The role of savings and credit to cope with shocks in Malawi. Considerations for nutrition.

Abstract

To investigate the relationship between shocks, coping strategies, and food and nutrition security, this study implements a two stages least squared approach using a panel dataset collected in Malawi between 2010-2017. This study contributes to the literature by evaluating the effectiveness of savings and credit-based coping responses on food and nutrition security when shocks occur in a developing country setting. Our measures of food and nutrition security refer to the food consumption score and estimated calorie and micronutrient consumption per adult male equivalent per day.

Our results suggest that the use of savings and credit acquisition do not fully protect households from declining food and nutrition security when shocks occur, as households tend to consume fewer food groups when shock strategies are used. Findings may aid policymakers developing adequate safety nets to allow households to build resiliency to shocks and achieve the sustainable development goal of 'Zero Hunger' by 2030.

Keywords: Food and nutrition security, shocks, savings, borrowing, Sub-Saharan Africa.

Classification codes: D14 Household savings, I3 Welfare, Well-Being, and Poverty, O12 Microeconomic Analyses of Economic Development, Q12 Micro Analysis of Farm Firms, Farm Households, and Farm Input Markets, Q18 Agricultural Policy • Food Policy.

1. Introduction

The Sustainable Development Goal (SDG) of Zero Hunger (SDG 2) aims to reduce hunger and all forms of malnutrition by 2030 (UN General Assembly, 2015). However, in many parts of the world rates of food insecurity are increasing. In 2019, nearly 690 million people globally were undernourished and if current trends continue, this number may increase to 840 million people by 2030 (FAO et al., 2020). 250 million people currently suffer from undernourishment in Africa and by 2030 Africa is projected to be the continent with the highest number of undernourished people (FAO et al., 2020). The COVID-19 pandemic has exacerbated food insecurity, as 928 million people faced severe food insecurity in 2020 (FAO et al., 2021). This is an increase of 148 million people in one year and is a stark reminder, that we as a global community are not on track to reach Zero Hunger by 2030.

In the context of Malawi, food insecurity has been on a downward trend since 2000, as reflected by decreasing rates of undernourishment and child stunting. Between 2004 and 2016, rates of undernourishment declined from approximately 25% to 17%. Yet, this trend has reversed since 2017, with the share of undernourishment rising to 19% of the population between 2017 and 2019. Similarly, child stunting reduced from 55% in 2000 to 37% in 2015 but this share increased again to 39% between 2016 and 2018 (FAO et al., 2020).

Malawi is impacted by a range of shocks that contribute to increased food and nutrition insecurity[1]. These may include health shocks, such as malaria and HIV/AIDS (Asenso-Okyere et al., 2011) and price shocks, such as increases in the price of maize, which is an important staple crop in Malawi, in 2002, 2006, 2008, and 2010 (Caracciolo et al., 2014). Malawi also has an increased vulnerability to the impacts of climate change (Warnatzsch and Reay, 2019). In particular, the agricultural sector is extremely susceptible to the effects of a changing climate, due to a dependence on rain-fed irrigation, as well as, heat-sensitive crops, such as maize, and agriculture contributes 28% of total gross domestic product (GDP) (Serdeczny et. al., 2017; FAO, 2018).

Adverse weather events or shocks, such as drought and flooding, will destroy harvests and decrease agricultural incomes for many smallholder farmers (Serdeczny et. al., 2017; FAO, 2018; Baquie and Fuje, 2020). Such events are already increasing in frequency, as since the turn of the century, severe drought occurred in 2002, 2005, and 2016, and flooding in 2005, 2015, 2016, and 2019 (Baquie and Fuje, 2020). Shocks will have detrimental impacts on household income and thus have severe consequences for food consumption (Gao and Mills, 2018; Kansiime et al., 2021). However, food security is not only impacted by the direct effects of shocks but also by the coping strategies employed by the household.

A developed body of literature identifies the coping strategies utilised by households when they experience shocks and whether such strategies enable households to smooth consumption (Yilma et al., 2014; DeLoach and Smith-Lin, 2018; Paumgarten et al., 2020). Gao and Mills, 2018, evaluate the effectiveness of social safety nets (SSNs), migration and off-farm employment on consumption, as captured by food expenditures per adult equivalent when households experience weather shocks. In addition, Acosta et al., 2021, assesses the impact of livestock to smooth consumption, measured by food expenditures per capita, when droughts occur. Lawlor et al., 2019, considers the effect of cash transfers on per capita food expenditures. Tesfaye and Tirivayi, 2020, also study the impact of crop diversification on the household dietary diversity score (HDDS) and food expenditure per adult equivalent.

Use of savings and a reliance on borrowing are also widely used coping strategies for many households experiencing a range of shocks (Heltberg and Lund, 2009; Yilma et al., 2014; Khan et al., 2015; Bonfrer and Gustafsson-Wright, 2017; Pradhan and Mukherjee, 2018). However, few studies estimate the effectiveness of savings and credit-based coping strategies on both food and nutrition security (Paxson, 1992; Heltberg and Lund, 2009; Khan et al., 2015; Akampumuza et al., 2020; Ansah et al., 2021). It is however vital to consider food security in terms of calories consumed but also in terms of the nutritional value of foods and micronutrient consumption, as individuals may suffer from ‘hidden hunger’. Hidden hunger results, when an individual consumes adequate intakes of calories but is deficient in micronutrients vital for health (Muthayya et al., 2013; von Grebmer et al., 2014).

To address this gap in the literature, this study uses estimated consumption of calories, iron, zinc, vitamin A, vitamin B2, folate, vitamin B12 and the Food Consumption Score (FCS), to fully assess the effectiveness of savings and credit-based strategies. We also reply upon a rich panel dataset, combining socioeconomic and farm-level variables with weather and climate data to conduct our analyses. To the best of the authors' knowledge, no study to date has evaluated the effectiveness of savings and credit-based coping strategies using indicators of both food and nutrition security. Such an assessment will be vital to aid policymakers to identify and develop the safety nets to aid countries prone to shocks, to increase their resiliency and foster food and nutrition security in SSA.

The remainder of this article is structured as follows. Section 2 presents the empirical framework, while section 3 describes the data and variables used in the empirical analyses of this study. Section 4 outlines the results. Conclusions and implications of results for policy are discussed in section 5.

2. Econometric framework

We implement a modified two stages least squared (2SLS) instrumental variables (IV) approach to assess the causal relationship between the choice of coping strategy and food and nutrition security. The choice of the 2SLS IV approach is guided by the need to mitigate statistical endogeneity concerns (Angrist and Krueger, 2001). We include weather variables, socio-economic and farm-specific characteristics as additional covariates.

2.1 Estimation strategy

The choice to use savings and/or obtaining credit is potentially endogenous, due to 1) unobserved heterogeneity or omitted variable bias, 2) reverse causality between nutrition variables and coping strategies, and 3) possible measurement error.

For the 2SLS procedure, variables used as instruments (IVs), permit the estimation of consistent coefficients, without bias due to the endogenous variables. As coefficients capture the part of the endogenous variable that is uncorrelated with omitted variables and thus the causal effect (Angrist and Krueger, 2001). Hence, the IV must be correlated with the choice of coping strategy but uncorrelated with the error term of the equations assessing the impact of coping responses on nutrition variables.

Variables selected as instruments for 2SLS regressions include two binary variables that indicate whether 1) there are any savings or credit cooperatives (SACCO), and 2) any commercial banks operating within the district, in which the household lives[2].

The presence of a bank, or savings and credit institution within the community is anticipated to increase the availability and accessibility of financial services to households. Selection of this variable as an IV follows comparable reasoning to Bidisha et al., 2017, who use distance to a commercial bank as an IV for the endogenous variable, use of credit, and the dependent variable, consumption of calories and the FCS, as measures of food security. Having access to savings or credit or a commercial bank, while influencing a household's choice to use savings or credit as a coping strategy, does not directly impact the dependent variables, estimated consumption of calories, micronutrients, and the FCS.

Therefore, variables used as instruments in the empirical analysis of this article satisfy the exclusion restriction. That is, IVs used do not directly influence the outcome variable, but the effect on nutrition is due to the impact of the choice of coping strategy, and not the instrument.

To further assess whether instruments qualify for inclusion, we conduct tests for under-identification and weak identification (Kaufmann et al., 2019). Results are reported in table 3. Instruments are included in first-stage regressions but excluded from second stage regressions.

In both stages of the 2SLS procedure, the endogenous variable should be continuous and first-stage regressions should be carried out using the ordinary least squares (OLS) estimator (Angrist and Pischke, 2009). Implementation of first-stage regressions, using anything other than OLS estimation, will result in first-stage residuals present within the error term that are correlated with covariates and fitted values (Angrist and Pischke, 2009). If the predicted values obtained from first-stage regressions carried out using non-linear models are applied to the second-stage regressions of 2SLS models, this becomes a 'Forbidden regression' (Angrist and Pischke, 2009). Therefore, due to the binary nature of the coping strategy variable and the decision to use a panel fixed effects model[3], a modified 2SLS procedure, as outlined by equation 1-3, is utilised.

3.1.1 Conditional logistic regression: Determining fitted values of the variable identifying whether the household chooses to utilise savings or acquire credit in response to shocks.

$$\mathrm{D_{it}} = \beta \mathrm{negrain_{rt}} + \mu \mathrm{postemp_{rt}} + \pi \mathrm{c_{it}} + \delta \mathrm{h_{rt}} + \varphi \mathrm{Z_{it}} + \varepsilon_{\mathrm{it}} \tag{1}$$

The subscripts *i* and *r* denote household and region level data, while *t* indicates that this variable varies through time. D represents the choice of coping strategy, which is potentially endogenous. This dependent variable is regressed on the control covariates. The coefficients β, μ, π, and δ, capture the vectors of parameter estimates for negrain, postemp, c, and h, which respectively reflect shock variables, socioeconomic and farm-specific variables, as well as climatic variables.

negrain$_{rt}$ and *postemp*$_{rt}$, represent dummy variables indicating whether the household is located in a district exposed to unusually low levels of rainfall or unusually high temperatures. *c* is a vector denoting household socio-economic and farm-specific characteristics. These include household size, the share of household members who are adults and share of females, and education of the household head, an index of wealth, annual household income from crop sales. Also included within this specification are the distance to the nearest road, as well as the number of SSNs the household has received assistance from in the past 12 months. Farm specific characteristics refer to crop and livestock diversity.

The vector *h* captures climatic variables, such as average monthly precipitation, and temperatures during the rainy season, elevation, and soil nutrient availability. The IV variables, access to credit and access to a bank, are represented by Z. ε_{it} represents the composite error term.

3.1.2 First-stage regressions: Identifying the factors associated with the choice to implement savings or credit-based strategies using the fixed effects estimator.

$$D_{it} = \beta negrain_{rt} + \mu postemp_{rt} + \pi c_{it} + \delta h_{rt} + \varphi Z_{it} + \phi \widehat{D}_{it} + \varepsilon_{it} \quad (2)$$

Nonlinear fitted values from the logit first-stage, captured by $\widehat{D}$ are used as instruments for first-stage regressions carried out as part of the conventional 2SLS procedure. The instruments, Z, are included in first stage regressions but excluded from second stage 2SLS regressions.

3.1.3 Second-stage regressions: Assessing the impact of savings or credit strategies in response to shocks on food and nutrition security using the fixed effects estimator.

$$y_{it}^{m} = \beta negrain_{rt} + \mu posrain_{rt} + \pi c_{it} + \delta h_{rt} + \rho \widetilde{D}_{it} + \varepsilon_{it} \quad (3)$$

The dependent variable captures, in eight distinct regressions indexed by superscript *m*, estimates of calories, iron, zinc, vitamin A, B2, folate, and B12 per adult male equivalent per day, as well as the FCS. The inverse hyperbolic sine transformation of all nutritional variables is included as the dependent variables in each regression[4]. Predicted values from first-stage regressions, outlined by $\widetilde{D}$, are inputted into the second-stage regressions to replace the variable signifying choice of coping strategy. In this second step of the modified 2SLS model, the impact of consumption strategies on the nutritional outcomes used in this article is determined.

2.2 Identification strategy

The estimation strategy, described above, aims to disentangle the impact of shocks and the coping strategy used to respond to such shocks, on food and nutrition security. Yet, before making any assumptions regarding the causality of estimation results, the sources of statistical endogeneity must be addressed by the identification strategy.

Endogeneity, as a result of unobserved heterogeneity, may be present due to self-selection bias, as households self-select certain coping strategies over others. This choice may be based on unobservable characteristics, that are omitted from the analysis, but contained within the error term and are correlated with independent and coping strategy variables (Heckman, 1979; Antonakis et al., 2010; Clougherty et al., 2016).

Some unobservable or omitted variables influencing the choice of the coping strategy will also impact food and nutrition security (Ansah et al., 2021). For example, coping strategies adopted by food-secure households are likely to be ex-ante, i.e., undertaken prior to the shock, which will increase the resilience capability of households in comparison to food-insecure households (Ansah et al., 2021). Estimations carried out using the 2SLS procedure with IVs will produce consistent coefficient estimates, as the part of the endogenous variable uncorrelated with omitted variables is captured (Angrist and Krueger, 2001). Thus, showing the causal impact of the choice to use savings or obtain credit as a shock response on nutrient consumption. The use of the fixed effects estimator will also reduce bias from unobserved heterogeneity, due to the time-invariant regressors.

The second source of endogeneity refers to reverse causality. Households who save are better able to smooth consumption when shocks occur, as they have an increased ability to generate assets and income (Ansah et al., 2019). In turn, being food secure promotes better health and an increased ability to work, thus leading to increased income and assets to enable households to cope with shocks. Furthermore, as described above, food-secure households may adopt more ex-ante coping strategies and are not as reliant upon ex-post coping responses (Ansah et al., 2021). Therefore, while the choice of coping strategy influences food security, food security may also impact the strategy chosen, and thus lead to reverse causality.

The third source of endogeneity is attributed to measurement error. Coping strategy variables are based on the strategies households used in response to shocks. Variables are therefore subjective measures, and subject to bias, as they are reliant upon a respondent's perception of shocks. For example, one individual may perceive themselves as experiencing a rainfall shock, yet another experiencing the same conditions, may not. Other potential sources of measurement error may arise from estimated amounts of calories and micronutrients per adult equivalent, as well as the FCS. Food consumption data has been obtained from self-reported measures, and individualised consumption has been estimated from household-level data, not accurately measured.

The use of fixed effects can also control for endogeneity attributed to the measurement error within variables estimating nutritional status and those indicating the choice of coping strategy. Biases are likely to be systemic, i.e., the same individual will make the same error in all survey waves. Therefore, the use of individual fixed effects will remove the component of the error term resulting from this form of measurement error (Collischon et al., 2020).

Robust standard errors clustered by household ID are also used to ensure models are robust to cluster correlation and heteroskedasticity, to prevent an underestimation of standard error and an overestimation of statistical significance (Cameron and Trivedi, 2010, Cameron and Miller, 2015). A multidimensional outlier detection analysis, based on the Mahalanobis distances, was also conducted to identify, and exclude observations with very high or low values (Weber, 2010; Billor et al., 2000).

3. Data sources and variables

4.1 Data sources

The dataset used for the empirical analyses in this paper has been constructed from two sources. Household food consumption data, socioeconomic variables, farm, and village specific characteristics, as well as information on the household's response to shocks, were obtained from three waves (2010/11, 2013, 2016/17) of the Integrated Household Panel Survey (IHPS) in Malawi. The IHPS is a nationally representative sample of Malawian households and is conducted by the National Statistical Office Malawi in conjunction with the World Bank and is part of the Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) (National Statistical Office Malawi, 2017). Analyses used in this article use an unbalanced panel dataset of 4,049 observations from 1,654 households.

Weather variables have been constructed using data from the Climatic Research Unit (CRU) TSv4 dataset, which provide monthly precipitation and average monthly near-surface temperatures on a 0.5° latitude by 0.5° longitude grid (Harris et al., 2020). Using GPS coordinates, provided by the IHPS, each of the 31 districts in Malawi were matched to the nearest grid.

4.2 Variable construction

4.2.1 Coping strategy variables

Survey modules from the IHPS asked respondents to rank the three most significant shocks they experienced in the 12 months prior to data collection and list up to three coping strategies they used to regain their former welfare level. Shocks include rainfall, earthquakes, crop pests, livestock disease, economic shocks, including, high food prices, end of assistance aid, reduction or loss of earnings or employment, low price of agricultural output, the high price of agri-inputs, illness, death, birth, household breakup, theft, conflict, or violence.

4.2.2 Estimates of nutrient consumption

Food security variables in this paper, include calories, the micronutrients iron, zinc, vitamin A, B12, folate and B12 per adult male equivalent, as well as the household FCS. To estimate nutrient consumption, quantities of 116 food items, covering 10 food categories, consumed within the household in the seven days prior to data collection were reported for the entire household in the IHPS modules. Food categories include cereals and grains, roots and tubers, nuts and pulses, vegetables, meat, fish, and animal products, fruit, milk and milk products, sugar and fats, spices and miscellaneous, and beverages. Analyses do not consider food consumed outside of the home, such as takeaway items.

Food amounts were converted to their gram equivalent, and the edible content of food items was determined using values obtained from Joy et al., 2015 and the IHPS research team. Amounts of calories and micronutrients consumed were estimated using food composition tables for Malawi and West Africa, which record quantities of nutrients present in 100g of the edible food content of the food item (MAFOODS, 2019; Stadlmayr et al., 2012). The quantity of nutrients present per gram for each food item were obtained from the food composition tables by dividing stated values by 100. Amounts of nutrients present in 1g were then multiplied by the weight of the food item in grams to determine the nutritional content in the stated amount of each specific food item.

Once quantities of nutrients consumed in one week by all household members were determined, values were divided by seven to deduce values per day. Following the methodology proposed by Smith and Subandoro, 2007, consumption of nutrients for each household member were then estimated from household-level data, using adult male equivalents. Using energy requirements provided by the Joint FAO/WHO/UNU Expert Consultation (UNU et al., 2004), for each age-sex category, values are divided by the energy requirement for a 30-60-year-old male completing moderate physical activity (3000 kcal/day) to derive the adult equivalent. Appendix table A.1 presents energy requirements and adult equivalents for each age-sex category. The number of individuals within each category are totalled and multiplied by the adult equivalent factor. Individual adult equivalents are summed to determine the household's total number of adult equivalent factors. Finally, estimates of daily household consumption of macro-and micronutrients are divided by the household adult equivalent factor to estimate individualised consumption.

In addition, consumption per capita was also determined by dividing household consumption by the number of household members. Values are reported in appendix table A.2. Due to the implausibility of reported amounts, observations reporting estimated consumption of calories to be less than 200 calories or greater than 8,000 calories per capita per day were excluded from the analysis (Gilbert et al., 2020).

The FCS is a household measure of diet diversity and the nutritional quality of food consumed (Dedehouanou and McPeak, 2020). This indicator is constructed based on the number of food groups consumed in one week (WFP, 2008). These include main staples, pulses, vegetables, fruit, vegetables, meat/fish, milk, sugar, and oil. Each weight is then multiplied by the consumption frequency, i.e., the number of days in the week these food groups were consumed by anyone in the household, and summed to generate the household FCS (WFP, 2008). Households with a higher FCS reflect increased food and nutrition security.

4.2.3 Socioeconomic variables

Wealth indices were generated using principal component analysis (PCA), using procedures outlined by Gezie et al., 2019. Choice and coding of variables to be included for analysis was guided by World Food Programme (WFP) and Demographic and Health Surveys (DHS) methodologies (Rutstein, 2015; Hjelm et al., 2017).

Variables denoting whether the household has access to drinking water from safe sources, such as water that is piped into the dwelling, borehole or protected well, whether the toilet facility is shared, as well as the number of household members sleeping per room were included in the PCA. Additionally, variables identifying household ownership of durable assets, including a mobile phone, bed, wireless radio, bicycle, or clock, land tenure, land area in acres, and ownership of goats, pigs, chickens, and other poultry were also included.

Variables scoring a Kaiser-Meyer-Olkin (KMO) statistic greater than or equal to 0.5 were acceptable for inclusion (Kaiser, 1970). Bartlett test statistics are significant for each indicator, reflecting variables are correlated with each other and are suitable to be included for factor analysis (Bartlett, 1951). Factor loadings, KMO, and Bartlett statistics are summarised in appendix table A.3.

Wealth indices are included as a measure of socioeconomic status, as captured by household assets and utilities (Mutisya et al., 2015; Lukwa et al., 2020). The wealth index is also correlated with food and nutrition, with poorer households facing greater food insecurity, and rates of child stunting (Mutisya et al, 2015; Hjelm et al., 2016; Lukwa et al., 2020). Subjective assessment of own wealth is also included as an additional measure of wealth.

The number of assets owned by the household is an important consideration for resiliency, as assets can be used to generate income and act as a buffer against shocks (Smith and Frankenberger, 2018). Assets include implements, such as hand hoe, slasher, axe, sprayer, panga knife, sickle, treadle pump and watering can, machinery such as ox cart, ox plough, tractor, tractor plough, ridger, cultivator, generator, motorised pump, and grain mill, and structures, such as a chicken house, livestock kraal, poultry kraal, storage house, granary, barn, and pigsty.

Education of the household head, defined in this paper by a dummy variable differentiating households where the head has attended school or not, have been included as a measure of human capital. Variables indicating the gender of the household head are incorporated to control for the differences in food security among males and females (Tibesigwa et al., 2016). Household size, as represented by the number of people living within the household, are included as increasing household size is associated with reduced food and nutrition security (Mango et al., 2014; Ahmed et al., 2017). The proportion of adults living in the household is included as a proxy to capture the number of economically active household members and the ability to participate in off-farm employment.

The number of programs the household has received assistance from in the last 12 months has been included as a measure of the social safety nets (SSN) utilized by the household. SSNs are fundamental in promoting resilience to shocks and reducing vulnerability to food insecurity through stabilizing and rising incomes (Devereux, 2016; d'Errico and Di Giuseppe, 2018). SSN programs examined in the IHPS modules include free food and maize, MASAF, food/cash/inputs for work, school feeding programme, targeted nutrition programmes for children and mothers, supplementary feeding for malnourished children, scholarships/ bursaries for education, direct cash transfers from government, development partners or NGOs.

A household’s distance to the nearest market is used as a proxy to capture market accessibility (Ahmed et al., 2017). Increased access to markets is linked with increased agricultural income and diet quality (Kihiu and Amuakwa-Mensah, 2021). Distance to the nearest population centre of more than 20,000 people indicates whether households live in an urban or rural location. This variable is important to include in models to control for the differences in food security among populations living in urban and rural areas (Abegaz, 2017).

4.2.4 Farm specific characteristics

Adjusted annual crop income has been included as increasing farm income is associated with greater consumption of calories and micronutrients (Van den Broeck et al., 2021). Monetary values are expressed in Malawian Kwacha (MK) and have been adjusted to account for inflation using the Consumer Price Index (CPI) for Malawi. Crop and livestock diversity represents the number of different crop and livestock species grown or produced by the farm. Variables capture farm production diversity, which is associated with increased dietary quality and the consumption of nutrient-dense foods, such as fruits, vegetables, and legumes (Jones et al., 2014).

4.2.5 Weather and climatic variables

As a result of relatively high elevation, the climate in Malawi is characterised by cooler temperatures than would be expected for other countries at the same latitude (Arndt et al., 2014). Therefore, the models used in this paper also incorporate elevation, as additional climate controls. Furthermore, the soil nutrient availability captures soil texture, pH, and organic carbon content (Fischer et al., 2008) and are included to control for bio-physical sensitivity to extreme weather events (Asfaw et al., 2014).

Regressions solely including precipitation to measure the impacts of climate change, may suffer from omitted variable bias, due to the correlation between rainfall and temperature

(Auffhammer et al., 2013; Bozzola and Smale, 2020). In these instances, coefficients will capture the impact of both temperature and rainfall (Auffhammer et al., 2013). Therefore, to address omitted variable bias, models include both average monthly precipitation (mm) and temperature (°C) during the rainy season in the 30 years prior to the year of data collection.

In addition, using 30 years of precipitation and temperature data preceding the year of data collection, standardized z-scores were generated to measure the standard deviations (SD) monthly observations of rainfall and average temperature varied from the mean for each district (Haile et al., 2018; Carrillo, 2019; Nübler et al., 2020). Based on this, dummy shock variables were derived, if at least once during the 12 months prior to data collection, they experienced, unusually high rainfall or temperatures. A higher rainfall or temperature shock is defined by average monthly precipitation or temperatures one or more SD above the long-term average and a negative shock as having an SD equal to or below minus one (Haile et al., 2018).

Definitions for all variables are outlined in table 1.

Table 1. Variable definitions.

Variable	Description
Household coping strategy	
Use of savings/credit	Relying on own savings or obtaining credit in response to shocks.
Instrumental variables (IVs)	
Access to savings or credit	Dummy variable indicating whether households within a community have access to savings or credit cooperatives (1=yes, 0= otherwise).
Access to bank	Dummy variable indicating whether households within a community have access to a commercial bank (1=yes, 0=otherwise).
Shock variables	
Negative rainfall shock	Households are in a district where monthly precipitation (mm) fell one standard deviation below the long-term average at

	least once in the 12 months prior to data collection (1=yes, 0=otherwise).
Positive temperature shock	Households are in a district where monthly near surface temperature (°C) rose one standard deviation above the long-term average at least once in the 12 months prior to data collection (1=yes, 0=otherwise).
<u>Household specific socioeconomic variables</u>	
Household (HH) size	Number of people living in the household.
Education HH head	Dummy variable indicating whether the household head has ever attended school (1=yes, 0= otherwise).
Female-headed HH	Gender of household head (1=female, 0=otherwise).
Share of adults	Share of household members who are adults aged 15-65 years.
Safety nets (no.)	Number of programs the household has received assistance from in the last 12 months.
Distance to population centre (KM)	Household distance to the nearest population centre of more than 20,000 people in kilometres (KM).
Distance to market (KM)	Household distance to the nearest weekly market in kilometres (KM).
Wealth index	Indicator of socio-economic status and reflects ownership of a range of durable assets, household utilities, as well as land and livestock ownership.
Self-wellbeing	Subjective assessment of well-being, based on respondents' valuation of household wealth on a scale of 1 to 6 (1=poor, 6=rich).
Productive assets (no.)	Number of productive assets.
<u>Farm specific variables</u>	
Adjusted annual crop income (MK)	Adjusted income from crop sales during the rainy and dry seasons.
Livestock diversity (no.)	Number of different livestock species (cattle, goat, sheep, pig, donkey or mule, chickens, and other poultry) owned by the household.
Crop diversity (no.)	Number of crop types grown by the household in the rainy and dry seasons.
<u>Climatic variables</u>	
Average monthly precipitation (mm)	Average monthly rainfall during the rainy season (November-April).
Average monthly temperature (°C)	Average monthly temperature during the rainy season (November-April).

Elevation (m)	Average elevation in meters (m) within a one-kilometre block.
Soil nutrient availability	Soil nutrient availability, scale 1-4, 5-7. (1=no or slight constraint, 2=moderate constraint, 3= severe constraint, and 4= very severe constraint, 5= mainly non-soil, 6=permafrost area, 7=water).

4.3 *Descriptive statistics*

Descriptive statistics for independent and explanatory variables are provided in table 2.

Table 2. Descriptive statistics.

Variable	Mean	Std. Dev	Min	Max
Calories (kcal)	3032.32	1574.54	224.66	12791.69
Iron (mg)	100.65	89.90	4.75	1353.30
Zinc (mg)	20.15	12.15	1.21	152.45
Vitamin A (μg)	501.66	475.69	0.00	6038.63
Vitamin B2 (mg)	457.12	344.21	26.46	8456.36
Folate (μg)	5.99	10.33	0.00	148.35
Vitamin B12 (μg)	149.70	155.41	0.00	3512.77
FCS	53.27	19.32	6.50	112.00
Use of savings/credit	0.55	0.50	0.00	1.00
Access to savings or credit	0.33	0.47	0.00	1.00
Access to bank	0.11	0.31	0.00	1.00
Negative rainfall shock	0.35	0.48	0.00	1.00
Positive temperature shock	0.37	0.48	0.00	1.00
Household (HH) size	5.09	2.28	1.00	21.00
Education HH head	0.84	0.36	0.00	1.00
Female-headed HH	0.24	0.43	0.00	1.00
Share of adults	0.54	0.23	0.00	1.00
Safety nets (no.)	0.49	0.82	0.00	5.00
Distance to pop. Centre (KM)	29.43	19.92	0.00	99.00
Distance to market (KM)	4.72	5.87	0.00	37.00
Wealth index	3.00	1.41	1.00	5.00
Self-wellbeing	2.08	0.94	1.00	6.00
Productive assets (no.)	3.26	2.22	0.00	20.00
Adjusted annual crop income (MK)	214.82	2986.26	0.00	162676.50
Livestock diversity (no.)	0.78	0.945	0.00	5.00
Crop diversity (no.)	2.98	2.71	0.00	21.00
Average monthly precipitation (mm)	148.65	11.89	126.03	173.65
Average monthly temperature (°C)	23.95	1.31	19.76	27.48

Elevation (m)	893.82	315.59	40.00	1710.00
Soil nutrient availability	1.65	1.48	1.00	7.00

Notes: Number of observations, 4,049.

4. Results and discussion

To attempt to make a causal statement about the impact of different coping strategies on our nutrition variables of interest, we turn to our 2SLS results. Results have also been estimated using the pooled ordinary least squares (OLS) estimator, see appendix table A.4. Conditional logistic regression estimation results determining fitted values of coping strategy variables are reported in appendix table A.5.

To test the validity of instruments, the Kleibergen-Paap rk Lagrange multiplier (LM) is used to test for under-identification (Kleibergen and Paap, 2006). The results reported in table 3, reject the null hypothesis, that instruments are under-identified.

First-stage regressions with an F-statistic greater than 10, suggests instruments are not weak (Staiger and Stock, 1997). Yet, to formally detect weak instruments, when errors are assumed to be independent and identically distributed (i.i.d.), the Cragg-Donald Wald statistic must be used (Stock and Yogo, 2005). However, as the i.i.d. assumption is violated, due to the inclusion of robust standard errors, the Kleibergen-Paap Wald rk F statistic must, therefore, be used instead. To reject the null, that instruments are weak, the Kleibergen-Paap Wald rk F statistic must be above the 5% critical value of 13.91. Therefore, as the F-statistic reported is 15.7, the null can be rejected, and instruments are assumed to be appropriate.

Table 3 shows, as expected, that our instrumental variables, access to a bank and access to credit, are positively associated with the choice to utilise savings or obtain credit to cope with shocks. This is consistent with findings from DeLoach and Smith-Lin, 2018, who concluded that access to formal credit increases a household's capacity to borrow. Additionally, DeLoach and Smith-Lin, 2018, also determined, access to formal savings, increases the ability of households to utilise their savings to cope with health shocks. Gertler et al., 2009, further support our findings, as they observed, households with increased proximity to formal banks, have a better ability to generate savings in which to rely upon to mitigate against the impact of shocks.

Furthermore, studies assessing the impact of health shocks on household income, noted membership to savings and credit cooperatives enabled households to smooth consumption through an increased ability to borrow. Thus, preventing a loss of income in response to such shocks (Kansiime et al., 2021). Access to savings and credit cooperatives increases the probability households will borrow in response to weather shocks (Akampumuza and Matsuda, 2017). Such groups appear to act to aid households to obtain finance to cope with weather shocks, such as drought (Demont, 2020).

Household size, the share of adult members, education of the household head, number of safety nets utilised by the households, crop income, self-wellbeing, and the number of productive assets owned and average rainfall and temperature in the rainy season are positively associated with the choice of coping strategy.

The size of the household may have an impact on the ability of agricultural households to generate income from farming, as households with a larger number of members, will have increased human capital and labour potential (Hussain et al., 2020). Additionally, households with a greater proportion of economically active members aged 15-64 years, will also have greater levels of human capital and income (Abafita and Kim, 2014). Furthermore, as the age of household members increases, so too does savings (Zwane et al., 2016). Consequently, larger households and those with more adult members may have a greater capacity to generate incomes and save, and therefore, be more likely to utilise savings and credit when shocks occur.

In contrast to weather shock variables, which reflect incidences of unusual rainfall or temperatures, average temperature capture changes in climate over the past 30 years. Weather shocks are based on the previous year and may be transitory in nature, however, if farmers perceive changes in temperature over a sustained period, these shocks become permanent. When shocks are permanent, households can anticipate their occurrence and redistribute resources before the shock to smooth consumption (DeLoach and Smith-Lin, 2018).

Households may engage in precautionary savings as an ex-ante coping strategy to shocks, which allows households to self-insurance and cope with risk (Dercon, 2002; Gao and Mills, 2018). This precautionary savings approach allows risk-averse individuals, to mitigate against high-risk situations, such as exposure to climate extremes, by saving more in good years and diminish savings in bad years (Deaton, 1991; Dercon, 2002). Therefore, helping to explain why average temperatures were linked with a greater likelihood of households engaging in savings and credit strategies when shocks occur.

The education of the household head is a measure of human capital, while the number of safety nets utilised by households captures social capital, and the number of productive assets owned infers the physical capital of the household. Households with increased, human, social, and physical capital have more accessibility to financial institutions and will, therefore, have a better ability to obtain credit and save (Zeller and Sharma, 2000). Thus, explaining the association between these variables and whether households obtain credit or deplete savings in response to shocks.

Households with higher incomes from crop sales, and those reporting to be of a higher wealth status reflect that these households are wealthier in comparison to others. Therefore, results suggest wealthier households have a better capacity to save and access credit to allow themselves to insure against shocks. This is comparable with Udry, 1990, Jalan and Ravallion, 1999, Islam and Maitra, 2012, Prina, 2015. Wealthier households are also more likely to save, even when access to bank accounts is equal (Dupas and Robinson, 2013).

Increasing distance to the nearest weekly market is linked with an increased likelihood, households would respond to shocks by relying upon savings and credit as a coping strategy. This is an unexpected finding, as increasing distance to markets is associated with reduced income (Kihiu and Amuakwa-Mensah, 2021), which may constitute an additional barrier that may reduce a household's ability to save or obtain credit. Further analyses may allow for a better understanding of the effect of market access on the choice of coping strategy.

Regression results also reveal more rural households, as captured by the distance to the nearest population centre, were linked with a reduced likelihood of utilising savings and credit when shocks occur. Findings are comparable to Nikoloski et al., 2017, who found, while depletion of savings was the most widely used strategy, poorer or more rural households, with a limited ability to save, adopted other practices, such as asset depletion.

This may be explained by the inaccessibility of financial institutions, such as commercial banks, in many developing countries, which are often lacking and they inhibit the ability of poorer, more rural households to save and obtain credit from formal organisations (Besley, 1995; Morduch, 1999; Islam and Maitra, 2012). Therefore, in the absence of functioning markets and public safety nets provided by the state, households will self-insure and utilise informal insurance strategies, such as depleting assets (Morduch, 1999).

First-stage regressions also identify periods of lower rainfall and higher temperatures to be negatively correlated with a household's choice to utilise savings or obtain credit to diminish the impact of shocks. These findings are also supported by the literature, which suggests, when incomes, especially, from agriculture are uncertain, e.g., due to weather shocks and when credit markets are incomplete and cause borrowing constraints, households accumulate and sell livestock to act as an economics buffer to cope (Rosenzweig and Wolpin, 1993). This form of self-insurance has also been noted by Fafchamps et al., 1998, Zimmerman and Carter, 2003, Alary et al., 2014, Hänke and Barkmann, 2017. In addition, this may also illustrate why increased livestock diversity is linked with a reduced likelihood of households responding to shocks by using savings and acquiring credit.

Increases in the elevation in which the household is located were correlated with a decrease in the number of households depending on savings and credit as a shock mitigation strategy. The climate in areas of higher elevation is characterised by cooler than anticipated temperatures, which may offer protection against the impacts of climate change if households choose to implement adaptation measures (Arndt et al., 2014). As climate change causes average temperatures to increase, heat-sensitive crops, currently grown at lower elevations may be grown at higher elevations, where temperatures are cooler (Arndt et al., 2014). Thus, reducing the vulnerability of households to shocks and decreasing the need to use savings and credit as a coping response.

Table 3. Fixed effect IV estimation results – first-stage regressions.

	Use of savings/credit
Access to savings or credit	0.261***
	[0.048]
Access to bank	0.448***
	[0.084]
Predicted values (eq. 12)	-1.304***
	[0.312]
Neg. rainfall shock	-0.073***
	[0.023]
Pos. temperature shock	-0.599***
	[0.126]
HH size	0.051***
	[0.012]
Education HH head	0.183***
	[0.050]
Female-headed HH	-0.032
	[0.045]
Share of adults	0.287***

	[0.082]
Safety nets	0.126***
	[0.025]
Distance to pop. Centre	-0.008***
	[0.002]
Distance to market	0.006***
	[0.002]
Wealth index	0.003
	[0.014]
Crop income	5.27e-06 ***
	[1.69e-06]
Self-wellbeing	0.084***
	[0.020]
Productive assets	0.020**
	[0.008]
Crop diversity	0.007
	[0.006]
Livestock diversity	-0.043**
	[0.019]
Average monthly precipitation	0.004
	[0.003]
Average monthly temperature	0.123***
	[0.043]
Elevation	-0.0003**
	[0.0001]
Soil Nutrient availability	-0.032
	[0.024]
R2	0.07
Observations	4,049
Number of households	1,654
Kleibergen-Paap Wald rk first stage F statistics for weak identification	15.69
Kleibergen-Paap rk LM first-stage Chi Squared statistics of underidentification	Chi-sq(3)=42.215, p-val=0.000

Notes: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Second-stage 2SLS regressions are reported in table 4. Results reveal the impact of utilising own savings or credit on food and nutrition security are diverse. Households using this strategy to regain their former welfare level are associated with the FCS declining by 96%, however, estimated consumption of vitamin A per adult male equivalent per day increased by 55%.

The literature mostly focuses on the impact of shocks on food and nutrition security and refer to the use of coping strategies utilised by households through descriptive analysis. Therefore, there are few studies to directly compare to the findings presented in this article. Ansah et al., 2021, is one study closely related to the methodologies applied in this article to assess the effectiveness of coping strategies on food and nutrition security outcomes in the presence of endogeneity.

Consistent with the results from 2SLS estimations, they also find households experiencing shocks and choosing to rely on savings as a means to cope, face increased food insecurity, as captured by a declining FCS. In addition, utilisation of savings to cope with health shocks is also correlated with decreases in the Household Dietary Diversity Score (HDDS) (Ansah et al., 2021). The HDDS captures the dietary diversity of the households and is closely related to the FCS with reductions in the HDDS indicative of poorer food security (Maxwell et al., 2014).

Heltberg and Lund, 2009, also find the effectiveness of savings and credit-based coping strategies to be inadequate to protect households from food scarcities and do not aid households regain their former welfare level when they experience health shocks. In addition, Akampumuza et al., 2020, also determine borrowing does not prevent a decline in food consumption when weather shocks occur.

In general, when shocks occur, especially weather shocks, such as drought, diets become less diverse, as evidenced by reduced consumption of fruit, vegetables, pulses, and animal-based products (Carpena, 2019). Due to cereals, being a lower-cost source of energy, in comparison to other food groups, such as meat and vegetables, households attempt to preserve current consumption through continued reliance on cereals (Carpena, 2019). Ecker and Qaim, 2011, further support this interpretation, as they find similar trends when households are exposed to price shocks.

Furthermore, increased consumption of cereals, such as maize, which constitute 54% of calorie intake in Malawi (Minot, 2010), may also increase consumption of vitamin A, due to the fortification of cereal products, such as maize flour with vitamin A (Williams et al., 2021). The association between the use of savings and credit and increased consumption of vitamin A may indicate households are using their savings and credit to purchase cereal-based foodstuffs when shocks occur. Such strategies ensure food consumption is maintained in terms of calorie intake, but results in declining dietary diversity, as captured by the FCS. Thus, helping to explain why decreases in the FCS occur simultaneously to increases in estimated consumption of vitamin A.

In addition, the number of SSNs utilised by the household is also significantly correlated with increased consumption of vitamin A. Williams et al., 2021, highlight the success of assistance programmes, such as targeted nutrition programmes for children and mothers, in reducing levels of vitamin A deficiency in Malawi. Therefore, SSNs may also help explain the increase in estimated consumption of vitamin A.

The type of shock experienced may further help account for the differing effects on food and nutrition security, as utilising savings and obtaining may adequately protect the households from one type of shock, but not others. These conclusions are reinforced by Ansah et al., 2021, who find mobilisation of savings when households face price and pest-related shocks are associated with an increasing FCS and an increasing HDDI when climatic shocks occur.

Further to this, Kansiime et al., 2021, also find membership to SACCOs and village savings and loan associations (VSLAs) limits the negative impacts of income shocks on food consumption. As captured by the food insecurity scale and the frequency in which nutritionally dense foods are consumed. These increases in food security may be attributed to these organisations, as they enable households to increase their savings and access to credit to stimulate investment in agriculture and income generation (Ksoll et al., 2016). Therefore, as analyses in this article assess shocks collectively, this mask the impact of individual shocks, and help interpret the diverse effects on food and nutrition security.

However, it is important to understand the specific context of the study sample. The study sample used by Kansiime et al., 2021, report, on average, 59% of Kenyan households and 64% of households from Uganda were members of savings groups. In contrast, only 33% of households included in the analyses of this article, had access to a savings group, and potentially fewer are members of such institutions. Therefore, the positive impacts of savings on food and nutrition security may be limited among households in Malawi, due to limited access to financial institutions, which inhibit a household's ability to save.

The positive impact of utilising savings or acquiring credit to cope with shocks may also be better explained by whether households obtain credit, and not solely rely upon savings. Twongyirwe et al., 2019, provide evidence to support this conclusion, as they find households with access to credit have better food security status when shocks, such as drought occur. Households experiencing drought may be able to purchase food on credit to maintain current consumption and prevent associated declines in food security (Tora et al., 2021). However, as households with access to credit tend to be wealthier and have more assets to rely upon when shocks occur, the positive impact on nutrition, may not solely be attributed to the role of credit.

Furthermore, for households facing a range of shocks, depletion of own-savings to cope with one may reduce a household's capability to adequately cope with multiple or future shocks (Del Ninno et al., 2016; DeLoach and Smith-Lin, 2018). Consequently, using savings as a form of self-insurance may leave households more vulnerable to further shocks by diminishing their capacity to adequately smooth consumption, thus undermining food and nutrition security.

Table 4. Fixed effect IV estimation results – second-stage regressions.

	Calories (kcal)	Iron (mg)	Zinc (mg)	Vitamin A (μg)	Vitamin B2 (mg)	Folate (μg)	Vitamin B12 (μg)	FCS
Use of savings/credit	0.015	-0.075	0.143	0.554**	0.004	0.283	-0.157	-0.964***
	[0.153]	[0.212]	[0.152]	[0.266]	[0.107]	[0.188]	[0.363]	[0.173]
Neg. rainfall shock	-0.002	0.047	0.053**	0.127***	0.021	0.127***	0.078	0.010
	[0.020]	[0.030]	[0.021]	[0.037]	[0.014]	[0.025]	[0.047]	[0.023]
Pos. temperature shock	0.044	-0.003	0.104	-0.153	-0.007	-0.098	0.027	0.030
	[0.078]	[0.113]	[0.081]	[0.136]	[0.056]	[0.090]	[0.202]	[0.094]
HH size	-0.086***	-0.109***	-0.113***	-0.126***	-0.063***	-0.099***	-0.139***	-0.015
	[0.009]	[0.013]	[0.010]	[0.017]	[0.007]	[0.011]	[0.022]	[0.011]
Education HH head	0.033	0.128**	0.041	0.005	0.037	0.032	0.051	-0.056
	[0.044]	[0.063]	[0.045]	[0.085]	[0.029]	[0.051]	[0.101]	[0.049]
Female-headed HH	0.012	-0.097	-0.072	0.029	-0.022	0.017	-0.275**	-0.092*
	[0.043]	[0.066]	[0.045]	[0.084]	[0.029]	[0.052]	[0.109]	[0.050]
Share of adults	-0.186**	-0.202**	-0.131*	-0.229*	-0.046	-0.197**	-0.075	0.053
	[0.073]	[0.102]	[0.076]	[0.126]	[0.052]	[0.092]	[0.172]	[0.081]
Safety nets	0.016	0.043*	0.013	0.063**	0.015	0.078***	0.050	0.008
	[0.016]	[0.024]	[0.017]	[0.030]	[0.011]	[0.020]	[0.042]	[0.020]
Distance to pop. Centre	-0.002	0.0004	-0.004**	-0.002	-0.003*	-0.001	-0.011***	-0.007***
	[0.002]	[0.003]	[0.002]	[0.004]	[0.001]	[0.003]	[0.004]	[0.003]
Distance to market	-0.009***	-0.006**	-0.009***	-0.005	-0.005***	-0.007**	-0.011**	-0.001
	[0.002]	[0.003]	[0.002]	[0.004]	[0.001]	[0.003]	[0.005]	[0.002]
Wealth index	0.065***	0.039*	0.049***	0.023	0.036***	0.055***	0.116***	0.085***
	[0.0146]	[0.021]	[0.015]	[0.025]	[0.010]	[0.018]	[0.034]	[0.0163]
Crop income	6.96e-07	-6.32e-06***	-3.78e-06**	-5.07e-06	-1.05e-06	-3.66e-06	-8.95e-06**	-1.50e-06
	[1.60e-06]	[1.99e-06]	[1.52e-06]	[1.93e-06]	[1.40e-06]	[3.57e-06]	[3.90e-06]	[1.58e-06]
Self-wellbeing	0.009	0.033	0.007	0.048*	0.006	-0.004	0.067**	0.045***
	[0.014]	[0.020]	[0.014]	[0.026]	[0.010]	[0.017]	[0.034]	[0.016]
Productive assets	0.027***	0.008	0.021***	0.009	0.019***	0.022**	0.043**	0.034***

	[0.007]	[0.011]	[0.008]	[0.015]	[0.005]	[0.009]	[0.018]	[0.009]
Crop diversity	0.007	0.012	0.006	0.014	0.006	0.013*	0.008	-0.006
	[0.005]	[0.008]	[0.006]	[0.011]	[0.004]	[0.007]	[0.014]	[0.006]
Livestock diversity	-0.035*	0.031	-0.003	0.027	-0.005	-0.013	-0.026	-0.057***
	[0.018]	[0.026]	[0.019]	[0.035]	[0.013]	[0.023]	[0.044]	[0.021]
Average monthly precipitation	0.006**	0.008**	0.008***	0.005	0.002	0.003	0.016***	0.010***
	[0.003]	[0.004]	[0.003]	[0.005]	[0.002]	[0.004]	[0.006]	[0.004]
Average monthly temperature	-0.035	-0.071	-0.063	0.102*	-0.050*	0.065	-0.165*	-0.061
	[0.043]	[0.053]	[0.040]	[0.061]	[0.028]	[0.050]	[0.084]	[0.041]
Elevation	8.77e-06	0.0003	0.0001	0.0005*	-2.61e-06	0.0002	0.0002	-0.0001
	[0.0001]	[0.0002]	[0.0002]	[0.0003]	[0.0001]	[0.0002]	[0.0003]	[0.0001]
Soil Nutrient availability	-0.004	-0.063	-0.026	-0.023	-0.003	-0.008	0.003	0.006
	[0.026]	[0.042]	[0.027]	[0.038]	[0.018]	[0.031]	[0.057]	[0.027]
Observations	4,049	4,049	4,049	4,049	4,049	4,049	4,049	4,049
Number of households	1,654	1,654	1,654	1,654	1,654	1,654	1,654	1,654

Notes: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. Regression coefficients reflect a percentage change in the amounts of calories and micronutrients consumed per adult male equivalent per day, as well as the FCS.

5. Conclusions and policy implications

The findings of this article should be interpreted with caution, fully considering the limitations of the data and approach, which will now be discussed. This article is unable to directly assess intakes of calories and micronutrients, as dietary assessment methods, such as 24-hour dietary recall, or food frequency questionnaires are not used. Food consumption is estimated per adult male equivalent and the findings of the paper should be interpreted with this in mind.

In addition, food consumption data is based upon self-reported accounts of foods consumed in one week within the household. Data collected in this manner is subject to response and recall bias, which may lead to an overestimation of food consumption, and a seven-day recall period cannot capture foods consumed infrequently or seasonality of diets (Rosenman et al., 2011; Ecker and Qaim, 2011; Harttgen et al., 2016).

Analyses are also unable to assess the impact of adaptation, which may be the missing component explaining how savings and credit impact food security and the resiliency of the household in response to shocks (Carpena, 2019). Therefore, as Ansah et al., 2021, find the ability of coping strategies to improve food security, is dependent on the type of shock experienced by the household. Consequently, future analyses should assess the effectiveness of coping strategies on specific shock types.

Nevertheless, the findings of this article have important policy implications, especially, as a significant number of households rely upon their savings or obtain credit when shocks occur. In general, results indicate this form of strategy to self-insure against shocks does not fully protect households from declining food and nutrition security when shocks occur. With the exception of estimated consumption of vitamin A, households consume fewer food groups, despite using their savings or obtaining credit to cope when they experience shocks. Findings, therefore, do not support the role of savings or credit to protect households from the adverse effects of shocks on food and nutrition security.

The impact of savings and credit-based coping strategies on the estimated consumption of vitamin A also have relevant policy contributions. Households engaging in this type of coping strategy to cope with shocks consume more vitamin A than households not engaging. This finding is particularly interesting, as deficiencies of vitamin A have historically been of great concern in Malawi, as well as in other developing nations. Between 2000 and 2010, micronutrient surveys in Malawi identified a high prevalence of vitamin A deficiency (National Statistical Office Malawi et al., 2017). Several SSNs also have great emphasis on vitamin A, such as school feeding programmes (Williams et al., 2021).

Households may be using their savings and credit to purchase cereal-based foodstuffs, at the expense of more expensive but nutritious food items, to maintain consumption in terms of calories consumed but not the consumption of micronutrients. However, the successful implementation of national nutritional interventions and programmes enables households to increase their consumption of vitamin A but decreases their FCS and overall food security. Results suggest savings and credit do not enable households to purchase more expensive, better quality food items, in terms of nutritional content, and may promote reliance on lower quality foodstuffs.

Responding to the negative impacts of shocks by obtaining credit through borrowing, may also increase household debt and destabilise food consumption in the future (Khan et al., 2015). Depletion of savings to cope with one shock may also leave the households without the capacity to cope if they are impacted by multiple shocks (DeLoach and Smith-Lin, 2018).

Savings and credit may be used as both an ex-post and an ex-ante coping strategy, however, this article does not differentiate between these two types. The use of savings or credit acquisition may have a better effect on food and nutrition security if used by smallholders to put in place ex-ante coping strategies that simultaneously reduce their vulnerability to climate change and promote food and nutrition security. This contrasts with the use of savings and credit as a reactive strategy to maintain consumption when shocks occur.

Future research needs to determine the way in which savings and credit are being used, i.e., precautionary savings (ex-ante) or used to maintain consumption when shocks occur (ex-post). In addition, future studies should investigate whether consumption behaviours change when households use savings and/or credit to cope when shocks occur. This will be important, as is vital to understand, whether the use of coping strategies enable households to consume food items from a more diverse range of food groups when they experience shocks. Continued exploration of the complex causes and solutions to food insecurity is essential to achieve the SDG of Zero Hunger by 2030.

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Footnotes

[1] A shock is an event experienced by a single household (idiosyncratic) or an entire community (covariate) that outstrips their ability to cope with the effects (Pradhan and Mukherjee, 2018; Niles and Salerno, 2018). Idiosyncratic shocks may refer to illness or death of household members, as well as loss of employment, while covariate shocks include weather shocks, such as drought or flooding, or high food prices.

[2] 33% of observations in the sample have access to a SACCO, and 11% have access to a commercial bank. However, 55% of the sample use their savings or obtain credit to cope with shocks.

[3] The choice of estimation strategy is guided by the binary nature of the variables of interest and the panel nature of the dataset used to conduct empirical analyses. Regressions could also have been estimated using probit models. However, the STATA manual, does not support the implementation of a probit model combining fixed effects, as an adequate statistic enabling the fixed effects to be conditioned out of the likelihood, does not currently exist to facilitate such an analysis (STATA, 2019).

[4] Due to the presence of variables with observations containing zero values, the inverse hyperbolic sine (arcsinh) transformation is taken to approximate the natural logarithm while ensuring observations with zero values are retained (Bellemare and Wichman, 2020). The arcsinh of a variable (x) is calculated using the following procedure: $\text{arcsinh}(x) = \ln(x + \sqrt{x^2 + 1})$.

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Appendices

Table A.1. Adult equivalents by age-sex category.

Age group (yrs)	Calories per day		Adult equivalent factor	
	Male	Female	Male	Female
Infants, young children				
<1	650	600	0.22	0.20
1-2	950	850	0.32	0.28
2-3	1,125	1,050	0.38	0.35
3-4	1,250	1,150	0.42	0.38
4-5	1,350	1,250	0.45	0.42
5-6	1,475	1,325	0.49	0.44
Older children, adolescents				
6-7	1,575	1,425	0.53	0.48
7-8	1,700	1,550	0.57	0.52
8-9	1,825	1,700	0.61	0.57
9-10	1,975	1,850	0.66	0.62
10-11	2,150	2,000	0.72	0.67
11-12	2,350	2,150	0.78	0.72
12-13	2,550	2,275	0.85	0.76
13-14	2,775	2,375	0.93	0.79
14-15	3,000	2,450	1.00	0.82
15-16	3,175	2,500	1.06	0.83
16-17	3,325	2,500	1.11	0.83
17-18	3,400	2,500	1.13	0.83
Adults				
18-30	3,050	2,375	1.02	0.79
30-60	3,000	2,375	1.00	0.79
>60	2,475	2,125	0.83	0.71

Notes: Energy requirements for adults based on a male weighing 65 kilograms and females weighing 55 kilograms undertaking moderate physical activity. Source: Smith and Subandoro, 2007.

Table A.2. Mean consumption of calories and micronutrients per capita per day.

Nutrient	**Mean**	**Std. Dev**	**Min**	**Max**
Calories (kcal)	2275.42	1235.13	203.32	7901.28
Iron (mg)	75.70	70.91	2.72	1069.11
Zinc (mg)	15.17	9.74	0.83	120.44
Vitamin A (μg)	378.48	378.48	378.48	378.48
Vitamin B2 (mg)	0.79	0.54	0.039	10.14
Folate (μg)	342.98	342.98	342.98	342.98
Vitamin B12 (μg)	4.55	4.55	4.55	4.55

Notes: Observations: 4,049.

Table A.3. KMO and Bartlett statistics for variables used to construct indices of wealth.

Variable	**KMO**		
	2010/11	2012/13	2016/17
Wealth Index			
Homeownership (1=owns property)	0.71	0.70	0.72
Roof material (1=strong; iron sheets, tiles)	0.75	0.73	0.76
Floor material (1=strong; cement, tiles)	0.74	0.72	0.79
Water source (1=improved: piped, protected, borehole)	0.58	0.51	0.56
Shared toilet (1=yes)	0.60	0.66	0.61
Mobile phone ownership (1=owns mobile phone)	0.86	0.86	0.86
Number of people sleeping per room (number)	0.84	0.81	0.75
Ownership of bed (1=owns a bed)	0.88	0.84	0.82
Ownership of radio (1=owns a radio)	0.84	0.83	0.82
Ownership of bicycle (1=owns a bicycle)	0.81	0.84	0.81
Ownership of clock (1=owns a clock)	0.89	0.84	0.79
Land tenure (1=owns land)	0.69	0.75	0.73
Area of land owned (ha)	0.57	0.85	0.81
Ownership of goats (1=yes)	0.62	0.69	0.62
Goats owned (number)	0.61	0.68	0.63
Ownership of pigs (1=yes)	0.57	0.54	0.53
Pigs owned (number)	0.56	0.53	0.54
Ownership of chickens/poultry (1=yes)	0.62	0.66	0.61
Chickens owned (number)	0.60	0.66	0.63
Ownership of other poultry (1=yes)	0.56	0.56	0.56
other poultry owned (number)	0.55	0.55	0.56
Overall:	0.68	0.69	0.67
Bartlett test: (chi-square)	4932.97***	8085.35***	7416.15***

Notes: H0: variables are not intercorrelated. *** p<0.01, ** p<0.05, * p<0.1.

Table A.4. OLS estimation results capturing the impact of coping strategies on food and nutrition security.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Calories (kcal)	Iron (mg)	Zinc (mg)	Vitamin A (μg)	Vitamin B2 (mg)	Folate (μg)	Vitamin B12 (μg)	FCS
Use of savings/credit	0.033**	-0.010	0.009	0.013	0.011	0.040**	0.034	-0.039***
	[0.016]	[0.024]	[0.017]	[0.029]	[0.011]	[0.020]	[0.039]	[0.011]
Neg. rainfall shock	-0.031*	0.031	0.003	0.106***	-0.006	0.084***	-0.002	-0.008
	[0.017]	[0.026]	[0.018]	[0.032]	[0.012]	[0.021]	[0.042]	[0.012]
Pos. temperature shock	-0.096***	-0.049	-0.023	-0.081	-0.064***	-0.106***	-0.162**	-0.035
	[0.031]	[0.046]	[0.033]	[0.058]	[0.021]	[0.038]	[0.075]	[0.021]
HH size	-0.087***	-0.103***	-0.104***	-0.123***	-0.061***	-0.103***	-0.112***	-0.010***
	[0.004]	[0.006]	[0.004]	[0.007]	[0.003]	[0.005]	[0.009]	[0.003]
Education HH head	0.090***	0.044	0.076***	0.063	0.065***	0.114***	0.095*	-0.001
	[0.025]	[0.036]	[0.025]	[0.044]	[0.016]	[0.029]	[0.057]	[0.016]
Female-headed HH	-0.007	0.035	-0.018	0.063*	-0.003	0.050**	-0.179***	-0.032**
	[0.020]	[0.030]	[0.021]	[0.038]	[0.014]	[0.024]	[0.048]	[0.014]
Share of adults	-0.146***	-0.145**	-0.109***	-0.146**	-0.040	-0.183***	0.090	-0.008
	[0.038]	[0.057]	[0.040]	[0.069]	[0.028]	[0.047]	[0.096]	[0.026]
Safety nets	0.004	0.032**	0.014	0.078***	0.014**	0.063***	0.034	-0.024***
	[0.011]	[0.014]	[0.010]	[0.020]	[0.007]	[0.012]	[0.024]	[0.007]
Distance to pop. Centre	-0.001***	-0.002***	-0.002***	-0.003***	-0.002***	-0.001**	-0.004***	-0.002***
	[0.0004]	[0.001]	[0 .0005]	[0.001]	[0.0003]	[0.001]	[0.001]	[0.0003]
Distance to market	-0.005***	-0.002	-0.006***	-0.006**	-0.003***	-0.005***	-0.011***	-0.002*
	[0.001]	[0.002]	[0.001]	[0.002]	[0.001]	[0.002]	[0.003]	[0.001]
Wealth index	0.061***	0.058***	0.077***	0.105***	0.048***	0.071***	0.171***	0.101***
	[0.008]	[0.011]	[0.008]	[0.013]	[0.005]	[0.009]	[0.019]	[0.005]
Crop income	5.04e-06***	-1.62e-06	2.28e-06*	-2.15e-06	2.64e-06*	1.58e-06	5.36e-06*	2.30e-07
	[9.94e-07]	[1.26e-06]	[1.21e-06]	[2.31e-06]	[1.45e-06]	[2.03e-06]	[2.78e-06]	[7.08e-07]
Self-wellbeing	0.037***	0.024*	0.024**	0.074***	0.024***	0.025**	0.107***	0.049***
	[0.009]	[0.014]	[0.010]	[0.017]	[0.007]	[0.012]	[0.023]	[0.007]
Productive assets	0.025***	0.011*	0.010**	0.002	0.008***	0.023***	0.020*	0.014***

	[0.004]	[0.007]	[0.005]	[0.009]	[0.003]	[0.006]	[0.011]	[0.003]
Crop diversity	0.011***	0.019***	0.014***	0.015**	0.010***	0.013***	0.025***	-0.003
	[0.003]	[0.005]	[0.004]	[0.006]	[0.002]	[0.004]	[0.009]	[0.002]
Livestock diversity	-0.045***	-0.043***	-0.060***	-0.074***	-0.040***	-0.059***	-0.113***	-0.060***
	[0.011]	[0.016]	[0.011]	[0.021]	[0.008]	[0.013]	[0.027]	[0.008]
Average monthly precipitation	-0.001	0.001	-0.0004	-0.001	-0.001**	-0.004***	-0.003*	-0.001*
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]	[0.001]
Average monthly temperature	0.018	0.015	0.007	-0.008	0.015*	0.008	0.021	-0.008
	[0.013]	[0.018]	[0.013]	[0.024]	[0.009]	[0.015]	[0.029]	[0.008]
Elevation	0.0001***	-0.0001**	-0.00005	0 .0003***	-0.00002	0.0002***	-0.00004	-0.00002
	[0.00003]	[0.00005]	[0 .00003]	[0 .0001]	[0 .00002]	[0.00004]	[0 .0001]	[0 .00002]
Soil Nutrient availability	0.010*	-0.045***	-0.021***	0.008	-0.009**	0.001	-0.024*	0.004
	[0.006]	[0.009]	[0.006]	[0.011]	[0.004]	[0.007]	[0.014]	[0.004]
Constant	8.328***	5.032***	3.818***	6.860***	0.810***	7.072***	1.615**	4.719***
	[0.324]	[0.472]	[0.333]	[0.609]	[0.233]	[0.399]	[0.779]	[0.215]
Observations	4,049	4,049	4,049	4,049	4,049	4,049	4,049	4,049
Number of households	1,654	1,654	1,654	1,654	1,654	1,654	1,654	1,654
R-squared	0.17	0.11	0.21	0.13	0.18	0.17	0.11	0.23

Notes: Robust standard errors in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Regression coefficients reflect a percentage change in the amounts of calories and micronutrients consumed per adult male equivalent per day, as well as the FCS.

Table A.5. Conditional logistic estimation results determining fitted values of coping strategy variables for 2SLS procedures.

	Use of savings or credit
Access to savings or credit	0.364***
	[0.094]
Access to bank	0.606***
	[0.173]
Neg. rainfall shock	-0.101
	[0.086]
Pos. temperature shock	-0.891**
	[0.355]
HH size	0.070*
	[0.036]
Education HH head	0.275*
	[0.165]
Female-headed HH	-0.040
	[0.184]
Share of adults	0.420
	[0.309]
Safety nets	0.174***
	[0.063]
Distance to pop. Centre	-0.012
	[0.008]
Distance to market	0.008
	[0.009]
Wealth index	1.38e-06
	[0.059]
Crop income	0.00001
	[0.0001]
Self-wellbeing	0.114**
	[0.056]
Productive assets	0.028
	[0.031]
Crop diversity	0.010
	[0.025]
Livestock diversity	-0.052
	[0.078]
Average monthly precipitation	0.003
	[0.015]
Average monthly temperature	0.216
	[0.182]
Elevation	-0.0004
	[0.001]
Soil Nutrient availability	-0.046
	[0.095]
Pseudo R2	0.04
Observations	2,538

Number of households	991

Notes: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.