Income shocks and intrahousehold resource allocation: evidence from rural Ethiopia

Jose, Anu

Trinity College Dublin

2024

Income Shocks and Intrahousehold Resource Allocation: Evidence from rural Ethiopia*,**

[a] *Trinity College Dublin*

Abstract

How do income shocks affect intra-household expenditure patterns in agricultural economies? Using rainfall data and household panel data, with responses from both spouses, from rural Ethiopia, we show that a negative household level income shock significantly reduces female expenditures relative to male expenditures (31.4% greater reduction). We specifically explore the channel of female and male labour supply as an explanation behind the observed differentiated impacts on spousal consumption. We find evidence that engaging in off-farm employment provides women with an independent income and allows them to smooth their expenditures during farm income shock. We also find evidence that the wife's involvement in managing and controlling the household farm, measured as her time spent on the farm relative to the husband, negates the shock-induced gender differential in expenditures. Together, these results highlight gender-specific impacts of household income shocks on consumption and the role female economic opportunities play in negating intra-household impacts of such household shocks.

Keywords: Income shocks, gender, intrahousehold allocation, labour supply, Ethiopia

JEL: J16, J22, D13.

1. Introduction

In the absence of private insurance markets and adaptive social insurance programmes, households in agrarian economies use a variety of strategies to manage income variability, including risk sharing through informal networks, selling assets and temporary labour market solutions (Kochar, 1995; Grimard, 1997; Harrower and

* I would like to thank Michael King, Selim Gulesci, Manuela Angelucci, and participants of CSAE Oxford 2024 and Irish Economic Association 2024 conference for their valuable feedback.

** Research data is available at: https://www.openicpsr.org/openicpsr/project/208586/version/V1/view

Hoddinott, 2005; Hoddinott, 2006). Informed by the unitary model of the household (Becker, 1991), these studies typically consider the household as one unit without considering the possibility of non-uniform effects within the household. As a result, a large literature on household risk-coping mechanisms focuses on the impacts of shocks measured at the household level and does not take into account how individuals within the household are affected by shocks and how these individuals, in turn, cope with shocks. However, more recently, Brown et al. (2019, 2021) and D'Souza and Tandon (2019) have highlighted the importance of within household inequalities. For instance, Brown et al. (2019) estimate that roughly three-quarters of underweight women and undernourished children in Sub-Saharan Africa are not found in the poorest 20% of households, and around half are not found in the poorest 40%, implying the presence of poor individuals in non-poor households.

Contributing to the within-household inequality strand of the literature, we estimate how household income shocks affect intrahousehold consumption patterns in agricultural economies and what role labour supply opportunities play in managing household shocks. Our paper complements recent literature that has highlighted the existence of within-household gender-specific disparities in the effects of income shocks on education, labour and asset holdings (Björkman-Nyqvist, 2013; Quisumbing et al., 2018; Afridi et al., 2022). These studies indicate the impact of household-level shocks is gender-specific, and the responses to coping with these shocks are also gendered. Despite the growth of this literature, there is little evidence on the impact of income shocks on female and male expenditures. This study attempts to bridge the knowledge gap in intrahousehold allocation by examining the gender-differentiated effect of income shocks on female and male expenditures in rural Ethiopia.

To capture the causal effect of a negative household income shock on gender-specific expenditures, we exploit the exogenous variation in household farm income caused by rainfall shocks. Rural households in developing countries face a high risk of income volatility due to high dependence on rain-fed agriculture. In such contexts, harvest failure due to drought, floods, storm damage and other climatic events leads to income variability (Morduch, 1995). We use high-resolution rainfall data from

TAMSAT (Tropical Application of Meteorology Using Satellite Data and Ground-Based Observations) to measure rainfall shock that acts as an exogenous negative income shock and then merge it with the Living Standard Measurement Survey (LSMS) from rural Ethiopia for three panel years 2011-12, 2013-2014, and 2015-16. The panel data allows us to account for household-level unobserved heterogeneity and establish the causal link between household-level negative income shock and the gender gap in expenditures.

We focus on non-food expenditure to identify gender-differentiated effects on expenditure for two main reasons. First, it rules out the relative price effect channel in identifying the causal relationship between rainfall shock and gender-specific expenditures. Rainfall variability may determine the price of food items; hence, the consumption may change due to the price change. But the price of non-food expenditures measured in this study, such as gender-assignable clothing and shoes, are not directly affected by a rainfall shock, allowing us to establish a causal relationship between income shock and individual expenditure. Second, individually assignable food expenditures are unavailable even in a rich dataset such as LSMS. LSMS provides data on non-food expenditures like clothing, fabric, and shoes for adult females and males, which allows for finding gender-differentiated effects among adults within the household. This approach of calculating individually assignable expenditures was previously used by several studies on intrahousehold consumption, such as Browning et al. (1994); Dunbar et al. (2013); Lechene et al. (2022)and Calvi et al. (2023).

We investigate the possibility of changes in spousal labour supply decisions with rainfall shocks as a mechanism to explain the intrahousehold gender-differentiated effects in expenditure decisions. We examine both the intensive and extensive margins of spouses' participation in various income-generating activities after a household-level income shock. Given the importance of off-farm labour for women in our context for her welfare outcomes (Buehren et al., 2019), we investigate the heterogeneous effect of wife's participation in off-farm activities on any gender differential that exists in intrahousehold expenditure allocation. Additionally, exploring the nuances of spousal control and management of resources within a collectively-held household farm, we

analyse the role of spouses' involvement in farm activities for gender-specific income shock absorption.

Our results indicate gender-differentiated effects of negative income shock on the intrahousehold allocation of expenditures. A negative income shock leads to a decrease in female non-food expenditures by 31.4% relative to male non-food expenditures. The higher budget elasticity of women's expenditure compared to men's expenditure in the intrahousehold allocation of resources implies a higher risk absorption by women than men within a household. Our finding adds to the literature on women's higher susceptibility to impacts of negative income shock than men (Hoddinott, 2006; Mottaleb and Erenstein, 2018; Quisumbing et al., 2018).

We find evidence of spouses' using off-farm employment as an income-smoothing mechanism during a negative household income shock and observe a gender differential in such labour supply adjustments. We find that, relative to the husband, the wife spends 15.5% more hours on household non-farm activities and spends 10.6% fewer hours on temporary wage employment following an income shock. Relative to their partners, the husbands increase hours spend towards temporary wage employment outside the household, and in contrast, wives increase their hours on non-agricultural activities within the household. We attribute the observed gender differential in labour supply responses after an income shock to women's limited access to off-farm employment outside their homes in Ethiopia due to factors such as cultural, religious, technical and financial constraints, as documented in several studies such as Amare and Belaineh (2013); Van den Broeck and Kilic (2019); Buehren et al. (2019).

Given the importance of off-farm employment in women's empowerment in Sub-Saharan Africa, especially rural areas (Van den Broeck and Kilic, 2019), we further analyse the heterogeneous effect of income shock on gender-specific expenditures based on the wife's participation in non-agricultural activities within the household and outside the household. We observe that the gender-differentiated changes in expenditure following a negative income shock are driven by households where the wife did not engage in any household off-farm employment, such as

small-scale business or temporary wage employment. This adds to the existing evidence on the role of off-farm employment in improving women's bargaining power in household decision-making (Maligalig et al., 2019; Anderson and Eswaran, 2009). Both types of employment provide women with an independent income which, in turn, contributes to closing the gender gap in household-level income shock absorption.

Additionally, we explore if the underlying gender-specific control of household farm activities affects the gender differential in household resource allocation during an income shock. We examine if the gender gaps in expenditure change due to farm productivity shock are determined by whether the husband spends more hours per week on household agricultural activities. We find that the wife absorbs the productivity shock when the husband spends more time on household agricultural activities. No gender gap exists in expenditures when the wife is involved in farm activities as much or more than the husband. This is in conjunction with how control of household plots determines the gender differential effect of a farm-related income shock, previously observed in West-African contexts, as demonstrated by Duflo and Udry (2004) in Cote d'Ivoire.

A number of caveats to the analysis are noteworthy. First, even though several other coping mechanisms exist, our gender-specific data availability allows us to explore only the spousal labour responses. For instance, the lack of data on gender-specific asset ownership limits our analysis to explore if selling assets owned by a specific gender within the household is a coping mechanism that household use. Second, unlike the West African context, where separate plots exist for females and males, farm production is jointly managed and controlled by men and women in Ethiopia. Hence, we perceive the farm productivity shock through rainfall variability as a household-level shock. However, as we can not decipher precisely the gender-specific contributions to the farm and hence claims to its returns, our results should be seen in the light of the particular setting of jointly managed farms.

This paper adds to the literature on intrahousehold effects of a negative income shock (Björkman-Nyqvist, 2013; Quisumbing et al., 2018; Afridi et al., 2022).

While the existing literature focuses on household-level consumption smoothing, this study estimates individual-level expenditure shifts using novel gender-assignable data. The presence of gender differential in expenditure in the presence of a negative income shock implies the vulnerability of women within the household during income shock and points to the need for specific targeting strategies for women. Moreover, results from our heterogeneous analysis based on spousal control and management of farm activities reveal the importance of women's on-farm participation for gender-equitable absorption of farm productivity shocks.

This paper also contributes to the literature on the role of off-farm employment in rural agricultural economies (Van den Broeck and Kilic, 2019; Dercon, 2002). In addition to being a coping mechanism for poor households, off-farm employment can help address the intrahousehold gender gaps that may arise during income shocks. Our finding that gender differences in expenditure do not exist for households where women engage in off-farm activities implies that off-farm employment mitigates the risk of gender disparities in intrahousehold allocation. This study bridges the gap in understanding the link between women's labour response to shocks and its impact on their relative expenditure compared to men.

This study generates some policy-relevant insights. Our findings add to the understanding of whom to target for anti-poverty programmes that aim to mitigate income shock effects on households (Chant, 2008). While most programmes target households as a whole for anti-poverty programmes, our findings recommend more finely targeted policies that improve outcomes for the most affected. Adding to the literature on what works for women empowerment (Buvinić and Furst-Nichols, 2016), our finding on the gender gap in women's and men's off-farm opportunities within and outside the household underlines the need for designing gender-specific social protection schemes to help households cope with farm income shocks. Such an approach would account for individual poverty traps within the household and hence promote gender equality within the household.

The paper is structured as follows: section 2 describes the conceptual frame-

work of this study, section 3 reviews the associated literature, section 4 explains the study's context and data, and section 4 explains the methodology for the empirical analysis. we discuss the results in section 5 and carry out robustness checks in section 6. Section 7 concludes.

2. Conceptual Framework

While it is an empirical question as to how gender-specific expenditures change ex-ante an income shock, in this section, we provide an outline of household decision-making conceptualising the estimation of the gender gap using a simple model. We illustrate that the gender gap in the effect of income shock on expenditure would depend on the expenditure elasticities of demand for gender-specific goods. Drawing heavily on the existing literature on the implications of income shock on intrahousehold resource allocation and gender-specific coping strategies, we hypothesise the existence of a gender gap in managing risks in our context.

Suppose the household comprises two individuals, female and male, who make decisions on their consumption c_f and c_m, respectively and their labour supply towards farm production L_f and L_m, respectively, that can be traded on a competitive market at wage w_f and w_m. Suppose the production function of the household farm is given by $F(L_f, L_m, r)$, where r is the rainfall variation that affects farm production.

The utility maximisation problem for an individual in the household can be given by

$$\underset{c_i, L_i}{Max}\ u_i(c_i) \tag{1}$$

subject to

$$p\ .\ (c_i) \leq F(L_f, L_m, r) - w_f L_f - w_m L_m$$

Assuming that preferences over leisure are separable from preferences over other con-

sumption, problem (1) is equivalent to

$$\underset{c_i}{Max}\ u_i(c_i) \tag{2}$$

subject to

$$p\ .\ (c_i) \leq \pi^*(r)$$

where

$$\pi^*(r) \equiv \underset{L_f, L_m}{Max}\ F(L_f, L_m, r) - w_f L_f - w_m L_m \tag{3}$$

Rainfall, r, affects the individual utility function only through its effect on farm production and hence on budget constraint and, therefore, affects the household's total expenditure.

Suppose total expenditure, $x = p\ (c_f + c_m)$, then for $i = f, m$

$$c_i = c_i(p, x) \tag{4}$$

Assuming that relative prices of non-food items are not related to rainfall realisations ($\frac{\partial p}{\partial r} = 0$), the above Equation (4) implies that the effect of rainfall realizations on expenditure on any particular commodity depends only on the expenditure elasticity of demand for that commodity and on the effect of rainfall on overall expenditure. That is, for any individual i,

$$\frac{dc_i}{dr} = \frac{\partial c_i}{\partial x} * \frac{\partial x}{\partial r} \tag{5}$$

A negative productive shock to the farm reduces the income from the farm $\pi^*(r)$, and hence one can expect that $\frac{\partial x}{\partial r} < 0$. We focus on the gender gap of the effect of rainfall shock on individual expenditures, expressed as

$$\frac{dc_f}{dr} - \frac{dc_m}{dr} = (\frac{\partial c_f}{\partial x} - \frac{\partial c_m}{\partial x}) * \frac{\partial x}{\partial r} \tag{6}$$

The gender differential effect of negative income shock in households would depend on the magnitude and sign of $\frac{\partial c_f}{\partial x} - \frac{\partial c_m}{\partial x}$. That is, the gender gap in the effect

of rainfall shock on expenditure towards a particular commodity depends on the gender differential expenditure elasticities of demand for that particular commodity. However, it is a priori ambiguous the gender differential in expenditure elasticities of individual specific goods. Hence, we describe the existing literature that sheds light on such gender differential elasticities in the next section.

In this study, we also focus on the coping strategy of income diversification through labour supply adjustments among couples. We explain below the individual labour adjustment mechanism from the aforementioned model of household.

From the first order conditions of Equation (3), we get

$$\frac{\partial F(L_f, L_m)}{\partial L_i} = w_i, i = f, m \tag{7}$$

The opportunity cost of an additional unit of time spent on the production of farm goods is the spouses' wage in any non-farm activity. A rainfall shock changes the marginal productivity of on-farm labour and its returns. In that case, the marginal productivity of labour from household agriculture is less than wage in non-farm activities. According to the first order condition of farm profit maximisation, the spouse i would spend less time working for the household agriculture and more for leisure or other temporary non-farm employment. Constraints such as availability of alternative employment, mobility, and social norms often determine such changes in labour even though the equilibrium conditions imply that spouse i would allocate less time towards farm activities and more time towards leisure or non-farm labour. In our empirical analysis, we illustrate the gender gap in labour supply adjustments following a productivity shock by analysing the differences in individual labour supply decisions.

3. Related Literature

There is substantial evidence in the literature on the systematic difference in the allocation of resources within households by gender. Through a semi-parametric estimation of the Engel curve for households in rural Pakistan, Bhalotra and Attfield (1998) finds that adult males consume more than adult females while there is no gender differential in consumption among children. Using a novel approach to

identify individual-level consumption within a collective household model to estimate intrahousehold inequality, Calvi et al. (2023) find that men consume a larger share of the budget relative to women, who in turn consume relatively more than boys and girls. Based on a reference household comprising one man, one woman, one girl and one boy, they compute that the man consumes 36 percent of the total budget, the woman consumes 30 percent, and the boy and girl each consume 17 percent, respectively. They also find that even in households which have per capita expenditure above the poverty line, women and children face high probabilities of living in poverty. Using data from thirty countries in sub-Saharan Africa, Brown et al. (2019) documents that even non-poor households have high shares of undernourished women and children, implying the gender gap in resource sharing in households.

Given there exists a gender gap in the distribution of household resources, it is possible that a gender differential exists in the presence of a household income shock. Most of the work on gender differential effects of income shocks on household outcomes have focused on outcomes such as labour time allocation, the value of asset holdings, children's educational outcomes, and health.[1] But studies that examine the gender gap in individual-level expenditures are almost absent. One exception would be Mottaleb et al. (2015) which provides evidence from Bangladesh on the gender-differentiated effect of negative income shock on children's educational expenditure. They find that boys' schooling expenditure was reduced following a cyclone, and girls' schooling expenditure did not. To the best of our knowledge, none of the studies explores the gender differential effect of income shock on adult expenditures.

Within the literature on the effect of income shock that examines consumption and expenditure changes by gender, the focus has been mainly on male-headed and female-headed households. Overall, the evidence so far points out that female-headed households are more vulnerable to income shocks than male-headed counterparts.

[1] (Afridi et al., 2022; Agamile et al., 2021; Maitra and Tagat, 2019) for labour time allocation, (Quisumbing et al., 2018; Rakib and Matz, 2016; Goh et al., 2012) for asset holdings, (Björkman-Nyqvist, 2013; Chaudhury et al., 2006) for children's educational outcomes, (Neumayer and Plümper, 2007) for health.

Using panel data from Malawi, Asfaw and Maggio (2018) documents that adverse welfare effects following a weather shock were more severe for households where women solely managed land. Mottaleb and Erenstein (2018) finds that female-headed households in Bangladesh reduced food and non-food consumption more than male-headed households as a result of commodity price shocks. Kumar and Quisumbing (2013) uses a similar strategy by comparing female and male-headed households in the presence of a food price crisis in rural Ethiopia. They find that female-headed households are more vulnerable to food price changes and are more likely to have experienced a food price shock.

While gender plays a significant role in the effect of an income shock on individual consumption in a household setting, it is also an important characteristic of the coping mechanisms used to smooth consumption. There exists a rich literature on how households in developing countries with borrowing constraints cope with income shocks through diversifying crops (Hassan and Nhemachena, 2008), diversifying income sources such as working in non-farm sector (Colmer, 2021; Beegle et al., 2006), selling household assets (Hoddinott, 2006; Andersson et al., 2011), and migration (Minale, 2018; Morten, 2019). However, little is known about individual-specific responses to shocks and the role that gender plays in the coping process. Factors such as social norms and power dynamics within the household may affect gender inequalities in coping capability against income shocks. Using data from rural Ethiopia, Kumar and Quisumbing (2013) compare the coping strategies of female and male-headed households in the presence of food price shock. They find that female-headed households ration food consumption during good months to cope with food price shock. Afridi et al. (2022) highlights a gender gap in an individual's ability to cope with agricultural productivity shock within a household. They find that women are less likely to work outside their village in response to droughts, explained by gender norms constraining women's access to non-farm work opportunities. Beck et al. (2019) indicates higher sensitivity of female wage employment to fluctuations in coffee prices such that in periods of high prices, women are less likely than men to undertake wage employment.

4. Context and Data

4.1. Context

The setting for this study is Ethiopia, a low-income, agrarian and drought-prone country in Sub-Saharan Africa. As of 2021, agriculture constitutes 37.6% of the GDP in Ethiopia and is the sector which employs about 67% of the total population.[2] 78% of the population in Ethiopia live in rural areas whose main livelihood is agriculture.[3]

Rainfall is an important component for agriculture in Ethiopia as in the other Sub-Saharan African countries (Miguel et al., 2004; Alem et al., 2010; Demeke et al., 2011). It plays a vital part in income generation and has welfare impacts at the household and individual levels. Segele and Lamb (2005),Bewket (2009), and Alemayehu and Bewket (2016) show that variability in agricultural production in Ethiopia is significantly correlated with rainfall variability. The experience of drought has been increasing over the last decades in Ethiopia, and so has the proportion of the population affected by it (Adenew, 2004). With little temperature variation within years and across years, rainfall remains an important dimension of weather variation in Ethiopia. Hence, in such a context, understanding how income variation proxied by rainfall shocks affects the intrahousehold allocation of resources by gender would be of crucial consequence for building resilient livelihoods.

Ethiopia has two main growing seasons, *Belg* and *Meher* where *Meher* is the main growing season for crops such as barley, teff, wheat, maize and sorghum. The surveys used in this study were conducted soon after the harvest season of *Meher* for the three rounds for all households across the country. For the purpose of this study, we use the rainfall shocks during the *Meher* season due to the timing of the survey.[4] The timing of the survey at the same time of the year for every panel year ensured no measurement error of consumption and labour supply as these outcomes tend to vary within a year in such settings (Paxson, 1993; Dercon and Krishnan,

[2] World Bank estimates
[3] World Bank estimates
[4] As an alternative specification, we define income shocks as rainfall shocks during the entire year in Appendix C, and is able to demonstrate that the productivity shock during *Meher* determine for gender gap in expenditures ex-ante an income shock.

2000; Skoufias, 1993). Figure 1 represents the timing of survey for a typical panel year.

Even though the Ethiopian population is heavily dependent on agriculture, temporary or casual off-farm labour is also prevalent, with 78.1% of paid employees in the age group of 15-64 years engaged in temporary labour in rural areas (ILO, 2013). Off-farm employment is found to contribute towards income smoothing and poverty reduction in Ethiopia (Van Den Berg and Kumbi, 2006; Bezu et al., 2012). Within the sector of off-farm employment, there exists a gender difference in off-farm casual wage employment where 4 percent of women and 11 percent of men participate in temporary off-farm labour (Van den Broeck and Kilic, 2019). While some studies indicate that women's low participation in off-farm paid employment in such settings to the fact that women most naturally seek employment in the farm sector (Bhalotra and Umana-Aponte, 2010), others point to the low demand and cultural barriers that women face for engaging in off-farm employment (Buehren et al., 2019).

4.2. Data

This study uses data from Living Standard Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) Ethiopian Rural Socioeconomic Survey (ERSS) for the panel years 2011-2012, 2013-14 and 2015-16.[5] The first round of Ethiopian LSMS-ISA covers 3,969 rural households across 18 districts of Ethiopia, out of which follow up surveys of 3,776 households are available for the second round, and 3,699 are available for the third round. By sampling households in all nine regions of Ethiopia, the data is representative of all rural areas in Ethiopia (see Figure 2). To investigate intrahousehold responses, we keep only households with information on both the head of household and their spouse on all three rounds of the survey and households who recorded farm activity during the current season. Hence, the final sample of the study is 1589 households, each observed thrice.[6] The survey contains detailed and comprehensive information at the household level on expenditures (including some individual assignable expenditures), household agriculture, and individual level on labour time allocation, health and education details. Figure 1 outlines a typical panel

[5] For more details, visit: https://microdata.worldbank.org/index.php/catalog/2053

[6] We keep only households who recorded farm activity during the current season since we consider only exogenous productivity shock due to rainfall variations.

year which records the household survey on expenditure and labour supply at the end of the harvest of *Meher* season.

Table 1 presents descriptive statistics on some basic characteristics of households in this study.[7] Almost all the households in the sample are male-headed, with an average household size of 6. The average age of the husband is 45, and the average age of the wife is 37. 38.2% of husbands have attended school, and 18.9% of wives have attended school. On average, 17% of households have self-reported to have faced drought during the panel years. This is similar to the proportion of households that faced negative rainfall shock as per our rainfall data calculation.

The consumption module of the survey contains non-food expenditure details made towards clothing, kitchen equipment, furniture, ceremonial expenses, transport, tobacco and so on. Individually assignable expenditures are only available for clothes, shoes and fabric. Even though this could be a limitation of our study, previous work on household and individual expenditures suggest that these could be a good indicator of individual expenditures (Browning et al., 1994; Dunbar et al., 2013; Lechene et al., 2022; Calvi et al., 2023). We categorise such expenditures as expenses for adult females and adult males. The recalling period for the gender-specific expenditures made is one year, which is a standard practice in survey methodology for non-food goods which are purchased with less frequency Deaton and Grosh (2000). On an average year, out of the total non-food expenditures, households spend 10.3% on female expenditure, 13.6% on male expenditure, 15% on children, 22.1% on minor purchases, 6.3% on major purchases and 20.2% on ceremonies. The summary statistics show that the share of non-food expenditures spent towards male expenditures is more than female expenditures. The total yearly non-food expenditure is an average of around 3880 Birr, and the total weekly food expenditure is around 139 Birr.

A significant majority of women (50.5%) and men (75%) are employed in household agricultural activities. 14.9% of wives and 12.1% of husbands engage in non-agricultural household activities. A very low proportion of households engage in work

[7] Detailed description of the variables used are available in Appendix E.

outside the household, and men are more likely to work in those sectors. 6.6% of husbands engage in temporary wage employment, while only 3.4% of wives engage in temporary wage employment. Similarly, 3.1% of husbands and 1% of wives work in permanent wage labour. In intensive margins of labour participation, women spend an average of 10 hours per week on household farm activities, and men spend an average of 20 hours per week on household farms.[8] Wives spend, on average, 3.5 hours per week on household non-agriculture activities and 0.4 hours per week on temporary wage labour outside the household, compared to 2.3 hours per week and 1.1 hours per week, respectively, for men.

Rainfall data used in this study, which is considered a proxy for household income, is collected from TAMSAT (Tropical Application of Meteorology Using Satellite Data and Ground-Based Observations).[9] TAMSAT has high-resolution data of 4km x 4km (0.0375 degrees) recorded using satellite data and ground-based observation. In the LSMS survey, geo-referenced information on households is available at the level of enumeration area of the survey. An enumeration area is the primary sampling unit in the survey, and each enumeration area contains approximately 12 households. In order to use rainfall shocks as the exogenous variation on household income, we use monthly rainfall data available for each enumeration area. Figure 2 represents the enumeration areas for which the rainfall data is calculated within each district (*Woreda*) in Ethiopia.

Following the literature which uses rainfall data to assess the effect on various household level outcomes (Maccini and Yang, 2009; Björkman-Nyqvist, 2013; Rocha and Soares, 2015), we calculate rainfall deviation as the difference between the natural log of rainfall and the natural log of long term average of ten years of rainfall during the current season. Rainfall deviation for household h during season t is constructed as below:

$$Rainfall\ Deviation_{ht} = lnr_{ht} - ln\overline{r_h}$$

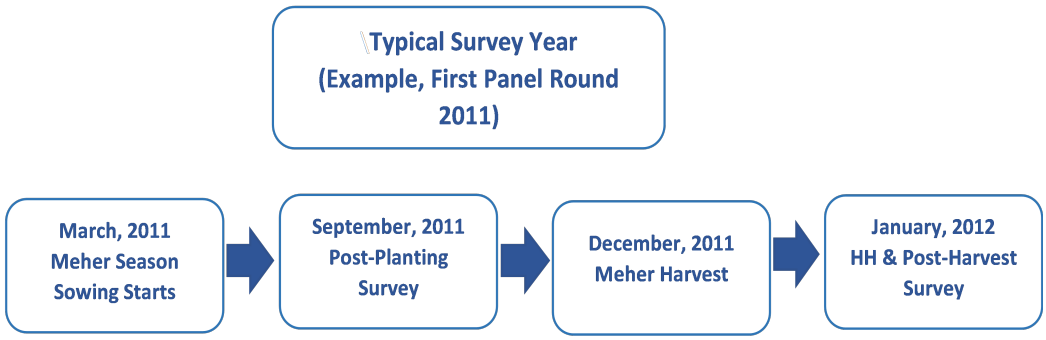
[8] It is worth noting that these numbers are based on post-harvesting weeks and is not representative of average hours of work per week throughout the year.

[9] For more details: `http://www.tamsat.org.uk/index.php/data`, Maidment et al. (2017); Tarnavsky et al. (2014); Maidment et al. (2014)

Based on the above, a negative sign in the rainfall deviation would mean that the current season rainfall is less than the long-term average and vice versa for the positive sign. For example, a negative value of 0.15 of rainfall deviation means 15% less rainfall than the long-term average.

We define a household experiencing a negative rainfall shock as a binary variable equal to one if the deviation in rainfall that the household experiences during the main agricultural season are more than one standard deviation away to the left from the average rainfall deviation that households in the sample experience. Figures 3, 4, and 5 presents the enumeration areas that experienced a negative rainfall shock during the panel years.[10] It can be observed that the distribution of rainfall shock is heterogeneous spatially and across the years. This shows the exogenous nature of rainfall shocks in Ethiopia; hence, rainfall shocks are a good proxy for income shocks for rural rain-dependent agricultural households. In Table 1, we report the proportion of households that experienced a negative rainfall shock during the panel years. 10.1% of households in the sample experienced a negative rainfall shock during the *Meher* season of 2011, 16.8% in 2013 and 18.7% in 2015.

Figure 1: A Typical Panel Year



[10] Out of 1489 households surveyed in three panel years, 929 did not experience negative rainfall shock during any of the years, 441 households experienced rainfall shocks during one year and 357 experienced during two years.

Table 1: Descriptive statistics

	Mean	SD	Count
Household Characteristics			
Household Head is Male	0.998	0.042	4460
Household Size	5.923	1.998	4465
Husband's Age	45.396	14.225	4467
Wife's Age	36.668	11.284	4467
Husband Attended School	0.382	0.486	4467
Wife Attended School	0.189	0.391	4465
Household Faced Drought	0.170	0.376	4467
Negative Rainfall Shock			
Negative Rainfall Shock in 2011	0.101	0.302	1489
Negative Rainfall Shock in 2013	0.168	0.374	1489
Negative Rainfall Shock in 2015	0.187	0.390	1489
Expenditure Shares			
Female Expenditure	0.103	0.096	4467
Male Expenditure	0.136	0.128	4467
Childrens Expenditure	0.150	0.133	4467
sh_min_purchase_exp	0.221	0.158	4467
Major purchases	0.063	0.079	4467
Ceremonies	0.202	0.191	4467
Total Non-food Expenditure (in Birr)	3879.540	3731.168	4467
Total Food Expenditure (in Birr)	138.819	874.821	4467
Labour Participation - Intensive Margin			
Household Agriculture - Wife	10.131	14.896	4444
Household Agriculture - Husband	19.465	18.220	4458
Household Non-agriculture - Wife	3.533	10.824	4443
Household Non-agriculture - Husband	2.265	8.271	4436
Temporary Wage Labour - Wife	0.424	3.368	4436
Temporary Wage Labour - Husband	1.127	5.829	4439
Permanent Wage Labour - Wife	0.080	1.702	4437
Permanent Wage Labour - Husband	0.799	6.286	4438
Labour Participation - Extensive Margin			
Household Agriculture - Wife	0.505	0.500	4467
Household Agriculture - Husband	0.750	0.433	4467
Household Non-agriculture - Wife	0.149	0.356	4467
Household Non-agriculture - Husband	0.121	0.326	4467
Temporary Wage Labour - Wife	0.034	0.180	4467
Temporary Wage Labour - Husband	0.066	0.249	4467
Permanent Wage Labour - Wife	0.010	0.101	4467
Permanent Wage Labour - Husband	0.031	0.172	4467

Figure 2: Districts and Enumeration Areas Covered Under LSMS Ethiopia Survey

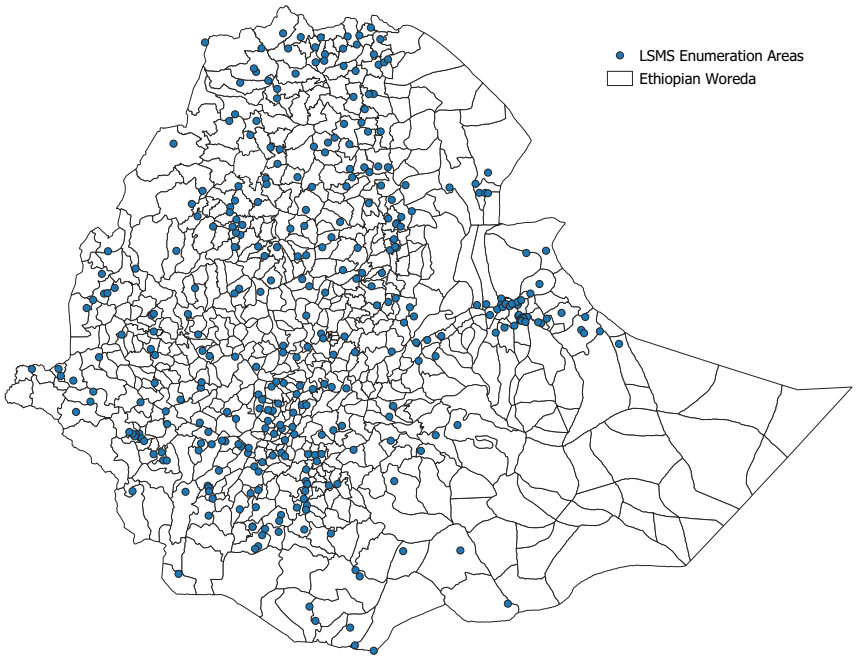


Figure 3: Negative Rainfall shock during *Meher* 2011

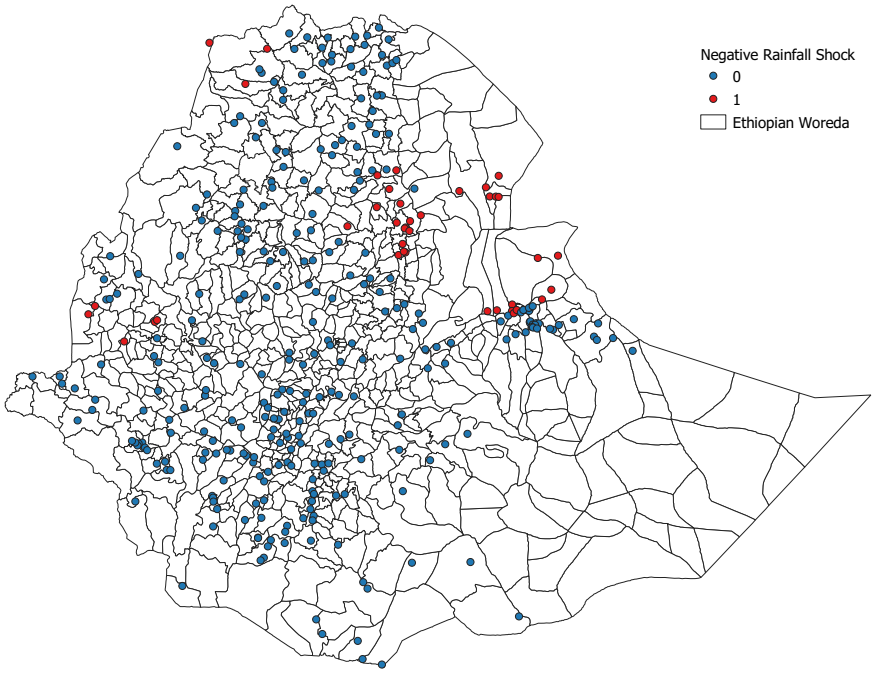


Figure 4: Negative Rainfall shock during *Meher* 2013

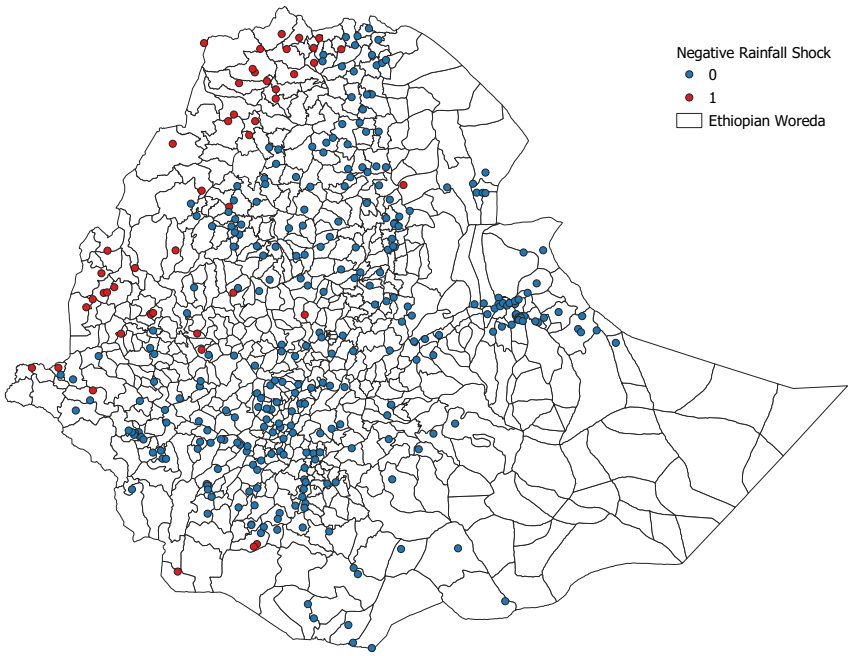
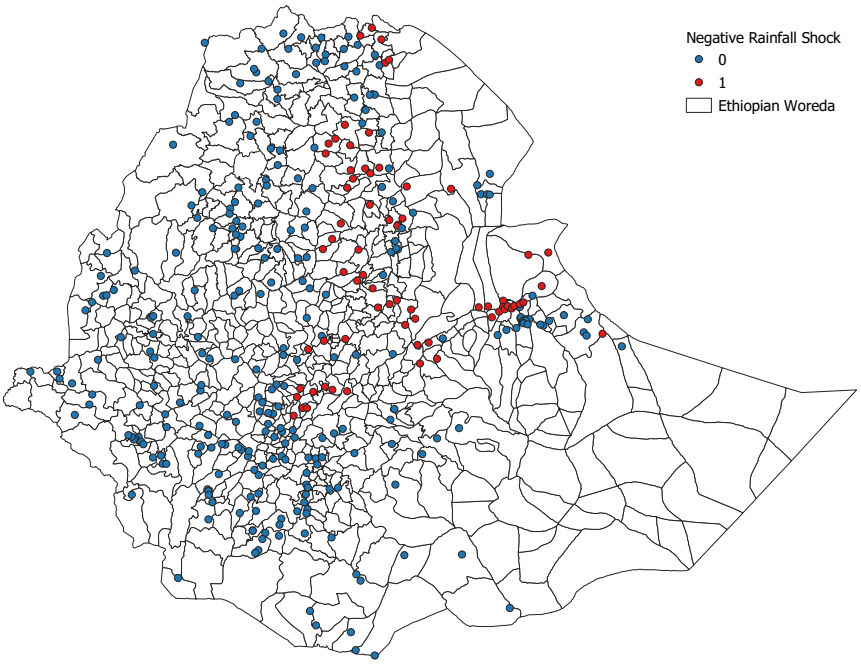


Figure 5: Negative Rainfall shock during *Meher* 2015



5. Empirical Strategy

In order to test for gender-differentiated effects of a household-level income shock on resource allocation, we use the following estimation equation:

$$Y_{ht} = \alpha_{ht} + \beta_{ht} Income\ \ Shock_{ht} + \gamma_h + \delta_t + \epsilon_{ht} \tag{8}$$

where Y_{ht} represents the difference in expenditure made towards female and male assignable goods in household h during year t. *Income Shock* is an indicator variable equal to one if household h experiences a negative rainfall shock during year t, and zero otherwise.[11] The dependent variable is log-transformed, and we interpret regression coefficients as a percentage change in the outcome variable due to rainfall shock. As in Afridi et al. (2022), our coefficient of interest β_{ht} estimates the impact of income shock on women relative to men for non-food expenditures. Although the main focus of this paper is to understand individual-level expenditure changes by gender, we additionally report the effect of negative income shock on expenditures observable only at the household level, such as food, major expenses, and expenditure towards ceremonies in Appendix D. We observe no changes in household-level expenditures ex-ante a negative income shock.

γ_h represents household fixed effects that control for unobserved, time-invariant, household-level factors that may affect expenditure allocation in a household.[12] As a robustness check later in the study, we also include community fixed effect to control for unobserved community characteristics that may affect the household distribution of resources. δ_t is a linear time trend, and ϵ^i_{ht} is the error term. The standard errors are clustered at the enumeration area level since the rainfall shock measure is defined at the enumeration area level, and shocks within enumeration areas are assumed to be correlated. In all our specifications, we account for sampling weights used for

[11] Besides this core explanatory variable, we also check with two other rainfall shock measures, in Appendix B. One, rainfall deviations of at least one standard deviation to the right of the long-term mean, and two, rainfall deviations of at least one standard deviation to the right or the left of the long-term mean.

[12] We check our empirical strategy with individual level fixed effect as well to account for any individual time-invariant characteristics. We find the same results as when accounting for household-level fixed effects.

selecting households in the survey.

β_{ht} estimates the effect of income shock on expenditure decisions under the assumption that rainfall shock is exogenous and is hence uncorrelated with other shocks to the demand or supply of non-food items. In Figure A1, we show that a negative rainfall shock has a significant negative effect on the revenue from crop sales for households in the data. This provides confidence for using negative rainfall shock as a proxy for household income in our setting.[13] We use a similar specification as Equation (8) to understand the gender differences in the coping mechanism of individual labour supply adjustments where Y_{ht} indicates the gender difference in labour force participation towards certain income generating activities.

6. Results

6.1. Gender Differentiated Effect of Income Shock on Expenditures

We begin by presenting our findings on the gender-differentiated effects on expenditures following a negative income shock in the household. In Table 2, we document the effect of income shock on female and male non-food expenditures, followed by the effect on women's expenditures relative to men's. We find that female-specific expenditures in households reduced significantly by 31.4% relative to men in the presence of a negative income shock, pointing to a gender gap in intrahousehold resource allocation. Although not statistically significant, there is an observed increase in expenditure towards male assignable goods and a decrease in expenditure towards female goods. Given that we define gender-specific assignable goods as clothing, shoes, and fabric, this trend may be attributed to the husband spending more time on employment outside the home during an income shock compared to his wife, which we discuss in detail in Section 6.2. Linking to the conceptual framework Equation (6), the empirical finding indicates that the demand elasticity for female-specific goods is higher relative to male-specific goods during an income shock.

[13] Rainfall shocks also affect livestock production, which is an income source for households in our setting Abay and Jensen (2020). Due to data limitations on calculating income from livestock production, we are able to show only the effect of negative rainfall shock on crop sales.

The higher budget elasticities of women's expenditure compared to men's expenditure implies more absorption of household-level income shock by women relative to men. Our findings mirror the existing empirical literature on gender-differentiated effects of household income shock, such as Hoddinott (2006) and Quisumbing et al. (2018) among others. For instance, Hoddinott (2006) finds that women's Body Mass Index (BMI) fell following a drought in Zimbabwe, whereas men's BMI was unaffected. Analysing the effect of household shocks on asset holdings in Uganda, Quisumbing et al. (2018) finds that drought reduces the wife's non-land assets more relative to the husband's. The results from our analysis add to the literature on women's higher susceptibility to impacts of negative income shock than men.

Table 2: Effect of Income Shock on Individual Expenditures

	Female		Male		Difference	
	(1)	(2)	(3)	(4)	(5)	(6)
Negative Income Shock	-0.138	-0.136	0.177	0.181	-0.314***	-0.317***
	(0.148)	(0.144)	(0.188)	(0.184)	(0.118)	(0.118)
N	4467	4462	4467	4462	4467	4462
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Other HH Controls	No	Yes	No	Yes	No	Yes

Notes: Dependent variables: Log transformed expenditure on different assignable non-food household items during the current year. The columns 'Female' and 'Male' indicates the effect of income shock on female and male non-food expenditures, respectively. Columns 'Difference' represents the impact of income shock on women's expenditure relative to men's. All specifications control for year and household fixed effects. Estimations without and with household controls are presented. Standard errors clustered at the enumeration level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

6.2. Labour Supply as a Mechanism to Cope with Income Shocks

Given that we find gender-differentiated effects on expenditures during an income shock, we check if the mechanism of labour supply could plausibly explain a part of the effect. An assumption we made in our simple household model while calculating the impact of income shock on expenditure is that leisure is separable from other consumption. However, it could be that the effect of income shock on individual expenditures is mediated by the effect of income shock on individual labour supply decisions. If the rainfall affects labour supply decisions, it may, in turn, affect expenditures made towards certain members of the household. In this subsection,

we analyse if a negative income shock due to rainfall shock affects female and male labour supply towards different activities.

Results from Table 3 provide evidence on the mechanism of labour supply adjustments for the gender differential in expenditures following an income shock. We find that there exists a gender differential of 10.6% where the husband spends significantly more labour hours in temporary off-farm employment as compared to the wife. In the presence of an income shock, we find that the wife and the husband increase their weekly number of hours spent on temporary off-farm labour by 9.5% and 20.2%, respectively. We also observe a 15.5% increase in the number of hours the wife spends on household non-farm activities relative to the husband. We do not find changes in the labour hours that couples allocate to any other income-generating activity. Relative to the husband, the wife spends more hours on household non-farm activities and less on temporary wage employment during an income shock.

As outlined in Dercon (2002), adjusting labour supply towards different income-generating activities is a prominent mechanism that rural households in Ethiopia use in the face of income shocks. Such coping strategies often include women's participation in off-farm activities in the form of self-employment or wage employment (Porter, 2012). Based on results from Van den Broeck and Kilic (2019), participation in self-employment is more common than in wage employment for women in Ethiopia, similar to other Sub-Saharan countries like Nigeria and Tanzania. This concurs with our finding that the wife engages more in non-farm activities such as small-scale business within the home and spends fewer hours towards wage employment outside the home relative to the husband.

The findings on the increase in hours spent by the wife and the husband towards non-farm activities indicate the role that off-farm employment, such as self-employment and productive safety net schemes, play in order to adjust to household income shocks among rural poor (Ba et al., 2021; Adjognon et al., 2017;

Mathenge and Tschirley, 2015).[14] The results also imply that husbands are able to increase their labour hours towards activities outside the home in the form of wage employment relative to their wives. In contrast, women increase their labour hours relative to their husbands to work within the household on non-agricultural activities. This particular effect in gender differential labour supply could be explained by women's limited access to off-farm employment outside their homes in Ethiopia due to factors such as cultural, religious, technical and financial constraints, as documented in several studies such as Van den Broeck and Kilic (2019); Amare and Belaineh (2013); Buehren et al. (2019).

Table 3: Effect of Income Shock on Labour Participation (Intensive Margins)

	Total Female	Total Male	HH Farm Female	HH Farm Male	HH Non Farm Female	HH Non Farm Male	Temporary Labour Female	Temporary Labour Male	Permanent Labour Female	Permanent Labour Male
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Negative Income Shock	0.102	0.028	-0.079	0.013	0.183	0.029	0.095*	0.202**	0.006	-0.046
	(0.177)	(0.170)	(0.162)	(0.186)	(0.112)	(0.065)	(0.051)	(0.079)	(0.007)	(0.036)
Difference		0.075		-0.093		0.155*		-0.106*		0.053
		(0.202)		(0.213)		(0.085)		(0.057)		(0.038)
N		4459		4436		4431		4436		4435
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Dependent variables: Log transformation of number of hours spent in the last seven days by wife and husband on the income generating activity. The first row indicates the effect of negative income shock on the number of hours spent spent in the past week by wife and husband on each activity. Row 'Difference' represents the impact of income shock on number of hours women spend working on the activity relative to men. All specifications control for year and household fixed effects. Standard errors clustered at the enumeration level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

We also investigate if there exists a gender gap in labour supply adjustments at an extensive margin in Table 4, and find no significant effects. At an extensive margin, we observe a 5.4 percentage points increase in the husband's rates of participation towards off-farm temporary labour and a 2.4 percentage point decrease in his participation towards permanent salaried employment. However, the participation of

[14] Temporary off-farm wage employment in rural Ethiopia includes farm worker for pay, labourer, domestic servant, unskilled worker, skilled labourers such as builders, flour mill operator, driver and mechanic (Beyene, 2008). Household non-farm activities include small trading, selling fuelwood, making charcoal, selling fruit, making pottery and handicrafts and stone mining (Woldehanna, 2002).

the wife relative to the husband in off-farm employment is not significantly different when a household experiences income shock.

Table 4: Effect of Income Shock on Labour Participation (Extensive Margins)

	HH Farm Female	HH Farm Male	HH Non Farm Female	HH Non Farm Male	Temporary Labour Female	Temporary Labour Male	Permanent Labour Female	Permanent Labour Male
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Negative Income Shock	-0.018	0.016	0.044	0.007	0.027	0.054*	-0.006	-0.024**
	(0.049)	(0.041)	(0.035)	(0.024)	(0.021)	(0.029)	(0.006)	(0.011)
Difference		-0.035		0.037		-0.027		0.018
		(0.060)		(0.027)		(0.020)		(0.012)
N	4467	4467	4467	4467	4467	4467	4467	4467
Mean Y	0.51	0.75	0.15	0.12	0.03	0.07	0.01	0.03
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Dependent variables: Dichotomous variable equal to one if individual worked in the last seven days on the income generating activity listed and 0 otherwise. The first row indicates the effect of negative income shock on the participation of wife and husband towards each activity. Row 'Difference' represents the impact of income shock on patricipation of women towards the activity relative to men. All specifications control for year and household fixed effects. Standard errors clustered at the enumeration level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

6.3. Women's Off-farm Employment as a Mediation to the Gender Gap in Shock Absorption

In the spirit of existing literature that underlines the importance of off-farm employment in women's empowerment in Sub-Saharan Africa, especially rural areas (Van den Broeck and Kilic, 2019), we investigate if wife's participation in off-farm activities mediates observed gender gap in expenditure changes during household income shock. As observed above, a gender gap exists in labour supply changes with respect to non-agricultural activities within the household and temporary wage employment outside the household. We follow up on this finding to analyse the heterogeneous effect of income shock on gender-specific expenditures further based on the wife's participation in off-farm activities.

First, from Table 5, we observe that the gender-differentiated changes in expenditure following a negative income shock are driven by households where the wife did not engage in any off-farm employment. We define the wife being engaged in any off-farm activities as a dichotomous variable equal to one if she spends more than zero

hours in non-agricultural activity at home, temporary wage or salaried employment outside the home (including participation in a safety net program) in the past week at the time of the survey and equal to zero if she spends zero hours in temporary labour.[15] The results in Panel B of Table 5 indicate that, in households where the wife did not engage in any off-farm employment, female expenditures reduced significantly by 27.8% - 28.9% relative to male expenditures. However, there is no statistically significant evidence of a gender-differentiated effect on expenditures following a negative income shock in households where the wife participated in household-level off-farm activities or temporary wage employment. However, it is worth noting that the point estimates are larger for the wives engaged in non-agricultural household activities but imprecisely estimated due to the low share of women engaged in any off-farm employment (19.6%). We propose that these are suggestive evidence on the role of off-employment for closing the gender gap in risk absorption, which needs to be explored further with data containing higher variability of female labour force participation.

Given we find a gender gap in time spent in non-agricultural household activities and temporary employment outside the home, we also analyse the heterogeneous effect of negative income shock based on women's participation in these activities in Table 6 and Table 7. We observe similar patterns as before. In households where the wife did not engage in household-level off-farm employment nor temporary wage employment, female expenditures reduced significantly by 28.6% and 29.9%, respectively, relative to male expenditures. However, there is no statistically significant evidence of a gender-differentiated effect on expenditures following a negative income shock in households where the wife participated in household-level off-farm activities or temporary wage employment. Point estimates remain larger for the wives engaged in non-agricultural household activities but imprecisely estimated due to the low share of women engaged in non-agricultural household activities (15%) and temporary wage employment (3.4%).

[15] Rural agriculture labour participation may be seasonal, and these effects may be driven by the timing of the survey. However, each round of the survey was conducted around the same period of the year, that is, after the harvest of crops from the main growing season. This provides confidence in our labour participation estimations.

As an extension to our heterogeneity analysis of the effect of household income shock on the gender gap in expenditures based on the wife's participation in temporary wage employment outside the home, we analyse the specific effect based on the wife's participation in a safety net program in Ethiopia, called Productive Safety Net Programme (PSNP). PSNP is a programme aimed at reducing food insecurity by providing economic opportunities through cash transfers, public works, and nutritional feeding programmes. Based on Table 8, the gender gap in expenditures ex-ante an income shock was only observed in households where the wife did not participate in the safety net program (Panel B, Columns 5 and 6). But, note that similar to the results of household non-agricultural activities and wage employment, the point estimates for women who are employed in PSNP are large but imprecisely estimated due to the low share of women in the sample who participated in the program (3.3%). The analysis can still be considered as an indication that women's participation in safety net programs in rural Ethiopia helps them to absorb the gender gap in expenditure changes during household income shocks.

The estimates on the heterogeneous effects of negative rainfall shock based on the wife's involvement in off-farm employment within the household and outside the household imply that off-farm employment helps offset possible gender-differentiated effects of income shock in rural settings. Both types of employment provide women with an independent income, which, in turn, contributes to closing the gender gap in household-level income shock absorption. Additionally, working outside the household farm can be deemed as an indicator of improvement in women's bargaining power, which could improve her relative position in the household for the allocation of resources. This finding is consistent with studies related to women's employment outside the home, such as Anderson and Eswaran (2009), which provides evidence for distinctive effects of household-based employment and employment outside the home.[16]

[16] Using data from rural Bangladesh, Anderson and Eswaran (2009) finds that working outside the family farm improves women's autonomy as compared to working on the family farm.

Table 5: Gender Differentiated Effect on Expenditures based on Wife's Participation in any Employment Outside Farm

	Female		Male		Difference	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A - Wife engaged in any employment outside farm						
Negative Income Shock	-0.253	-0.179	0.213	0.270	-0.466	-0.448
	(0.347)	(0.339)	(0.352)	(0.357)	(0.335)	(0.337)
N	4467	4462	4467	4462	4467	4462
Panel B - Wife not engaged in any employment outside farm						
Negative Income Shock	-0.125	-0.146	0.153	0.143	-0.278**	-0.289**
	(0.174)	(0.169)	(0.214)	(0.209)	(0.114)	(0.115)
N	4467	4462	4467	4462	4467	4462
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Other HH Controls	No	Yes	No	Yes	No	Yes

Notes: Dependent variables: Log transformed expenditure on different assignable non-food household items during the current year. The columns 'Female' and 'Male' indicates the effect of income shock on female and male non-food expenditures, respectively. Columns 'Difference' represents the impact of income shock on women's expenditure relative to men's. Panel A indicates the effect of negative income shock on the non-food expenditures if wife participated in any off-farm labour after the harvest season and panel B indicates the effect of negative income shock on non-food expenditures if wife did not. All specifications control for year and household fixed effects. Estimations without and with household controls are presented. Standard errors clustered at the enumeration level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table 6: Gender Differentiated Effect on Expenditures based on Wife's Participation in Non-Agricultural Household Activites

	Female		Male		Difference	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A - Wife engaged in non-agricultural household activites						
Negative Income Shock	0.108	0.154	0.605	0.644	-0.497	-0.490
	(0.477)	(0.464)	(0.413)	(0.417)	(0.437)	(0.441)
N	4467	4462	4467	4462	4467	4462
Panel B - Wife not engaged in non-agricultural household activites						
Negative Income Shock	-0.190	-0.197	0.096	0.096	-0.286***	-0.293***
	(0.174)	(0.170)	(0.206)	(0.201)	(0.108)	(0.107)
N	4467	4462	4467	4462	4467	4462
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Other HH Controls	No	Yes	No	Yes	No	Yes

Notes: Dependent variables: Log transformed expenditure on different assignable non-food household items during the current year. The columns 'Female' and 'Male' indicates the effect of income shock on female and male non-food expenditures, respectively. Columns 'Difference' represents the impact of income shock on women's expenditure relative to men's. Panel A indicates the effect of negative income shock on the non-food expenditures if wife participated in non-agricultural household activites after the harvest season and panel B indicates the effect of negative income shock on non-food expenditures if wife did not. All specifications control for year and household fixed effects. Estimations without and with household controls are presented. Standard errors clustered at the enumeration level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table 7: Gender Differentiated Effect on Expenditures based on Wife's Participation in Temporary Employment

	Female		Male		Difference	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A - Wife engaged in temporary off-farm labour						
Negative Income Shock	-0.422	-0.280	0.244	0.336	-0.665	-0.616
	(0.468)	(0.482)	(0.515)	(0.517)	(0.432)	(0.446)
N	4467	4465	4467	4465	4467	4465
Panel B - Wife not engaged in temporary off-farm labour						
Negative Income Shock	-0.130	-0.138	0.169	0.171	-0.299**	-0.309**
	(0.153)	(0.150)	(0.196)	(0.193)	(0.123)	(0.123)
N	4467	4465	4467	4465	4467	4465
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Other HH Controls	No	Yes	No	Yes	No	Yes

Notes: Dependent variables: Log transformed expenditure on different assignable non-food household items during the current year. The columns 'Female' and 'Male' indicates the effect of income shock on female and male non-food expenditures, respectively. Columns 'Difference' represents the impact of income shock on women's expenditure relative to men's. Panel A indicates the effect of negative income shock on the non-food expenditures if wife participated in temporary labour after the harvest season and panel B indicates the effect of negative income shock on non-food expenditures if wife did not. All specifications control for year and household fixed effects. Estimations without and with household controls are presented. Standard errors clustered at the enumeration level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table 8: Gender Differentiated Effect on Expenditures based on Wife's Participation in PSNP

	Female		Male		Difference	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A - Wife Engaged in Safety Net Program (PSNP)						
Negative Income Shock	-1.799***	-1.719***	-0.408	-0.323	-1.391	-1.395
	(0.536)	(0.521)	(0.819)	(0.816)	(0.968)	(0.967)
N	4461	4459	4461	4459	4461	4459
Panel B - Wife not Engaged in Safety Net Program (PSNP)						
Negative Income Shock	-0.073	-0.077	0.202	0.206	-0.275**	-0.282**
	(0.148)	(0.146)	(0.193)	(0.190)	(0.109)	(0.109)
N	4461	4459	4461	4459	4461	4459
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Other HH Controls	No	Yes	No	Yes	No	Yes

Notes: Dependent variables: Log transformed expenditure on different assignable non-food household items during the current year. The columns 'Female' and 'Male' indicates the effect of income shock on female and male non-food expenditures, respectively. Columns 'Difference' represents the impact of income shock on women's expenditure relative to men's. Panel A indicates the effect of negative income shock on the non-food expenditures if wife did not participate in safety net program (PSNP) during the previous year and panel B indicates the effect of negative income shock on non-food expenditures if wife did not. All specifications control for year and household fixed effects. Estimations without and with household controls are presented. Standard errors clustered at the enumeration level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

6.4. Heterogeneity based on Time Spent by Couples on On-farm Activities

In Ethiopia, family plots are owned and managed jointly by husband and wife, unlike the West African countries where wife and husband manage separate plots Slavchevska et al. (2021). Nevertheless, one spouse may have more control over farm-related decisions than the other. In that case, an income shock through farm-related productivity may affect individual expenditures based on who controls and manages the farm and its outputs. In this subsection, we check if the change in female expenditures relative to males due to farm productivity shock differs based on who controls the farm production. We proxy the number of hours the partner spends on farm activities as an indication of the control they have over on-farm activities. Hence in Table 9, we examine if the gender gaps in expenditure changes as a result of farm productivity shock depend on whether the husband spends more hours per week on on-farm activities. We find that the gender-differentiated effect of income shock on expenditures is only significant in households where the husband manages the plots. When the husband is in charge of the decisions of the farm, the wife absorbs the productivity shock. An ex-ante income shock reduces female expenditures by 33.3% relative to male expenditures in households where the husband spends more time in farm activities than the wife. There exists no gender gap when the wife is involved in farm activities as much or more than the husband. This result explains how control of household plots determines the gender differential effect of a farm-related income shock, previously observed in studies such as Duflo and Udry (2004) which demonstrates the gender-differentiated effect through female and male managed plots in Cote d'Ivoire.

7. Robustness Checks

In this section, we analyse if our findings on the gender-differentiated effect of household income shock are robust to alternate specifications such as controlling for lagged rainfall shock, household having children above age ten, community-specific trends and extreme values of dependent variables. We explain each of the checks in detail below.

Table 9: Gender Differentiated Effect on Expenditures based on Couples' Participation in On-farm Activites

	Female		Male		Difference	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A - Husband Spends More Time in On-farm than Wife						
Negative Income Shock	0.020	0.034	0.353*	0.374*	-0.333**	-0.340**
	(0.187)	(0.183)	(0.206)	(0.204)	(0.131)	(0.132)
N	4467	4465	4467	4465	4467	4465
Panel B - Wife Spends More or Same Time in On-farm than Husband						
Negative Income Shock	-0.398*	-0.418**	-0.116	-0.133	-0.282	-0.285
	(0.208)	(0.209)	(0.266)	(0.266)	(0.257)	(0.261)
N	4467	4465	4467	4465	4467	4465
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Other HH Controls	No	Yes	No	Yes	No	Yes

Notes: Dependent variables: Log transformed expenditure on different assignable non-food household items during the current year. The columns 'Female' and 'Male' indicates the effect of income shock on female and male non-food expenditures, respectively. Columns 'Difference' represents the impact of income shock on women's expenditure relative to men's. Panel A indicates the effect of negative income shock on the non-food expenditures if husband spends more hours per week than wife on on-farm activities and panel B indicates the effect of negative income shock on non-food expenditures otherwise. All specifications control for year and household fixed effects. Estimations without and with household controls are presented. Standard errors clustered at the enumeration level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

7.1. Inclusion of lagged rainfall shock

Contrary to the simple model of household decision-making, where consumption in the current period is affected by income shocks during the current period, consumption in the current period may be affected by income shocks in the previous period. This could be the case when expenditure is spread across multiple years. In Table 10, we control for lagged rainfall shock of the previous season in addition to the contemporaneous value to test if the current expenditure of individuals in the household is also affected by income shock during the previous season. This allows us to separate the contemporaneous effect of the shock from the lagged effect. The results of gender-differentiated effects on expenditures remain similar. Even accounting for the effects previous years' income shock can have on expenditures, we find a gender differential in favour of men by 33%. Our main results are stable after accounting for the effect of previous years' rainfall shock on expenditure.

Table 10: Effect of Income Shock, Controlling for Lagged Rainfall Shock

	Female		Male		Difference	
	(1)	(2)	(3)	(4)	(5)	(6)
Negative Income Shock	-0.177	-0.177	0.153	0.160	-0.330***	-0.337***
	(0.151)	(0.149)	(0.189)	(0.186)	(0.114)	(0.114)
N	4467	4465	4467	4465	4467	4465
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Other HH Controls	No	Yes	No	Yes	No	Yes

Notes: Dependent variables: Log transformed expenditure on different assignable non-food household items during the current year. The columns 'Female' and 'Male' indicates the effect of income shock on female and male non-food expenditures, respectively , additionaly controlling for an indicator variable if household experienced rainfall shock in the previous year. Columns 'Difference' represents the impact of income shock on women's expenditure relative to men's, additionaly controlling for an indicator variable if household experienced rainfall shock in the previous year.. All specifications control for year and household fixed effects. Estimations without and with household controls are presented. Standard errors clustered at the enumeration level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

7.2. Controlling for Household having Children over Age Ten

Another mechanism through which households cope with shocks is using child labour in times of economic distress. In order to check if the use of child labour alters the gender-differentiated expenditure patterns in households facing income shock, we add a control variable in our main analysis, which indicates if the household has children over the age of 10. In Table 11, we find that controlling for the household having children who are older than years does not change the main results. The gender gap in income shock effects on expenditures is 30.7% and is statistically significant.

Table 11: Effect of Income Shock on Individual Expenditures, Controlling for Children above 10

	Female		Male		Difference	
	(1)	(2)	(3)	(4)	(5)	(6)
Negative Income Shock	-0.140	-0.143	0.167	0.172	-0.307***	-0.315***
	(0.149)	(0.147)	(0.188)	(0.186)	(0.117)	(0.117)
N	4467	4465	4467	4465	4467	4465
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Other HH Controls	No	Yes	No	Yes	No	Yes

Notes: Dependent variables: Log transformed expenditure on different assignable non-food household items during the current year. The columns 'Female' and 'Male' indicates the effect of income shock on female and male non-food expenditures, respectively , , controlling for household having atleast one child above the age of 10. Columns 'Difference' represents the impact of income shock on women's expenditure relative to men's, additionaly controlling for an indicator variable if household experienced rainfall shock in the previous year.. All specifications control for year and household fixed effects. Estimations without and with household controls are presented. Standard errors clustered at the enumeration level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

7.3. Community specific trends

In the empirical analysis of this study, we control for household-level fixed effects to take into account any time-invariant household characteristics that may affect the result. It could also be the case that community-specific socio-economic factors that affect how households cope with income shocks confound the results. In this subsection, we check if the results are robust after controlling for Kebele-specific (equivalent to community-level) linear trends. Based on Table 12, we can conclude that the results remain stable when community-level fixed effects are accounted for. As a result of negative income shock, female expenditures decreased by 31.4% as compared to male expenditures.

Table 12: Effect of Income Shock, Controlling for Community Specific Trends

	Female		Male		Difference	
	(1)	(2)	(3)	(4)	(5)	(6)
Negative Rainfall Shock	-0.138	-0.138	0.177	0.183	-0.314***	-0.321***
	(0.149)	(0.147)	(0.189)	(0.186)	(0.118)	(0.119)
N	4467	4465	4467	4465	4467	4465
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Other HH Controls	No	Yes	No	Yes	No	Yes

Notes: Dependent variables: Log transformed expenditure on different assignable non-food household items during the current year. The columns 'Female' and 'Male' indicates the effect of income shock on female and male non-food expenditures, respectively , additionally controlling for community specific linear trends. Columns 'Difference' represents the impact of income shock on women's expenditure relative to men's, additionally controlling for community specific linear trends. All specifications control for year and household fixed effects. Estimations without and with household controls are presented. Standard errors clustered at the enumeration level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

7.4. Winsorsing Expenditures at 10%

Due to measurement error or misreporting, there may be extreme values of individual expenditures reported, which drive the empirical findings of this study. To overcome the extreme values bias, we winsorise the expenditure data by 5%. This means the bottom and the top 5 per cent of the cases in expenditure variables are recoded as the values corresponding to the 5th and the 95th percentile, respectively. From Table 13, we find that our main empirical finding of the gender-differentiated effect of income shock on expenditures still holds after winsorising the main outcome variables. An ex-ante income shock reduces female expenditure by 28.9% more relative to male expenditure.

Table 13: Effect of Income Shock on Individual Expenditures (Expenditures winsorised at 10%)

	Female		Male		Difference	
	(1)	(2)	(3)	(4)	(5)	(6)
Negative Income Shock	-0.137	-0.137	0.169	0.176	-0.289***	-0.296***
	(0.148)	(0.146)	(0.187)	(0.185)	(0.104)	(0.105)
N	4467	4465	4467	4465	4467	4465
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Other HH Controls	No	Yes	No	Yes	No	Yes

Notes: Dependent variables: Log transformed expenditure on different assignable non-food household items during the current year, winsorised at the 10% level. The columns 'Female' and 'Male' indicates the effect of income shock on female and male non-food expenditures, respectively. Columns 'Difference' represents the impact of income shock on women's expenditure relative to men's. All specifications control for year and household fixed effects. Estimations without and with household controls are presented. Standard errors clustered at the enumeration level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

8. Conclusion

Rural households in developing countries, mainly dependent on rain-fed agriculture, face substantial risks due to income shock from rainfall variability. These risks are anticipated to intensify with climate change. Little is known about the effects of such shocks on individuals within households, and subsequently, policies that help households cope with shocks are often targeted at the household level. This paper attempts to progress towards identifying intrahousehold gender-differentiated effects of a household-level income shock.

Using detailed information on households in rural Ethiopia, we show that income shocks can have different impacts on men and women within the household, with women being more vulnerable. Our results contradict the underlying assumptions of policies that all individuals in the households absorb the effects equally. Hence, in order to address individual-level poverty, more fine-tuned gender-based targeting would be necessary. Gender-sensitive targeting to address the specific needs of women and ensure that they have access to resources in times of income shocks can help to ensure that women are able to cope with income shocks.

Our findings on the gender gap in labour supply adjustments that households adapt to cope with income shocks provide important insights on designing social protection schemes that help build more resilient households and individuals in the

face of increasing climate-related shocks. Furthermore, independent income from non-agricultural household activities and temporary wage employment contributes to closing the gender gap in expenditures during an income shock. This points to the relevance of encouraging off-farm employment opportunities such as small-scale business, skill training, and safety net programs for rural women to ensure them better welfare outcomes. Addressing technical, cultural and social barriers that limit women's participation in the labour force would be key to building stability for women within households.

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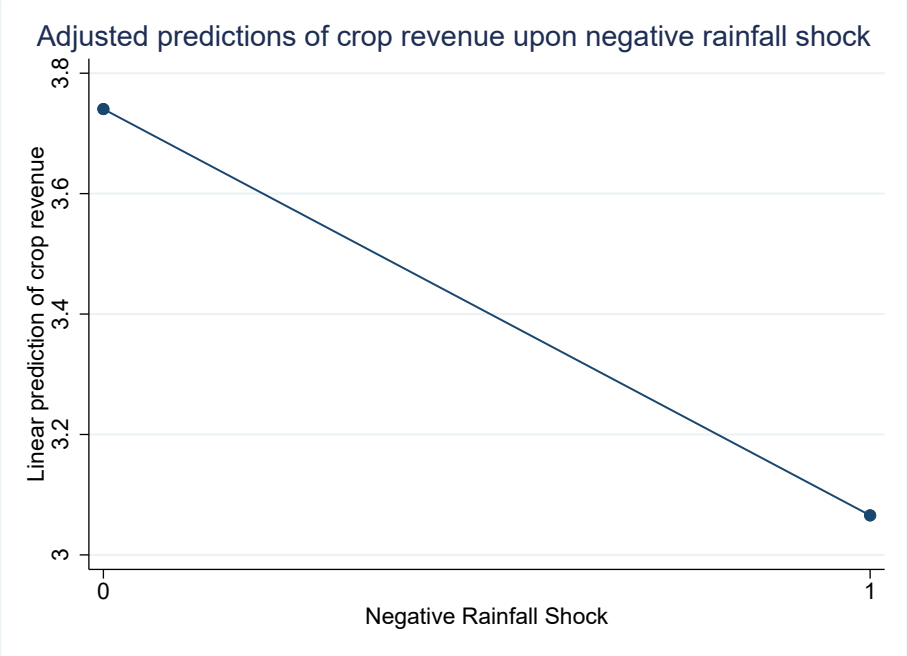
Appendix A: Effect of Rainfall Shock on Crop Revenue

In this subsection, we show evidence to support the approach of using rainfall shock, defined as rainfall deviation in the current year is more than one standard deviation to the left from the long-term average, as a proxy for negative income shock. Figure A1 show that a negative rainfall shock reduces revenue from the crops significantly by 67.5% ($p < 0.05$). This provides confidence in our approach of defining rainfall shock and using negative rainfall shock as a proxy for a determinant of variation in household income.

Figure A1: Adjusted linear prediction of crop revenue based on negative rainfall shock



Appendix B: Alternative Definitions of Rainfall Shock

In this section, we check for gender differentiated effect of income shock based on some alternative definitions of rainfall shocks. Other rainfall shock measures used are rainfall deviations of at least one standard deviation to the right of the long-term mean and rainfall deviations of at least one standard deviation either to the right or the left of the long-term mean. According to Table B1, there exists no gender differentiated effect of income shock when rainfall during the current year is more than one standard deviation to the right of the long-term mean. This could

be due to the marginal effects that high rainfall shock has on crop revenue (Table B3). High levels of rainfall did not significantly affect crop revenue compared to low levels of rainfall. This could be why we do not observe the gender gap in expenditure changes after a negative income shock from high levels of rainfall as much as low levels of rainfall. By defining rainfall shock as rainfall deviations of at least one standard deviation either to the right or the left of the long-term mean, we find marginal gender differentiated effect in expenditures. The marginal significance in effect could be driven by the negative rainfall shock, which is the main focus of our study.

Table B1: Effect of Income Shock on Individual Expenditures

	Female		Male		Difference	
	(1)	(2)	(3)	(4)	(5)	(6)
Positive Rainfall Shock	-0.241	-0.210	-0.238	-0.221	-0.004	0.011
	(0.189)	(0.186)	(0.195)	(0.190)	(0.155)	(0.155)
N	4467	4465	4467	4465	4467	4465
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Other HH Controls	No	Yes	No	Yes	No	Yes

Notes: Dependent variables: Log transformed expenditure on different assignable non-food household items during the current year. The columns 'Female' and 'Male' indicates the effect of income shock, proxied by positive rainfall shock, on female and male non-food expenditures, respectively. Columns 'Difference' represents the impact of income shock, proxied by positive rainfall shock, on women's expenditure relative to men's. All specifications control for year and household fixed effects. Estimations without and with household controls are presented. Standard errors clustered at the enumeration level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table B2: Effect of Income Shock on Individual Expenditures

	Female		Male		Difference	
	(1)	(2)	(3)	(4)	(5)	(6)
Positive/Negative Rainfall Shock	-0.213*	-0.197	0.002	0.014	-0.215*	-0.211*
	(0.128)	(0.123)	(0.162)	(0.159)	(0.110)	(0.110)
N	4467	4465	4467	4465	4467	4465
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Other HH Controls	No	Yes	No	Yes	No	Yes

Notes: Dependent variables: Log transformed expenditure on different assignable non-food household items during the current year. The columns 'Female' and 'Male' indicates the effect of income shock, proxied by positive or negative rainfall shock, on female and male non-food expenditures, respectively. Columns 'Difference' represents the impact of income shock, proxied by positive rainfall shock, on women's expenditure relative to men's. All specifications control for year and household fixed effects. Estimations without and with household controls are presented. Standard errors clustered at the enumeration level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table B3: Effect of Rainfall Shock on Crop Revenue

	Rainfall deviation is more than 1 SD to the left from long term average (1)	Rainfall deviation is more than 1 SD to the right from long term average (2)	Rainfall deviation is more than 1 SD (both side) from long term average (3)
Revenue from crop sales	-0.675**	-0.604*	-0.758***
	(0.290)	(0.319)	(0.219)
N	4467	4467	4467
Year fixed effect	Yes	Yes	Yes
Household fixed effect	Yes	Yes	Yes

Notes: Dependent variables: Crop revenue during the current agricultural season. Columns (1) and (2) presents the effect of negative and positive rainfall shock on crop revenue, respectively. Column (3) indicates the effect of a negative or positive rainfall shock on crop revenue. All specifications control for year and household fixed effects. Standard errors clustered at the enumeration level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Appendix C: Alternative Reference Period for Measuring Rainfall Shock

In the main analysis of this paper, we study the effect of negative rainfall shock experienced during the main agricultural season, *Meher*. Hence, the *Meher* season, from March to December, is the reference period of measuring income shock due to rainfall variability. As an alternative specification for negative rainfall shock, we check if our main results change significantly if we calculate rainfall shock during the entire year instead of *Meher* season. From Table C1, we find that there exist no significant gender differentiated effect of negative rainfall shock during the previous year on expenditures. This means that in our context we can attribute the productivity shock during the main agricultural season to be the determinant for gender gap in expenditures ex-ante an income shock.

Appendix D: Effect of Income Shock on Other Household-level Observable Expenditures

While the main focus of the study is to understand gender-based expenditure changes ex-ante an income shock, we additionally analyse the effect on expenditures observed household-level to gain an all-round understanding of household consumption smoothing. We examine the effect of negative income shock on household-level expenditures such as food, expenses for children, major and minor purchases, and ceremonies. Food expenditures include only money households spend to buy food items

Table C1: Effect of Income Shock on Individual Expenditures

	Female		Male		Difference	
	(1)	(2)	(3)	(4)	(5)	(6)
Negative Income Shock	-0.291	-0.260	-0.219	-0.204	-0.072	-0.056
	(0.198)	(0.195)	(0.206)	(0.202)	(0.154)	(0.154)
N	4467	4465	4467	4465	4467	4465
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Other HH Controls	No	Yes	No	Yes	No	Yes

Notes: Dependent variables: Log transformed expenditure on different assignable non-food household items during the current year. The columns 'Female' and 'Male' indicates the effect of income shock proxied by negative rainfall shock during the current year, on female and male non-food expenditures, respectively. Columns 'Difference' represents the impact of income shock on women's expenditure relative to men's. All specifications control for year and household fixed effects. Estimations without and with household controls are presented. Standard errors clustered at the enumeration level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

and do not include food produced on the farm which was consumed. From Table D1, we observe that no category of expenditure observed at the household level changes significantly during an income shock. However, due to a lack of gender-disaggregated data, it remains an open question as to whether a gender gap exists for these expenditure changes.

Table D1: Effect of Income Shock on Other Expenditures (Household level)

	Food		Children		Major Purchases		Minor Purchases		Ceremonies	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Negative Income Shock	-0.007	-0.011	-0.109	-0.150	-0.281	-0.317*	-0.015	-0.010	-0.001	-0.037
	(0.086)	(0.085)	(0.127)	(0.132)	(0.176)	(0.175)	(0.082)	(0.081)	(0.284)	(0.283)
N	4467	4464	4467	4464	4467	4464	4467	4464	4467	4464
Household FE	Yes	Yes	Yes	Yes	Yes	Yes				
Year FE	Yes	Yes	Yes	Yes	Yes	Yes				
Other HH Controls	No	Yes	No	Yes	No	Yes				

Notes: Dependent variables: Log transformed expenditure on different household items during the current year, for which the data is available only per household and is not assignable by gender. All specifications control for year and household fixed effects. Estimations without and with household controls are presented. Standard errors clustered at the enumeration level in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Appendix E: Variable Definitions

Table E1: Variable Definitions

Variable	Definition
Household Head is Male	Dichotomous variable indicating if the household head is male
Household Size	Number of people residing in household at the time of interview
Husband attended school	Dichotomous variable indicating if the husband attended school
Wife attended school	Dichotomous variable indicating if the wife attended school
Household faced drought	Dichotomous variable indicating if the household farm experienced drought during the panel years (2011, 2013, 2015, self-reported)
Negative Rainfall Shock (2011,2013, 2015)	Binary variable equal to 1 if the deviation in rainfall that the household experiences during the main agricultural season are more than one standard deviation away to the left from the average rainfall deviation that households in the sample experience, 0 otherwise.
Expenditure Shares - Female	Share of total non-food expenditure spent during the year on average towards female clothing, shoes and fabric
Expenditure Shares - Male	Share of total non-food expenditure spent during the year on average towards male clothing, shoes and fabric

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Table E1: Variable Definitions

Variable	Definition
Expenditure Shares - Children	Share of total non-food expenditure spent during the year on average towards children's clothing, shoes and fabric
Expenditure Shares - Minor purchases	Share of total non-food expenditure spent during the year on average towards matches, batteries, candles, laundry soap, hand soap, other personal care goods, charcoal, firewood, and kerosene
Expenditure Shares - Major purchases	Share of total non-food expenditure spent during the year on average towards kitchen equipment, linen, furniture, and lamp
Expenditure Shares - Ceremonies	Share of total non-food expenditure spent during the year on average towards ceremonial expenses and donations to church
Total Non-food expenditures	Total expenditure spent towards non-food items during a year on average
Total Food expenditures	Total expenditure spent towards food items during a year on average (excluding the consumption of food produced on-farm)
Labour Participation - Extensive Margin	
Household Agriculture - Wife	Dichotomous variable indicating if the wife worked in household agricultural activities during the past 7 days

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Table E1: Variable Definitions

Variable	Definition
Household Agriculture - Husband	Dichotomous variable indicating if the husband worked in household agricultural activities during the past 7 days
Household Non-agriculture - Wife	Dichotomous variable indicating if the wife worked in household non-agricultural activities during the past 7 days
Household Non-agriculture - Husband	Dichotomous variable indicating if the husband worked in household non-agricultural activities during the past 7 days
Temporary Wage Labour- Wife	Dichotomous variable indicating if the wife worked in temporary wage employment during the past 7 days
Temporary Wage Labour- Husband	Dichotomous variable indicating if the husband worked in temporary wage employment during the past 7 days
Permanent Wage Labour - Wife	Dichotomous variable indicating if the wife worked in permanent wage employment during the past 7 days
Permanent Wage Labour - Husband	Dichotomous variable indicating if the husband worked in permanent wage employment during the past 7 days
Labour Participation - Intensive Margin	
Household Agriculture - Wife	Number of hours spent by the wife in household agricultural activities during the past 7 days

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Table E1: Variable Definitions

Variable	Definition
Household Agriculture - Husband	Number of hours spent by the husband in household agricultural activities during the past 7 days
Household Non-agriculture - Wife	Number of hours spent by the wife in household non-agricultural activities during the past 7 days
Household Non-agriculture - Husband	Number of hours spent by the husband in household non-agricultural activities during the past 7 days
Household Temporary Wage Labour- Wife	Number of hours spent by the wife in temporary wage employment during the past 7 days
Household Temporary Wage Labour- Husband	Number of hours spent by the husband in temporary wage employment during the past 7 days
Household Permanent Wage Labour - Wife	Number of hours spent by the wife in permanent wage employment during the past 7 days
Household Permanent Wage Labour - Husband	Number of hours spent by the husband in permanent wage employment during the past 7 days