Navigating the Maize of Poverty: Intra-Household Allocation and Investment in Children's Human Capital in Tanzania

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Abstract

Intra-household resource allocation influences investment in children's human capital and hence influences long-term poverty levels. I study how climate shocks in Tanzania shift intra-household bargaining power and investment in children's human capital. Past empirical work finds that bargaining power is associated with income, assets, education, and other often unobservable factors. Anthropological evidence from Tanzania suggests that male decision-makers in poor households control most income and own most assets. Conditioning on changes in total household resources due to climate shocks, I find evidence consistent with climate shocks increasing female bargaining power through a reduction in male decision-maker's income. Specifically, climate shocks in households with more educated women increase investment in children's education and improve anthropometric measures of health. Lastly, I comment on the usefulness of relative education as a proxy for bargaining power in contexts of data and cultural limitations on distinct assets and income streams for decision-makers.

JEL Codes: D13, I20, J12, J16, Q54

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1. Introduction

Approximately 10% of people (736 million people) live in extreme poverty, more than half of which are children. Moreover, 82% of the poor live in rural areas and are engaged in agriculture. Most of these rural poor farmers are smallholder farmers and work their own plots (World Bank, 2018a). Consequently, the majority of a rural poor household's resources come from agriculture (Davis, Di Guiseppe, and Zezza, 2017). The level and distribution of these resources across household activities can have severe implications for children's long-term outcomes. Indeed, a substantial body of past empirical work has linked higher levels of education and health expenditures to increased children's human capital (Acemoglu and Pishke, 2001; Cameron and Heckman, 2001; Akee et al., 2010), higher wages in adulthood (Hill and Duncan, 1987; Peters, 1992; Corak, 2006), and better health and cognitive development in the life cycle (Behrman and Skoufias, 2006; Macours, Schady, and Vakis, 2012; Noble et al., 2015). Thus, identifying the drivers of household resource allocation is of critical importance to economists and policy makers seeking to lift impoverished populations out of poverty and meet development goals.

Rigorous analysis of household resource allocation requires an underlying model of household behavior. In the literature, two overarching models have emerged: the unitary model and the collective model. I focus on the notion of relative bargaining power, or more simply the ability of one decision-maker to realize her preferences and maximize her objective function in competition with another decision-maker. Bargaining power analyses are consistent with the collective but not unitary model. The unitary model requires intuitively and empirically unreasonable assumptions such as household decision-making controlled by a dictator or all household decision-makers having perfectly identical preferences (Becker, 1981; Samuelson, 1956). Moreover, extensive empirical and theoretical work, particularly regarding patterns of resource allocation, supports the collective model in which individual

decision-makers have distinct preferences and objective functions (Thomas, 1990; Thomas, Contreras, and Frankenberg, 2002; Browing, Chiappori, and Lewbel, 2013; Doss, 2013). Finally, the unitary model has been widely rejected by tests of income pooling (Chiappori and Mazzocco, 2017).[1]

A complicating factor is that rural poor farmers are significantly and repeatedly affected by climate shocks (natural disasters, negative weather pattern deviations). The effects of these shocks are often persistent and exacerbated in settings of limited access to shock-smoothing mechanisms such as insurance and credit markets. Past empirical work has often exploited plausibly exogenous shocks to distinct assets and income streams of household decision-makers to isolate individual preferences and determine relative intra-household bargaining power (Duflo, 2000; Cameron and Worswick, 2001; Duflo and Udry, 2004; Quisumbing, Kumar, and Behrman, 2017). Examples of distinct assets and income streams include relative female and male land ownership and relative income from female-controlled crops and male-controlled crops. However, in some contexts like Tanzania, it is often difficult to observe such distinct assets and income streams of male and female decision-makers. Reasons include data constraints or simply even cultural norms (Leavens and Anderson, 2011). I demonstrate that relative education is a useful proxy for bargaining power in such contexts.

In this paper, I explore the following research question. Do changes in intra-household bargaining power affect children's human capital in impoverished rural populations? I exploit climate shocks to answer this question and frame the analysis around contexts in which there are no clear distinct assets and income streams among decision-makers. I use the Tanzania National Panel Survey (TZNPS) Waves 1, 2, and 3 (2010-2011, 2012-2013, 2014-2015) to extract 3,186 households and 9,338 individuals and conduct panel analysis. I use the difference between female and male decision-makers' education attainment as my proxy for higher relative female bargaining power, henceforth referred to as

[1] See Alderman, Chiappori, Haddad, Hoddinott, and Kanbur (1995) for a more thorough discussion on the two models and why much of the literature has shifted towards collective models of household behavior.

female bargaining power. Past empirical work connects education attainment to outside opportunities of decision-makers. Thus, the education gap between male and female decision-makers should capture some aspect of intra-household bargaining power (Angelucci, 2008; Handa, 2009; Lundberg and Ward-Batts, 2013). My empirical strategy is modeled off of region fixed effects analyses of changing shares of expenditures due to changes in intra-household bargaining power (Quisumbing and Maluccio, 2003; Duflo and Udry, 2004; Doss, 2006). Specifically, I regress female bargaining power on children's human capital and interact female bargaining power with climate shocks. Climate shocks help capture changes in female bargaining power by reducing agricultural income generated by the male decision-maker and isolate individual investment preferences of household decision-makers. I condition on household characteristics, assets, access to social assistance, and most importantly, total household expenditure. By conditioning on total household expenditure, my results are robust to changes in total household resources due to climate shocks.

I find that in a nationally representative sample of rural and small-town Tanzanian households, my proxy for female bargaining power is consistently and significantly correlated with an increased share of education expenditure for children. I further show that, in the presence of a climate shock, my proxy for female bargaining power is consistently and significantly correlated to an almost 2x increased share of education expenditure for children. Finally, I show that my proxy for female bargaining power, in the presence of a climate shock, is consistently and significantly correlated to heterogeneous effects by age including (a) increased height-for-age z-scores for a subsample of children aged 5 years or less and (b) increased weight-for-age z-scores for a subsample of children aged 5 years or less. The latter finding is of particular interest to policy makers and economists, especially considering the lasting effects early childhood health has on life cycle outcomes (Alderman, Hoddinott, and Kinsey, 2006; Dewey and Begum, 2011). I also present preliminary evidence on heterogeneous effects by child's

gender and find that female bargaining power, in the presence of climate shock, is positively and significantly correlated to (a) increased height-for-age z-scores for female children as compared to male children and (b) increased weight-for-age z-scores for female children as compared to male children.

I make four primary contributions to the field with this paper. First and foremost, my findings add to the growing literature showing female bargaining power has significant positive effects on children's human capital. Furthermore, I show that these positive effects are significantly larger in the presence of a climate shock. By using education gap as a proxy for female bargaining power, I also demonstrate an alternative mechanism to understand and interpret intra-household bargaining power. Second, my proxy for female bargaining power is simply the education gap between male and female decision-makers. This proxy is calculated from individual responses to the TZNPS, and considering the relatively discrete set of answers, not likely to have high degrees of measurement error. Third, this proxy is particularly useful in settings where data collection is not disaggregated enough to identify distinct assets and income streams of male and female decision-makers. This proxy is also useful in contexts where culture dictates that one decision-maker controls all income but there still exist other unobserved factors driving bargaining power. Thus, in contexts where more popular measures of bargaining power such as female and male land ownership, income from female and male controlled crops, and female and male personal assets are not easily observable, I show education gap can be a useful tool to understand bargaining power. Fourth, there are larger repercussions and policy implications of these findings towards targeting social protection programs to female decision-makers or increasing education of female decision-makers. Both would increase cost-efficiency and government capacity and ability to more fully cover vulnerable households under social protection and safety nets.

The remainder of the paper proceeds as follows. Section 2 offers key insights on the Tanzanian context and provides information regarding norms of controlled income and bargaining power. Section 3

details a literature review of robust techniques and theory related to intra-household resource allocation, human capital development, and intergenerational mobility. Section 4 more rigorously situates the paper in a theoretical framework of household bargaining and resource allocation. Section 5 provides a detailed description of my empirical strategy and accompanying robustness checks. In Section 6, I describe the data, important caveats related to it, and the development of my analytic samples and sub-samples. I present an analysis of my results alongside limitations in Section 7. Section 8 concludes.

2. Background

2.1. Tanzania Context

Tanzania is one of the poorest countries in the world based on income per capita (World Bank, 2019a). The country has made recent strides in poverty alleviation with national poverty rate falling from 34.4% in 2007 to 26.8% in 2016 and fertility rate decreasing from 5.8 in 1995 to 4.9 in 2017 (World Bank, 2018b, 2019b). However, climate shocks continue to affect household resource allocation and poverty. These shocks disproportionately affect the rural population which makes up more than 66% of the population of Tanzania. On one level, this is due to lack of infrastructure and preparedness for shocks (World Bank, 2018c). On another level, 74% of the rural population is engaged in agriculture, an industry particularly vulnerable to climatic shocks. Agriculture itself only accounts for 28.4% of Tanzania's GDP, implying rural agricultural workers receive little income for their work. Correlated to low income for rural agricultural workers, 10% of Tanzanians live below the food poverty line and one in three children is chronically malnourished (World Food Programme, 2019).

The effect climate shocks have on staple crop production, especially maize, is particularly devastating. Not only is maize the most consumed staple crop in Tanzania, Tanzania has the largest maize field area in the entirety of East Africa. Small-scale and rural farmers in Tanzania contribute to

more than 80% of total maize production in the country. Notably, for the average Tanzanian, maize provides 80% of dietary calories and more than 35% of utilizable protein (USDA FAS, 2019).

2.2. Law and Land Rights in Tanzania

In Tanzania, women comprise 54% of the labor force in agriculture. In rural areas, 98% of women are engaged in some form of agricultural activity (Ovensen, 2010). Furthermore, 81% of the female population works in agriculture, compared to 55% in the rest of sub-Saharan Africa (FAO, IFAD, ILO, 2010). Though it is clear women play a critical role in Tanzanian smallholder agriculture, women only own 19% of titled land. Even when women do own land, the size of their average land holding is less than half that of men. Though statutory law (practiced in urban settings) provides provisions for women's land ownership, customary law (practiced in rural settings) and traditional norms continue to discriminate against women. It is true that many women have usufruct rights through their spouses or male family members. However, they still do not actually own land (Ellis, 2007).

After marriage, men tend to provide small plots for food cultivation to women. These plots are still owned by the man, but planting decisions are made by the woman (Sender and Smith, 2012). Though customary law dictates that the man cannot claim the land cultivated by the woman for cash crop farming, in practice this rarely holds. Indeed, even judging simply by land ownership, the man of the household has a monopoly on all agricultural-related activities (Leavens and Anderson, 2011).

2.3. Gendered Division of Labor in Tanzania

As is common across much of sub-Saharan Africa, men in Tanzania are responsible for income-generating activities and cash crop farming while women are responsible for food crop farming, supporting cash crop farming, and the majority of unpaid household labor. Unpaid household labor includes (a) caring for children, the sick, and the elderly, (b) feeding household members via food crop production, (c) collecting water and fuelwood for washing, cooking and other use, and (d) weeding,

post-harvest processing, and other agricultural support activities. Importantly, men nearly always control income from cash crops, regardless of women's labor input (Ellis, 2007).

2.4. Intra-Household Bargaining in Tanzania

The fact that men control nearly all cash income and own the majority of land makes conducting a bargaining power analysis in which bargaining power is proxied by distinct assets or income streams unreasonable. First, there are close to no cases in which the woman makes income or holds assets over which the husband does not have control over. Second, in the few cases in which the woman does have a distinct income stream or personal assets, the man often can (and does) ask for these resources. Importantly, though the typical rural man in Tanzania may control all aspects of agricultural income and assets, the woman is not without bargaining power. Particularly relevant for this paper, Wandel and Holmboe-Otteson (1992) find that female decision-makers with more schooling than male decision-makers within the household had more bargaining power.

In addition, anthropological literature suggests that there is often intra-household conflict related to production and resource allocation decisions that are determined almost exclusively by the relative bargaining power of the male and female decision-makers. For example, a study in the Tanga region found that men invest in resources for personal benefit (clothes, coats, shoes, watches) whereas women preferred to meet household food and other needs (Smith and Sender, 2012). Similarly, men prefer maximizing cash crop production at the cost of food. These anthropological findings prompted empirical work on alternative mechanisms through which Tanzanian women establish their bargaining power. Particularly, women in Tanzanian households seem to establish their bargaining power by appealing to community norms and men's dependency on their labor. Women can leverage community leaders or even household elders to gain bargaining power. The recognized importance of women's unpaid household labor input also facilitates greater bargaining power for the woman (Mbilinyi, 1994).

3. Literature Review

In this section, I explore three strands of literature pertinent to household resource allocation and children's human capital. First, I discuss evidence on the effects of exogenous shocks on household resource allocation with a particular focus on climate shocks. Second, I investigate common bargaining power measurement techniques and variation due to context and data constraints. Finally, I analyze empirical work on the relationship between children's human capital and household resource allocation and connect it to theoretical models of human capital and intergenerational mobility of income. A more thorough discussion of theoretical models and insights used in this paper is in Section 4.

3.1. Exogenous Shocks

For this paper, understanding the relationship between exogenous shocks, particularly climate shocks, and patterns of resource allocation is important to motivate why exploiting these types of shocks gives insight on changes in female bargaining power. There is extensive literature using shocks to infer how access to key resources during childhood contemporaneously affects household resource allocation and in the long-term affects outcomes. For example, Yi, Heckman, Zhang, and Conti (2015) find that early childhood health shocks increase health expenditures and decrease education expenditures but overall negatively affect long-term health, education, and socioemotional outcomes. Dinkelman (2017) finds that early childhood exposure to droughts increases later-life disability rates by 3.5-5.2%. Considering that droughts in rural areas have become close to synonymous with income shocks (IPCC, 2014), this finding may be related to changes in education and health spending. Beegle, Dehejia, and Gatti (2005) and Bandara, Dehejia, and Lavie-Rouse (2014) find that household income shocks decrease education spending as children are forced to enter into labor, which in turn has negative effects on labor market outcomes in adulthood.

There is a smaller but still substantial body of literature linking female bargaining power (in most cases proxied by female income share) to increases in children's expenditure.[2] Here, I focus on the few that leverage climate shocks to justify these findings.[3] Bobonis (2009) finds that climate shocks, specifically shocks that influenced a female's bargaining power, increased household expenditures on children's goods (education, health). Similarly, Duflo and Udry (2004) find that positive rainfall shocks to women-controlled crops in Cote D' Ivoire increased shares of education expenditures for children. Notably, Duflo and Udry (2004) reject Pareto efficient allocation of household resources, but this is contested in subsequent literature (Akresh, 2005; Rangel and Thomas, 2006). Lépine and Strobl (2013) find that positive rainfall shocks to women-controlled crops in Ghana increased children's nutritional status. In a more theoretical approach, Holger (2009) uses semiparametric Engel curves to estimate that households with empowered women spend significantly more on the welfare of children and less on adult-only goods. There are several theories explaining this bias including but not limited to old age security, preference gaps, and altruism/care.[4]

3.2. Measuring Bargaining Power

Here, I describe the various approaches to measuring bargaining power and explain in detail why using education gap is a useful approach in the Tanzanian context. Bargaining power is unobservable. Much of the literature regarding bargaining power focuses on using proxies to indirectly measure bargaining power. Particularly when trying to connect the impact of women's bargaining power on some outcome, an "inferential approach" must be used (Thomas, 1990). If the proxy for women's bargaining power has a significant impact on the outcome in question, a reasonable inference can be made that

[2] Note that there does exist a literature on differential expenditures on children by gender (Alderman and King, 1998; Alderman and Gertler, 1997; Björkman-Nyqvist, 2013; Jayachandran and Pande, 2017). The core results of this paper focus on changes in shares of expenditure for children in general and the literature review is reflective of that.
[3] For non-shock related findings, see Thomas (1993), Lundberg, Pollak, and Wales (1997), Attanasio and Lechene (2002), and Qian (2008).
[4] See Willis (1980), Lundberg and Pollak (1993), Eswaran and Kotwal (2004), and Browning, Chiappori, and Lechene (2010).

women prefer that outcome. Some common proxies that are used include income and employment, asset ownership, and education (Doss, 2013).

Women's earned income and earned income share carries much intuitive appeal as a proxy for bargaining power. Luke and Minshi (2011) study the effects of changes in earned income from tea estates in India and children's human capital, marital violence, and marriage outcomes. Similarly, Yusof and Duasa (2010) use women's earning share to find significant differences in decision-making and expenditure patterns. There are three caveats to this approach. First, as noted in Tanzania and other contexts, even if women earn income, they may not control it. Without control of the income, earned income and earned income share is not a reasonable proxy for bargaining power. Second, there may be reverse causality because labor market decisions of household decision-makers are made within the household and thus may depend on bargaining power. Third, earned income and earned income shares may be measured with high measurement error due to fluidity and recall length.

Women's owned assets are another common proxy for bargaining power. In most developing countries, land is the most important asset due to the prevalence of rural agriculture. Panda and Agarwal (2005) use land ownership as a measure of bargaining power in India. Doss (2006) uses both owned farmland and savings and business assets as measures of bargaining power in Ghana. Friedemann-Sanchez (2006) considers less common measures of assets such as social networks as proxies for bargaining power. Beegle, Frankenberg, and Thomas (2001) use women's perception of share of asset ownership as another proxy for bargaining power. To address a similar concern of reverse causality in asset ownership and bargaining power, some studies have used assets brought at onset of marriage as proxies for bargaining power (Quisumbing and de la Briere, 2000; Quisumbing and Maluccio, 2003). There are two limitations to this approach. First, individual asset ownership is only measured in specific contexts. For surveys that measure asset ownership at the household level, it is difficult to disentangle

male and female assets without anthropological support and assumptions. Second, in many contexts such as Tanzania, women rarely own land and only sometimes hold usufruct rights making comparisons for bargaining power analysis quite difficult.

Finally, women's (relative) education has been used as a proxy for bargaining power. Thomas (1994) uses education levels of the male and female decision-makers to examine effects on child height for age. Quisumbing, Estudillo, and Otsuka (2005) similarly use education levels of both decision-makers to determine effects of bargaining power on children's human capital and land access. Though education is perhaps the least direct of the discussed bargaining power proxies, it is useful in contexts where data does not measure distinct assets and income streams for decision-makers. Furthermore, even in contexts where the male decision-maker controls most of the income, land, and other assets, education and relative education can still be used to determine bargaining power.

3.3. Children's Human Capital and Intergenerational Mobility of Income

Children's human capital is a critical factor in determining later-life outcomes and sustainable escape from poverty. A common outcome of bargaining power analyses is effect on children's human capital, most normally measured through children's education attainment, health and education expenditures on children, and health of children through anthropometric measures such as height for age and weight for age. For example, Duflo (2003) explored the impact of providing pensions to South African black grandmothers on weight for height and height for age of granddaughters. Notably, subsequent literature has raised concerns on Duflo (2003) due to intergenerational changes in household composition (Edmonds, Mammen, and Miller, 2004; Hamoudi and Thomas, 2014). Deininger, Jin, Nagarajan, and Xia (2014) used increases in education attainment to explore effects of bargaining power changes due to changes in India's inheritance law. Similarly, Qian (2008) also uses education attainment as an outcome for bargaining power analysis in China. Particularly relevant for this paper, Brown (2006)

finds that more educated parents tend to make greater education investments in children. Furthermore, the marginal effect of the female decision-maker's education on education investment is greater than that of the male decision-maker. Menon, Rodgers, and Nguyen (2014) confirm this finding in Vietnam by exploiting Vietnam's 1993 Land Law, noting that households in which females were given land rights reallocated expenditures towards food and raised school enrollment.

To highlight the importance of bargaining power effects on children's human capital and subsequent effects on escape from poverty and intergenerational mobility of income, note Gary Becker and Nigel Tomes' seminal piece (Becker and Tomes, 1986). In their paper, Becker and Tomes discuss how the transmissions of earnings, assets, and consumption from parents to children may occur. Becker and Tomes describe the sets of investment and consumption decisions for children and how they together affect a child's human capital and long-term outcomes. Particularly relevant are investment and consumption decisions related to health and education. Other models of human capital and intergenerational mobility of income have similarly emphasized the importance of investments in health and education for children (Becker and Tomes, 1979; Corak, 2013; Solon, 2002). Thus, empirical work that connects intra-household bargaining power to significant variation in children's human capital, as this paper does, can reasonably be interpreted to establish bargaining power itself as a major determinant of children's ability to escape poverty and intergenerational mobility of income.

4. Theoretical Framework

In this section, I describe one theoretical model that kickstarted models of household behavior, a method to motivate weighting bargaining power in social welfare functions, and two theoretical models from which I derive my empirical strategy, variables of interest, and conditioning vector.

First, I note the Beckerian model in which household decision-makers jointly maximize a household welfare function. This model inherently assumes common preferences between household

decision-makers. Income is assumed to be allocated such that the marginal rate of substitution between any two goods is equal for any pair of goods (Becker, 1975). The Beckerian model is an example of a unitary model and has largely been rejected across geographies. The findings of this paper are similarly not consistent with the unitary model.

Second, I briefly discuss a method used in some collective models: the Bergson-Samuelson social welfare function. This function constructs a social utility function based on a particular configuration or "profile" of individual preferences (Bergson, 1938; Samuelson, 1948). In regard to household behavior and bargaining power, each household member's respective individual utility function is aggregated and weighted by bargaining power. For the purposes of this paper, I restrict the sample to monogamous households with both parents living in the household and analyze relative bargaining power between the two. Thus, in the context of the Bergson-Samuelson social welfare function, only the two parents' individual utility functions enter the weighted aggregator function while the utility functions of other members of the household are weighted zero (Thomas, 1990). Though the mathematics behind the function are not displayed here or directly used in this paper, it is important to motivate clearly under which objective function (and assumptions) bargaining power is discussed.

The theoretical model of Thomas (1990) uses a derivation of the Bergson-Samuelson social welfare function conditioning on parental education instead of male and female wages as a proxy for bargaining power. Thomas also uses region fixed effects to account for variation in prices. The theoretical model of Duflo and Udry (2004) similarly assumes the collective model. They examine a testable restriction of that model, the income pooling hypothesis. In short, the income pooling hypothesis states that household income earners will pool their respective incomes and jointly make household decisions rather than use their respective incomes for particular types of expenditures. This implies that, conditional on prices, total expenditure, and preference parameters, expenditure shares of

any particular type of activity are independent of exogenous shocks. Only the expenditure elasticity of demand for that type of expenditure and effect of the exogenous shock on total expenditure come into play. Duflo and Udry reject this hypothesis in the context of Cote D' Ivoire.

5. Empirical Specification

I use two closely related empirical models to comprehensively answer the research question. First, I run a baseline check and see the relationship between female bargaining power and outcomes of interest, without conditioning on climate shocks. Recall that bargaining power is proxied by education gap between the male and female decision-makers. Second, in the core model of this paper, I include climate shocks and interactions with bargaining power to determine the relationship between a shift in bargaining power towards the female decision-maker and outcomes of interest.

5.1. Baseline Check

This baseline check model is run primarily to show that education gap itself does contain explanatory power as a proxy for bargaining power. For the baseline check, I run a fixed-effects ordinary least squares (OLS) regression model. I choose fixed effects to control for time-invariant differences among 26 regions (or *mikoa*) of Tanzania, as recorded in the TZNPS. Notably, the inclusion of these fixed effects has two purposes. First, these fixed effects account for regional variation in geography and tendency for climate shocks. Second, these fixed effects assume markets are regionally integrated such that at any given time, relative prices are the same across the region. I discuss the validity of this assumption in Section 7.

Excluding shocks for this baseline check, I assume the relevant outcome equation for a particular household *i* in period *t* in region *j* is of the form

$$Y'_{ijt} = \beta_1 EduGap_{it} + \beta_2 HeadEduc_{it} + \beta_3 HeadAge_{it} + \beta_4 HHSize_{it} + [\gamma_2 Assets_{it}] + [\gamma_3 Assistance_{it}] + [\alpha_j + \delta_t] + TotalExp_{it} + \varepsilon_{ijt} \quad (\mathbf{1})$$

where Y'_{ijt} is a vector of outcomes. These outcomes include shares of education expenditure, health expenditure, homegrown food expenditure (food inside), purchased/luxury food expenditure (food outside), weight-for-age z-scores (by gender), and height-for-age z-scores (by gender). On the right-hand side, the key independent variable is $EduGap_{it}$. This variable is female-minus-male difference in education attainment. The most basic conditioning vector includes education of the household head ($HeadEduc_{it}$), age of the household head ($HeadAge_{it}$), and size of the household ($HHSize_{it}$). Brackets denote additional specifications for more extensive conditioning vectors. The $Assets_{it}$ additional specification includes the total plot value of all owned plots and the total number of livestock owned by the household. The $Assistance_{it}$ additional specification includes a measure of the number of safety nets (such as Tanzania's flagship Productive Social Safety Net (PSSN)) and other social assistance programs the household was enrolled in. Finally, $TotalExp_{it}$ conditions for the effect of changes in overall expenditure on individual preferences for outcomes.

The coefficient β_1 on the key variable of interest, $EduGap_{it}$, can be interpreted as the association between female bargaining power and the outcome. This coefficient is expected to be positive and significant for education, food inside, and health expenditures and anthropometric measures. This would imply female bargaining power is associated with increases in these outcomes. For food outside expenditures, β_1 should be negative and significant.

One caveat is that, by excluding climate shocks, this model only allows for an interpretation of the relationship between current, fixed bargaining power and outcomes of interest.

5.2. Core Model

Similar to the baseline check, I run a region fixed-effects OLS regression model. In this model, I include shocks and assume the outcome equation to be of the form

$$Y'_{ijt} = \beta_1 EduGap_{it} + \beta_2 Shock_{it} + \beta_3 (EduGap \times Shock)_{it} + \beta_4 HeadEduc_{it} + \beta_5 HeadAge_{it} + \beta_6 HHSize_{it} + [\gamma_2 Assets_{it}] + [\gamma_3 Assistance_{it}] + [\alpha_j + \delta_t] + TotalExp_{it} + \varepsilon_{ijt} \quad (\mathbf{2})$$

where all repeated outcomes and variables from model **(1)** are defined as in model **(1)**. On the right-hand side, *Shock*it is a dummy for a severely negative climate shock, mostly in the year before the survey. Now, the coefficient β_1 is the association between female bargaining power on the outcome specifically when there is no shock. The coefficient sum $\beta_1 + \beta_3$ is the association between female bargaining power on the outcome specifically when there is a shock. β_3 captures how higher female bargaining power moderates the effect of a climate shock on the outcome. β_3 is expected to be positive and significant for education, food inside, and health expenditures, and anthropometric measures. Depending on the magnitude, this would imply female decision-makers have stronger distinct preferences for children's goods in comparison to male decision-makers. Recall that a climate shock will affect only the male decision-maker's earned income stream (because he controls most agricultural income) and thus lower his relative bargaining power in the household. This subsequently increases the female decision-maker's relative bargaining power in the household.

6. Data

6.1. Dataset

To answer the research question, I choose the Tanzania National Panel Survey (TZNPS). The TZNPS is a joint project between the Tanzania National Bureau of Statistics and the World Bank Living Standards Measurement Survey (LSMS). The TZNPS is a panel dataset with four waves with Wave 1 (2008-2009) collecting data on four primary domains: Dar es Salaam, other urban areas on mainland Tanzania, rural mainland Tanzania, and Zanzibar. Wave 2 (2010-2011) continued with the same households and importantly includes any split-off households from Wave 1. Split-off households are households headed by former members of the households sampled in Wave 1, usually created by adult

children marrying or leaving permanently for work. Wave 3 (2012-2013) revisits all households interviewed during the first two waves. The TZNPS has household-level, individual-level, community-level, and highly granular agricultural data as the TZNPS is part of the LSMS-Integrated Surveys on Agriculture (LSMS-ISA) program. Wave 1 interviewed 3,265 households (10,420 eligible adults) of which 2,063 households were in rural areas and 1,202 households in urban areas. Wave 2 re-interviewed 3,168 households (9,338 eligible adults) from the Wave 1 sample and added 756 split-off households for a total sample size of 3,924 households. Wave 3 re-interviewed all 3,924 households (10,041 eligible adults) and added 1,091 new or split-off households for a total of 5,015 households. Wave 4 (2014-2015) of the TZNPS is not used in this paper because it involved a "Refresh Sample" and did not re-interview Waves 1-3 households. Thus, the number of households with panel data across the three waves is 3,168 households (9,338 eligible adults), making total panel attrition up to TZNPS Wave 3 roughly 4.84% for households.

There are three reasons why the TZNPS is particularly suited for intra-household analysis. First, the TZNPS recorded granular disaggregated expenditure data. For my analysis, this makes it possible to directly see changes in shares of expenditures as a result of climate shocks. Second, the TZNPS rigorously tracked each household over time. In TZNPS Waves 2 and 3, any household from the original sample that had relocated or moved from its original location were interviewed in their new location. This minimizes attrition and makes the dataset more reflective of a common occurrence in developing countries, intra-country migration. Specifically, household attrition from Wave 1 to Wave 2 was 3% and individual attrition from Wave 1 to Wave 2 was 10%. Household attrition from Wave 2 to Wave 3 was 3.50% and individual attrition from Wave 2 to Wave 3 was 7.52%. Third, the TZNPS also rigorously tracked each individual over time. If an individual over the age of 15 split-off from the original household to form a new household, both the individual's original household and new household were

included in the sample. This further minimizes attrition and ensures that anthropometric measures are measured accurately.

The TZNPS is representative at the national, urban/rural, and major agro-ecological zone levels. Weights are provided. However, as is common in the literature, I assume homogeneity of sampled households for the coefficient on female bargaining power and thus do not use weights in my regression models (Deaton, 1997). Following the World Bank naming convention, TZNPS Wave 1 will henceforth be discussed as TZNPS1, TZNPS Wave 2 as TZNPS2, and TZNPS Wave 3 as TZNPS3. Four questionnaires were used across TZNPS1-3: (1) Household Questionnaire, (2) Agriculture Questionnaire, (3) Livestock/Fishery Questionnaire, and (4) Community Questionnaire.

6.2. Analytical Sample

I construct two analytic samples: (1) monogamously married male-female couple households who were interviewed in all three waves of the TZNPS and (2) a similar set of households with the additional restriction that only households with children less than 5 years old are included. Sample 1 is composed of 2,604 adults in 1,302 households. Sample 2 is composed of 846 adults and 423 households. Sample 2 is used only for anthropometric analyses for children less than 5 years old. Due to the nature of intra-household bargaining power analysis, it is common to restrict analytical samples to monogamously married male-female couple households. Thus, widows/widowers, divorcees, polygamous households, and married couples living apart are dropped from the original 3,186 household sample.

6.3. Key Variables and Outcomes

Expenditure shares are created by dividing level of a particular type of expenditure by total expenditure. For visual ease in the output tables, all share variable values are multiplied by 100. For similar reasons, I divide total plot value and total consumption by 100,000. Note that total plot value and total consumption are measured in Tanzanian shillings (Tsh). I construct anthropometric z-scores using

the World Health Organization (WHO) Child Growth Standards and Reference 2007. For these z-scores I take the average for children aged 5 years or less by household. For the heterogeneous analysis by gender, I take separate averages for male and female children aged 5 years or less by household. I also create an education gap measure by subtracting male decision-maker's education attainment from female decision-maker's education attainment.[5] TZNPS collected granular data up to four years of university. Less than 1% of the sample had education beyond four years of university.

Lastly, there are several important notes on the climate shock indicator. First, the climate shock indicator is a variable in the TZNPS Dataset that is activated if a household was severely and negatively affected by a drought or a flood anytime within five years before the survey date. Though this is a lengthy period, most households reported climate shocks within one year before the survey date for each wave.[6] Second, though there may be heterogeneous effects on changes in female bargaining power based on if specifically a drought or a flood occurred, the TZNPS does not have this disaggregated information and data suggests that at the least, floods and droughts have a negative impact on agricultural income generation (Mollet and Barelli, 2016). Finally, these climate shocks can be considered orthogonal to outcomes of interest and unexpected because households were asked only to record *severe* shocks. Thus, recorded shocks were of a severity beyond the expected cycles of drought and floods and over and above any adaptations to climate risk (Skjeflo and Westberg, 2015). A valuable robustness check for future analyses could be using rainfall falling above or below a percentile threshold of local historical rainfall distribution as the climate shock indicator (Burke, Gong, and Jones, 2015).

6.4. Data Limitations

Even though the key variable of interest, $EduGap_{it}$ has low potential for measurement error, there are still several areas where measurement error may affect results. Missing data is an issue for large

[5] See **Appendix A1** for tables of summary statistics for the outcome variables and key and conditioning variables.
[6] See **Appendix A2** for a matrix on occurrence of climate shocks and year of occurrence by wave.

portions of the dataset. For the key variables, it is necessary to conduct a complete case analysis and remove households that have missing data. This removes 423 households from the 1,302-household analytical sample. Econometrically, this assumes data is missing-at-random, which while not deniable is still a strong assumption. I partially address this limitation by adding "missing indicators" to empirical specifications. Essentially, the "missing indicator" is activated if the original variable observation value was missing. All missing observation values in the original variable are then transformed to zero. This should partially account for selection bias on households that had missing data for particular variables. Note that since this approach is econometrically dubious, I include it in output tables but do not focus heavily on interpretation (Jones, 1996). Finally, there may be measurement error in one household's understanding of the question asked versus another household's understanding. For example, when households in a district where the Productive Social Safety Net (PSSN) was recorded to be implemented were asked, some stated that no such implementation had occurred while others stated the opposite. Fortunately, the representative nature of the TZNPS alleviates most issues of individual household differences in comprehension.

7. Results and Limitations

7.1. Results

The results are divided up into six tables. **Table 1** describes the key results of model **(1)**, specifically on education expenditures.[7] **Tables 2**, **3**, and **4** describe the key results of model **(2)**, specifically on education expenditures and anthropometric measures (Sample 2 only).[8] Finally, **Tables 5** and **6** describe results of model (**2)** on a heterogeneous effects analysis by gender for anthropometric measures, specifically on female children.[9]

[7] See **Appendix B1** for tables on health expenditures, food inside/outside expenditures, and anthropometric measures (Sample 2 only).
[8] See **Appendix B2** for tables on health and food inside/outside expenditures.
[9] See **Appendix B3** for tables on anthropometric measures for male children.

There are two caveats before delving into analysis. First, identification partially relies on the assumption that markets are regionally integrated and rural farmers face the same regional prices. While road quality, infrastructure, and terrain make direct market access difficult (Magesa Michael, and Ko, 2014; Aku, Mshenga, Afari-Sefa, and Ochieng, 2018), more than 70% of agricultural households sold at least one crop, either directly in market or via a middleman. Considering also that more than 70% of agricultural plots are within 10 kilometers of a market, even farmers who cannot directly access markets and face price hikes from middlemen most likely do not face extreme price differentials (Anderson and Gugerty, 2012). Thus, it is reasonable to assume regional integration and validate the use of region fixed effects. Second, Specification 5 in each table includes a "missing indicator". Recall this "missing indicator" is included to try to account for selection bias in missing observations of total plot value. I do not interpret this specification as it is quite similar in interpretation to Specification 4 in each table.

The most important specification in **Table 1** is Specification 4, which includes region fixed effects. Fixed effects do not particularly change coefficients on the conditioning vector. However, the coefficient on female bargaining power increases in magnitude and becomes more strongly significant. One hypothesis for this could be that there are disparities in geography, arable land, and relative prices across regions that attenuate the effect of female bargaining power on share of education expenditure. This table indicates that a one unit increase in female bargaining power is associated with a 0.17 percentage point increase in share of education expenditure. Though seemingly small, this amounts to a 2.69% standard deviation increase. In real currency, this translates to an approximately 19,614 Tanzanian shilling (Tsh) reallocation to education expenditures. Though this is only $8.47 USD, in Tanzania this is approximately half of what books and supplies, uniforms, and other supplementary education materials cost in a given year for a Standard 6 student. Importantly, the share of education expenditure in Tanzania is still relatively low. This is likely explained by the fact that Tanzania primary

school fees were abolished in 2002, six years before the first wave of the TZNPS was conducted (Vavrus and Moshi, 2009).

Table 1. Relationship Between Female Bargaining Power and Education (Real) Share x100

VARIABLES	(1) HH Controls	(2) Asset Controls	(3) Buffer Controls	(4) Region + Wave FE	(5) Region + Wave FE
Education Gap (F-M)	**0.134****	0.125	**0.129***	**0.169*****	**0.163*****
	(0.063)	(0.078)	(0.078)	(0.049)	(0.041)
HH Size	**0.440*****	**0.382*****	**0.379*****	**0.425*****	**0.505*****
	(0.059)	(0.063)	(0.062)	(0.060)	(0.058)
HH Head Age	**0.092*****	**0.086*****	**0.086*****	**0.087*****	**0.099*****
	(0.011)	(0.012)	(0.012)	(0.012)	(0.011)
HH Head Education	**0.345*****	**0.354*****	**0.357*****	**0.431*****	**0.398*****
	(0.069)	(0.082)	(0.082)	(0.048)	(0.039)
Total Plot Value / 100000		**-0.001****	**-0.001****	**-0.001*****	**-0.001*****
		(0.000)	(0.000)	(0.000)	(0.000)
# of Livestock		**-0.023***	**-0.025***	**-0.042*****	**-0.047*****
		(0.013)	(0.013)	(0.015)	(0.016)
# of Asst. Programs			**0.532***	0.091	0.427
			(0.303)	(0.350)	(0.346)
Total Consumption (Real) / 100000	**0.046*****	**0.046*****	**0.046*****	**0.042*****	**0.044*****
	(0.007)	(0.008)	(0.008)	(0.005)	(0.004)
Total Plot Value (Missing Dummy)					0.492
					(0.392)
Constant	**-10.206*****	**-9.818*****	**-9.960*****	**-11.402*****	**-11.944*****
	(1.334)	(1.565)	(1.568)	(1.058)	(0.911)
Observations	2,635	1,888	1,888	1,888	2,430
R-squared	0.263	0.250	0.251	0.241	0.267
Outcome Variable Mean	3.852	3.852	3.852	3.852	3.852
Number of Regions				26	26

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

Specification 1, 2, and 3 in **Table 1** are implementations of model **(1)** without fixed effects. They show that female bargaining power (as measured by education gap) is significant and positively associated with share of education expenditure. Though female bargaining power loses significance in Specification 2, the point estimate remains largely the same across specifications. Note that Specification 2 drops 747 observations that are included in Specification 1. This increases the standard

error by roughly 30%. If the standard error in Specification 2 was the same as in Specification 1, the coefficient would be significant at the 5% level. Significance on assets in Specification 3 is expected as a household's current assets are positively correlated with a household's general welfare, which in turn is positively correlated to higher education expenditure shares. These findings are consistent with the theory. Female decision-makers prefer investing in children's human capital more so than male decision-makers. Household characteristics are significant and positively associated with share of education expenditure, as expected. Larger households spend a larger share of total expenditures on education and a smaller share on food outside the household (**Appendix B1**). This suggests that as household size increases, there are more children to educate and economies of scale are more easily realized in food expenditures than in education expenditures. Thus, larger households may compromise on food spending for education expenditures. Indeed, **Table 1** (and **Appendix B1**) does suggest this.

Note that the drop in sample size from **Table 1** to **Table 2** is due to missing values for climate shocks for some households in the sample. Specification 4 in **Table 2** is the critical finding of this paper. Conditioning on region fixed effects increases both coefficients of interest and decreases their standard errors, so that both are statistically significantly different to zero. This is interesting because it implies that regions have time-invariant characteristics that differentially prepare them for climate shocks. In this specification, a one unit increase in female bargaining power in the presence of a climate shock is associated with a 0.29 percentage point increase in share of education expenditure. In contrast, a similar increase in female bargaining power without a climate shock is associated with only a 0.14 percentage point increase in share of education expenditure. This implies that a climate shock has a **2.07x** effect on how female bargaining power influences share of education expenditures. This is convincing evidence for two effects. First, female decision-makers, even in contexts where they have no individual control over income streams or assets, still gain bargaining power when the male decision-maker's income stream is

disrupted. Second, this bargaining power proxy was able to capture the effect of a disruption to the male decision-maker's income stream without having to face issues of measurement error or bias. Thus, in contexts where there are no clear distinctions between male and female decision-maker's assets or income streams, this proxy can be used to capture those unobserved distinctions and changes in them.

Table 2. Relationship Between Female Bargaining Power, Climate Shocks, and Education (Real) Share x100

VARIABLES	(1) HH Controls	(2) Asset Controls	(3) Buffer Controls	(4) Region + Wave FE	(5) Region + Wave FE
Education Gap (F-M)	0.095	0.097	0.101	**0.137****	**0.110****
	(0.062)	(0.084)	(0.085)	(0.054)	(0.045)
Climate Shock Dummy	0.287	0.292	0.289	0.241	0.330
	(0.341)	(0.357)	(0.357)	(0.353)	(0.351)
EduGap x Climate Shock	0.105	0.143	0.138	**0.155***	0.104
	(0.107)	(0.120)	(0.121)	(0.091)	(0.089)
HH Size	**0.422*****	**0.364*****	**0.360*****	**0.400*****	**0.476*****
	(0.061)	(0.064)	(0.064)	(0.064)	(0.060)
HH Head Age	**0.088*****	**0.086*****	**0.086*****	**0.086*****	**0.095*****
	(0.011)	(0.012)	(0.012)	(0.012)	(0.011)
HH Head Education	**0.302*****	**0.353*****	**0.356*****	**0.426*****	**0.336*****
	(0.061)	(0.085)	(0.085)	(0.050)	(0.041)
Total Plot Value / 100000		**-0.001****	**-0.001****	**-0.001*****	**-0.001*****
		(0.000)	(0.000)	(0.000)	(0.000)
# of Livestock		**-0.022***	**-0.024***	**-0.041*****	**-0.048*****
		(0.013)	(0.013)	(0.016)	(0.016)
# of Asst. Programs			0.494	0.062	0.411
			(0.312)	(0.362)	(0.354)
Total Consumption (Real) / 100000	**0.048*****	**0.045*****	**0.045*****	**0.042*****	**0.049*****
	(0.007)	(0.008)	(0.008)	(0.005)	(0.004)
Total Plot Value (Missing Dummy)					0.549
					(0.416)
Constant	**-9.333*****	**-9.691*****	**-9.816*****	**-11.102*****	**-10.611*****
	(1.187)	(1.628)	(1.631)	(1.117)	(0.973)
Observations	2,409	1,781	1,781	1,781	2,248
R-squared	0.258	0.244	0.245	0.236	0.261
Outcome Variable Mean	3.852	3.852	3.852	3.852	3.852
Number of Regions				26	26

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

Here, I suggest one possible channel of causality. First, a climate shock negatively impacts crop harvest. Second, a negative impact on a crop harvest negatively impacts the extractable income from the harvest. Third, since the male is in control of all agricultural income, a decrease in agricultural income reduces his relative bargaining power. This is so because, as discussed in Section 2 and 3, bargaining power in the household is associated with various measures including income streams. Fourth, in the context of Tanzania and because of the reduction in the male's relative bargaining power, the female is able to better leverage community leaders, her own household value, and her relative education to gain bargaining power. Fifth and finally, this allows the female to invest higher shares in her preferred investments (children's human capital, health). Importantly, this causal chain is amplified when the female is more educated. Note that this pattern is not explained by Engel curve effects, where households change expenditure shares on specific categories as their total expenditure changes. Conditioning on the climate shock indicator and total expenditures already accounts for Engel curve effects.

Specification 1, 2, and 3 in **Table 2** are implementations of model **(2)** without fixed effects. The coefficient on female bargaining power and the interaction term are both insignificant. This implies that between regions, there is no evidence of a relationship between female bargaining power and share of education expenditure, regardless of shock. The conditioning vector acts as in **Table 1**.

Specification 4 in **Table 3** shows that a one unit increase in female bargaining power in the presence of a climate shock is associated with a 0.076 unit increase in height-for-age z-scores. This is an important finding considering literature has linked long-term outcomes to anthropometric measures of children. That region fixed effects do not particularly change results is not surprising. Height-for-age z-scores are less prone to respond differently to regional characteristics than weight-for-age z-scores because weight is a more dynamic measure than height (del Ninno and Lundberg, 2005) .

Specification 1, 2, and 3 in **Table 3** are implementations of Model **(2)** without fixed effects. Notably, the coefficient on female bargaining power is not significant across the three specifications. Considering the interaction term is significant, this may indicate that females only gain enough bargaining power to realize their preferences for children's health in the presence of a shock (or any relative decrease in the male's bargaining power).

Table 3. Relationship Between Female Bargaining Power, Climate Shocks, and Height-for-Age Z-Scores (Children <5)

VARIABLES	(1) HH Controls	(2) Asset Controls	(3) Buffer Controls	(4) Region + Wave FE	(5) Region + Wave FE
Education Gap (F-M)	0.000	0.001	0.001	-0.020	-0.010
	(0.016)	(0.021)	(0.021)	(0.021)	(0.016)
Climate Shock Dummy	-0.055	0.082	0.082	0.040	-0.029
	(0.100)	(0.108)	(0.108)	(0.110)	(0.107)
EduGap x Climate Shock	**0.074****	**0.067****	**0.067****	**0.075****	**0.077****
	(0.029)	(0.033)	(0.033)	(0.037)	(0.035)
HH Size	**-0.051*****	**-0.054*****	**-0.055*****	**-0.075*****	**-0.076*****
	(0.018)	(0.021)	(0.021)	(0.024)	(0.023)
HH Head Age	0.006	0.007	0.007	0.008	0.007
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
HH Head Education	**0.039*****	0.025	0.024	-0.003	0.008
	(0.013)	(0.019)	(0.019)	(0.019)	(0.015)
Total Plot Value / 100000		-0.000	-0.000	-0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)
# of Livestock		0.002	0.002	-0.002	0.002
		(0.004)	(0.004)	(0.006)	(0.005)
# of Asst. Programs			-0.032	0.071	0.149
			(0.096)	(0.116)	(0.109)
Total Consumption (Real) / 100000	**0.008*****	**0.009*****	**0.009*****	**0.010*****	**0.011*****
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Total Plot Value (Missing Dummy)					0.113
					(0.138)
Constant	**-1.487*****	**-1.415*****	**-1.402*****	**-0.710***	**-0.867****
	(0.306)	(0.400)	(0.404)	(0.408)	(0.338)
Observations	995	722	722	722	914
R-squared	0.080	0.061	0.061	0.053	0.072
Outcome Variable Mean	-0.704	-0.704	-0.704	-0.704	-0.704
Number of Regions				26	26

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4. Relationship Between Female Bargaining Power, Climate Shocks, and Weight-for-Age Z-Scores (Children <5)

VARIABLES	(1) HH Controls	(2) Asset Controls	(3) Buffer Controls	(5) Region + Wave FE	(6) Region + Wave FE
Education Gap (F-M)	**-0.034*** **	**-0.037** **	**-0.035** **	-0.023	-0.019
	(0.012)	(0.017)	(0.017)	(0.017)	(0.013)
Climate Shock Dummy	0.014	0.070	0.071	0.062	0.055
	(0.081)	(0.088)	(0.087)	(0.089)	(0.088)
EduGap x Climate Shock	**0.054***	0.051	0.051	**0.057***	**0.056***
	(0.029)	(0.032)	(0.032)	(0.030)	(0.029)
HH Size	**-0.047*** **	**-0.039** **	**-0.039** **	**-0.049** **	**-0.058*** **
	(0.016)	(0.020)	(0.020)	(0.020)	(0.019)
HH Head Age	-0.001	-0.002	-0.002	0.002	0.003
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
HH Head Education	0.007	-0.005	-0.004	0.009	0.013
	(0.010)	(0.015)	(0.015)	(0.016)	(0.012)
Total Plot Value / 100000		0.000	0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)	(0.000)
# of Livestock		0.003	0.003	-0.001	0.001
		(0.004)	(0.004)	(0.005)	(0.004)
# of Asst. Programs			**0.135***	0.115	0.106
			(0.075)	(0.094)	(0.090)
Total Consumption (Real) / 100000	**0.007*** **	**0.006*** **	**0.006*** **	**0.006*** **	**0.009*** **
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Total Plot Value (Missing Dummy)					0.118
					(0.114)
Constant	**-0.483** **	-0.339	-0.393	-0.515	**-0.681** **
	(0.233)	(0.297)	(0.297)	(0.332)	(0.280)
Observations	1,004	729	729	729	923
R-squared	0.075	0.048	0.051	0.066	0.096
Outcome Variable Mean	-0.464	-0.464	-0.464	-0.464	-0.464
Number of Regions				26	26

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

In Specification 4 of **Table 4**, there is no significance on the female bargaining power term. However, the interaction term in Specification 4 is significant and positive. This implies that a unit increase in bargaining power is associated with a 0.059 increase in weight-for-age z-scores in the presence of a shock. Again, this is an important finding considering the linkages between anthropometric measures for children aged 5 years of less and their long-term outcomes.

Specification 1, 2, and 3 in **Table 4** are implementations of model **(2)** without fixed effects. Interestingly, the coefficient on female bargaining power in the absence of a climate shock is strongly significant and negative. This contrasts with the original hypothesis that female decision-makers will invest more in children's human capital regardless of shock. Acknowledging the negative significance is counterintuitive, one possible reason for a zero effect is similar to the case in **Table 3**. Even if women are more educated, their bargaining power in the absence of a shock is not enough to realize their preferences for children's health. The above rationale seems reasonable considering that in all three specifications, when a shock does occur, an increase in female bargaining power is associated with an increase in weight-for-age z-scores in children aged 5 years or less. This implies that the shock to the male's income stream was enough for the female decision-maker to gain bargaining power and begin redressing the accumulating negative health effects in children under the absence of a shock. Another reason may be that on average across Tanzania, weight-for-age z-scores are influenced heavily by the general climate, arable land, and food type by region (Wandel and Holmboe-Otteson, 1992). This implies that even if within regions female bargaining power did not have a negative effect, on average across Tanzania the effect was negative.

Even with the lower sample size in the sample restricted to households with female children aged 5 years or less, the interaction term in Specification 4 of **Table 5** is positive and significant. Compared to the zero effect on male children (see **Appendix B3**), this implies that female decision-makers heterogeneously invest in children's health and focus on female children when given more bargaining power. This may be indicative of female decision-makers preferring equity between male and female children within the household in terms of distribution of resources when they have increased bargaining power. In essence, female decision-makers may be compensating for a lesser focus on female children in times when they had lower bargaining power.

Table 5. Relationship Between Female Bargaining Power, Climate Shocks, and Female Height-for-Age Z-Scores (Children <5)

VARIABLES	(1) HH Controls	(2) Asset Controls	(3) Buffer Controls	(5) Region + Wave FE	(6) Region + Wave FE
Education Gap (F-M)	-0.004	-0.003	-0.004	-0.019	-0.023
	(0.020)	(0.027)	(0.027)	(0.031)	(0.023)
Climate Shock Dummy	0.140	**0.289****	**0.287****	**0.304****	0.220
	(0.134)	(0.138)	(0.139)	(0.152)	(0.153)
EduGap x Climate Shock	0.054	0.077	0.077	**0.097***	0.072
	(0.051)	(0.055)	(0.055)	(0.056)	(0.055)
HH Size	**-0.052****	**-0.076*****	**-0.076*****	**-0.111*****	**-0.082****
	(0.023)	(0.028)	(0.028)	(0.033)	(0.032)
HH Head Age	0.005	0.009	0.009	0.010	0.008
	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)
HH Head Education	**0.044*****	**0.037***	**0.036***	0.022	0.010
	(0.016)	(0.021)	(0.021)	(0.029)	(0.022)
Total Plot Value / 100000		0.000	0.000	-0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)
# of Livestock		0.005	0.005	0.004	0.001
		(0.006)	(0.006)	(0.008)	(0.008)
# of Asst. Programs			-0.037	-0.053	-0.028
			(0.129)	(0.159)	(0.159)
Total Consumption (Real) / 100000	**0.009*****	**0.010*****	**0.010*****	**0.011*****	**0.012*****
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Total Plot Value (Missing Dummy)					0.128
					(0.196)
Constant	**-1.570*****	**-1.597*****	**-1.579*****	**-1.066***	**-0.932***
	(0.372)	(0.468)	(0.476)	(0.602)	(0.485)
Observations	576	418	418	418	525
R-squared	0.093	0.083	0.083	0.085	0.085
Outcome Variable Mean	-0.651	-0.651	-0.651	-0.651	-0.651
Number of Regions				26	26

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

Specifically, a unit increase in bargaining power is associated with a 0.097 increase in height-for-age z-scores for female children in the presence of a shock. Though these are preliminary results, they indicate that empowering female decision-makers now may have multiplicative effects in the long-term by fostering healthier female children. These healthier female children have higher human capital and subsequently may have higher bargaining power once they are married.

Specification 1, 2, and 3 in **Table 5** are implementations of model **(2)** without fixed effects, specifically for households with female children aged 5 years or less. As in **Table 3**, the coefficient on female bargaining power is not significant across the three specifications. However, here the interaction term is also insignificant across the three variables. A likely reason for this is increased standard errors due to the decrease in sample size.

Table 6. Relationship Between Female Bargaining Power, Climate Shocks, and Female Weight-for-Age Z-Scores (Children <5)

VARIABLES	(1) HH Controls	(2) Asset Controls	(3) Buffer Controls	(5) Region + Wave FE	(6) Region + Wave FE
Education Gap (F-M)	**-0.043*** **	**-0.044***	**-0.043***	-0.020	-0.023
	(0.016)	(0.026)	(0.026)	(0.026)	(0.019)
Climate Shock Dummy	0.104	0.154	0.157	0.173	0.162
	(0.121)	(0.136)	(0.136)	(0.126)	(0.126)
EduGap x Climate Shock	0.078	0.074	0.073	**0.078***	0.072
	(0.057)	(0.064)	(0.064)	(0.047)	(0.046)
HH Size	**-0.049** **	**-0.060** **	**-0.060** **	**-0.084*** **	**-0.068*** **
	(0.021)	(0.026)	(0.026)	(0.027)	(0.026)
HH Head Age	-0.005	-0.003	-0.003	0.002	0.002
	(0.006)	(0.006)	(0.006)	(0.007)	(0.006)
HH Head Education	0.015	0.003	0.004	0.035	**0.033***
	(0.013)	(0.021)	(0.021)	(0.025)	(0.018)
Total Plot Value / 100000		0.000	0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)	(0.000)
# of Livestock		0.005	0.005	-0.000	-0.002
		(0.006)	(0.006)	(0.007)	(0.007)
# of Asst. Programs			0.080	-0.052	-0.033
			(0.104)	(0.133)	(0.132)
Total Consumption (Real) / 100000	**0.006*** **	**0.006*** **	**0.006*** **	**0.005** **	**0.007*** **
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Total Plot Value (Missing Dummy)					-0.009
					(0.161)
Constant	-0.470	-0.308	-0.346	-0.647	**-0.782***
	(0.306)	(0.422)	(0.427)	(0.499)	(0.402)
Observations	583	423	423	423	532
R-squared	0.096	0.059	0.060	0.097	0.114
Outcome Variable Mean	-0.424	-0.424	-0.424	-0.424	-0.424
Number of Regions				26	26

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

In Specification 4 of **Table 6**, the coefficient on the interaction term is positive and significant. This coincides with the theory. Compared to the zero effect on male children's weight-for-age z-scores (see **Appendix B3**), these findings reinforce that when female decision-makers have more bargaining power, they focus more on female children. As discussed in the interpretation of **Table 5**, this may be indicative of preference for equity between male and female children in the household and compensation for female children in response to times when the female decision-maker had lower bargaining power.

Specification 1, 2, and 3 in **Table 6** are implementations of model **(2)** without fixed effects, specifically for households with female children aged 5 years or less. As in **Table 4**, the coefficient on female bargaining power in the absence of shocks is significantly negative across all three specifications. One explanation may be that households with more educated female decision-makers may be less prosperous or have certain characteristics that are not conducive to weight-for-height of children. Again, this is counterintuitive and begets further analysis.

7.2. Limitations and Future Directions

Though the results are promising indicators of the effect of female bargaining power on children's human capital, there are still several limitations. I focus on three: (1) Proxy Testability, (2) Potential Versus Realized Human Capital, and (3) Dynamic Preferences. Measurement error and missing data as a limitation of the dataset was discussed in Section 6.

An important aspect of empirical work is testability of assumptions. One of the primary assumptions I make regarding my bargaining power proxy is that it is a useful tool in contexts where more popular proxies for bargaining power such as distinct assets and income streams of decision-makers are not easily observed. While the findings of this paper certainly point in that direction, with the data currently available, that assumption is not likely to be testable. This is because of two reasons. First, the TZNPS does not contain disaggregated information on income streams and assets for male and

female decision-makers. Thus, it is not possible to compare results from using education gap as a proxy for bargaining power and the other more popular proxies. Second, the male decision-maker in Tanzania owns most assets and controls most income. Thus, there may not even exist possibility for disaggregation by assets and income streams. To address this issue of testability, future analyses could collect granular disaggregated data in specific locales in Tanzania to test if education gap is indeed comparable to changes in assets and income streams. Alternatively, as some studies have begun to do, surveys on perception of ownership over income streams and assets may be useful to see whether the female decision-maker actually does have some unobserved control over assets and her income streams.

Another limitation is how well my outcome measures reflect potential versus realized human capital. For example, increased education expenditures, while definitely a sign of increased potential human capital, do not necessarily imply increased realized human capital. Consider school and teacher quality, enrollment rate, and dropout rate of students. Increased education expenditures do not mean that the children in question are actually learning. Future analyses would benefit from considering grade attainment and test scores as outcome measures for similar empirical models as employed in this paper.

Finally, one apparent policy recommendation from the findings of this paper is for governments to invest in female decision-maker education. An implicit assumption of this paper is that increases in education attainment for female decision-makers will not change their preferences for investing. Increases in female education attainment may shift occupational choices, marriage patterns, and migration. Thus, the relationships that I estimate in this paper may change once those factors are taken into account. Though it is quite difficult to empirically see dynamic preferences, future analyses may be able to parse this dynamism out by conducting a similar analysis to this paper over a larger period of time or after a women's education program is implemented.

8. Conclusion

Many of the impoverished live in rural areas and many of the rural poor are engaged in agriculture. For economists and policy makers to meet development goals, uplift those in poverty, and maximize children's human capital, understanding household resource allocation is critical. Climate shocks represent a disruption to the income streams of any who grow crops. For female decision-makers, I show that climate shocks may actually be an opportunity to gain intra-household bargaining power and subsequently invest in children's human capital.

Using a 6-year panel of household survey data and a fixed effects model to address regional heterogeneity, I find evidence to suggest that in the presence of a climate shock, female decision-makers are empowered to increase shares of household resources allocated to education expenditures. I further find that, in households affected by climate shocks, anthropometric measures for children aged 5 years or less are significantly and positively associated with female bargaining power. Finally, I present preliminary evidence that suggests female decision-makers show preference for female children. Through these findings, I show that education gap can be a useful proxy for bargaining power, especially in contexts of data and cultural limitations on more popular proxies such as distinct assets and income streams for decision-makers.

Considering the ubiquity of climate shocks, these findings convincingly and importantly indicate that investing in women's education and empowering women in the household may have lasting impacts on children's human capital, their long-term outcomes, and their ability to escape poverty.

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Appendix Description

This Appendix is divided into five sections: (1) Appendix A1, (2) Appendix A2, (3) Appendix B1, (4) Appendix B2, and (5) Appendix B3. Appendix A1 contains descriptive statistics for outcome variables and key and conditioning variables. Appendix A2 contains a matrix of climate shocks by year of occurrence and wave. Appendices B1-B3 contain results on secondary outcomes of interest and corresponds to Section 7 (Results) of the paper. Specifically, Appendix B1 corresponds to model **(1)**, Appendix B2 to model **(2)**, and Appendix B3 to heterogeneous effects of model **(2)**.

Appendices B1 and B2 contain eight tables. Table B1.1 and Table B2.1 display the relationship between female bargaining power and share of health expenditures. These tables are in the appendix because they are largely insignificant and represent share of health expenditures for all household members, not just children. The insignificance and limited explanatory power for children motivated analysis of anthropometric measures. Table B1.2, Table B1.3, Table B2.2, Table B2.3 display results for food inside and food outside expenditures. Regardless of conditioning on shock, the results in these tables are suggestive of a reallocation of share of total food expenditure from food outside to food inside when female decision-makers have more bargaining power. These tables are in the appendix to offer one potential mechanism through which the anthropometric measures of health for children aged 5 or less increased. As a caveat, the reallocation from outside to inside food may be driven by changes in prices caused by climate shocks. Table B1.4 and Table B1.5 display the relationship between female bargaining power and anthropometric measures of health without conditioning on climate shocks. These tables are presented in the Appendix for balance. The more interesting corresponding tables are Table 3 and Table 4 in the main paper.

Finally, Appendix B3 contains two tables. Table B3.1 and Table B3.2 display the zero effect between male children and anthropometric measures when conditioning on shocks.

Appendix A1

Table A1.1. Descriptive Statistics, Outcome Variables

Variable	Observations	Mean	Std.Dev.	Min	Max
Educ Share	3909	3.852	6.298	0	62.912
Health Share	3909	3.407	6.343	0	76.900
Food In Share	3909	66.108	21.027	0	100
Food Out Share	3909	9.043	14.132	0	96.049
Weight-for-Age	1587	-0.464	1.117	-4.536	4.922
Height-for-Age	1572	-0.704	1.375	-4.686	4.967
Weight-for-Age (F)	919	-0.424	1.171	-3.658	4.922
Height-for-Age (F)	908	-0.651	1.396	-4.499	4.967
Weight-for-Age (M)	866	-0.503	1.141	-4.536	4.712
Height-for-Age (M)	856	-0.781	1.433	-4.818	4.860

Table A1.2. Descriptive Statistics, Key and Conditioning Variables

Variable	Observations	Mean	Std.Dev.	Min	Max
EduGap	2635	-1.125	4.527	-28	19
Climate Shock	3585	.204	.403	0	1
HH Size	3909	5.924	2.525	2	21
HH Head Age	3909	46.302	14.376	20	102
HH Head Educ	3232	18.455	5.285	2	45
Total Plot Value*	3243	69.245	814.716	0	40000
Livestock Num	3578	3.696	9.518	0	146
Assistance	3907	0.168	0.395	0	2
Total Consump*	3909	36.397	34.398	1.286	465.523

***** Divided by 100,000 for visual ease in output tables.

Appendix A2

Table A2.1. Matrix of Climate Shocks by Year of Occurrence and Wave

Weather Shock Year	Wave Number			Total
	1 (2008-09)	2 (2010-2011)	3 (2012-2013)	
2003	6	0	0	6
2004	26	2	0	28
2005	58	10	0	68
2006	80	40	4	124
2007	114	48	0	162
2008	166	94	24	284
2009	18	146	42	206
2010	0	102	60	162
2011	0	16	218	234
2012	0	0	186	186
2013	0	0	2	2
Total	468	458	536	1462

Appendix B1

Table B1.1. Relationship Between Female Bargaining Power and Health (Real) Share x100

VARIABLES	(1) HH Controls	(2) Asset Controls	(3) Buffer Controls	(4) Region+Wave FE	(5) Region+Wave FE
Education Gap (F-M)	-0.020	-0.044	-0.048	-0.054	-0.037
	(0.032)	(0.038)	(0.038)	(0.050)	(0.039)
HH Size	**-0.083***	-0.049	-0.046	**-0.107***	**-0.133****
	(0.046)	(0.052)	(0.052)	(0.062)	(0.055)
HH Head Age	-0.014	-0.009	-0.009	-0.008	-0.008
	(0.010)	(0.012)	(0.012)	(0.012)	(0.010)
HH Head Education	**-0.100*****	**-0.129*****	**-0.132*****	**-0.129*****	**-0.128*****
	(0.032)	(0.039)	(0.039)	(0.049)	(0.037)
Total Plot Value / 100000		-0.000	-0.000	-0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)
# of Livestock		**-0.024*****	**-0.023*****	-0.025	**-0.029****
		(0.008)	(0.008)	(0.016)	(0.015)
# of Asst. Programs			**-0.450***	-0.493	-0.204
			(0.269)	(0.356)	(0.331)
Total Consumption (Real) / 100000	**0.015*****	**0.013*****	**0.013*****	**0.015*****	**0.019*****
	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)
Total Plot Value (Missing Dummy)					0.278
					(0.375)
Constant	**5.545*****	**5.739*****	**5.858*****	**6.090*****	**6.116*****
	(0.778)	(0.911)	(0.932)	(1.078)	(0.873)
Observations	2,635	1,888	1,888	1,888	2,430
R-squared	0.009	0.008	0.009	0.010	0.014
Outcome Variable Mean	3.408	3.408	3.408	3.408	3.408
Number of Regions				26	26

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

Table B1.2. Relationship Between Female Bargaining Power and Food Inside (Real) Share x100

VARIABLES	(1) HH Controls	(2) Asset Controls	(3) Buffer Controls	(4) Region+Wave FE	(5) Region+Wave FE
Education Gap (F-M)	0.066	0.145	0.141	-0.058	-0.080
	(0.122)	(0.147)	(0.146)	(0.139)	(0.107)
HH Size	**1.657*****	**1.130*****	**1.133*****	**0.912*****	**0.984*****
	(0.148)	(0.168)	(0.168)	(0.171)	(0.151)
HH Head Age	**0.058***	0.031	0.031	0.022	0.021
	(0.030)	(0.033)	(0.033)	(0.033)	(0.029)
HH Head Education	**-0.358*****	-0.256	-0.258	**-0.488*****	**-0.398*****
	(0.131)	(0.163)	(0.163)	(0.135)	(0.103)
Total Plot Value / 100000		0.001	0.001	0.001	0.001
		(0.001)	(0.001)	(0.001)	(0.001)
# of Livestock		**0.142*****	**0.144*****	**0.134*****	**0.122*****
		(0.038)	(0.038)	(0.043)	(0.041)
# of Asst. Programs			-0.481	-0.490	-1.478
			(0.923)	(0.989)	(0.907)
Total Consumption (Real) / 100000	**-0.292*****	**-0.294*****	**-0.294*****	**-0.222*****	**-0.211*****
	(0.022)	(0.029)	(0.029)	(0.014)	(0.011)
Total Plot Value (Missing Dummy)					**-7.597*****
					(1.028)
Constant	**68.851*****	**73.203*****	**73.331*****	**78.918*****	**74.824*****
	(2.731)	(3.276)	(3.282)	(2.991)	(2.392)
Observations	2,635	1,888	1,888	1,888	2,430
R-squared	0.330	0.323	0.323	0.230	0.240
Outcome Variable Mean	66.108	66.108	66.108	66.108	66.108
Number of Regions				26	26

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

Table B1.3. Relationship Between Female Bargaining Power and Food Outside (Real) Share x100

VARIABLES	(1) HH Controls	(2) Asset Controls	(3) Buffer Controls	(4) Region+Wave FE	(5) Region+Wave FE
Education Gap (F-M)	**-0.385*** **	**-0.489*** **	**-0.481*** **	**-0.339*** **	**-0.261*** **
	(0.090)	(0.109)	(0.109)	(0.114)	(0.090)
HH Size	**-0.951*** **	**-0.650*** **	**-0.656*** **	**-0.529*** **	**-0.580*** **
	(0.117)	(0.136)	(0.135)	(0.140)	(0.127)
HH Head Age	**-0.082*** **	**-0.070*** **	**-0.070*** **	**-0.070*** **	**-0.072*** **
	(0.022)	(0.025)	(0.025)	(0.027)	(0.024)
HH Head Education	**-0.512*** **	**-0.588*** **	**-0.582*** **	**-0.418*** **	**-0.382*** **
	(0.090)	(0.113)	(0.113)	(0.110)	(0.086)
Total Plot Value / 100000		**-0.001*** **	**-0.001*** **	-0.001	-0.001
		(0.000)	(0.000)	(0.001)	(0.001)
# of Livestock		**-0.088*** **	**-0.090*** **	**-0.071** **	**-0.072** **
		(0.024)	(0.025)	(0.035)	(0.034)
# of Asst. Programs			0.949	1.004	1.070
			(0.689)	(0.810)	(0.761)
Total Consumption (Real) / 100000	**0.153*** **	**0.154*** **	**0.155*** **	**0.116*** **	**0.107*** **
	(0.013)	(0.017)	(0.017)	(0.011)	(0.010)
Total Plot Value (Missing Dummy)					**2.603*** **
					(0.863)
Constant	**22.170*** **	**20.764*** **	**20.512*** **	**16.560*** **	**17.283*** **
	(2.002)	(2.510)	(2.531)	(2.450)	(2.007)
Observations	2,635	1,888	1,888	1,888	2,430
R-squared	0.124	0.124	0.125	0.076	0.068
Outcome Variable Mean	9.043	9.043	9.043	9.043	9.043
Number of Regions				26	26

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

Table B1.4. Relationship Between Female Bargaining Power and Height-for-Age Z-Scores (Children <5)

VARIABLES	(1) HH Controls	(2) Asset Controls	(3) Buffer Controls	(4) Region+Wave FE	(5) Region+Wave FE
Education Gap (F-M)	0.012	0.019	0.019	-0.003	-0.003
	(0.015)	(0.019)	(0.019)	(0.020)	(0.015)
HH Size	**-0.065*** **	**-0.061*** **	**-0.061*** **	**-0.080*** **	**-0.081*** **
	(0.017)	(0.020)	(0.020)	(0.023)	(0.022)
HH Head Age	0.008	0.008	0.008	0.009	0.009
	(0.005)	(0.006)	(0.006)	(0.006)	(0.005)
HH Head Education	**0.040*** **	0.026	0.026	-0.002	0.005
	(0.014)	(0.019)	(0.019)	(0.019)	(0.015)
Total Plot Value		-0.000	-0.000	-0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)
# of Livestock		0.002	0.002	-0.002	0.001
		(0.004)	(0.004)	(0.006)	(0.005)
# of Asst. Programs			-0.016	0.074	0.134
			(0.095)	(0.114)	(0.107)
Total Consumption (Real)	**0.000*** **	**0.000*** **	**0.000*** **	**0.000*** **	**0.000*** **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Total Plot Value (Missing Dummy)					0.124
					(0.130)
Constant	**-1.535*** **	**-1.431*** **	**-1.425*** **	**-0.788** **	**-0.873*** **
	(0.310)	(0.400)	(0.404)	(0.396)	(0.324)
Observations	1,109	782	782	782	1,004
R-squared	0.074	0.056	0.056	0.047	0.062
Outcome Variable Mean	-0.704	-0.704	-0.704	-0.704	-0.704
Number of Regions				26	26

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

Table B1.5. Relationship Between Female Bargaining Power and Weight-for-Age Z-Scores (Children <5)

VARIABLES	(1) HH Controls	(2) Asset Controls	(3) Buffer Controls	(4) Region+Wave FE	(5) Region+Wave FE
Education Gap (F-M)	**-0.025****	-0.026	-0.024	-0.013	-0.018
	(0.012)	(0.016)	(0.016)	(0.016)	(0.013)
HH Size	**-0.056*****	**-0.052*****	**-0.051*****	**-0.064*****	**-0.065*****
	(0.016)	(0.019)	(0.019)	(0.019)	(0.018)
HH Head Age	-0.001	-0.000	-0.001	0.005	0.004
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
HH Head Education	0.008	-0.005	-0.004	0.007	0.005
	(0.012)	(0.015)	(0.015)	(0.016)	(0.012)
Total Plot Value		0.000	0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)	(0.000)
# of Livestock		0.005	0.005	0.001	0.002
		(0.004)	(0.004)	(0.004)	(0.004)
# of Asst. Programs			0.104	0.104	0.108
			(0.074)	(0.093)	(0.090)
Total Consumption (Real)	**0.000*****	**0.000*****	**0.000*****	**0.000*****	**0.000*****
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Total Plot Value (Missing Dummy)					0.128
					(0.109)
Constant	**-0.430***	-0.297	-0.337	-0.439	-0.445
	(0.243)	(0.305)	(0.305)	(0.323)	(0.272)
Observations	1,121	789	789	789	1,016
R-squared	0.064	0.042	0.044	0.066	0.090
Outcome Variable Mean	-0.464	-0.464	-0.464	-0.464	-0.464
Number of Regions				26	26

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

Appendix B2

Table B2.1. Relationship Between Female Bargaining Power, Climate Shocks, and Health (Real) Share x100

VARIABLES	(1) HH Controls	(2) Asset Controls	(3) Buffer Controls	(4) Region+Wave FE	(5) Region+Wave FE
Education Gap (F-M)	-0.018	-0.059	-0.062	-0.056	-0.036
	(0.035)	(0.041)	(0.041)	(0.054)	(0.043)
Climate Shock Dummy	**0.901****	**0.919****	**0.922****	**0.939*****	**0.935*****
	(0.365)	(0.405)	(0.405)	(0.352)	(0.337)
EduGap x Climate Shock	-0.045	-0.010	-0.006	-0.019	0.000
	(0.094)	(0.102)	(0.102)	(0.091)	(0.085)
HH Size	**-0.107****	-0.068	-0.065	**-0.128****	**-0.152*****
	(0.050)	(0.055)	(0.055)	(0.064)	(0.058)
HH Head Age	-0.011	-0.011	-0.011	-0.008	-0.006
	(0.011)	(0.012)	(0.012)	(0.012)	(0.011)
HH Head Education	**-0.102*****	**-0.144*****	**-0.146*****	**-0.129*****	**-0.125*****
	(0.035)	(0.039)	(0.039)	(0.050)	(0.040)
Total Plot Value / 100000		-0.000	-0.000	-0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)
# of Livestock		**-0.027*****	**-0.026*****	**-0.027***	**-0.030****
		(0.008)	(0.008)	(0.016)	(0.015)
# of Asst. Programs			-0.411	-0.489	-0.181
			(0.273)	(0.361)	(0.339)
Total Consumption (Real) / 100000	**0.017*****	**0.015*****	**0.014*****	**0.016*****	**0.021*****
	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)
Total Plot Value (Missing Dummy)					0.538
					(0.399)
Constant	**5.403*****	**5.902*****	**6.006*****	**5.911*****	**5.815*****
	(0.838)	(0.929)	(0.951)	(1.116)	(0.933)
Observations	2,409	1,781	1,781	1,781	2,248
R-squared	0.013	0.014	0.015	0.015	0.018
Outcome Variable Mean	3.407	3.407	3.407	3.407	3.407
Number of Regions				26	26

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

Table B2.2. Relationship Between Female Bargaining Power, Climate Shocks, and Food Inside (Real) Share x100

VARIABLES	(1) HH Controls	(2) Asset Controls	(3) Buffer Controls	(4) Region+Wave FE	(5) Region+Wave FE
Education Gap (F-M)	0.104	0.103	0.100	-0.129	-0.068
	(0.130)	(0.163)	(0.162)	(0.152)	(0.118)
Climate Shock Dummy	**1.861****	0.711	0.713	0.690	0.747
	(0.917)	(0.969)	(0.968)	(0.987)	(0.926)
EduGap x Climate Shock	**0.436***	0.451	**0.454***	**0.489***	**0.448***
	(0.240)	(0.275)	(0.275)	(0.254)	(0.234)
HH Size	**1.675*****	**1.156*****	**1.159*****	**0.923*****	**0.998*****
	(0.157)	(0.177)	(0.177)	(0.179)	(0.159)
HH Head Age	**0.081****	0.042	0.042	0.028	0.034
	(0.032)	(0.035)	(0.035)	(0.034)	(0.030)
HH Head Education	**-0.224***	-0.209	-0.211	**-0.461*****	**-0.307*****
	(0.132)	(0.169)	(0.169)	(0.139)	(0.109)
Total Plot Value / 100000		0.001	0.001	0.001	0.001
		(0.001)	(0.001)	(0.001)	(0.001)
# of Livestock		**0.146*****	**0.147*****	**0.142*****	**0.129*****
		(0.038)	(0.038)	(0.044)	(0.042)
# of Asst. Programs			-0.295	-0.597	-1.466
			(0.945)	(1.013)	(0.933)
Total Consumption (Real) / 100000	**-0.294*****	**-0.292*****	**-0.292*****	**-0.222*****	**-0.216*****
	(0.023)	(0.030)	(0.030)	(0.014)	(0.012)
Total Plot Value (Missing Dummy)					**-7.041*****
					(1.097)
Constant	**64.836*****	**71.119*****	**71.193*****	**76.922*****	**71.615*****
	(2.778)	(3.415)	(3.419)	(3.128)	(2.563)
Observations	2,409	1,781	1,781	1,781	2,248
R-squared	0.332	0.323	0.323	0.227	0.238
Outcome Variable Mean	66.108	66.108	66.108	66.108	66.108
Number of Regions				26	26

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

Table B2.3. Relationship Between Female Bargaining Power, Climate Shocks, and Food Outside (Real) Share x100

VARIABLES	(1) HH Controls	(2) Asset Controls	(3) Buffer Controls	(4) Region+Wave FE	(5) Region+Wave FE
Education Gap (F-M)	**-0.385*** **	**-0.440*** **	**-0.433*** **	**-0.285** **	**-0.260*** **
	(0.100)	(0.124)	(0.124)	(0.125)	(0.100)
Climate Shock Dummy	**-1.397** **	-1.105	-1.110	**-1.455***	**-1.412***
	(0.653)	(0.682)	(0.681)	(0.817)	(0.786)
EduGap x Climate Shock	-0.235	-0.240	-0.248	-0.265	-0.270
	(0.206)	(0.236)	(0.236)	(0.210)	(0.199)
HH Size	**-0.931*** **	**-0.608*** **	**-0.615*** **	**-0.492*** **	**-0.558*** **
	(0.125)	(0.142)	(0.142)	(0.148)	(0.135)
HH Head Age	**-0.096*** **	**-0.079*** **	**-0.079*** **	**-0.076*** **	**-0.082*** **
	(0.024)	(0.027)	(0.027)	(0.028)	(0.026)
HH Head Education	**-0.572*** **	**-0.585*** **	**-0.580*** **	**-0.420*** **	**-0.445*** **
	(0.092)	(0.118)	(0.119)	(0.115)	(0.093)
Total Plot Value / 100000		**-0.001*** **	**-0.001*** **	-0.001	-0.001
		(0.000)	(0.000)	(0.001)	(0.001)
# of Livestock		**-0.088*** **	**-0.091*** **	**-0.071***	**-0.073** **
		(0.025)	(0.026)	(0.037)	(0.036)
# of Asst. Programs			0.831	1.096	1.172
			(0.705)	(0.838)	(0.792)
Total Consumption (Real) / 100000	**0.153*** **	**0.151*** **	**0.151*** **	**0.115*** **	**0.109*** **
	(0.014)	(0.018)	(0.018)	(0.011)	(0.010)
Total Plot Value (Missing Dummy)					**2.295** **
					(0.931)
Constant	**24.292*** **	**21.440*** **	**21.230*** **	**17.615*** **	**19.577*** **
	(2.082)	(2.642)	(2.660)	(2.587)	(2.176)
Observations	2,409	1,781	1,781	1,781	2,248
R-squared	0.124	0.121	0.122	0.072	0.067
Outcome Variable Mean	9.043	9.043	9.043	9.043	9.043
Number of Regions				26	26

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

Appendix B3

Table B3.1. Relationship Between Female Bargaining Power, Climate Shocks, and Male Height-for-Age Z-Scores (Children <5)

VARIABLES	(1) HH Controls	(2) Asset Controls	(3) Buffer Controls	(4) Region+Wave FE	(5) Region+Wave FE
Education Gap (F-M)	0.025	0.024	0.023	0.012	0.034
	(0.024)	(0.030)	(0.031)	(0.030)	(0.025)
Climate Shock Dummy	-0.167	-0.073	-0.072	-0.141	-0.166
	(0.145)	(0.160)	(0.161)	(0.157)	(0.145)
EduGap x Climate Shock	**0.061***	0.035	0.035	0.020	0.032
	(0.035)	(0.041)	(0.041)	(0.050)	(0.047)
HH Size	**-0.046***	-0.049	-0.049	**-0.076****	**-0.095*****
	(0.026)	(0.030)	(0.030)	(0.037)	(0.033)
HH Head Age	0.006	0.005	0.005	0.004	0.008
	(0.008)	(0.009)	(0.009)	(0.009)	(0.008)
HH Head Education	**0.043****	0.028	0.028	0.003	0.032
	(0.020)	(0.028)	(0.028)	(0.028)	(0.022)
Total Plot Value / 100000		-0.000	-0.000	-0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)
# of Livestock		0.010	0.010	0.005	**0.014***
		(0.007)	(0.008)	(0.009)	(0.008)
# of Asst. Programs			-0.075	0.151	0.249
			(0.149)	(0.172)	(0.153)
Total Consumption (Real) / 100000	**0.006****	**0.007****	**0.007****	**0.008****	**0.006***
	(0.002)	(0.003)	(0.003)	(0.004)	(0.003)
Total Plot Value (Missing Dummy)					0.136
					(0.195)
Constant	**-1.540*****	**-1.393****	**-1.373****	-0.575	**-1.072****
	(0.471)	(0.574)	(0.578)	(0.589)	(0.492)
Observations	534	386	386	386	490
R-squared	0.055	0.041	0.041	0.040	0.074
Outcome Variable Mean	-0.781	-0.781	-0.781	-0.781	-0.781
Number of Regions				26	26

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

Table B3.2. Relationship Between Female Bargaining Power, Climate Shocks, and Male Weight-for-Age Z-Scores (Children <5)

VARIABLES	(1) HH Controls	(2) Asset Controls	(3) Buffer Controls	(4) Region+Wave FE	(5) Region+Wave FE
Education Gap (F-M)	-0.026	-0.031	-0.030	-0.014	0.003
	(0.018)	(0.022)	(0.022)	(0.024)	(0.021)
Climate Shock Dummy	-0.065	-0.014	-0.015	-0.033	-0.036
	(0.105)	(0.108)	(0.107)	(0.123)	(0.119)
EduGap x Climate Shock	0.043	0.039	0.039	0.023	0.009
	(0.027)	(0.031)	(0.031)	(0.039)	(0.039)
HH Size	-0.018	-0.010	-0.010	-0.032	**-0.049***
	(0.029)	(0.032)	(0.032)	(0.029)	(0.027)
HH Head Age	-0.003	-0.004	-0.004	-0.001	0.002
	(0.007)	(0.008)	(0.008)	(0.007)	(0.007)
HH Head Education	-0.005	-0.008	-0.008	0.008	0.016
	(0.016)	(0.020)	(0.020)	(0.022)	(0.019)
Total Plot Value / 100000		0.000	0.000	0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)
# of Livestock		0.013	0.012	0.010	**0.014****
		(0.008)	(0.008)	(0.007)	(0.006)
# of Asst. Programs			0.114	**0.225***	0.168
			(0.119)	(0.135)	(0.126)
Total Consumption (Real) / 100000	**0.007*****	**0.004***	**0.004***	0.004	**0.008*****
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Total Plot Value (Missing Dummy)					0.203
					(0.162)
Constant	-0.354	-0.347	-0.379	-0.409	**-0.716***
	(0.351)	(0.385)	(0.383)	(0.465)	(0.408)
Observations	540	391	391	391	497
R-squared	0.036	0.037	0.040	0.055	0.082
Outcome Variable Mean	-0.503	-0.503	-0.503	-0.503	-0.503
Number of Regions				26	26

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