

Gendered Effects of Climate Shock, Formal and Informal Financial Institutions, and Welfare in Post-Conflict Somalia

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List of abbreviations and acronyms

ATE	Average Treatment Effects
EAs	Enumeration Areas
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
IDP	Internally Displaced Persons
IMF	International Monetary Fund
IPW	Inverse Probability Weighting
MM	Mobile Money
UNCHR	United Nations High Commissioner for Refugees
UNICEF	United Nations International Children's Emergency Fund

Abstract

This study investigates the impact of climate shock on Somali households' welfare status, and examines the mediating roles of formal and informal financial institutions—mobile banking and remittances—in enhancing households' coping capacity. Using representative panel data, we show that climate shock has adverse effects on multiple welfare indicators for both female- and male-headed households. However, we find that female-headed households are more likely to fall below the poverty line, have a larger poverty depth, and shift their diet due to climate shock than male-headed households. Interestingly, we find that remittances decrease following climate shock, both on average and for female-headed households, but such reduction does not have a significant adverse effect on the households' coping ability. This could be an indication that Somali households rely on other coping mechanisms to shocks than remittances. Similarly, even though we find that mobile money increases the likelihood of receiving remittances, we find no evidence that this translates into a higher coping ability to climate shock. Further investigation is needed to identify Somali households' coping strategies.

Key words: *Climate shock; Financial institutions; Welfare; Post-conflict; Gender.*

JEL classification codes: *D14; E42; G23; I3; L96; O17; Q54.*

1. Introduction

Studies based on various settings have documented the effects of climate shock both at macro and micro levels. These effects range from adverse effects on macroeconomic performances such as export (Jones & Olken, 2010), labour productivity (Cachon et al., 2012; Niemelä et al., 2002), economic growth (Dell et al., 2012) to migration (Feng et al., 2010; Gray & Mueller, 2012), insurgency, civil war and political stability (Cools et al., 2015; Miguel et al., 2004), domestic violence (Sekhri & Storeygard, 2011), food insecurity (Bocchiola et al., 2019; Wheeler & Von Braun, 2013) and malnutrition (Cooper et al., 2019; Lohmann & Lechtenfeld, 2015).

Studies also showed that drought shock that happened at early childhood can have persistent effects that might diminish adulthood health status, intellectual performance, work capacity, and earnings (Abiona, 2017; Dercon & Porter, 2014; Dinkelman, 2017; Kumar et al., 2016). Particularly, childhood shocks for women have the potential of transmissibility across generations. For example, Hyland and Russ (2019) showed the long-lasting effects of drought on wealth status, years of formal education received, employment status, and the health status of the off-springs of women who experienced drought shock during their childhood. Studies like Lohmann and Lechtenfeld (2015) argue that the effects of such shocks are more pronounced on households without access to coping mechanisms.

In line with this, recent literature has also been exploring various coping techniques and investigating their effectiveness. These studies can be broadly categorized into those that look at the effects of interventions and government responses and studies that examine the effectiveness of household adaptation strategies. Among the former, Kankwamba and Kornher (2019) and Hirvonen et al. (2020) showed the role of access to infrastructures in mitigating the effects of drought, whereas Janzen and Carter (2019) explored the role of micro insurances in reducing the drought-induced consumption reduction. Others investigated the role of policy responses like developmental aid (Rustad et al., 2020) and social protection programmes (Hou, 2010). Even though the literature documents the positive roles of such interventions, the likelihood of defying shock events with them could be minimal in countries like Somalia, where a decade-long civil war and repeated political and humanitarian crises have weakened the capacity of the state to invest in such infrastructures and institutions.

Another strand of the literature examines adaptation strategies undertaken at the households' level. This includes mitigating shock through informal risk-sharing

networks. However, such strategies are more effective during idiosyncratic shocks like illness or death, and they may not be able to help households cope with covariate shocks like floods or droughts that impact everyone in the same location at the same time. Studies like Kazianga and Udry (2006) also showed that there is almost no risk-sharing during drought events among networks, and households exclusively rely on self-insurance. The available self-insurance options documented in the existing studies include, among others, the sale of productive assets such as land and livestock (Carter et al., 2008; Hoddinott, 2006) and reducing basic household consumption (Tongruksawattana & Wainaina. 2019). Both options can lead to adverse long-term consequential effects since they limit households' future earnings and capacity to invest in human capital development (Janzen & Carter, 2019).

Remittances, flowing from the migration of household members to areas with better job opportunities, are also another coping mechanism used by households. In this case, the out-migrant members are culturally expected to support the household members that are “left behind” and for this reason, we categorize remittances as ‘informal financial instruments/institutions’ as there is no written legal requirement that would be reinforced by government body for migrants who would not send remittances.¹ For example, Karanja Ng’ang’a et al. (2016) showed that, households with migrating members are more likely to adopt drought-tolerant agricultural innovations and are also more likely to purchase productivity-enhancing agricultural inputs. They found that remittance is the main mechanism that led to higher adaptation outcomes among Kenyan households with migrant members. Similarly, studies also show that remittance increases in response to shocks. For example, an earlier study by Lucas and Stark (1985) found that remittances increased when there was climate shock in Botswana.² Similarly, Couharde et al. (2011) found that negative climate shock increased remittances, whereas a positive climate shock decreased it in West African countries. The effectiveness of remittances in consumption smoothing is also documented by Yang and Choi (2007) and Arouri et al. (2015). For example, Yang and Choi (2007) showed that 60% of the reduction in the households’ income due to drought shock was replaced by remittances received from overseas, and the consumption in households with migrant members remained unaffected during the shock event.

The literature also provides insight into the role of innovations in the formal financial markets in various aspects of the economy in developing countries, including its role in enabling households to absorb the shock from climate variability. A recent study by Riley (2018) revealed that households who use mobile money are more likely to maintain their consumption after facing climate shocks such as floods and drought than households who do not use mobile money technology. A related study was undertaken in Kenya by Jack and Suri (2014) and showed that consumption of users remains unaffected in the face of drought shock while that of the non-users was reduced by 7%. They listed an increased amount of remittances received as one of the

main pathways. Similarly, Abiona and Koppensteiner (2020) find that, not only are households that use mobile money more likely to smooth their consumption during climate shocks, but they are also less likely to become poor and are more likely to keep their children at school.

While the literature provides some insights on the nexus among climate shocks, financial institutions, and welfare, most of the evidence comes from politically significantly different countries from Somalia. Hence, although the abovementioned studies showed positive effects of mobile money and remittance, the extent to which these effects can be generalizable to the Somali case is less understood. For example, while remittances may allow people to maintain their ability to spend on consumption items, they may not improve the availability of food. Since drought affects food production, food products have to be transported from areas not affected by the shock, which depends on factors like access to road, credit, and storage—infrastructures that have been negatively affected by the decade-long civil war. Particularly, micronutrient-rich foods like vegetables and dairy products may not be readily accessible in that situation because most of them are perishable.

Additionally, as a result of the long-lasting conflict and the weak governance that accompanied it, data on the livelihood of Somali households has been scant to draw any evidence as to how Somali households are being affected by climate shocks and understanding their adaptation strategies. It is particularly interesting to investigate how the effect of climate shock might be mediated by the availability of formal and informal financial institutions for two main reasons. Firstly, because of the weak government, trust in the financial markets in Somalia is very low to the point that people prefer to trade in US dollars than Somali shillings (World Bank, 2018). This lack of trust in the local currency could constrain poor people, who lack access to the US currency, to be financially excluded and may suffer more from climate shock. Secondly, this lack of trust in the financial institutions could constrain migrant family members from making transfers safely. In this scenario, mobile money could mitigate the trust issue, whereby migrant members could easily and safely make timely transfers, which could assist poor households to better cope with the effects of a climate shock.

We also further disaggregate our analysis by subpopulations, mainly by the gender of the household head. The main reason behind such disaggregation is the desire to enrich our understanding of how different population segments would be affected by climate shocks and to check whether their coping strategies would differ. Such understanding would enable policy makers to design better-targeted policies.

Given that societies assign varying roles and set different expectations based on the individuals' sex, men and women are likely to be affected by environmental factors, such as climate shocks, in different ways. Existing literature has been documenting unequivocally that women and households headed by women are disproportionately affected by climate shocks and that their adaptation strategies tend to differ from their male counterparts (Asfaw & Maggio, 2018; Ngigi et al., 2017). Studies have also shown that the impact of interventions aimed at improving adaption strategies vary

depending on the recipient's gender (Pitt & Khandker, 1998; Sholkamy, 2014). For example, their adaption strategies may differ as a result of existing gender norms. More precisely, in patriarchal societies like Somalia, men are assigned higher authority and have higher decision-making power compared to women. They are expected to fulfil the financial wellbeing of their households. Women, on the other hand, are expected to "compliment" the men by raising children, obtaining and preparing food, and taking care of other household chores, such as fetching water and cleaning.³ On top of this, women in Somalia carry an unequal burden of hardships caused by weak government apparatus, poverty, and conflict coupled with culture and traditions which advocate strict male hierarchy. Women in the country are either systematically excluded from the job market (female to male labour force participation rate in the country is only 29.6% according to World Bank (2019a)), from asset ownership and have low decision-making power, or they have to work under patriarchy Koshin (2016). Furthermore, studies also show that men and women differ in their spending habits, such that men are more likely to spend their money on household durables and women on food and nutrition for their families (Ochieng et al., 2017; Kurz et al., 2000; Sraboni et al., 2014). As a result, we expect the welfare effects of remittances channelled through men and women to vary. Against this backdrop, we study the extent to which Somali women are affected by climate shock compared to their male counterparts, and investigate whether the presence of formal and informal financial institutions, such as mobile money and remittances, increase their coping strategies.

To achieve our objectives, we use data from two rounds of a comprehensive and representative data set of the World Bank's Somali High Frequency Survey. For analysis, we use a combination of the household fixed-effects model and inverse probability-weighting approaches. Our results consistently show that, climate shocks have a negative impact on the welfare position of Somali families, with the consequences being worse for female-headed households. We also find that, while having a mobile phone enhances the likelihood of receiving remittances, we find no evidence that this translates into a higher coping ability to climate shock. Interestingly, and contrary to our expectations, we also find that remittances decrease following climate shocks. Our results contradict those in Nguyen et al. (2020), Newman and Tarp (2020), Hirvonen et al. (2020), and Azzarri and Signorelli (2020), where they find that households smooth their consumption from adverse weather shocks by taking advantage of better access to institutions and infrastructures.

The remainder of this paper is organized as follows. Section 2 provides background information on the study context, climate shocks, remittances, and mobile banking in Somalia. Section 3 presents the empirical strategies. Section 4 presents data and descriptive statistics. Section 5 presents and discusses the results, and Section 6 concludes.

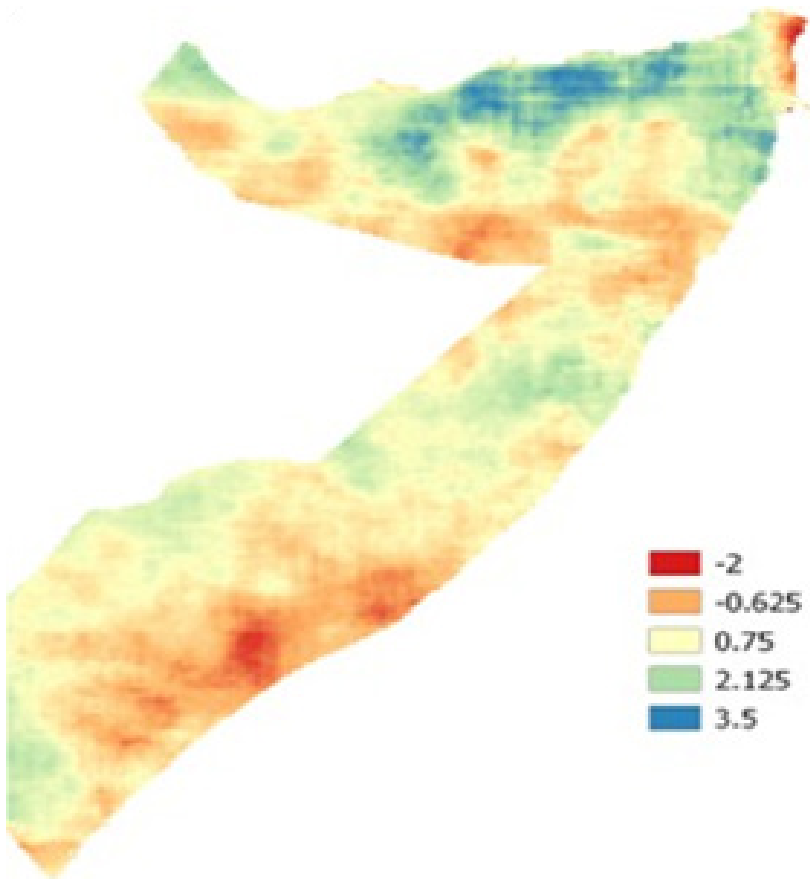
2. Context

Somalia, a country that has not had a functioning central government for more than 20 years since 1991, has been struggling with economic and social stagnation caused by the interplay of the absence of central government, environmental degradation, civil wars, and insurgencies inspired by transnational radical ideology. This has made living for millions challenging and created widespread poverty in the country. To put it in numbers, more than a quarter of its population lives on an average monthly income of less than US\$100, the wellbeing of one-third of the population is vulnerable (based on living and housing conditions) and 31% of the population cannot read (World Bank, 2019b). However, it is also appropriate to recognize the recent success stories documented in the country. For example, though the magnitude is not sufficient to reduce poverty rates, Somalia's real GDP grew by an average of 2.5% between 2013 and 2017. Estimates show that the rise in private consumption expenditure, which was growing with an average of 3.7% per year, supported mainly by the international remittances, played a vital role in the economic growth (World Bank, 2018).

Climate shock

Although the country, in general, is facing various shocks, droughts remain to be the main catastrophic events causing tremendous economic and social losses (Abdulkadir, 2017). The most recent drought events that caused significant harm in the country include the 2015/16 drought, which was coupled with El Niño effects, and the drought that happened during 2016/17. Figure 1 shows the severity of drought in the country by comparing rainfall received during the main rainy seasons of 2015 with the average rainfall received within the last three decades. The figure shows that noticeable weather shock had occurred although it varies in size and spatial coverage.

Figure 1: Drought index (Z-scores) during the main rainy season in 2015



Source: Authors' illustration based on the CHIRPS climate data.

Remittances

In Somalia, remittances are the largest source of foreign funding, and the volume of remittances received by the country surpasses the total of the foreign direct investment (FDI), development aid, and emergency assistance (Elmi & Ngwenyama, 2019; Maimbo, 2006; Paul et al., 2015). This makes remittances fundamental for both economic performance at the macro-level and sources of start-up and consumption at micro-levels. For example, the International Monetary Fund (IMF, 2017) shows that international remittances account for nearly a quarter of the national gross domestic product (GDP), and from a micro perspective, eight out of ten of all new business ventures in the country are funded by remittances, and four out ten individuals rely on it to cover their daily expenditures.

Mobile money also enabled prompt responses in the face of shock events such as drought and conflict, even to areas that are hard to reach due to poor access to infrastructure and areas that have security problems. For example, mobile money

enabled the transfer of US\$10 million to one million Somalis within a month during the incidence of the 2017 drought (Majoka, 2019). Indeed, in a country where a series of conflicts significantly damaged the infrastructure and institutional capacity of the country and four out of ten people need humanitarian aid and more than 1.1 million are internally displaced (United Nations International Children's Emergency Fund [UNICEF], 2016), mobile money can play matchless support during such hazardous events.

Mobile money

World Bank (2018) characterizes Somalia's economy as a dollarized economy since most of the transactions in the country are undertaken using the dollar, not the national currency. This is partly because of a lack of trust in the local currency since almost all the existing notes of the official currency, Somali shilling, is counterfeit because the government has not been able to issue banknotes since 1991. Hence, the lack of faith in the national currency, inflation, and the difficulty of using dollars for low-value transactions and poor access to conventional banking increased the need for mobile money in the country. Consequently, starting from 2009, in Puntland, Golis Telecom started a mobile money service called SAHAL; in Southern Somalia, Hormud Telecom started EV-PLUS mobile money services; and in Somaliland, Somtel Telecom started ZAAD mobile money services (Mohamed, 2019).

With transactions worth US\$2.7 billion in a month, Somalia has one of the most active mobile money markets in the world. It is currently an important financial tool for both individuals and entities in the country, and its usage ranges from paying bills and retails to receiving salaries and remittances to savings in mobile wallets. Estimates show that around 70% of the population aged above 16 year use mobile money services regularly, and subscriptions for the services have been growing at an average of about 20% per year since 2014 (World Bank 2019b). Though men and urban dwellers were more agile to adopt mobile money innovations, women and rural residents are also swiftly catching up (Elmi & Ngwenyama, 2019). For example, recent estimates show that the adoption rate has already reached 55% in rural parts of the country, and 70% of women have mobile money accounts, which signals the contribution of mobile money to financial inclusion and gender empowerment in the country. Indeed, a business venture started as a simple exchange of airtime credit among consumers around 2009 is now creating a 'cashless society' in the country where only 15% of the population has a bank account and banks rarely offer ATM and credit cards (Majoka, 2019; World Bank, 2018).

Many factors have contributed to the spread of mobile banking innovations in the country. This includes the existence of a large number of mobile phone users (about 90% of the population aged above 16 years own at least one mobile (World Bank, 2017) and the suitability of the innovation with the lifestyle of a significant portion of the population who are nomadic or semi-nomadic contributed to the high level of mobile money adoption in the country. Besides, the presence of large amounts of

counterfeit currency notes and poor performance of traditional banking services in the country also contributed to the replacement of cash with mobile money. The business model used by mobile money companies in Somalia also contributed a positive role in the process. For example, all mobile money services (including transaction or cash withdrawal fee) are offered free of charge, and mobile money is considered by the companies as a retention device for indirect revenues (Elmi & Ngwenyama, 2019). This has added the feature of being affordable in addition to being convenient and fast compared with traditional financial institutions.

The industry is not free from obstacles, and it is not also immune from causing considerable risks both to the users and macro economy of the country. Problems associated with mobile phone coverage in rural areas, affordability of mobile phone ownership, poor access to electricity, illiteracy, weak integration among service providers (companies mainly rely on their own distribution networks), and high dependency of the business on US dollar are some of the challenges the industry has to struggle with. Among the risks, lack of regulation and formal Know-Your-Customer requirements on the identity of customers make the industry both fragile and vulnerable to money laundering, financial fraud, and terrorism financing. Tax evasion, causing depreciation of the local currency and leading to inflation fuelled by the “dollarization” of the economy are also among the risks associated with the industry. Despite all these concerns, mobile money is providing a significant opportunity to the economy, especially through facilitating money transfers such as remittances in the country (Elmi & Ngwenyama, 2019).

3. Empirical strategy

Since we have panel data for most of our variables of interest, except for mobile money, we use fixed-effects regression models. Even though we see the incidence of climate shock to be exogenous, fixed-effects analysis improves our identification by accounting for any time-invariant household and community-level heterogeneity that may influence households' welfare and consumption patterns. For mobile money, unfortunately, data is only available in the last round and therefore we resort to an inverse probability-weighting method. Below, we present the specific models.

Climate shocks, welfare, and diet quality

We start by estimating the effects of drought shock in our welfare indicators (the likelihood of falling below the poverty line and hunger as well as the poverty depth) and diet quality indicators (consumption of meat, pulse, and fruit). For this purpose, we estimate the following fixed-effects model:

$$Outcome_{jit} = \alpha_{ij} + \vartheta_j Shock_{it} + \beta_j X_{it} + \epsilon_{ijt} \quad (1)$$

Where: $Outcome_{jit}$ shows the outcome indicator j of household i , where j denotes whether household i is below poverty line, experienced hunger, poverty gap index (poverty depth), consumed meat, consumed pulse, or consumed fruit. $Shock_{it}$ shows whether household i faced climate shocks in time t , and X_{it} stand for the set of covariates, such as age, family size, education, etc., that we control for in our analyses. α_{ij} represents household level idiosyncrasies related to outcome j , and ϵ_{ijt} is the stochastic error term related to outcome j . ϑ_j are our parameters of interest associated with outcome j .

Heterogeneity by gender

Next, we investigate the gendered effects of climate shocks. For this purpose, we include an interaction between the household heads' gender and climate sock to our specification in Equation 1, giving us the following specification:

$$Outcome_{jit} = \alpha_{ij} + \vartheta_j Shock_{it} + \zeta_j Female_{it} + \rho_j Shock_{it} X Female_{it} + \beta_j X_{it} + \epsilon_{ijt} \quad (2)$$

Where: ρ_j is our parameter of interest capturing the effects of climate shocks on female-headed households relative to male-headed households.

Remittance as a coping strategy

For remittance to be taken as a coping mechanism, it has to fulfil the following two conditions:

- 1) its inflow increases following climate shocks, and 2) remittances increase welfare and diet quality. Therefore, to check whether these two conditions are fulfilled, and whether there is heterogeneity by gender of the household head, we estimate the following fixed-effects models:

$$R_{it} = \alpha_i + \Gamma Shock_{it} + \zeta Female_{it} + \gamma Shock_{it} X Female_{it} + \theta X_{it} + \epsilon_{it} \quad (3)$$

and,

$$Outcome_{ij_t} = \alpha_i + \delta_j R_{it} + \vartheta_j Shock_{it} + \lambda_j R_{it} X Shock_{it} + \theta_j X_{it} + \epsilon_{ij_t} \quad (4)$$

and, the following specification with a three-way interaction to see whether female-headed households are more/less likely to use remittances as their coping strategy in response to climate shock compared to their male counterparts.

$$\begin{aligned} Outcome_{ij_t} = & \alpha_{ij} + \vartheta_j Shock_{it} + \pi_j R_{it} + \zeta_j Female_{it} \\ & + \rho_j Shock_{it} X R_{it} + \xi_j Shock_{it} X R_{it} + \psi_j Female_{it} X R_{it} \\ & + \Delta_j Shock_{it} X Female_{it} X R_{it} + \theta_j X_{it} + \epsilon_{ij_t} \end{aligned} \quad (5)$$

Where: R_{it} shows whether household i received remittances from either national or international sources in a given year; $Shock_{it} X R_{it} X Female_{it}$ stands for the triple interaction showing women facing climate shocks and accessing remittance. λ_j and Δ_j are our main parameters of interest showing the effects of remittance and climate shocks on outcome j , respectively.

Mobile money as a coping strategy

Furthermore, we use inverse probability weighting (IPW) estimates to evaluate the impacts of mobile money (MM) on households' coping ability. We also use the same approach to test whether mobile money increases the flow of remittances. This is because we only have data on mobile money usage in the last round—making it impossible to apply fixed-effects regression. As its name implies, IPW refers to weighting outcome measures by the inverse of the likelihood of a particular set

of covariates being assigned to its treatment. By doing so, IPW removes confounding by creating a "pseudo-population" in which the treatment is independent of the measured confounders.

The implementation of the IPW approach requires estimating the conditional probability of an individual being a mobile money user (propensity score) and the calculation of stabilizing weights for both mobile money users and non-users for our case. In our case, since the treatment indicator (decision to use mobile money) is binary, the propensity score can be computed using a logistic regression, assuming the regression is parametrized by $\alpha = (\alpha_0, \alpha_1, \alpha_2 \dots \alpha_n)^T$. By denoting the list of variables hypothesized to affect the decision to use mobile money and the outcome variables by $X = (X_1, \dots, X_p)$, the equation can be represented as:

$$\log\left(\frac{e(x)}{1 - e(x)}\right) = X^T \alpha \quad (6)$$

Following this, the probability of being either a mobile money user or non-user is computed for each household represented by i . Conditional on the household and community-level characteristics, the probability (propensity scores) can be computed from the fitted model as follows:

$$\hat{e}_i = \hat{e}_i(X_i) = \frac{\exp(X_i^T \hat{\alpha})}{1 + \exp(X_i^T \hat{\alpha})} \quad (7)$$

After computing propensity scores, we compute stabilizing weights for both mobile money users and non-users. These weights can be calculated as $w_i = 1/\hat{e}$ for mobile money users and $w_i = 1/(1 - \hat{e})$ for non-users.

As a result, we will analyse the effects of mobile money on household welfare and diet quality using the IPW framework. We also assess if mobile money improves household coping abilities for reasons other than facilitated remittance by estimating the average treatment effects of households affected and not affected by the drought shock separately.

4. Data and descriptive statistics

Data

To address our research questions, we employ a rich and representative data set that come from two rounds (2016 and 2017) of the World Bank's Somali High Frequency Survey. The Survey covers 17 regions of Somali. It uses a multi-stage stratified random sampling technique to select households. The strata are defined based on; 1) administrative dimension, and 2) population type, which are again classified as rural, urban, Internally Displaced People's (IDP) settlement areas, and nomadic communities. In the rural and urban strata, households are clustered into enumeration areas (EAs), whereby from each EA, 12 households are selected by using the random probability proportional to size method. For the IDP settlement areas, UNCHR's shelter clusters are used as the primary sampling units instead of EAs. Lastly, the primary sampling units for the nomadic households are clustered at water point levels and similar to the previous two strata, 12 nomadic households are selected by using random probability proportional to size method. The survey constitutes a total sample size of 6,092 households. More specifically, the sample constitutes 4,011 households from urban areas, 1,106 households from rural areas, 468 households from IDP settlement areas, and 507 households from nomadic areas.

The data set contains information on various demographic and socioeconomic variables, such as household characteristics, food, and non-food consumption, food security, exposure to various types of shocks, income, and remittances, as well as behavioural information and perceptions. Given that our aim is to understand the nexus among shock exposure, remittances, and mobile money access on household's welfare, we use information on whether the household faced drought shock; whether the household has access to remittances (both from internal and international sources), and whether the household uses mobile money services as our main variables of interest (unfortunately, this information is only available in the second wave of our data set). Concerning our outcome variable of interest—household welfare—we use a diverse set of indicators that are constructed based on consumption expenditure. Consumption expenditures are computed as the total value of monthly consumption (including consumption from own production, purchased, gift, or donations) and international cut-off

points are used to delineate households as poor and non-poor (we call this ‘below poverty line’) and compute the poverty gap index (or, the household's poverty depth). We also use an indicator for whether the household has faced hunger. Hunger is measured in the data set by asking households if they have had no food to eat of any kind for the last four weeks due to a lack of resources to buy. The importance of measuring welfare using current consumption expenditure in rural context than relying on income is discussed by Meyer and Sullivan (2003). Accordingly, we represented the welfare status of the households by the poverty headcount ratio, poverty gap index, hunger, as well as access to nutritious food items (we call this ‘diet quality’).

The household's status vis-a-vis the poverty line is the simplest and commonly used indicator of poverty. It shows whether a household's consumption expenditures fall below a predetermined poverty line.⁴ This will help us to see if there are drought-induced sliding back to transient poverty, and will also enable us to check whether mobile money protected vulnerable households from the sliding. One of the shortcomings of this indicator is that it does not distinguish between “very poor” and “less poor” households, nor does it account for changes in income distribution below the poverty line, making it impossible to determine whether a poor person becomes poorer or less poor. However, experts argue that income distribution below the poverty line also matters to effectively address poverty (Sen, 1976). Hence, we also use the poverty gap index that shows how far each household's income falls below the poverty level. Additionally, we use consumption of nutrient-rich food items as additional welfare status indicators—proxied by the consumption of meat, pulse, and fruit. It is believed that increasing the variety of foods ensures adequate intake of essential nutrients, promotes good health, and improves health outcomes (such as birth weight and child anthropometric status) (Arimond & Ruel, 2004; Moursi et al., 2008; Pangaribowo et al., 2013; Rao et al., 2001; Steyn et al., 2006).

The information on drought shock is obtained from the survey instrument that asks respondents whether they have faced unexpected drought shock in the past. Given the fact that up to 60% of the Somali population is either pastoralist or semi-pastoralist, and on a continuous move, using their experienced drought provides us with relatively more accurate information than relying on a climate data collected in fixed location.

Descriptive Statistics

We report the descriptive statistics for male- and female-headed households in Table 1, where we present the main variables of interest (treatment and mechanisms) in panel A, outcome variables of interest in panel B, and control variables in panel C. Accordingly, about 28% of male-headed and 24% of female-headed households in our sample have experienced climate shocks. When we look at access to formal and

informal financial services, about 70% of male-headed and 65% of female-headed households in our sample households use mobile money, and about 19% of male-headed and 21% of female-headed households have access to remittances. Notice that this is significantly smaller than the IMF (2017) estimate that four out of ten persons (i.e., 40%) rely on remittance for daily expenditure. When we look at the outcome variables, about 54% of male-headed and 51% of female-headed households are below the national poverty line (in purchasing power parity terms), about 34% of sample male-headed and 33% of female-headed households have experienced hunger, and the average consumption expenditure gap between poor households' and the poverty line is about 22% for male-headed households and 21% for female-headed household. On the other hand, when we look at the diet quality indicators, we find that large proportion of households have a good quality diet. Within the seven days prior to the survey, 92% of male-headed and 94% of female-headed households consumed meat, about 82% of male-headed and 84% of female-headed households consumed fruits, and about 84% of male-headed and 85% of female-headed households consumed pulses.⁵ In terms of our sample's demographics, the average age of the male household head is around 40 years, and that of female head is about 36 years. While male household heads have an average of 1.6 years of schooling, females have one year of schooling. The average household size is about 5.3 persons for both male- and female-headed households; and the share of literate household members being about 51% for both male- and female-headed households. The share of males is about 52% for male-headed households but about 43% for female-headed counterparts. Surprisingly, about 67% of males and 69% of females in our sample respondents are trusting towards strangers, much higher than the trust level found in 29 high income countries by Knack and Keefer (1997), which is 36%. Lastly, about 63% of male-headed and 72% of female-headed respondents are urban dwellers.

Table 1: Descriptive statistics by household head's sex

	(1)	(2)	(3)
	Male-headed	Female-headed	Diff
Panel A: Variables of interest			
Climate shock = 1	0.281	0.238	-0.043***
	(0.450)	(0.426)	(0.009)
Mobile money = 1	0.703	0.653	-0.051***
	(0.457)	(0.476)	(0.012)
International remittance = 1	0.190	0.212	0.022***
	(0.392)	(0.408)	(0.008)
(ln)International amount, US\$	0.643	0.745	0.102**
	(1.985)	(2.092)	(0.040)

continued next page

Table 1 Continued

	(1)	(2)	(3)
	Male-headed	Female-headed	Diff
Panel B: Outcome variables			
Below poverty line	0.536	0.510	-0.027***
	(0.499)	(0.500)	(0.010)
Hunger = 1	0.335	0.328	-0.007
	(0.472)	(0.469)	(0.009)
Poverty gap index	22.292	20.777	-1.514***
	(25.568)	(25.387)	(0.506)
Fruit = 1	0.822	0.845	0.023**
	(0.383)	(0.362)	(0.009)
Meat = 1	0.924	0.938	0.014**
	(0.265)	(0.240)	(0.006)
Pulse = 1	0.842	0.849	0.007
	(0.365)	(0.359)	(0.009)
Panel C: Control variables			
Household head's age	39.913	36.195	-3.717***
	(12.080)	(12.211)	(0.241)
Household head's education	1.645	0.991	-0.654***
	(2.058)	(1.685)	(0.041)
Share of literate	0.511	0.509	-0.002
	(0.376)	(0.376)	(0.007)
Household size	5.336	5.278	-0.058
	(2.217)	(2.190)	(0.044)
Trust = 1	0.670	0.692	0.022**
	(0.470)	(0.462)	(0.010)
Share of male	0.524	0.429	-0.095***
	(0.168)	(0.205)	(0.004)
Urban = 1	0.628	0.718	0.090***
	(0.483)	(0.450)	(0.009)
Observations	5,077	5,132	10,209

Note: Significance: *** $p < 0.01$, ** $p < 0.05$.

5. Results and discussions

In this section, we present and discuss our results starting from the baseline analyses where we investigate the impacts of climate shock on various welfare and diet quality indicators. We then zoom in on women and study whether female-headed households are most affected by shocks and whether their coping mechanisms differ from that of male-headed households.

Climate shock, welfare, and diet quality

Here, we report the main results that show the effects of climate shock on the likelihood of falling under the poverty line (columns 1 and 2), hunger (columns 3 and 4), and the poverty gap index (columns 7 and 8) in Table 2. In all of these analyses, we start with a simple model where we only look at the effect of climate change. In the second column, we include various controls to check whether the results of the simple model are robust.

Based on the results reported in Table 2, we find that exposure to climate shock increases households' likelihood of falling under the poverty line and hunger. It also increases households' poverty severity and poverty gap index. Our results show that, after controlling for various factors, exposure to climate shock, on average, increases households' likelihood of falling under the poverty line by about 9% (significant at 1%), and increases the likelihood of hunger by about 18% (significant at 1%). Similarly, exposure to climate shock, on average, increases households' poverty gap index (depth of poverty) by 4.6 percentage points (significant at 5%).

These results are in line with existing evidence from other settings such as those in Ngoma et al. (2019) where they find a 2.3 percentage point increase in the likelihood of falling under the poverty line in response to lower-than-normal rainfall in Zambia, and the findings of Geffersa and Berhane (2015) show that climate shock increases food insecurity in Ethiopia. Niles and Salerno (2018) also find a similar relationship between climate shocks and food security on data from 15 countries in three continents—Latin America, Africa, and South Asia. Our results are also in line with a cross-country analysis by Hallegatte and Rozenberg (2017) where they show how vulnerable the poor are to climate shocks. Our results are also largely consistent with the conclusions drawn by the literature review by Skoufias et al. (2011).

Next, we study the effects of climate shock on households' diet quality, proxied by the consumption of three food groups, i.e., meat, pulse, and fruits, and report the results in Table 3. Similarly, we start our analyses with a simple model where we only look at the effect of a climate shock, and in a second model, we account for various factors that might affect households' diet quality to probe the robustness of our results. As can be seen from columns (2), (4), and (6) of Table 3, after controlling for various factors, exposure to climate shock decreases households' diet quality. Specifically, it reduces the likelihood of meat consumption by about 16%, the likelihood of pulse consumption by about 31%, and the likelihood of fruit consumption by about 36%, all significant at 1%. This implies drought shock affects both the quantity and quality of household diets.

Table 2: Climate shock and welfare

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Below Poverty Line		Hunger		Poverty Gap Index	
Climate shock = 1	0.174*** (0.030)	0.086*** (0.032)	0.262*** (0.027)	0.179*** (0.029)	8.678*** (1.651)	4.601** (1.888)
Female = 1		0.002 (0.026)		0.013 (0.024)		-0.834 (1.371)
Constant	0.477*** (0.008)	0.322*** (0.058)	0.263*** (0.007)	0.606*** (0.060)	19.268*** (0.430)	13.776*** (3.400)
Observations	10,156	7,707	10,209	7,754	10,156	7,707
R-squared	0.024	0.214	0.063	0.153	0.024	0.213
Number of HHID	6,196	5,426	6,198	5,444	6,196	5,426
Controls	NO	YES	NO	YES	NO	YES

Notes: Robust standard errors clustered at the enumeration area level are in parentheses. The results are based on fixed-effects linear probability models. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Controls include all the variables listed in panel C of Table 1.

These results are also consistent with existing evidence that shows a negative link between climate shocks and food and nutrition security. To mention some examples, Carpena (2019) shows drought shock forces households to rely more on less nutritious food items and consume fewer vegetables, fruits, pulses, and animal-based foods, whereas Hirvonen et al. (2020) show that climate shock increases chronic under-nutrition in areas with less road connectivity in Ethiopia; and, Dimitrova (2021) where she also shows exposure to climate shock increases the likelihood of under-nutrition among children aged under five in Ethiopia.

Table 3: Climate shock and diet quality

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Meat	= 1	Pulse	= 1	Fruit	= 1
Climate shock = 1	-0.182*** (0.021)	-0.158*** (0.023)	-0.304*** (0.028)	-0.313*** (0.032)	-0.343*** (0.029)	-0.355*** (0.032)
Female = 1		0.009 (0.021)		-0.025 (0.029)		-0.035 (0.028)
Constant	0.969*** (0.004)	0.882*** (0.042)	0.908*** (0.006)	0.910*** (0.066)	0.904*** (0.006)	0.841*** (0.066)
Observations	7,123	5,712	7,123	5,712	7,123	5,712
R-squared	0.084	0.136	0.105	0.169	0.129	0.210
Number of HHID	5,140	4,546	5,140	4,546	5,140	4,546
Controls	NO	YES	NO	YES	NO	YES

Notes: Robust standard errors clustered at the enumeration area level are in parentheses. The results are based on fixed-effects linear probability models. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Controls include all the variables listed in panel C of Table 1.

Gendered effects of climate shock

As we discuss in the introduction, our main interest is to investigate whether climate shock has a gendered effect, i.e., whether it disproportionately affects female-headed households. As Skoufias et al. (2011) argue, the link between climate shocks and welfare/poverty is often complex and dependent on various overlapping factors, such as individual and household characteristics, decision-making processes, socioeconomic conditions, and quality of institutions and governance. Eastin (2018) also ascertains that climate shocks have differential effects on males and females due to the pre-existing disparities in their vulnerability (for example, female-headed households could be less likely to own fertile land) and coping ability (for example, female-headed households have fewer resources to cope with the adverse effects of shocks than their male-headed counterparts). Moreover, in conflict-torn communities, females face additional challenges than their counterparts in non-conflict communities. For example, in conflict communities, since the men would be direct actors to the conflict, women would be more often left in charge of their households. Furthermore, such disparities are stronger for women in “traditional” societies and low-income countries (Terry, 2009).⁶

Table 4 presents the gender-disaggregated analysis. In columns (2) to (3), we present the results on our welfare indicators, and in columns (4) to (6), the results on our diet quality indicators. Looking at the results on welfare, we make two interesting observations. Firstly, the main effects on the likelihood of falling under the poverty line and poverty gap index disappear when we include the interaction term between a female-headed household and climate shock exposure. This indicates that the climate shock's adverse effects on welfare are exclusively experienced by female-headed

households. On average, female-headed households are about 11% more likely to fall under the poverty line when they face climate shocks compared to male-headed households (significant at 5%), and they also experience a 5.2 percentage points increase in their poverty gap index (significant at 10%). These results are consistent with those in Adzawla et al. (2019) where they also find female-headed households and female members to be disproportionately affected by climate shocks in Ghana than their male counterparts. Contrarily, we find no difference between male- and female-headed households in their likelihood of experiencing hunger in response to exposure to climate shocks. In other words, our results show that households are, on average, about 16% more likely to experience hunger in response to climate shocks regardless of the household head's sex. Another interesting heterogeneity we observe is that female-headed households respond to climate shock by consuming more pulses and fruits. As can be seen from columns (5) and (6), female-headed households, when they experience climate shock, increase their consumption of pulse by about 10% (significant at 10%) and their consumption of fruits by about 13% (significant at 5%). Interestingly, we find no such effects for meat consumption. These results contradict anecdotal and some empirical evidence that show an increase in meat consumption during drought, for example, as lack of feed drive households into consuming their livestock (see, for example, Fleurett (1986), Fleuret (2019), and Aboul-Naga et al. (2014)).

Table 4: Gendered effects of climate shock

VARIABLES	Welfare Indicators			Diet Quality Indicators		
	(1)	(2)	(3)	(4)	(5)	(6)
	Below poverty line	Hunger	Poverty gap index	Meat = 1	Pulse = 1	Fruit = 1
Climate shock = 1	0.037 (0.039)	0.156*** (0.036)	2.208 (2.280)	-0.179*** (0.033)	-0.359*** (0.042)	-0.414*** (0.044)
Female X shock	0.106** (0.052)	0.050 (0.049)	5.226* (2.703)	0.045 (0.042)	0.101* (0.057)	0.128** (0.056)
Female = 1	-0.025 (0.031)	-0.000 (0.026)	-2.157 (1.536)	-0.003 (0.022)	-0.052 (0.032)	-0.069** (0.031)
Constant	0.340*** (0.059)	0.614*** (0.060)	14.628*** (3.442)	0.890*** (0.042)	0.927*** (0.067)	0.863*** (0.068)
Observations	7,707	7,754	7,707	5,712	5,712	5,712
R-squared	0.216	0.154	0.215	0.137	0.172	0.214
Number of HHID	5,426	5,444	5,426	4,546	4,546	4,546
Controls	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors clustered at the enumeration area level are in parentheses. The results are based on fixed-effects linear probability models. Significance: ***p < 0.01, **p < 0.05, *p < 0.1. Controls include all the variables listed in panel C of Table 1.

Remittance as a coping mechanism?

One of our main objectives is to study whether Somali households use remittances as their climate shock coping strategies. Even though remittance plays an essential source of livelihood among the Somali, to be considered a coping mechanism, we expect the flow of remittances to increase during climate shocks, and that translates to lower adverse effects of climate shocks. To check whether remittances indeed increase in response to climate shock, we start out by looking at the relationship between climate shock and remittances and present the results in Table 5. In columns (1) to (3), we present the results that show whether climate shock affects the likelihood of receiving remittances and columns (4) to (6) show the effect on the amount received. Interestingly, contrary to our expectations, we find some evidence that the likelihood of receiving remittances declines in response to climate shock, and the decline is pronounced among female-headed households. As can be seen from column (1), climate shock, on average, reduces the likelihood of remittance by about 3.3% (significant at 10%). Similarly, we find that climate shock also reduces the amount of remittance received, both on average, and specifically among female-headed households. Based on column (4), climate shock, on average, reduces the amount of remittance by about 36% (significant at 1%). The further reduction of remittances to female-headed households could be the result of male-biased gender norms that drive families to financially support male-headed households more than female-headed households during climate shocks.⁷ This is an interesting and novel insight, as existing studies that look at the nexus between gender and remittances focus on their supply-side interaction (Niimi & Reilly, 2011; Park et al., 2017; Semyonov & Gorodzeisky, 2005).

Table 5: Remittance and climate shock

VARIABLES	International remittance = 1			(ln)International amount (US\$)		
	(1)	(2)	(3)	(4)	(5)	(6)
Climate shock = 1	-0.033*	-0.032*	0.056*	-1.013***	-1.009***	-0.573***
	(0.020)	(0.019)	(0.029)	(0.100)	(0.100)	(0.142)
Female = 1		0.015	0.048**		0.052	0.225*
		(0.015)	(0.022)		(0.081)	(0.122)
Female X shock			-0.116***			-0.576***
			(0.042)			(0.218)
Constant	0.210***	0.202***	0.020	0.958***	0.930***	0.387
	(0.005)	(0.009)	(0.049)	(0.026)	(0.048)	(0.287)
Observations	10,140	10,140	7,717	10,209	10,209	7,754
R-squared	0.001	0.002	0.048	0.041	0.041	0.092
Number of HHID	6,195	6,195	5,428	6,198	6,198	5,444
Controls	NO	NO	YES	NO	NO	YES

Notes: Robust standard errors clustered at the enumeration area level are in parentheses. The results are based on fixed-effects linear probability models for columns (1) to (3) and OLS for columns (4) to (6). Significance: ***p < 0.01, **p < 0.05, *p < 0.1. Controls include all the variables listed in panel C of Table 1.

Now that we have established a negative relationship between climate shock and remittances, our next inquiry is whether the climate shock-induced reduction in remittances exacerbated the effects of climate shock on households' welfare and diet quality. Columns (1) to (3) and (4) to (6) of Table 6 present the results on welfare and diet quality, respectively. Based on these results, even though we find a clear positive contribution of remittances on welfare and diet quality, we find no significant effect that the reduction in remittances due to climate shock degrades households' coping ability (notice that none of the coefficients for the interaction effect between remittances and climate shock are statistically significant except for the positive relationship to fruit consumption). The fact that the reduction in remittances following climate shock does not reduce households' welfare may be an indication that Somali households do not rely on remittances as their coping mechanisms. Existing studies also show inconclusive evidence regarding the role of remittances as households' coping mechanisms. For example, Generoso (2015) find a positive role in reducing short-term food insecurity during climate shock but find no effect on households' productive capacity. On the other hand, Musah-Surugu et al. (2017) find a positive role of remittances in improving households' consumption in response to both experienced and expected climate shocks.

Lastly, we check whether the reduction in remittances for female households would devastate female-headed households' coping ability to climate shocks. For this purpose, we include a three-way interaction, along with the respective two-way interactions among sex, remittances, and climate shock. Interestingly, again, we find no evidence that the reduction in remittances following climate shock among female-headed households devastates their coping ability. We report these results in Table A2 (in the appendix).

Table 6: Remittance as a coping mechanism

VARIABLES	Welfare Indicators			Diet Quality Indicators		
	(1)	(2)	(3)	(4)	(5)	(6)
	Below poverty line	Hunger	Poverty gap index	Meat = 1	Pulse = 1	Fruit = 1
Climate shock = 1	0.077** (0.035)	0.185*** (0.031)	3.984* (2.133)	-0.163*** (0.026)	-0.307*** (0.035)	-0.372*** (0.035)
Remittance = 1	-0.174*** (0.032)	0.023 (0.030)	-10.433*** (1.590)	0.004 (0.023)	0.042 (0.036)	0.022 (0.034)
Remittance X Shock	0.048 (0.065)	-0.034 (0.063)	4.004 (3.576)	0.052 (0.045)	-0.007 (0.071)	0.132* (0.068)
Constant	0.330*** (0.056)	0.609*** (0.061)	14.182*** (3.289)	0.870*** (0.042)	0.897*** (0.066)	0.823*** (0.067)
Observations	7,671	7,717	7,671	5,675	5,675	5,675
R-squared	0.229	0.153	0.234	0.134	0.168	0.213
Number of HHID	5,410	5,428	5,410	4,520	4,520	4,520
Controls	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors clustered at the enumeration area level are in parentheses. The results are based on fixed-effects linear probability models. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Controls include all the variables listed in panel C of Table 1.

Mobile money as a coping mechanism?

This section investigates whether mobile money use increases households' coping ability by easing the flow of remittances. From our analyses in the previous section, we have seen that remittances improve households' welfare and diet quality. For this purpose, we first look at whether mobile money increases remittances, especially when households face climate shocks. As we discuss in Section 3, data on mobile money is available only in the second wave of our data set. Therefore, since we are unable to apply fixed-effects analysis, we present results from an inverse probability of treatment weighting (IPW) analysis.

In Table 7, we present the results that show whether mobile money use increases the likelihood of receiving remittances. In the first column, we present the results for the whole sample. Next, we disaggregate by gender and present the results for female-headed households in column (2) and for male-headed households in column (3). As expected, mobile money increases the likelihood of receiving remittances, specifically for female-headed households, by about 5% (significant at 5%). These results support earlier findings by Elmi and Ngwenyama (2019). We further disaggregate our analyses to see whether mobile money increases remittances in response to climate shock and present the results in Table A3 (in the appendix). Consistent with the results reported in Table 5 (in the appendix), we do not find evidence that suggests mobile money to have a significant role in increasing remittances during climate shock.

Table 7: Mobile money and remittance: Average treatment effects (ATE)

VARIABLES	Remittance		
	(1) Full sample	(4) Female-headed	(7) Male-headed
Mobile money = 1	0.031** (0.013)	0.049*** (0.018)	0.015 (0.020)
Observations	4,097	2,033	2,064
Controls	YES	YES	YES

Notes: Robust standard errors clustered at the enumeration area level are in parentheses. The results are based on fixed-effects linear probability models. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Controls include all the variables listed in panel C of Table 1.

Even though the analyses insofar contradict our hypothesis that remittances would increase during climate shock and that having mobile money account would facilitate the transfers and hence improve households' coping ability, we still investigate the effect of mobile money on households' welfare and diet quality, both on average, and for female and male-headed households separately. Moreover, we also conduct similar analyses to see whether mobile money plays a role in improving households' coping ability to climate shocks that arise for reasons other than remittance facilitation.

We present these results in Table 8. Based on the results from these analyses, we find that, indeed, mobile money decreases the likelihood of falling below the poverty line, hunger, and depth of poverty for male-headed households and the likelihood of falling below the poverty line and depth of poverty for female-headed households. Looking at the results of the full sample, presented in columns (1) to (3), on average, mobile money decreases the likelihood of falling under the poverty line by 9%, the likelihood of hunger by about 11%, and the depth of poverty by about nine percentage points, all significant at 1%. Based on the gender-disaggregated results, we find that mobile money user female-headed households have, on average, about 9% lower likelihood of falling under the poverty line and depth of poverty, that is lower by about 17 percentage points, both significant at 1%. For male-headed households, we find that, on average, mobile money users have a 69% lower likelihood of falling under the poverty line, 97% lower chance of hunger, and 36 percentage points lower depth of poverty, all significant at 1%.

We also repeat similar analyses on diet quality, but find no consistent effect of mobile money on households' diet quality with the exception of meat consumption that increases in both male- and female-headed households and higher fruit consumption in male households. Based on the results resented in Table 9, mobile money user female-headed households are, on average, 5% more likely to consume meat (significant at 5%). This effect is also similar for male-headed households, but for male-headed households, mobile money also increases fruit consumption by about 8%, also significant at 5%.

Lastly, we present the results that show whether mobile money improves households' coping ability for reasons other than facilitating remittances. These results are reported in Table 10 for welfare indicators and Table 11 for diet quality. Our results show that mobile money reduces the likelihood of poverty, hunger, and depth of poverty during climate shock. On average, mobile money user households are 5% less likely to fall under the poverty line (significant at 5%), about 13% less likely to experience hunger (significant at 1%), and have a poverty depth lower by about 14 percentage points (significant at 1%). Contrarily, we find no significant improvement in diet quality arising from mobile money usage (see columns (1) to (3) of Table 11).

Table 8: Mobile money and welfare: Average treatment effects (ATE)

VARIABLES	Full Sample			Female-headed			Male-headed		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Poverty	Hunger	Poverty gap	Poverty	Hunger	Poverty gap	Poverty	Hunger	Poverty gap
Mobile money = 1	-0.090*** (0.016)	-0.107*** (0.022)	-0.076*** (0.022)	-0.088*** (0.017)	-0.002 (0.022)	-0.171*** (0.025)	-6.943*** (0.882)	-9.745*** (1.258)	-3.645*** (1.216)
	4,097	2,033	2,064	4,097	2,033	2,064	4,097	2,033	2,064
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Standard errors are in parentheses. Significance: ***p < 0.01, **p < 0.05, *p < 0.1.
Controls include all the variables listed in panel C of Table 1.

Table 9: Mobile money and diet quality: Average treatment effects (ATE)

VARIABLES	Full Sample			Female-headed			Male-headed		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Meat	Pulse	Fruit	Meat	Pulse	Fruit	Meat	Pulse	Fruit
Mobile Money = 1	0.001 (0.018)	-0.013 (0.024)	0.015 (0.026)	0.050** (0.024)	0.049 (0.033)	0.040 (0.034)	0.054** (0.024)	0.026 (0.032)	0.078** (0.035)
	2,057	994	1,063	2,057	994	1,063	2,057	994	1,063
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Standard errors are in parentheses. Significance: ***p < 0.01, **p < 0.05, *p < 0.1.
Results are from inverse probability-weighted matching estimations.
Controls include all the variables listed in panel C of Table 1.

Table 10: Mobile money, climate shock, and welfare: Average treatment effects (ATE)

VARIABLES	Remittances					
	Climate shock = 1			Climate shock = 0		
	(1)	(2)	(3)	(4)	(5)	(6)
	Poverty	Hunger	Poverty gap	Poverty	Hunger	Poverty gap
Mobile money = 1	-0.050** (0.023)	-0.129*** (0.021)	-0.135*** (0.025)	-0.057** (0.023)	-4.055*** (1.264)	-8.912*** (1.206)
Observations	1,804	2,293	1,804	2,293	1,804	2,293
Controls	YES	YES	YES	YES	YES	YES

Notes: Standard errors are in parentheses. Significance: ***p < 0.01, **p < 0.05, *p < 0.1. Results are from inverse probability-weighted matching estimations. Controls include all the variables listed in panel C of Table 1.

Table 11: Mobile money, climate shock, and diet quality: Average treatment effects (ATE)

VARIABLES	Remittances					
	Climate shock = 1			Climate shock = 0		
	(1)	(2)	(3)	(4)	(5)	(6)
	Meat	Pulse	Fruit	Meat	Pulse	Fruit
Mobile money = 1	-0.009 (0.027)	0.017 (0.024)	-0.035 (0.033)	0.110*** (0.033)	0.019 (0.033)	0.093*** (0.034)
Observations	930	1,127	930	1,127	930	1,127
Controls	YES	YES	YES	YES	YES	YES

Notes: Standard errors are in parentheses. Significance: ***p < 0.01, **p < 0.05, *p < 0.1. Results are from inverse probability-weighted matching estimations. Controls include all the variables listed in panel C of Table 1.

Robustness check: Mediation analyses using structural equations method

As illustrated by Acharya et al. (2016), investigating mechanisms by analysing the relationship between the hypothesized mediator and the independent variable can lead to biased estimations. As a result, we augmented our research with Stata's 'medsem' package, which solves systems of equations to explore potential mechanisms. To be considered a mediator in this technique, a variable must meet particular criteria (Mehmetoglu, 2018; Zhao et al., 2010). Assume that our outcome (welfare indicators), explanatory (climate shock), and mediating variables (remittance and mobile money) are represented as X, Y, and M, respectively. The first condition is that both the effects of the independent variable on the mediating variable and the effects of the mediating variable on the dependent variable must be statistically significant (i.e., $X \rightarrow M$ and $M \rightarrow Y$). There will be 'some' mediation if the aforementioned two prerequisites are satisfied; else, there will be no mediation effect. To have a complete mediation effect Sobel's z-test must be statistically significant,⁸ and the

coefficient of the independent variable on the dependent variable must be statistically insignificant ($X \rightarrow Y$), in addition to the two conditions listed above; otherwise, partial mediation will occur. One of the additional aspects of this technique is that it examines the contributions of mediators to overall effects by calculating the ratio between indirect and total effects. In Table 12 and Table 13, we present the mediation analyses for remittance and mobile money, respectively.⁹

Table 12: Structural equation mediation analyses: Climate shock, remittance and welfare

Outcomes	P-value			Sobel-test	Decision Share ¹⁰	
	($X \rightarrow M$)	($M \rightarrow Y$)	($X \rightarrow Y$)			
Poverty	0.000	0.000	0.012	0.000	partial	18%
Hunger	0.000	0.685	0.000	0.686	no mediation	-
Poverty gap	0.000	0.000	0.001	0.000	partial	16 %
Meat	0.000	0.096			no mediation	-
Pulse	0.000	0.117			no mediation	-
Fruit	0.000	0.003	0.000	0.012	partial	1 %

Table 13: Structural equation mediation analyses: Climate shock, mobile money, and welfare

Outcomes	P-value			Sobel-test	Decision Share	
	($X \rightarrow M$)	($M \rightarrow Y$)	($X \rightarrow Y$)			
Poverty	0.000	0.000	0.000	0.000	partial	10%
Hunger	0.000	0.000	0.467	0.000	complete	154 %
Poverty gap	0.000	0.000	0.002	0.000	partial	25 %
Meat	0.000	0.956			no mediation	-
Pulse	0.000	0.045	0.918	0.074	partial	270 %
Fruit	0.000	0.026	0.649	0.053	partial	66 %

6. Conclusion

In this study, we examine the gendered effects of climate shocks on welfare and diet quality, as well as examine the roles of informal (remittances) and formal (mobile money) financial instruments as households' coping strategies in post-conflict Somalia. For this purpose, we use a representative data set that comes from two rounds of the World Bank's Somali High Frequency Survey collected in 2016 and 2017. For analysis, we employ fixed-effects regression and inverse probability-weighted matching methods to attenuate potential endogeneity bias.

Our results, consistent with existing studies from other settings, show that climate shocks adversely affect households' welfare and diet quality. Further analyses reveal that the effects are stronger for female-headed households except for the likelihood of hunger, which is felt equally by both male- and female-headed households. When we look at the role of remittances in attenuating the adverse effects of climate shocks, we find interesting results. Contrary to our expectations, we find that climate shock reduces the likelihood of remittances, both on average and specifically for female-headed households. Fortunately, we find no evidence that the reduction in remittances devastates the households' coping ability neither on average nor for female-headed households. We speculate that this could be because Somali households rely on other strategies than remittances to cope with climate shocks. Similarly, our analyses regarding the role of mobile money show that, even though mobile money does increase the likelihood of receiving remittances, its effect on taming the adverse effects of climate shock seems insignificant.

Based on these results, we suggest that further research is needed to pinpoint why exactly remittances decrease in response to climate shocks, and to understand Somali households' coping mechanisms in order to inform policy.

It's also worth mentioning the limits of our data set and estimation methods. Firstly, the consumption data was collected using the 7-day recall method. As a result, we are unable to account for seasonal variations in the food supply. In addition, we also could not account for intra-home food allocation since the consumption data is collected at the household level. Secondly, though we were able to effectively account for time-invariant heterogeneities that could bias our estimates by using household fixed-effects, we should caution that our estimation approaches do not rule out the possibility of the effects of time-variant unobservables. Finally, complementing the analysis with objective drought data such as satellite imageries would insure the robustness of our results. Unfortunately, lack of community-level location coordinates precludes us from supplementing our study with such indicators.

Notes

1. For example, Redmond (2008: 570) defines formal institutions as “formal refers to an institution in which a recognized elite has appropriated the power to control the rules and other meaningful content of the institution”.
2. According to the World Bank report, the annual flow of personal remittances to sub-Saharan African countries amounts to about 3% of the region’s GDP (World Bank, 2019).
3. <https://culturalatlas.sbs.com.au/somali-culture/somali-culture-family> Accessed, August 2021.
4. For this study we used the international poverty line computed using the ratio between Somali Shillings and \$PPP, the Somali Consumer Price Index, and the nominal exchange rate between the Somali Shilling and the US Dollar.
5. According to food and culture profiling sources, meat (camel, goat, and chicken) is stable in the Somali diet and is paired with rice, pasta, and beans. Fruits are also very common. Banana is often served with meals. Other fruits such as mango and guava are also very common in the Somali diet. See, for example, <https://ethnomed.org/resource/nutrition-and-fasting-in-somali-culture/#:~:text=Somali%20meals%2C%20generally%20always%20cooked,lunch%2C%20dinner%20and%20sometimes%20breakfast> and <https://dune.une.edu/an/studedres/5/> (both accessed on 15 February 2022). Therefore, we take these three food groups as staple food.
6. We also conduct additional analyses looking at the effects of climate shock on internally displaced persons (IDPs) vis-a-vis nomadic areas and by sex of the household head and find no statistically significant difference neither on average nor for female-headed households (see Table A4 and Table A5 in the appendix).
7. We also look at how internal remittances respond to climate shock. On one hand, climate shock would decrease internal remittance as families living in Somali would face similar shock. On the other hand, it could also lead to higher solidarity as families would have better information of the adversity of the shock and would become more eager to help their fellow families. To test this, since we only have data on internal remittance, we use an inverse probability-weighted matching. The results show that climate shock increases internal remittance, but only among male-headed households (see Table A1 in the appendix).

8. The Sobel z-test helps to determine if an “independent variable has an indirect effect on the dependent variable mediated by another variable by testing the hypothesis that there is no statistically significant difference between the total and the direct effects of the independent variable after accounting for the influence of a potential mediator” (Allen, 2017).
9. The full results of system regression equations are not supplied here to save space and maintain brevity. We supply to the readers upon request.
10. The stata’s medsem package calculates the ratio by dividing the indirect effect by the total effect.

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Appendix

Table A1: Climate shocks and internal remittance

VARIABLES	(1) Full Sample	(4) Female-headed	(7) Male-headed
r1vs0.climate shock	0.019**	0.005	0.036**
	(0.009)	(0.013)	(0.014)
Observations	4,098	2,032	2,066
Controls	YES	YES	YES

Table A2: Remittance as a coping mechanism for female headed households

VARIABLES	Welfare Indicators			Diet Quality Indicators		
	(1)	(2)	(3)	(4)	(5)	(6)
	Below poverty line	Hunger	Poverty gap index	Meat = 1	Pulse = 1	Fruit = 1
Climate shock = 1	0.051 (0.045)	0.164*** (0.039)	2.487 (2.644)	-0.179*** (0.037)	-0.363*** (0.046)	-0.426*** (0.047)
Remittance = 1	-0.119*** (0.045)	0.124*** (0.042)	-10.102*** (2.138)	0.007 (0.031)	0.032 (0.049)	0.031 (0.047)
Remittance X Shock	-0.025 (0.078)	-0.039 (0.080)	1.391 (4.148)	0.035 (0.061)	0.022 (0.086)	0.089 (0.085)
Female X shock	0.057 (0.055)	0.051 (0.053)	3.111 (2.929)	0.034 (0.048)	0.122** (0.060)	0.117* (0.060)
Female X Remit	-0.099* (0.059)	-0.182*** (0.051)	-0.484 (2.852)	-0.003 (0.045)	0.028 (0.069)	-0.008 (0.071)
Remit X shock X female	0.161 (0.116)	-0.050 (0.108)	6.992 (6.183)	0.048 (0.078)	-0.063 (0.140)	0.120 (0.110)
Constant	0.336*** (0.058)	0.599*** (0.061)	14.908*** (3.355)	0.878*** (0.043)	0.919*** (0.068)	0.848*** (0.068)
Observations	7,671	7,717	7,671	5,675	5,675	5,675
R-squared	0.232	0.160	0.236	0.135	0.171	0.218
Number of HHID	5,410	5,428	5,410	4,520	4,520	4,520
Controls	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors clustered at the enumeration area level are in parentheses. The results are based on fixed-effects linear probability models. Significance: ***p < 0.01, **p < 0.05, *p < 0.1. Controls include all the variables listed in panel C of Table 1.

Table A3: Mobile money, remittance, and climate shock

VARIABLES	(1)	(2)	(3)
	Remittance		
	ATE (Full sample)	ATE (Climate shock = 1)	ATE (Climate shock = 0)
Mobile money = 1	0.029** (0.014)	0.019 (0.019)	0.040** (0.019)
Observations	4,097	1,804	2,293
Controls	YES	YES	YES

Notes: Standard errors are in parentheses. Significance: ***p < 0.01, **p < 0.05, *p < 0.1. Results are from inverse probability-weighted matching estimations. Controls include all the variables listed in panel C of Table 1.

Table A4: Climate shock, welfare, and diet quality: Internally displaced persons vs. nomads

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Below poverty line		Hunger = 1		Poverty gap index		Meat = 1		Pulse = 1		Fruit = 1	
Climate shock = 1	0.031	-0.052	0.002	-0.299***	-0.780	-3.343	-0.097**	-0.171*	-0.109**	-0.115	-0.341***	-0.265**
	(0.055)	(0.110)	(0.054)	(0.070)	(3.721)	(5.313)	(0.043)	(0.096)	(0.050)	(0.135)	(0.059)	(0.107)
IDP = 1	0.054	0.111	0.091	-0.138**	7.601	13.561**	0.199***	0.146*	0.262***	0.296**	0.157**	0.293***
	(0.080)	(0.129)	(0.069)	(0.068)	(4.617)	(6.670)	(0.064)	(0.084)	(0.064)	(0.130)	(0.070)	(0.109)
IDP X shock		0.057		0.323***		1.148		0.063		-0.021		-0.133
		(0.123)		(0.092)		(6.769)		(0.111)		(0.153)		(0.129)
Constant	0.618***	0.260	0.523***	0.742***	23.874***	7.796	0.769***	0.789***	0.653***	0.640***	0.707***	0.652***
	(0.077)	(0.172)	(0.069)	(0.124)	(4.482)	(8.564)	(0.063)	(0.096)	(0.065)	(0.148)	(0.070)	(0.144)
Observations	1,401	1,224	1,406	1,228	1,401	1,224	920	806	920	806	920	806
R-squared	0.002	0.125	0.008	0.068	0.021	0.152	0.147	0.182	0.159	0.214	0.229	0.290
Controls	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

Notes: Robust standard errors clustered at the enumeration area level are in parentheses. The results are based on fixed-effects linear probability models. Significance: ***p < 0.01, **p < 0.05, *p < 0.1. Controls include all the variables listed in panel C of Table 1.

Table A5: Gendered effects of climate shock on welfare and diet quality: Internally displaced persons vs. Nomads

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Below poverty line	Hunger = 1	Poverty gap index	Meat = 1	Pulse = 1	Fruit = 1
Climate shock = 1	-0.004 (0.048)	-0.027 (0.049)	-2.341 (3.623)	-0.117** (0.048)	-0.132** (0.059)	-0.378*** (0.059)
Female = 1	-0.047 (0.065)	0.165*** (0.058)	-5.934* (3.313)	0.064 (0.073)	0.036 (0.081)	-0.040 (0.076)
IDP = 1	0.180** (0.070)	0.164** (0.070)	15.498*** (4.512)	0.223*** (0.071)	0.307*** (0.072)	0.200*** (0.069)
IDP X female	-0.069 (0.079)	-0.103 (0.072)	-3.068 (4.184)	-0.079 (0.073)	-0.095 (0.090)	-0.062 (0.091)
Constant	0.196 (0.120)	0.441*** (0.113)	6.142 (6.914)	0.717*** (0.089)	0.639*** (0.087)	0.757*** (0.102)
Observations	1,224	1,228	1,224	806	806	806
R-squared	0.126	0.062	0.152	0.184	0.217	0.289
Controls	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors clustered at the enumeration area level are in parentheses. The results are based on fixed-effects linear probability models. Significance: ***p < 0.01, **p < 0.05, *p < 0.1. Controls include all the variables listed in panel C of Table 1.



Mission

To strengthen local capacity for conducting independent, rigorous inquiry into the problems facing the management of economies in sub-Saharan Africa.

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