary appendix S1).

[23]The coefficient of household consumption expenditure itself is not statistically significant, which may surprise as household living standard should have a positive effect on child nutrition. Note, however, that the Mundlak approach controls for time averages, so that the estimates build on the variation within households over time, which is relatively small for the consumption expenditure variable. When we use a random effects estimator, which also considers between-variation, the effect of household consumption expenditure is positive and significant, as expected (table A8 in the online supplementary appendix S1). Another concern may be that the expenditure variable is measured with substantial error. To test whether measurement error may affect the results, we tried alternative indicators of living standard in additional model specifications. First, we used an asset index composed of the physical assets a household owns, as this is less likely to be affected by measurement error. Second, we used non-food expenditures (instead of total expenditures), because food expenditures (including the value of home-produced foods) may be particularly prone to measurement error. In both model specifications, the coefficient estimates for the alternative living standard indicators are statistically insignificant when using the Mundlak estimator (and positive and significant when using random effects), while the maternal employment coefficients remain robust (table A9 in the online supplementary appendix S1).

In a third robustness check, we use the sample of children that were surveyed at least twice to examine the dynamics in HAZ and better account for the cumulative nature of HAZ in relation to maternal employment. First, we estimate the change in child HAZ as a function of current maternal employment and find that the results are consistent with our main findings: children of mothers that work off-farm experience reductions in HAZ (table A13 in the online supplementary appendix S1). Second, we interact the age of the child with maternal participation in off-farm work and find that the interaction term is statistically insignificant, suggesting that the relationship between maternal labor supply and child nutrition is independent of the child's age (table A13, online supplementary appendix S1). Third, we estimate current HAZ as a function of current and lagged maternal hours in off-farm work. Results show a similar non-linear relationship for current maternal labor supply and no significant associations for lagged labor supply (table A14, online supplementary appendix S1).

In a last robustness check, we test the sensitivity of the findings with respect to the measurement of the maternal employment variables. In the original models discussed above, we used the number of hours worked in off-farm and on-farm activities during the seven days prior to the survey. While the relatively short recall period of seven days leads to quite precise response data, it does not account for seasonality, which 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 surveys, the time spent in off-farm activities over a twelve-month 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 twelve-month period). The results of these alternative regressions remain similar to the ones discussed above in terms of signs, magnitude, and significance levels, with a clear non-linear relationship between maternal off-farm employment and child nutrition (table A15, online supplementary appendix S1). For on-farm work, the survey captured labor inputs of different household members in the agricultural production section. We used these data to calculate the number of labor days spent by the mother in on-farm activities. Including this alternative indicator of maternal on-farm work and controlling for other variables in the Mundlak regressions results in insignificant associations with child nutrition, which is also consistent with the estimates above.

Conclusions

We have analyzed the associations between maternal employment and 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 (*a*) income, (*b*) intrahousehold bargaining power, and (*c*) time available for childcare.

The associations and the underlying mechanisms have been evaluated empirically with panel regression models and the Mundlak estimator to control for time-invariant heterogeneity. We have also tried to control for time-variant heterogeneity by including a broad set of covariates, including child, maternal, and household characteristics, and location conditions. We have differentiated between maternal work in off-farm employment and in on-farm agricultural activities, as the implications for child nutrition may differ. Around 11% of the mothers with small children in rural Tanzania are involved in off-farm employment. Maternal off-farm employment is negatively associated with child height-for-age Z-scores (HAZ), when employment is represented as a dummy variable. However, the association varies with the amount of time that the mother spends in off-farm activities. Maternal off-farm employment is negatively associated with child HAZ at low levels of labor supply. This suggests that—at low levels of labor supply—the negative influence of reducing the time for childcare is stronger than the positive influence of rising income and/or female bargaining power. The association between maternal off-farm employment and child HAZ turns positive at higher levels of labor supply and negative again at very high levels, suggesting that time constraints become increasingly binding. When exploring the mechanisms in more detail, we have found limited evidence that the income mechanism as such plays an important role empirically in our context. Yet, the results suggest that maternal off-farm employment contributes to a gain in female bargaining power within the household, which could explain (*a*) why HAZ increases with female off-farm work even after controlling for household consumption expenditures (at least at moderate levels of off-farm hours worked), and (*b*) why girls benefit more than boys from maternal off-farm work.

In most of the regressions, we have not found statistically significant associations between maternal on-farm work and child nutrition. Whereas on-farm agricultural work of the mother can have a direct positive effect on food and nutrient availability, it is probably associated with a smaller gain in female intrahousehold 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, which is typically located further away from the homestead. Hence, the negative 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. Empowering women is often related to improving female employment opportunities. Our results suggest that there can be tradeoffs between the child nutrition and women's 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 associations between maternal employment and child nutrition can evolve. For instance, improved female education and better access to lucrative employment opportunities can strengthen the positive income and intrahousehold 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 findings also suggest that there is substantial scope for social policy interventions, such as providing paid maternity leave. While the share of women with access to paid maternity leave is increasing globally, related benefits are so far mostly tied to formal work contracts, excluding women employed in the informal sector or working on the family farm. In some developing countries, social protection programs are being expanded to include more gender-sensitive components, including benefits for women during pregnancy and lactation, thus accounting for maternal time constraints. A case in point is the third phase of Ethiopia's Productive Safety Net Program, which allows pregnant and lactating mothers to temporarily receive free food and cash instead of participating in food-for-work programs (World Bank 2016).

Our concrete empirical results are specific for rural Tanzania, but the general finding that maternal employment can be associated with child nutrition in unexpected and non-linear ways 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 very robust to using alternative measures and indicators. 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.

Supplementary Material

Supplementary material are available at *American Journal of Agricultural Economics* online.

References

Alderman, Harold, and Derek Headey. 2018. The Timing of Growth Faltering Has Important Implications for Observational Analyses of Underlying Determinants of

Nutrition Outcomes. *PLoS One* 13(4): e0195904.
Atkin, David. 2009. Working for the Future: Female Factory Work and Child Health in Mexico. Available at: http://www.mit.edu/~atkin/Women%20in%20Manufacturing_old.pdf. Last accessed date: January 25, 2020.
Becker, Gary S. 1981. *A Treatise on the Family*. Cambridge, MA: Harvard University Press.
Behrman, Jere R. 1997. Intrahousehold Distribution and the Family. In *Handbook of Population and Family Economics*, Vol 1, ed. Mark R Rosenzweig and Oded Stark, 125–87. Amsterdam, The Netherlands: Elsevier.
Berger, Lawrence M, Jennifer Hill, and Jane Waldfogel. 2005. Maternity Leave, Early Maternal Employment and Child Health and Development in the US. *Economic Journal* 115: F29–47.
Bhalotra, Sonia. 2010. Fatal Fluctuations? Cyclicality in Infant Mortality in India. *Journal of Development Economics* 93: 7–19.
Black, Robert E, Cesar G Victora, Susan P Walker, Zulfiqar A Bhutta, Parul Christian, Mercedes de Onis, Majid Ezzati, Sally Grantham-McGregor, Joanne Katz, Reynaldo Martorell, and Ricardo Uauy. 2013. Maternal and Child Undernutrition and Overweight in Low-Income and Middle-Income Countries. *Lancet* 382: 427–51.
Blau, David, David Guilkey, and Barry Popkin. 1996. Infant Health and the Labor Supply of Mothers. *Journal of Human Resources* 31: 90–139.
Chiappori, Pierre-Andre. 1992. Collective Labour Supply and Welfare. *Journal of Political Economy* 100: 437–67.
Chowdhury, Omar H, Shahidur Khandker, Daniel Millimet, and Mark Pitt. 2003. Credit Programs for the Poor and the Health Status of Children in Rural Bangladesh. *International Economic Review* 44: 87–118.
Cunningham, Kenda, George B Ploubidis, Purnima Menon, Marie Ruel, Suneetha Kadiyala, Ricardo Uauy, and Elaine Ferguson. 2015. Women's Empowerment in Agriculture and Child Nutritional Status in Rural Nepal. *Public Health Nutrition* 18: 3134–45.
de Hoop, Jacobus, Patrick Premand, Furio Rosati, and Renos Vakis. 2018. Women's Economic Capacity and Children's Human Capital Accumulation. *Journal of Population Economics* 31: 453–81.
de Onis, Mercedes, and Francesco Branca. 2016. Childhood Stunting: A Global Perspective. *Maternal & Child Nutrition* 12: 12–26.
Development Initiatives. 2018. *Global Nutrition Report*. Bristol, UK: Development Initiatives.
Ferrant, Gaelle, Luca Maria Pesando, and Keiko Nowacka. 2014. Unpaid Care Work: The Missing Link in the Analysis of Gender Gaps in Labour Outcomes. Issues Paper, December. OECD Development Center, Paris, France.
Glick, Peter, and David E Sahn. 1998. Maternal Labour Supply and Child Nutrition in West Africa. *Oxford Bulletin of Economics and Statistics* 60: 325–55.
Headey, Derek, David Stifel, Liangzhi You, and Zhe Guo. 2018. Remoteness, Urbanization, and Child Nutrition in Sub-Saharan Africa. *Agricultural Economics* 49: 765–75.
Heath, Rachel, and A Mushfiq Mobarak. 2015. Manufacturing Growth and the Lives of Bangladeshi Women. *Journal of Development Economics* 115: 1–15.
Heggeness, Misty L. 2020. Improving Child Welfare in Middle Income Countries: The Unintended Consequence of a Pro-Homemaker Divorce Law and Wait Time to Divorce. *Journal of Development Economics* 143: 102405.
Hoddinott, John, Harold Alderman, Jere R Behrman, Lawrence Haddad, and Susan Horton. 2013. The Economic Rationale for Investing in Stunting Reduction. *Maternal & Child Nutrition* 9: 69–82.
Hoddinott, John, and Lawrence Haddad. 1995. Does Female Income Share Influence Household Expenditures? Evidence from Cote d'Ivoire. *Oxford Bulletin of Economics and Statistics* 57: 77–96.
Horton, Sue, and Richard Steckel. 2013. Malnutrition: Global Economic Losses Attributable to Malnutrition 1900–2000 and Projections to 2050. In *How Much Have Global Problems Cost the World? A Scorecard from 1900 to 2050*, ed. Bjorn Lomborg, 247–72. Cambridge: USA, New York, Cambridge University Press.
Iannotti, Lora, Kenda Cunningham, and Marie Ruel. 2009. Improving Diet Quality and Micronutrient Nutrition: Homestead Food Production in Bangladesh. IFPRI Discussion Paper 928, International Food

Policy Research Institute, Washington DC.

Jain, Monica, and Manfred Zeller. 2015. Effect of Maternal Time Use on Food Intake of Young Children in Bangladesh. Paper presented at the 11th Annual Conference on Economic Growth and Development, New Delhi, 17–19 December.

Johnston, Deborah, Sara Stevano, Hazel J Malapit, Elizabeth Hull, and Suneetha Kadiyala. 2018. Review: Time Use as an Explanation for the Agri-Nutrition Disconnect: Evidence from Rural Areas in Low and Middle-Income Countries. *Food Policy* 76: 8–18.

Kabeer, Naila. 1999. Resources, Agency, Achievements: Reflections on the Measurement of Women's Empowerment. *Development and Change* 30: 435–64.

Komatsu, Hitomi, Hazel Jean L Malapit, and Sophie Theis. 2018. Does Women's Time in Domestic Work and Agriculture Affect Women's and Children's Dietary Diversity? Evidence from Bangladesh, Nepal, Cambodia, Ghana, and Mozambique. *Food Policy* 79: 256–70.

Lepine, Aurelia, and Eric Strobl. 2013. The Effect of Women's Bargaining Power on Child Nutrition in Rural Senegal. *World Development* 45: 17–30.

Leroy, Jef L, and Edward A Frongillo. 2019. Perspective: What Does Stunting Really Mean? A Critical Review of the Evidence. *Advances in Nutrition* 10: 196–204.

Leslie, Joanne. 1988. Women's Work and Child Nutrition in the Third World. *World Development* 16(11): 1341–62.

Majlesi, Kaveh. 2016. Labor Market Opportunities and Women's Decision Making Power within Households. *Journal of Development Economics* 119: 34–47.

Malapit, Hazel Jean L, Suneetha Kadiyala, Agnes R Quisumbing, Kenda Cunningham, and Parul Tyagi. 2015. Women's Empowerment Mitigates the Negative Effects of Low Production Diversity on Maternal and Child Nutrition in Nepal. *Journal of Development Studies* 51: 1097–123.

Masset, Edoardo, Lawrence Haddad, Alexander Cornelius, and Jairo Isaza-Castro. 2012. Effectiveness of Agricultural Interventions that Aim to Improve Nutritional Status of Children: Systematic Review. *British Medical Journal* 344: 1–7.

Mundlak, Yair. 1978. On the Pooling of Time Series and Cross Section Data. *Econometrica* 46: 69–85.

Ngenzebuke, Rama L., and Yoko Akachi. 2017. Female Work Status and Child Nutritional Outcome in Nigeria. WIDER Working Paper 2017/196. World Institute for Development Economic Research (UNU-WIDER).

Oddo, Vanessa M, Pamela J Surkan, Kristen M Hurley, Caitlin Lowery, Silvia de Ponce, and Jessica C Jones-Smith. 2018. Pathways of the Association between Maternal Employment and Weight Status among Women and Children: Qualitative Findings from Guatemala. *Maternal & Child Nutrition* 14: 1–10.

O'Donnell, Owen, Eddy van Doorslaer, Adam Wagstaff, and Magnus Lidelow. 2008. *Analysing Health Equity Using Household Survey Data: A Guide to Techniques and their Implementation*. Washington DC: World Bank.

Ogutu, Sylvester O, Theda Gödecke, and Matin Qaim. 2020. Agricultural Commercialisation and Nutrition in Smallholder Farm Households. *Journal of Agricultural Economics* 71: 534–55.

Popkin, Barry M, and Florentino S Solon. 1976. Income, Time, the Working Mother and Child Nutrition. *Journal of Tropical Pediatrics and Environmental Child Health* 22: 156–66.

Pratley, Pierre. 2016. Associations between Quantitative Measures of Women's Empowerment and Access to Care and Health Status for Mothers and their Children: A Systematic Review of Evidence from the Developing World. *Social Science & Medicine* 169: 119–31.

Rangel, Marcos. 2006. Alimony Rights and Intrahousehold Allocation of Resources: Evidence from Brazil. *Economic Journal* 116: 627–58.

Rashad, Ahmed S, and Mesbah F Sharaf. 2019. Does Maternal Employment Affect Child Nutrition Status? New Evidence from Egypt. *Oxford Development Studies* 47: 48–62.

Reggio, Iliana. 2011. The Influence of the Mother's Power on her Child's Labor in Mexico. *Journal of Development Economics* 96: 95–105.

Rivera-Pasquel, Marta, Leticia Escobar-Zaragoza, and Teresita González de Cosío. 2015. Breastfeeding and Maternal Employment: Results from Three National Nutritional Surveys in Mexico. *Maternal and Child Health Journal* 19: 1162–72.

Ruel, Marie, and Harold Alderman. 2013. Nutrition-Sensitive Interventions and

Programmes: How Can They Help to Accelerate Progress in Improving Maternal and Child Nutrition? *Lancet* 382: 536–51.

Senauer, Benjamin, and Marito Garcia. 1991. Determinants of the Nutrition and Health Status of Preschool Children: An Analysis with Longitudinal Data. *Economic Development and Cultural Change* 39: 371–89.

Shively, Gerald E. 2017. Infrastructure Mitigates the Sensitivity of Child Growth to Local Agriculture and Rainfall in Nepal and Uganda. *Proceedings of the National Academy of Sciences of the United States of America* 114: 903–8.

Sraboni, Esha, Hazel Jean Malapit, Agnes R Quisumbing, and Akhter U Ahmed. 2014. Women's Empowerment in Agriculture: What Role for Food Security in Bangladesh? *World Development* 61: 11–52.

Tucker, Katherine, and Diva Sanjur. 1988. Maternal Employment and Child Nutrition in Panama. *Social Science & Medicine* 26: 605–12.

United Nations. 2018. Sustainable Development Goals. Goal 5: Gender Equality: Why it Matters. Available at: https://www.un.org/sustainabledevelopment/wp-content/uploads/2018/09/Goal-5.pdf. Last accessed date: December 19, 2018.

WHO. 2006. *The WHO Child Growth Standards: Length/Height-for-Age, Weight-for-Age, Weight-for-Length, Weight-for-Height and Body Mass Index-for-Age: Methods and Development*. Geneva, Switzerland: World Health Organization.

Wooldridge, Jeffrey M. 2019. Correlated Random Effects Models with Unbalanced Panels. *Journal of Econometrics* 211: 137–50.

World Bank. 2007. From Agriculture to Nutrition: Pathways, Synergies and Outcomes. Report 40196-GLB. Washington DC.

———. 2016. Implementation Completion and Results Report. Productive Safety Net APL III Project. Social Protection and Labor Global Practice. Africa Region. Report No. ICR00003659. Washington DC.