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# The gendered impacts of index-insurance on food-consumption: Evidence from southern Ethiopia

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ABSTRACT

Index insurance has been promoted as an innovative strategy for enhancing long-term resilience to climate-related shocks and providing financial inclusion, particularly to poor women farmers in developing countries. In this paper, we evaluate the gendered impact of an index-based livestock insurance product on food consumption among pastoral households in southern Ethiopia. We exploit intertemporal variation in household risk exposure and insurance payouts to evaluate the *ex ante* and *ex post* insurance impacts and use randomly distributed discount coupons to instrument the insurance purchase variables. We find that during the pre-drought period, a previous season insurance purchase and the intensity of insurance coverage significantly and equally reduces food expenditure in male- and female-headed households. In the post-drought period, we find that an insurance payout significantly increases food expenditure per adult equivalent among female-headed households.

## Introduction

In many low-income countries, agricultural producers face multiple production risks. The pervasive sources of agricultural risk are those associated with extreme climate and weather uncertainty and variability, particularly drought and floods (Barrett, 2011). Empirical evidence show that poor households are unable to fully insure against such shocks (Townsend, 1994). The inability to protect household consumption and productive assets results in chronic economic and social repercussions that push households into long-term poverty traps (Morduch, 1995; Dercon et al. 2005; Alderman et al. 2006; Dinkelman, 2017). There are various strategies to mitigate such risks while protecting household investment and consumption, including the provision of affordable financial instruments such as credit and insurance. Unfortunately, the financial markets needed to provide these products are either missing or underdeveloped in many rural areas of developing countries (Santos and Barrett, 2011). This is attributed to the classical information asymmetry problems common with insurance products such as moral hazard, adverse selection, and the high cost of delivery (Alderman and Haque, 2007).

Index insurance products have been developed and piloted as a promising alternative to conventional insurance for rural farmers in low-income countries (Alderman and Haque, 2007; Barnett and Mahul, 2007; Miranda and Farrin, 2012). In contrast to conventional insurance, index insurance does not compensate based on individual losses. Rather, it provides insurance coverage on the basis of an exogenous, publicly observable index such as rainfall, temperature, or vegetation cover, which is highly correlated with the individual losses incurred by insured households (Giné and Yang, 2009). Using an exogenous index minimizes problems of information asymmetry (such as moral hazard and adverse selection) and drastically reduces the insurance companies' labor costs that result from monitoring individual farms and loss assessments (Clarke and Mahul, 2011).

Overall, research on the impacts of index insurance on household welfare has been mixed. On the one hand, there is evidence that farmers with index insurance are likely to have better outcomes in terms of enhanced adoption of high-yielding farm technologies, improved access to both formal and informal credit services, and increased accumulation of productive assets (Karlan et al. 2014; Cai, 2016; Jensen et al. 2017; Janzen and Carter, 2019; Matsuda et al, 2019; Noritomo and Takahashi, 2020). A long-term index insurance simulation also shows that continuous access to index insurance can cut long-term poverty by half, and it

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reduces public expenditure on social protection programs by 6–16 percent (Janzen et al. 2021). On the other hand, some researchers have shown that the long-term effects of insurance on household well-being are rather weak (Binswanger-Mkhize, 2012; Tobacman et al. 2017). Index insurance can be welfare reducing under two circumstances: when high commercial loadings by insurers drive the premium rates above the actuarially fair levels, or if there is an imperfect correlation between the index and actual losses, that is 'basis risk'. From a developed country perspective, Glauber (2012) provides evidence of how insurance benefits, especially programs involving heavy public subsidies, might be skewed to the wealthier farmers. A recent review by Timu and Kramer (2023) also indicates how differential gender roles and vulnerabilities can reduce women's access to and their ability to draw benefits from index insurance markets. As such, to fully understand the effectiveness of index insurance as a risk-management tool, it is important to account for the distribution of insurance outcomes among the different socio-demographic and economic groups. However, empirical studies on the heterogeneous impacts of index insurance are limited; the handful of existing heterogenous evaluations have focused on index insurance impacts by wealth classifications (such as Janzen and Carter, 2019; Matsuda et al. 2019) and to the best of our knowledge, no study evaluates the differential insurance impacts by gender. This paper fills this literature gap by evaluating the *ex ante* and *ex post* impacts of index insurance by the gender of the household head.

The paper focuses on household food consumption, one of the main livelihood aspects that is highly impacted by climate risks (Ayanlade et al. 2022). We use a six-wave panel of data on index insurance purchases based on the index-based livestock insurance (IBLI) program in southern Ethiopia and specifically focus on two food consumption indicators: household food expenditure per adult equivalent and household dietary diversity score (HDDS). We exploit intertemporal variation in household risk exposure and insurance payouts to evaluate the impact of an IBLI purchase and the level of IBLI purchase under two different scenarios: one, when the weather conditions are good and insurance premiums lapse without a payout, and two, when a severe drought triggers a payout for insured households. This temporal variation will help us in not only understanding the role of agricultural insurance as a tool that can help households to cope with consumption variability across time, but also the potential *ex ante* behavioral changes induced by an insurance purchase. To control for endogeneity in IBLI uptake and intensity of uptake, we exploit randomly issued discount coupons as reliable instrumental variables and estimate a two-stage least square (2SLS) model.

We find that female-headed households have significantly lower food consumption outcomes than male-headed households. Female-headed households also have lower productive asset ownership (in terms of livestock, land, and non-agricultural assets), lower education and income levels, and higher dependency ratio, factors that reduce their ability to cope with climate shocks. We also find that although there are no gender differences in IBLI purchase rates, the intensity of IBLI coverage, proxied by the number of livestock insured, is significantly high among male-headed households which subsequently increases their premium payment. Our empirical analysis shows that current season IBLI purchase and the intensity of IBLI coverage have non-significant impacts on household food consumption in both male- and female-headed households. We however find that a previous season IBLI purchase and an increase in the intensity of IBLI coverage significantly reduces household expenditure on food during the pre-drought period. These negative impacts do not vary with the gender of the household head. During the post-drought period, we show that receiving an IBLI payout significantly increases food expenditure per adult equivalent in female-headed households. Additional results show that households with older heads and higher dependency levels, and those that heavily rely on livestock as their main source of livelihood are likely to have lower food consumption outcomes. Wealthier households, educated households, diversified households (in terms of crop production), and households that belong to informal mutual self-help groups are likely to have better food consumption outcomes during both pre-drought and post-drought periods.

We summarize our findings as follows: First, income loss due to an IBLI purchase without a payout can reduce food consumption outcomes for both men and women. Secondly, although previous studies show evidence of *ex ante* insurance impacts due to behavioral changes induced by an insurance purchase, for instance increased farm investment and subjective well-being (Hill et al. 2019; Karlan et al. 2014; Tafere et al. 2019), we do not replicate these findings with respect to households' food consumption. Third, index insurance, or agricultural insurance in general, can be an effective strategy in helping poor female farmers cope with climate-related consumption shock, but these effects are only realized *ex post* when insured households have received an indemnity payout.

The rest of this paper is organized as follows. Section 2 briefly reviews the literature of gender, vulnerability to climate shocks and index insurance uptake, Section 3 provides the details of the research setting and data used in the analysis. Section 4 and 5 discuss the summary statistics and the estimation strategy, followed by a discussion of the main findings in section 6. Section 7 concludes.

## Literature on gender, climate shocks and index insurance uptake

Previous studies indicate that in the developing world, women are disproportionately affected by household production shocks, which negatively impact their food security and consumption outcomes (Doss, 2001; Quisumbing et al. 2015; Andrijevic et al. 2020). A growing body of literature on differential gender vulnerability suggests that women are not inherently more at risk than their male counterparts, but the intersection between gender, power dynamics, socio-economic structures, and societal expectations increases their exposure to climatic risks. For instance, women allocate a large share of their time to home-based production, which limits their mobility (Kakota et al., 2011; Djoudi et al. 2016; Dinkelman et al., 2022). Moreover, women have limited ownership of productive assets such as land and livestock, with comparatively few opportunities to participate in and influence decision-making on use of these resources (Meinzen-Dick and Mwangi, 2009; Quisumbing et al. 2015). Women's limited mobility, and lack of resources reduces their ability to cope with the negative impacts of climate variability, which exposes them to heightened levels of food insecurity.

Although some of these risks can be transferred to the insurance markets in return for a premium payment when extreme climatic events occur, recent studies indicate that even when insurance markets are well developed, female farmers are less likely to use them as a risk-management option. For instance; studies from Africa and Asia show that female farmers are less likely to purchase index insurance, and, when they do, the value of their premiums is significantly lower than the premiums of male purchasers (Akter et al. 2016; Delavallade et al. 2015; Clarke and Kumar, 2016; Bageant and Barrett, 2017). Past research suggests that the low uptake of agricultural insurance products by both men and women is associated with both supply-side constraints, such as limited risk coverage, basis risk, non-inclusive training and extension approaches, and missing credit markets, and demand-side constraints, such as low liquidity, high risk aversion, lack of trust in the product and product providers, and limited financial literacy levels (Giné et al. 2008; Casaburi and Willis, 2018; Hill et al. 2016, Hill et al., 2019; Kramer et al., 2021). However, the magnitude of these supply- and demand-side constraints is larger among women than men (see Timu and Kramer (2023) for a detailed review).

Based on this background, we expect that insurance outcomes will also vary among men and women. We postulate that given women's limited access to and control of productive assets, out-of-pocket payment for an insurance premium that does not lead to a payout might result in a significant liquidity loss which can subsequently reduce food consumption. However, if an insurance payout is triggered, women might spend a larger share of the payout proceeds on activities that improve the general household welfare such as food and education (Quisumbing and Maluccio, 2003; Gitungwa et al. 2021).

## Study context and data

### *Study area and IBLI product design*

This study was conducted in the Borana rangelands, situated in the Oromia region of southern Ethiopia. The region is characterized by low and erratic rainfall that makes it more suited for extensive livestock grazing than for crop production. The majority of the population are pastoralists who depend on livestock as their primary source of livelihood. Frequent droughts in the region result in forage and water scarcity that reduce livestock productivity and, in severe cases, lead to widespread livestock losses (Coppock et al. 2011). The loss of productive assets in this environment often leads to severe and long-lasting consequences (Lybbert et al. 2004; Azariadis and Stachurski, 2005; Carter and Barrett, 2006). The adverse impacts of extreme weather conditions is further aggravated by the absence of formal insurance and credit services. Poor households in the region are disproportionately rationed out of the formal and informal credit market (Santos and Barrett, 2011). As a result, they are not able to borrow money for investment in meaningful high-return ventures. The lack of financial markets also limits households' ability to restock and bounce back after the drought period passes, which creates a feedback loop that perpetuates the poverty cycle for generations. Traditional forms of informal risk-sharing and mutual insurance that are pervasive in the rural areas are either costly or offer inadequate risk protection, particularly against large-scale covariant events where all households are affected (Santos and Barrett, 2011; Ligon et al. 2011).

In response to these challenges, IBLI was piloted in the Borana region by the International Livestock Research Institute (ILRI) in collaboration with Oromia Insurance Company (OIC) and Cornell University in January 2012 following the successful piloting of a similar product in Kenya in January 2010. IBLI is a microinsurance product that is aimed at protecting pastoral households against the widespread livestock mortality events that often follow catastrophic drought. The IBLI contract relies on an index that tracks relative forage scarcity using an exogenous, satellite-based and freely available normalized difference vegetation index (NDVI). As such, IBLI (like other index insurance products) is less exposed to moral hazard and adverse selection challenges that are common with conventional insurance schemes. Additionally, the use of a freely available index reduces the need to collect household-level actuarial data for individual risk assessments and claim validation, therefore reducing the cost of delivery. The IBLI premium rate is woreda specific, ranging from 6.7 to 11.1 percent, which captures local variation in the livestock mortality risk associated with each woreda. Households who wish to insure their livestock choose how many of each species of animals to insure —which is then aggregated as total insured herd value (TIHV)[1]—for a given period. The premium paid by the policyholder is equal to the woreda-specific premium rate multiplied by the TIHV. When the index falls below the 15th percentile of the historical index distribution at the woreda level, then IBLI policy holders receive a payout based on the relative severity of the anomaly and the amount of TIHV.

Fig. 1 provides a summary of IBLI contracts and the monthly average NDVI values. The figure shows a bimodal rainfall pattern in the study area. Each year, IBLI is marketed and sold during two sales windows occurring directly before the rainy seasons (August-September and January-February). An insurance policy provides coverage for 12 months and offers two potential payouts, one after each dry season (March-April and October-November). If a household purchases IBLI in two consecutive sales periods, the household can have overlapping policies and could receive payouts on both.

In order to stimulate demand and create exogeneous variation in IBLI uptake, randomly selected households received a price discount that would allow them to purchase IBLI for up to 15 tropical livestock units (TLU) at a discount below the unsubsidized policy premium rate. In each sales period, about 80 percent of sample households were randomly selected to receive discount coupons. The value of the discount coupons varied from 10 to 100 percent. Each coupon was uniquely attached to a specific survey respondent, creating variation in the effective price faced by the prospective buyers (Ikegami and Sheahan, 2015).

### *Data*

To study the impact of IBLI, data were collected annually from pre-selected households. Seventeen study sites were purposively selected from eight woredas for inclusion in the sample. A list of all inhabitants was developed, and households were stratified into wealth terciles depending on TLU holdings. Fifteen percent of households were randomly selected in each study site with one-third coming from each TLU tercile. Pre-intervention baseline data were collected in February 2012 from 513 households. This was followed by IBLI extension and training activities, and the bi-annual IBLI contract sales. Annual follow-up surveys were also conducted with the original sample in March-April 2013, 2014, and 2015 resulting in a total of four survey rounds and data on six IBLI sales periods. Each survey round included detailed questions about household socio-economic characteristics, incomes and livelihood activities, expenditure on food and non-food items, food consumption frequency, livestock holdings, durable and non-durable assets, and the seasonal IBLI purchase information. To maintain a robust sample size, new households with similar TLU holdings from the same study site were added to replace households lost due to attrition. A severe drought hit the study area in June-September 2014. The drought triggered a payout based on the IBLI contracts purchased in August-September 2013 (IBLI3) and January-February 2014 (IBLI4). Eligible policyholders received the payouts in November 2014. Table 1 presents the timeline of IBLI activities.

The seasonal recall structure of the IBLI survey modules allows for analysis based on two sales periods within each year. Our analysis is based on 1990 observations drawn from four pre-drought sales periods (IBLI1 to IBLI4) and 1026 observations from two post-drought periods (IBLI5-IBLI6). We use two indicators of household food consumption: the seasonal real aggregate food expenditure per adult equivalent in purchasing power parity and the household dietary diversity score (HDDS).

## Summary statistics

Table 2 reports the summary statistics of the study households based on IBLI6 data and presented separately for male-headed (MHH) and female-headed households (FHH). The results shows that FHH have significantly lower food consumption outcomes than MHH. The season specific IBLI purchase rates are statistically similar among MHH and FHH. However, MHH insure significantly higher TLU values than FHH (that is 2788 vs 1073 Ethiopian Birr). About 10 percent of the households in the study area received a premium payment in November 2014. Although there is no statistical difference in payout receipt among FHH and MHH, MHH receive a significantly higher amount of payout due to their higher value insurance purchase. Further, the results show that compared to FHH, MHH have significantly higher education levels,

[1] TIHV is equivalent to 15,000 Ethiopian Birr (ETB) * number of camel insured + 5,000 ETB * number of cows insured + 700 ETB * number of sheep and goats insured for the first three insurance sales periods. The monetary values of camel, cows, and sheep and goats are revised into 10,000, 6,000, and 800 ETB, respectively, in the fourth insurance sales period. 1 USD = 35.23 ETB as of August 2020.

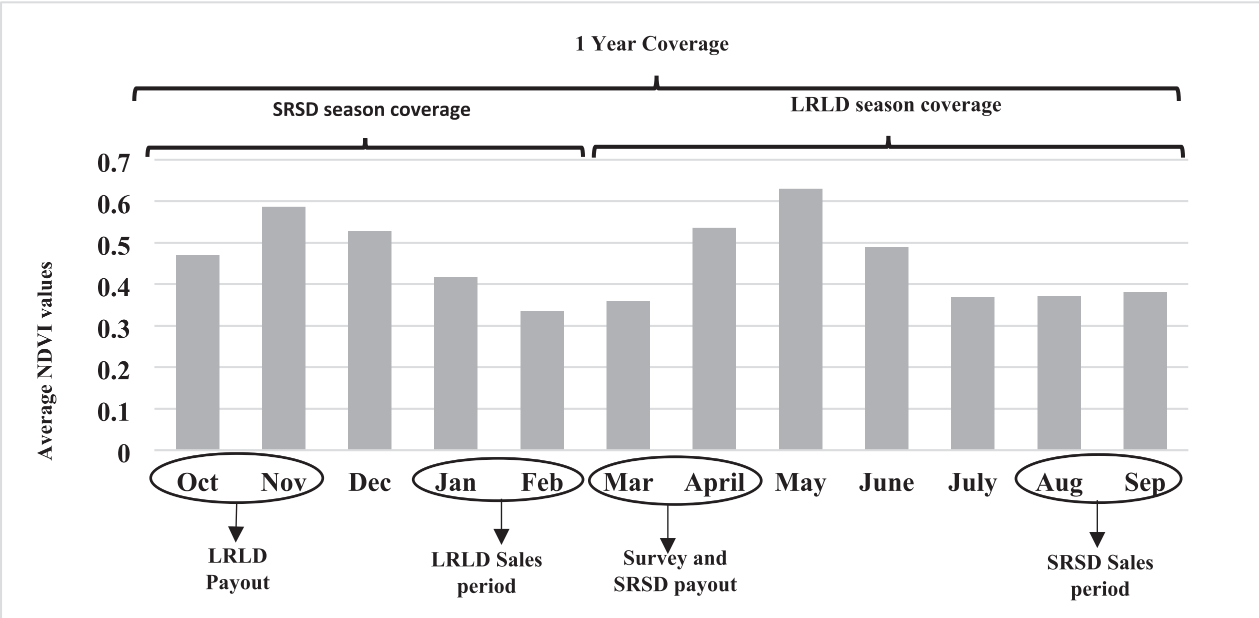


**Fig. 1.** IBLI Coverage.

**Table 1**
IBLI Activity Timelines.

| *Dates* | *Activity* |
|---|---|
| March 2012 | Baseline survey |
| August-September 2012 | IBLI1 sales |
| January-February 2013 | IBLI2 sales |
| April 2013 | Household survey round 2 |
| August-September 2013 | IBLI3 sales |
| January-February 2014 | IBLI4 sales |
| March 2014 | Household survey round 3 |
| June-September 2014 | Severe drought |
| August-September 2014 | IBLI5 sales |
| November 2014 | Insurance Payouts issued |
| January-February 2015 | IBLI6 sales |
| March 2015 | Household survey round 4 |

**Table 2**
Summary statistics.

| | MHH | | FHH | | Difference | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | MHH-FHH | p-val. |
| Exp. per adult equivalent (*1000) | 2.429 | 1.417 | 2.319 | 1.668 | 0.11 | * |
| HDDS | 6.891 | 1.405 | 6.544 | 1.431 | 0.347 | *** |
| Purchase IBLI | 0.122 | 0.328 | 0.107 | 0.311 | 0.015 | |
| TIHV (*1000) | 2.788 | 10.466 | 1.073 | 4.715 | 1.715 | *** |
| Receive Payout | 0.112 | 0.316 | 0.105 | 0.226 | 0.007 | |
| Amount of payout received | 702.574 | 4041 | 99.018 | 945.213 | 603.556 | ** |
| Age of hh head | 50.127 | 17.794 | 55.395 | 18.864 | −5.268 | *** |
| Education level of hh (years) | 0.656 | 2.085 | 0.194 | 1.244 | 0.462 | *** |
| Household size | 7.02 | 2.617 | 5.155 | 1.776 | 1.866 | *** |
| Dependency ratio | 1.426 | 0.784 | 2.283 | 3.027 | −0.856 | *** |
| Gross income (*000) | 19.208 | 23.237 | 11.200 | 13.184 | 8.007 | *** |
| TLU size | 21.135 | 29.749 | 10.396 | 15.831 | 10.740 | *** |
| Income from livestock (%) | 0.736 | 0.286 | 0.627 | 0.337 | 0.109 | *** |
| Non-agricultural asset index | 0.004 | 0.995 | −0.016 | 1.017 | 0.02 | |
| Area of land cultivated (acres) | 1.609 | 1.785 | 1.012 | 1.374 | 0.597 | *** |
| Member of an informal group | 0.879 | 0.887 | 0.546 | 0.703 | 0.333 | *** |
| # of observations | 401 | | 112 | | | |

incomes, livestock holdings, non-agricultural assets, they cultivate relatively larger land areas, and they are significantly more likely to be members of local mutual self-help groups. On the contrary, FHH have significantly older heads, and a higher dependency ratio. These findings demonstrate evidence of how women in the study area are more vulnerable to climate risks and their limited pathways to cope with the aftermaths of climate shocks.

## Empirical approach

In this section, we discuss the empirical strategy used in evaluating the impacts of IBLI on household food consumption outcomes. Our benchmark model takes the form of:

$$Y_{iws} = \mathrm{IBLI}_{iws} + \mathrm{IBLI}_{iws-1} + FHH_{iw} + \mathrm{IBLI}_{iws}{*}FHH_{iw} + \mathrm{IBLI}_{iws-1}{*}FHH_{iw} + X_{iws} + \delta_w + \epsilon_{iws} \tag{1}$$

where $Y_{iws}$ is the food consumption outcome for household $i$ living in woreda $w$ during season $s$, and $IBLI_{iws}$ is a binary variable that is equal to one if the insurance was purchased in season s. To capture the intertemporal effects of IBLI, we also include a lagged IBLI purchase variable $IBLI_{iws-1}$ indicating whether the household purchased IBLI in the previous season. Since our main objective is to estimate the differential impact of IBLI by the gender of the household head, we include a binary variable $FHH_{iw}$ which is equal to one if the gender of the household head is female. $IBLI_{iws}{*}FHH_{iw}$ is the interaction term between an IBLI purchase and gender of household head for season s and $IBLI_{iws-1}{*}FHH_{iw}$ the gender interaction for the lagged IBLI purchase. $X_{iws}$ is a vector of covariates that influence household consumption, $\delta_w$ are the woreda fixed effects, and $\epsilon_{isw}$ is the error term.

One of the key characteristics of IBLI is that the program was available to all households in the study area and therefore households voluntarily select into the purchase process. As such, participation is not random and could be systematically correlated with the respondents' observable and unobservable characteristics. In addition, the unobserved characteristics such as climate risk assessment might be correlated with the households' food consumption outcomes. To deal with the endogeneity in IBLI uptake, we employ the 2SLS approach by using period-specific discount coupons as reliable instrumental variables. Since the distribution of the coupons was random and time-specific by design, they are highly correlated with the decision to purchase IBLI but exogenous to the outcomes of interest. The first stage regression is expressed as:

$$IBLI_{iws} = DR_{iws} + X_{iws} + \delta_w + \varepsilon_{iws} \quad (2)$$

where $DR_{iws}$ is the value of discount coupon received by household $i$ for sales period $s$'s IBLI purchases. To deal with the endogeneity in the interaction variables, we use an interaction between value of the discount coupon and gender of the household head ($DR_{iws}*F_{iws}$) and estimate the following model:

$$\text{IBLI}_{iws}*FHH_{iw} = DR_{iws} + FHH_{iw} + DR_{iws}*FHH_{iw} + X_{iws} + \delta_w + \varepsilon_{iws.} \quad (3)$$

In the second stage regression, the predicted IBLI uptake is used to estimate the causal impact of IBLI on the two indicators of household food consumption. We estimate the following regression equation:

$$Y_{iws} = \widehat{IBLI}_{iws} + \widehat{IBLI}_{iws-1} + FHH_{iw} + \widehat{IBLI}_{iws}*FHH_{iw} + \widehat{IBLI}_{iws-1}*FHH_{iw} + X_{iws} + \mu_w + \epsilon_{iws} \quad (4)$$

where $\widehat{IBLI}_{iws}$ and $\widehat{IBLI}_{iws}*FHH_{iw}$ are the predicted IBLI purchase variable and the gender interaction term between predicted IBLI purchase for season s and $\widehat{IBLI}_{iws-1}$ and $\widehat{IBLI}_{iws-1}*FHH_{iw}$ are the predicted previous season IBLI purchase and the corresponding interaction term. All predicted variables are drawn from first stage regression.

To capture the effect of the intensity of IBLI coverage on household food consumption—that is if an increase in the volume of IBLI uptake impacts the household's food consumption—we replace the IBLI uptake dummy variable in equations (2) and (3) with TIHV and estimate impacts as follows:

$$Y_{iws} = \widehat{TIHV}_{iws} + \widehat{TIHV}_{iws-1} + FHH_{iw} + \widehat{TIHV}_{iws}*FHH_{iw} + \widehat{TIHV}_{iws-1}*FHH_{iw} + X_{iws} + \mu_w + \epsilon_{iws.} \quad (5)$$

The main explanatory variables, $X_{iw}$, are the age, gender and education level of the household head, the household size, the household dependency ratio, non-agricultural asset ownership, TLU owned, gross incomes, share of income from livestock, membership in informal mutual self-help groups, and size of land cultivated. We also include the amount of the payout received by the household in the post-drought period.

## Empirical results

Table 3 presents the results from the first stage regressions based on equations (2) and (3) for both the pre- and post-drought period. The dependent variables include the binary IBLI uptake decision and the interaction terms between FHH and IBLI uptake for columns (1) and (2) and the intensity of purchase measured by TIHV and interaction between FHH and TIHV for columns (3) and (4). The first stage results demonstrate a strong correlation between the value of discount received and IBLI purchase, and the intensity of IBLI purchase. There is also a strong correlation between the interacted terms. In addition, the F-statistics for the excluded instruments are all above the weak instrument critical value of 7.03 at the 10 percent level. Given these results, and the fact that the treatment assignment was randomized, is a demonstration of the validity of our instrument.

**Table 3**
First Stage Regression on Demand for IBLI and the TIHV.

| | (1) IBLI | (2) IBLI*FHH | (3) TIHV | (4) TIHV *FHH |
|---|---|---|---|---|
| ***Pre-drought Period*** | | | | |
| Discount rate | 0.0252***<br>(0.002) | | 86.798***<br>(9.433) | |
| Discount rate *FHH | | 0.023***<br>(0.003) | | 12.129**<br>(4.393) |
| HH Controls | Yes | Yes | Yes | Yes |
| Cragg-Donald Wald F-stat | 39.93 | 29.44 | 42.58 | 9.02 |
| Cragg-Donald Wald F-stat (p-value) | 0.000 | 0.000 | 0.000 | 0.002 |
| # of observations | 2,038 | 2,038 | 2,038 | 2,038 |
| ***Post-drought Period*** | | | | |
| Discount rate | 0.012**<br>(0.004) | | 60.408***<br>(13.034) | |
| Discount rate*FHH | | 0.012***<br>(0.004) | | 83.24***<br>(11.827) |
| HH Controls | Yes | Yes | Yes | Yes |
| Cragg-Donald Wald F-stat | 8.04 | 7.65 | 14.30 | 39.72 |
| Cragg-Donald Wald F-stat (p-value) | 0.004 | 0.000 | 0.000 | 0.000 |
| # of observations | 1,026 | 1,026 | 1,026 | 1,026 |

Woreda level clustered standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Tables 4 and 5 show the second stage estimates of the impacts of IBLI purchase and the intensity of purchase on household food consumption during the pre-drought and post-drought periods respectively. The dependent variable in columns (1) and (3) is the HDDS, while that in columns (2) and (4) is the natural log of consumption per adult equivalent. The variables of interest are the predicted IBLI uptake, TIHV, and the corresponding interaction terms. Since the randomized discount coupons were used as instruments for the potentially endogenous IBLI uptake in stage one, the coefficient on IBLI and TIHV variables measures the average treatment effects.

We begin by discussing the gendered impacts of IBLI on household food consumption during the pre-drought period (Table 4). The results show that FHH have significantly lower household food consumption in terms of HDDS and food expenditure per adult equivalent. These findings are not surprising as literature has consistently shown that women tend to face higher levels of food insecurity than men (Kassie et al. 2014; Negesse et al. 2020). Next, we find that the current season IBLI purchase, and the intensity of purchase have non-significant impacts on both HDDS and food expenditure per adult equivalent. At the same time, the interaction variables indicate that current season IBLI impacts do not vary by gender. We however find that both the previous season's IBLI purchase and the intensity of coverage (that is, $\widehat{IBLI}_{iws-1}$ and $\widehat{TIHV}_{iws-1}$), have negative and significant effects on the food expenditure per adult equivalent outcome. The corresponding interaction terms also indicate that the impacts of these variables do not vary by the gender of the household head. These findings could suggest that insured households do intentionally destabilize their consumption before a shock event for a smooth consumption during and after the shock event. But they could also be explained by the fact that purchasing insurance without payouts leads to income loss that reduces household food consumption. The results also indicate that the *ex ante* behavioral effects of insurance reported in previous studies (such as those reported in Karlan, et al. (2014); Tafere et al. (2019); Hill et al. (2019)) are missing in the food consumption domain.

Additional results from the pre-drought period analysis indicate that both HDDS and expenditure per adult equivalent are significantly lower

**Table 4**
Impacts of IBLI on household food consumption in the pre-drought period.

| | **IBLI purchase decision** | | Intensity **of IBLI purchase (TIHV)** | |
|---|---|---|---|---|
| | HDDS | Expenditure /adult equivalent | HDDS | Expenditure/ adult equivalent |
| | (1) | (2) | (3) | (4) |
| FHH = 1 | −0.468* | −0.159** | −0.302** | −0.151* |
| | (0.199) | (0.069) | (0.133) | (0.082) |
| Predicted IBLI purchase | 0.264 | 0.105 | | |
| | (0.448) | (0.166) | | |
| Predicted IBLI*FHH | −0.649 | 0.015 | | |
| | (0.653) | (0.242) | | |
| Predicted IBLI purchase lag | 0.433 | −0.641*** | | |
| | (0.388) | (0.144) | | |
| Predicted IBLI*FHH (t-1) | 0.038 | 0.190 | | |
| | (0.624) | (0.232) | | |
| Predicted TIHV | | | 0.033 | 0.043 |
| | | | (0.154) | (0.056) |
| Predicted TIHV*FHH | | | −0.823 | 0.017 |
| | | | (0.935) | (0.342) |
| Predicted TIHV (t-1) | | | 0.122 | −0.219*** |
| | | | (0.138) | (0.050) |
| Predicted TIHV (t-1)*FHH | | | 0.248 | −0.282 |
| | | | (0.827) | (0.303) |
| Age of HH (Years) | −0.007*** | −0.004*** | −0.007*** | −0.004*** |
| | (0.002) | (0.001) | (0.002) | (0.001) |
| Education of HH (years) | 0.070*** | 0.029*** | 0.071*** | 0.029*** |
| | (0.016) | (0.006) | (0.016) | (0.006) |
| Household size | −0.006 | −0.097*** | −0.006 | −0.097*** |
| | (0.013) | (0.005) | (0.013) | (0.005) |
| Dependency ratio | −0.020 | 0.021*** | −0.019 | 0.020*** |
| | (0.021) | (0.008) | (0.021) | (0.008) |
| Log gross income | 0.173*** | 0.118*** | 0.169*** | 0.122*** |
| | (0.039) | (0.014) | (0.038) | (0.014) |
| TLU | −0.004** | 0.003*** | −0.004** | 0.003*** |
| | (0.002) | (0.001) | (0.002) | (0.001) |
| Share of income from livestock | −0.238* | −0.239*** | −0.248** | −0.229*** |
| | (0.122) | (0.045) | (0.119) | (0.044) |
| Non-agricultural assets index | 0.059* | −0.006 | 0.052* | −0.000 |
| | (0.031) | (0.011) | (0.031) | (0.011) |
| Land area cultivated (HA) | 0.064*** | 0.019** | 0.062*** | 0.019** |
| | (0.021) | (0.008) | (0.022) | (0.008) |
| Group membership | 0.340*** | 0.138*** | 0.350*** | 0.121*** |
| | (0.071) | (0.026) | (0.067) | (0.025) |
| Constant | 6.351*** | 7.402*** | 6.480*** | 7.297*** |
| | (0.380) | (0.141) | (0.348) | (0.127) |
| Observations | 1,990 | 1,990 | 1,990 | 1,990 |
| R-squared | 0.171 | 0.147 | 0.169 | 0.167 |

Woreda level clustered standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table 5**
Impacts of IBLI on Household Food Consumption in the Post-Drought Period.

| | IBLI purchase decision | | Intensity of IBLI purchase (TIHV) | |
|---|---|---|---|---|
| | HDDS | Expenditure /adult equivalent | HDDS | Expenditure/ adult equivalent |
| | (1) | (2) | (3) | (4) |
| FHH = 1 | −0.993*** | −0.219** | −0.477 | −0.054 |
| | (0.365) | (0.097) | (1.563) | (0.276) |
| Predicted IBLI purchase | −1.718 | −0.159 | | |
| | (1.476) | (0.436) | | |
| Predicted IBLI*FHH | 0.528 | −0.330 | | |
| | (1.271) | (0.376) | | |
| Predicted IBLI purchase lag | 1.775 | 0.471 | | |
| | (2.614) | (0.696) | | |
| Predicted IBLI*FHH (t-1) | −2.030 | −0.813 | | |
| | (5.210) | (1.388) | | |
| Predicted TIHV | | | −0.445 | −0.106 |
| | | | (0.581) | (0.166) |
| Predicted TIHV*FHH | | | 3.618 | −0.659 |
| | | | (14.921) | (4.260) |
| Predicted TIHV (t-1) | | | 0.346 | 0.038 |
| | | | (0.766) | (0.219) |
| Predicted TIHV (t-1)*FHH | | | 1.391 | 0.240 |
| | | | (4.584) | (1.309) |
| Payout amount | 0.365 | 0.016 | 0.611 | 0.144 |
| | (0.296) | (0.088) | (0.569) | (0.266) |
| Payout amount X FHH | 0.412 | 1.417*** | 0.699 | 1.572** |
| | (1.307) | (0.386) | (1.458) | (0.683) |
| Age of HH (Years) | −0.002 | −0.003*** | −0.003 | −0.003** |
| | (0.003) | (0.001) | (0.002) | (0.001) |
| Education of HH (years) | 0.019 | 0.019** | 0.022 | 0.013*** |
| | (0.028) | (0.008) | (0.033) | (0.005) |
| Household size | 0.005 | −0.101*** | 0.015 | −0.105*** |
| | (0.024) | (0.007) | (0.028) | (0.013) |
| Dependency ratio | 0.013 | 0.009 | 0.001 | 0.002 |
| | (0.036) | (0.011) | (0.026) | (0.012) |
| Log gross income | 0.189*** | 0.138*** | 0.166*** | 0.142*** |
| | (0.069) | (0.020) | (0.060) | (0.028) |
| TLU | −0.000 | 0.002*** | 0.001 | 0.002** |
| | (0.002) | (0.001) | (0.002) | (0.001) |
| Share of income from livestock | −0.213 | −0.161** | −0.195 | −0.109 |
| | (0.220) | (0.065) | (0.269) | (0.126) |
| Non-agricultural assets index | −0.095 | 0.033** | −0.062 | 0.031 |
| | (0.061) | (0.016) | (0.123) | (0.035) |
| Land area cultivated (HA) | 0.117*** | 0.021** | 0.090*** | 0.015 |
| | (0.035) | (0.010) | (0.032) | (0.015) |
| Group membership | 0.228** | 0.079*** | 0.195** | 0.070* |
| | (0.091) | (0.027) | (0.091) | (0.042) |
| Constant | 5.729*** | 7.175*** | 5.977*** | 7.142*** |
| | (0.640) | (0.189) | (0.539) | (0.252) |
| Observations | 1,026 | 1,026 | 1,026 | 1,026 |
| R-squared | 0.224 | 0.280 | 0.122 | 0.183 |

Woreda level clustered standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

among households with older heads, while an increase in household earnings and education of the household head significantly increases both food consumption outcomes. HDDS significantly increases with non-agricultural assets holdings, but it decreases with increases in livestock holdings (TLU). On the other hand, food expenditure per adult equivalent increases with both TLU and dependency ratio: these results are plausible because previous evidence shows that given the relative prices of animal-source foods such as eggs, milk and meat, some households might prefer to sell the farm produce in order to purchase other cheaper, mostly less nutritious, and less diversified food options (Alderman et al. 2019). Moreover, when the dependents are younger children, parents are likely to spend more on food. We also find that larger households are likely to experience a significant decrease in food expenditure per adult equivalent; this can be directly attributed to the increased pressure that larger families place on the already limited household resources. An increase in land area under crop cultivation and membership in informal mutual help groups are positively and significantly associated with HDDS and expenditure per adult equivalent. A plausible explanation for these findings is that crop-producing households are able to supplement livestock-sourced food products with own-farm production and/or they can sell surplus crops to purchase non-farm food commodities. Mutual support groups also function as safety-nets especially when food consumption shocks are idiosyncratic in nature.

Moving to the post-drought period, we evaluate whether an IBLI purchase and TIHV can help households recover from the consumption shocks created by prolonged drought events and the subsequent gender differences on the level of impacts (Table 5). Unlike the pre-drought period where IBLI policies lapsed without a payout, in the post-drought period, households with IBLI premiums were either anticipating or had received their full payouts based on the area-specific drought intensity. We find that current and previous IBLI purchase, and the intensity of purchase have non-significant impacts on both indicators of food consumption in both MHH and FHH. Receiving a payout is positively associated with an increase in household food consumption, but these impacts vary with the gender of the household head: while the impacts are non-significant in MHH, an increase in the amount payout received significantly increased the household food expenditure in FHH. These findings point to the potential of IBLI and agricultural insurance in general in helping women farmers smooth their consumption over time. But they also highlight the fact that insurance impacts on food consumption are experienced *ex-post* and after insured household receive a premium payment. The results are also in line with the previous literature that shows that when women have access to, and control over finances, they are more likely to spend on their families' food and nutritional needs (Quisumbing and Maluccio, 2003; Gitungwa et al. 2021). The differential gender impacts of payout on food consumption does not mean that insurance is not an effective strategy in helping MHH households cope with climate-related consumption shocks: there is evidence of a number of indirect mechanisms through which an IBLI payout can improve household consumption in the long-term including improved asset protection, increased farm investment, incomes and savings (Matsuda et al. 2019; Janzen and Carter, 2019; Noritomo and Takahashi, 2020).

## Conclusion

Index insurance has been promoted as a cheaper alternative to conventional insurance products in developing countries. Interest in index insurance stems from its potential to reduce information asymmetries that plague conventional insurance products. In addition, research shows that index insurance products can promote investments in productive technologies, can help farmers preserve their productive assets in the face of climatic shocks, and can also serve as a substitute for collateral, improving access to formal and informal credit (Karlan et al. 2014; Cai, 2016; Jensen et al. 2017; Janzen and Carter, 2019; Matsuda et al, 2019; Noritomo and Takahashi, 2020). However, under special circumstances, index insurance can be welfare-reducing, especially when premium rates are set too high and/or in the presence of basis risk. Given these potential outcomes, it is important to understand the potentially heterogeneous impacts of index insurance. While there exists a small amount of literature evaluating the heterogenous impacts of index insurance, evidence of differential impacts by gender is still missing. This paper seeks to fill this literature gap by evaluating the gendered impacts of index insurance, with a specific focus on food consumption. We use data from the index-based livestock insurance (IBLI) product in southern Ethiopia and exploit intertemporal variation in household risk exposure and insurance payouts to evaluate both the *ex ante* and *ex post* IBLI impacts under normal weather conditions and after a drought severe enough to trigger a payout. We use two food consumption indicators, household food expenditure per adult equivalent and the HDDS. We use data from six semi-annual IBLI sales periods and employ the 2SLS model using randomly issued discount coupons as reliable instrumental variables.

We find that there is no statistical difference between men and women's IBLI demand. However, men purchase higher value insurance than women. Due to the high intensity of insurance coverage among MHH, when a payout is triggered, they receive a significantly higher payment. The regression results show that FHH have lower food consumption outcomes in both the pre- and post-drought periods. In terms of the impacts of IBLI purchase and intensity of purchase (proxied by the number of livestock units insured) on household food consumption, we report three main findings: first, the current period IBLI purchase, and the intensity of purchase, have non-significant impacts on household food consumption in both the pre- and post-drought periods. The non-significant impacts are homogenous across male- and female-headed households. Second, previous IBLI purchase, and intensity of purchase significantly reduces household food expenditure during the pre-drought period; however in the post-drought period, the impact of a previous purchase is positive, but not significant. These impacts do not vary with the gender of the household head. Third, receiving an insurance payout significantly increases the food expenditure per adult equivalent in FHH in the post-drought period. Other results show that wealthier households with educated heads, diversified households (in terms of crop production), and households that belong to informal mutual self-help groups are likely to have better food consumption outcomes during the pre-drought and/or post-drought period. We also find that an increase in the age of the household head and increased dependency on livestock is negatively associated with both food consumption outcomes.

Overall, our findings can be summarized as follows; index insurance can reduce food consumption *ex ante*, especially when an insurance purchase does not lead to a payout. Insurance can help poor female farmers to cope with climate-related consumption shocks *ex post*, but this is only realized after they receive a premium payment. Index-insurance does not have direct impacts on helping MHH cope with food consumption shocks, but this could be as a result of the differential intrahousehold gender roles regarding food consumption and nutrition.

## CRediT authorship contribution statement

**Anne G. Timu:** Conceptualization, Methodology, Visualization, Writing – review & editing. **Christopher R. Gustafson:** Conceptualization, Methodology, Writing – review & editing. **Taro Mieno:** Conceptualization, Methodology, Writing – review & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Data will be made available on request.

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