Coping with Negative Shocks and the Role of Farm Input Subsidy Programme in Rural Malawi

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Abstract

This study uses household panel data from the 2010/11 and 2012/13 Malawi's Integrated Household Panel Survey to investigate the mitigating role of farm input subsidy programme (FISP) against the deleterious impacts of negative rainfall shock on households' welfare in rural Malawi. The study finds that Farm Input Subsidy Programme has a cushioning role on the negative impact of rainfall shocks. The use of Farm Input Subsidy Scheme enables rural households to substantially increase their food consumption and overall food security, despite the increasing threat of climate change. The results of this study highlight the importance of agricultural policy such as FISP in rural households' mitigation of weather risk.

Keywords: Agricultural productivity, Farm input subsidy, Food security, Land tenure, Rainfall, Malawi.

JEL Classification: N57; Q12; Q15; Q18

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1 Introduction

A number of countries in sub-Saharan Africa (SSA) are faced with increasing rate of undernourishment and malnourishment due to the aftermath of climate change. Promoting agricultural productivity in order to improve the welfare of the most vulnerable group has been a major public policy issue in these countries in recent years. As evidenced in the Food and Agriculture Organisation – FAO (2017) report, the prevalence of chronic undernourished people in SSA has risen from 20.8 per cent in 2015 to 22.7 per cent in 2016, amounting to 224 million people from 200 million in the previous years, and which accounts for 25 percent of the global number of undernourished people. These statistics is predicted to rise with the increase of extreme-weather related events and rainfall variability.

Many rural dwellers in SSA are smallholder farmers that depend on rainfed agriculture and are mainly at the lower income quantile (Livingston *et al*., 2011). They are likely to be vulnerable to adverse effects of weather-related shocks, and this can lead to poor household's welfare. Hence, a growing number of studies show that the poorest agrarian households are the worst hit by weather shocks (Asfaw and Braun, 2004; Fussel, 2010; Ericksen *et al.*, 2011; Skoufias *et al*., 2011; Levine and Yang, 2014; Asfaw and Maggio, 2018)[4].

Also, these farmers are likely to have limited productivity enhancing technologies, particularly because they are unaffordable due to cost, and the relative high transaction cost (like distance to input market) to even acquire farm inputs could be an additional impediment. Therefore, sustainable agricultural policy for the welfare of smallholders in rural regions of SSA countries should be such that considers both efficient agricultural input supply and the rising weather variability.

[4] The channels through which weather-related shocks affect include crop failures and yields variability. Hence, the study suggests that weather related shocks can potentially affect all aspects of food security through reduction in food access and utilization, and price instability (Challinor *et al*. 2010; IPCC, 2014).

Economic theory provides explanations for the potential role of agricultural programmes in moderating the relationship between weather variability and household's outcomes. First, FISP may increase the efficiency of agricultural inputs for farmers who may have been affected by weather variability in previous seasons (Lunduka *et al.*, 2013; Ricker-Gilbert and Jayne, 2017).

Second, considering that the outcome of FISP is to improve food and cash crop production of vulnerable smallholders in Malawi (Dorward *et al*., 2011), the income from the sale of such production could cushion the negative effect that could stem from weather vulnerability, and the overall household's welfare will be improved.

Third, FISP may increase the strength of social networks in isolated communities through the community of agricultural input retail stores across districts (Kaiyatsa *et al*., 2018; 2019), which could be helpful for risk-sharing among farmers within such districts through mechanisms such as knowledge sharing (among others) to cushion the weather shocks (Maertens and Barrett 2012; Mbugua *et al*., 2019).

The focus of this research on Malawi is motivated by its historical records of weather variability and its being among the 12th most exposed country to the effects of climate change (World Bank, 2010; Chinsinga, 2013). For instance, 'El Niño[5]' event resulted in severe drought in Malawi and led to failed crops for many subsistence farmers (USAID, 2016), which further shows the country's susceptibility to weather shocks.

Further, the structural economic conditions of Malawi further exacerbate the vulnerability of smallholders to weather shocks. For example, its economy is characterized by high dependence on agriculture, which accounts for about 36 to 39 percent of the total economic income, it employs about 80 percent of the total workforce, and contributes about 75 percent to foreign exchange earnings (FAO, 2014). In addition, about 80 percent of the export

[5] This weather 'crisis' occurs when the Pacific Ocean warms and disrupts weather around the globe.

products are of the country's agricultural sector while it also serves as the backbone for national and household food security (Ministry of Agriculture and Food Security, 2010).

However, the country is still lagging in food security and consumption. Malawi currently ranks 105/113 countries in the overall food security index with a respective breakdown of 111, 99 and 92 in the affordability, availability and quality/safety of food categories (Global Food Security Index – GFSI, 2018). These conditions typically explain why food security indices in Malawi may be highly elastic to rainfall shocks.

Against this background, this study uses household panel date from the 2010/11 and 2012/13 Malawi's Integrated Household Panel Survey to investigate the mitigating role of the Malawi's Farm Input Subsidy Programme (FISP) in the nexus between climate variability and household's welfare. Specifically, the objective of this paper is twofold: to examine the impact of rainfall shocks on household welfare and; to investigate the mitigating role of the farm input subsidy scheme in the relationship between weather variability and household's welfare outcomes in rural Malawi[6].

This study is related to a growing literature on the moderating role of agricultural interventions on the effects of weather variability on smallholder households. A few studies such as Kaiyatsa *et al*. (2019), Harou (2018), and Karamba and Winters (2015) have examined the effects of FISP on households' outcomes. However, our study differs from the existing literature as it focuses on the mitigating role of agricultural policy such as FISP on weather shocks and household's outcomes. Our results show that negative rainfall shocks lead to a significant decline in household's welfare. However, households with access to FISP vouchers experience improve welfare compared to households without FISP vouchers.

[6] Food security is commonly defined as a situation when all people, always, have physical, social and economic access to enough, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO 2014).

The remainder of this paper is structured as follows: the context of the study is in the second section while the third section discusses the empirical literature. The fourth section considers the data sources and the empirical strategy. The results and discussion are included in the fifth section while the paper concludes in the sixth section.

2 Farm Input Subsidy in Malawi

Malawi is a landlocked southeastern African country with a population of over 19 million people (World Population Review, 2018). It boasts of two main seasons: the cold-dry and hot-wet seasons and climate temperatures of 14 to 32 degrees Celsius (United Nations, 2014). The country is ranked one of the world's poorest at 170 out of 187, it suffers from low levels of nutrition, and it is vulnerable to weather shocks (United Nations, 2014; World Bank, 2018).

After Malawi's independence in 1964, up to the mid-1980s when the structural adjustment programme (SAP) was introduced, the food security policy was the main guide for agricultural plans and strategies in the country. Following this, a number of policies have evolved over the years, such as the Agriculture and Livestock Development Strategy and Action Plan (ALDSAP) established in 1995; Malawi Agricultural Sector Investment Programme (MASIP) of 1999; the Agricultural Development Programme (ADP) of 2006; the Agricultural Sector Wide Approach (ASWAP) of 2007–2009 and 2010-2015 (Ministry of Agriculture and Food Security, 2010; FAO, 2014).

In 2010, the government decided to establish a policy with the responsibility of harmonising the various agricultural development strategies. This was named the National Agricultural Policy Framework (NAPF), and it was tasked with the responsibility of promoting agricultural productivity and realising national food security, amongst others (FAO, 2014).

Malawi's Farm Input Subsidy Programme (FISP) is an offshoot of the Agricultural Input Subsidy Programme, a small-scale targeted input subsidy programme popularly referred to as the Starter Pack Scheme which was initiated in 1998. The FISP became popular in 2005 after a severe drought attack in the country that led to the programme being augmented from only a few farmers to about 50 percent of the country's farmers, and to over 70 percent of farmers in recent years (Harou, 2018).

The objective of the programme is to enable farmers access improved agricultural inputs which can bring about food self-sufficiency and enhance rural income via higher levels of food and cash crop production (Lunduka *et al*., 2013; Dorwad and Chirwa, 2011), by handing out vouchers and coupons to smallholder farmers who own their farm lands and reside legitimately in their own villages for the purchase of farm input[7] at subsidized rates (Dorward and Chirwa, 2011; Dorward *et al*., 2011; Chibwana and Fisher, 2011; Harou, 2018).

The distributions of the vouchers are carried out at two levels (Ricker-Gilbert and Jayne (2017). First, the fertiliser and seeds are officially allocated to regions and districts based on agricultural cultivation area and the number of smallholders in such locations. Second, at the community-level, the community and the village heads are then involved determine the eligible smallholders. The original allocation strategy for the vouchers targeted smallholders who are full time farmers, and who are unable to purchase at most two bags of fertilizers at the prevailing commercial price in the community as determined by local leaders (Dorward *et al*., 2013). From 2008 onward, the target group was defined as 'vulnerable' group, including resource-poor households, disabled, elderly, female and child-headed households (see Ricker-Gilbert and Jayne, 2017).

The voucher could be used to purchase agricultural inputs at a subsidised price from participating private retail stores, and such retailer would then submit the voucher and receipt to the government for payment. Each smallholder who participates in the FISP is eligible to receive two vouchers used for one 50-kg bag of fertiliser at a discounted price, and for between 5 and 10 kg of improved maize seed (see Ricker-Gilbert and Jayne, 2017).

[7] These include fertilizers for maize production, improved maize seeds, pesticides and tobacco fertilizers.

Existing studies show that since the implementation of the FISP, there has been improvement in agricultural output among smallholder farmers, such that the rise in maize increased from 43 percent deficit in 2005 to 53 percent surplus by 2007 (Chibwana and Fisher, 2011; Harou, 2018). However, due to the declining food insecurity levels in Malawi from about 57 percent in 2004/05 to 42 percent in 2010/11 (Government of Malawi-GOM, 2005; 2012; Sibande *et al*., 2015), and the enormity of FISP[8], there has been criticisms of beneficiaries of FISP adopting poor climate-resilient farming systems such as sustainable land management and crop diversification strategies (see Zulu, 2017).

More so, other criticism of the FISP is the cultural sentiment associated with the distribution of the agricultural input, such that non-beneficiary neighbours could still benefit from the programme (Holden and Lunduka, 2013).

There are some issues about the effectiveness of the targeting system of the FISP, including the frequent exclusion of poor household (Holden and Lunduka, 2013), high administration cost (Lunduka *et al*., 2013), tacit exclusion of female farmers from the programme (Ricker-Gilbert *et al*., 2011; Chibwana *et al*., 2012), consideration of household's wealth and agricultural land holding (Fisher and Kandiwa, 2013; Killic *et al*., 2013). In some other cases, there are instances of elite capture, village leaders reducing the number of coupons per beneficiary household and some villages that are excluded based on egalitarian bias (Holden and Lunduka, 2013). In the light of these issues, there is the need for a better targeting of the FISP based on a random and universal framework for the distribution of coupons. Such efforts will be necessary to ensure that the programme is actually targeting the intended group, which are the rural poor.

[8] As at 2010/2011 period, the programme costs were about US$ 143.57 million and 8 percent of the national budget of Malawi (Ricker-Gilbert and Jayne, 2017).

3 Empirical Literature

This study is related to two strands of literature which are discussed in this section. First, we consider studies that focus on agricultural policies and food security, paying attention to smallholders in Africa. Second, we focus on weather shocks and its impact on smallholders' outcomes.

Considering the first strand, some studies like Daidone *et al.* (2017) highlight the need for agricultural programmes to consider both cash transfers and input programmes for efficient improvement of the outcome of beneficiary farmers. Although the authors focus on welfare outcomes like poverty and hunger, they conclude that the efficiency of such programmes will largely depend on other factors including the prevailing climatic condition.

Further, Sibande *et al*. (2015) also consider a similar agricultural policy in Malawi on both the broad measure of food security, and per capita consumption of smallholder farmers. The authors find a significant improvement in these two outcome variables for smallholders who are beneficiaries of the agricultural input programme. Similar findings are re-echoed in Chirwa and Dorward (2013), Dorward *et al*., (2013) Asfaw *et al*. (2016) and Ricker-Gilbert and Jayne (2017). Malhotra (2015) accounts for the impact of a different programme – National Agriculture Input Voucher Scheme – on smallholders' food security in Tanzania. The author notes that this programme increases farmers' level of food security. However, this impact was noted to be through some important individual characteristics of the smallholders like the educational attainment, among others. For Nigeria, Ayoade *et al*. (2011) find the National Special Programme for Food Security (NSPFS) to be highly effective for poverty reduction, while taking into account the gender dimension to their study.

Finding a positive and significant impact of agricultural related programmes that target farm production efficiency is only logical considering that such programmes facilitate farm productivity by improving planting, reducing farm related cost in farm input acquisition, or even by improving farm processes. However, this is not always the case as studies are beginning to advocate for the consideration of other non-controllable factors that affect the efficiency of agricultural programmes (see Giller *et al*., 2011; Daidone *et al.*, 2017) note that agricultural programmes in Africa have had mixed results due to ecological variability within farming systems in this region. Hence, the need to consider the impact of weather shocks on smallholders' agricultural outcomes.

Weather shocks include those unpredicted natural and environmental occurrences that directly affect farm yield, such as floods, droughts, frost and hailstorms, and can also have significant and severe consequences on agricultural productivity and general household welfare. The literature on this linkage abounds with important evidences from developing countries (Jayanchandran, 2006; Yang and Choi, 2007; Dell *et al.*, 2009; Schlenker and Lobell, 2010; Björkman-Nyqvist, 2013). For instance, Badolo and Kinda (2012), and Benton and Bailey (2015) note that weather variability increases the frequency and severity of devastating impacts on the sufficiency of food production in developing countries.

However, when smallholder farmers become vulnerable to certain weather shocks, studies have noted that having access to some agricultural inputs that can help reduce the impact of such shocks will have beneficial effects on farm performance. With the perceived adverse effect from weather shocks, and the need for farmers' access to some agricultural input, this study is set-up to investigate the shock-cushioning capacity of specific agricultural policy in Malawi – the Farm Input Subsidy Programme – on food security outcomes of smallholder farming households.

4 Data Sources and Empirical Methodology

4.1 Data Sources

This study uses panel data for households provided by the Malawi's Integrated Household Panel Surveys (IHPS) for 2010/11 and 2012/13.[9] The Government of Malawi through the National Statistical Office (NSO) conducted these surveys with support from the World Bank Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) programme.

The IHPS collects detailed demographic and household's characteristics and provides information on rainfall and temperature measures in the geospatial data relating to seasonal variation of weather. Other plot-specific information relating to agricultural productivity includes the topographic and vegetation indicators of household's plot ownership and management.

The 2010/11 wave of the IHPS collected information on 3426 households in the 2009/2010 agricultural years. The 2012/13 wave of the survey collected information on 4000 households and attempted to track and resample all the households and individuals in the previous wave. For 4000 households in the 2012/2013 wave, interviewers were able to track back for a second interview only 3104 households from the original panel subsample (2010/11 wave).

Moreover, about 76.80% of the 3104 households from the 2010/2011 wave did not split over time; 18.49% split into two households; and 4.70% split into three to six households, and the data has an overall attrition rate of only 3.78% at the household level. For our analysis, we

[9] The Malawi IHPS was incorporated into the core Integrated Household Survey (IHS) program to provide information on poverty trends, socioeconomic and agricultural characteristics over time through a longitudinal survey. The IHPS tracked a sub-sample of households (about 204 enumeration areas) from the Third Integrated Household Survey (IHS3) which was implemented between the period of March 2010 and March 2011 to form the IHPS for the period of 2010-2013.

dropped urban households from the sample of the first and second waves respectively. This is because agricultural activities (e.g. farming) in Malawi are predominantly carried out in the rural areas.

4.1.2 Other Sources of Information: Rainfall data

For the rainfall data used in our analysis, we match the household survey data with rainfall data obtained from the National Oceanic and Atmospheric Administration Climate Prediction Centre (NOAA CPC) African Rainfall Estimation Algorithm version 2.0. Seasonal precipitation data gathered from the Malawian meteorological weather stations are used in the interpolation of the global positioning system (GPS) of the surveyed households. These data include annual and wet season precipitation measures respectively, and spatial distribution of households included in the LSMS-ISA survey for Malawi enhances the credibility of the rainfall variation at the Enumeration Area (EA) level.

The measure of rainfall shocks we used for precipitation data was provided by the World Bank (along with the LSMS data). We follow Maccini and Yang (2009), Björkman-Nyqvist (2013), and Rocha and Soares (2015) in constructing rainfall shocks and creating measures of deviations in rainfall from the long-run mean rainfall for an area by constructing rainfall shock in the following ways:

$$Rainshock_{ht-1}=lnR_{ht-1} - \overline{lnR_h} \quad (1)$$

where lnR_{ht-1}indicates the yearly rainfall in household h for the preceding year's planting season and is the average historical yearly rainfall in household h. The average historical yearly rainfall was calculated from 2001 to 2013. Thus, the $Rainshock_{ht-1}$ is the shock measure used for deviation of the natural logarithm of the total rainfall in the 12 months prior to the 2009/2010 and 2012/2013 periods and the natural logarithm of the average yearly historical rainfall in the household h prior to the corresponding years.

The rainfall deviation basically implies a percentage deviation from mean rainfall. However, we use negative shock in the regressions, which is measured as absolute value of deviation if a negative deviation exists between rainfall deviation from the historical norm and 0 if otherwise. We use this rainfall shock definition for the following reasons: (1) to take care of the outlier issue and (2) to easily interpret the result as percentage deviation with reference to the historical rainfall information.

4.1.3 Summary Statistics

For the household welfare measure, we use the following outcomes in our analysis: (i) log. of per capita food expenditure (ii) log. of non-food consumption per capita (iii) log. of total consumption per capita (iv) Food Consumption Score (FCS). We compute a Food Consumption Score (FCS) following the World Food Programme guidelines that captures both dietary diversity and food frequency. It is the weighted sum of the number of days the household consumed foods from eight food categories in the last week. The score is calculated based on the sum of weighted number of days in the last week the household ate food from eight food groups: (2 * number of days of cereals, grains, maize grain/flour, millet, sorghum, flour, bread and pasta, roots, tubers and plantains) + (3 * number of days of nuts and pulses) + (number of days of vegetables) + (4 * number of days of meat, fish, other meat, and eggs) + (number of days of fruits) + (4 * number of days of milk products) + (0.5 * number of days of fats and oils) + (0.5 * number of days of sugar, sugar products, and honey). Spices and condiments are excluded. The maximum value of FCS is 126.

Table 1 presents the summary statistics for the dependent variables used in our analysis. For the two periods used (2010-2013) in the analysis, the average total expenditure, food expenditure and non-food are approximately 4453, 3496 and 485 of Malawian Kwacha respectively.

Also, the average Food Consumption Score reported by the households is 51 out of a maximum score of 126. For the rainfall variable, the 3-year average rainfall across rural households for the periods of our data (2009/10 and 2012/2013) is 822mm and the average historical rainfall (2001- 2012) is 8649mm. The negative rainfall shock is 0.078 (in absolute deviation). Household size is 5 with an average household head age of 44 years.

Table 2 shows mean characteristics by household's receipt of Farm Input Subsidy. More households received the FISP planted crops in the previous season compared to households with the FISP. In terms of the average age of household age, the mean difference shows no statistically significant difference between the recipient of FISP and the non-recipient of FISP. Moreover, households that received FISP reported larger farm size of 2.32 acres compared to household without FISP that reported 1.892 acres. Also, the mean difference shows that 39% of households in communities with public works programme (MASAF) received FISP compared to 46% of households in communities without public works program.

4.2 Empirical Methodology

We adopt an identification strategy similar to Björkman-Nyqvist (2013) and Yang and Choi (2007). We exploit the exogenous variations in seasonal precipitation patterns to investigate the mitigating role of FISP due to negative rainfall shocks on rural households' welfare. We use data on FISP provided by the Malawi's Integrated Panel Survey to investigate whether Malawi's FISP mitigates the impact of negative rainfall shocks on household welfare in rural Malawi. The primary focus of the estimation is to model the interaction of FISP on the relationship between negative rainfall shocks and households' welfare.

The paper analyses negative rainfall shocks, FISP and household welfare nexus by estimating the following equation:

$$Y_{ht} = \delta_t + \emptyset_f NS_{ht-1} + \varphi_f (NS_{ht-1} * FISP_{ht}) + FISP_{ht} + X'_{ht} + \varepsilon_{ht} \quad (2)$$

Where Y_{ht} denotes household welfare measures for household 'h' at time 't', and δ_t represents year fixed effects. Also, parameter $\emptyset$ denotes the direct effect of negative rainfall shocks on household welfare, φ captures our parameter of interest – the interaction of rainfall shocks (NS) and dummy for receipt of farm input subsidy by the household (FISP) - a dummy variable equals to one if a household redeemed at least one input subsidy in the previous planting season and zero if otherwise. Evaluating the relationship between the interactions of coefficient estimates from $\emptyset$ and φ is the underlying basis for equation 2. Lastly, X'_{ht} denotes household and community covariates used in the estimation and ε_{ht} is the error term which is assumed to be normally distributed. The error term is assumed to be independent and identically distributed (iid) between villages, but correlated within enumeration areas; hence, we clustered the standard errors at the enumeration areas for all estimations.

4.2.1 Endogeneity of Households' Receipt of Farm Input Subsidy Programme Voucher

The potential threat to the identification of the mitigating role of the FISP is non-random assignment of FISP recipient across the rural households. Hence, households that received the FISP voucher are likely to systematically differ from non-recipient households in some other ways. To allay this concern, we use an interaction instrumental variable by interacting the share FISP vouchers distributed in a district with negative rainfall shock as an instrumental variable for the interaction of dummy variable of receipt of FISP vouchers by each household with negative rainfall shock. The use of district shares of FISP vouchers received as an instrument for FISP voucher received by a household is closely related to that which is used by Mason and Ricker-Gilbert (2013), and Harou (2018)[10].

[10] Mason and Ricker-Gilbert (2013) use the mean district kilogram of subsidized fertilizer received by households to investigate the effect of receiving subsidized maize seeds on commercial purchases of improved seeds.

The argument for the use of district shares of FISP vouchers receipt is that household receipt of FISP vouchers is likely to be positively correlated with the share of vouchers distributed to a district. But the district share of FISP vouchers is unlikely to affect households' welfare directly, except through households' receipt of FISP vouchers. Although we cannot empirically test whether there is correlation between the shares of FISP vouchers allocated to a district and unobserved factors that could potentially affect households' welfare, we are making the argument that any uncontrolled factors in our regressions that could affect the instrument is also likely to affect households' receipt of FISP vouchers.

Further, in an instrumental variable analysis, two conditions should be fulfilled in order for the instrument to be relevant and valid. These conditions include the following: (i) the instrument must be relevant, i.e., $cov(Z_i,X_i) \neq 0$. (ii) The instrument must fulfil the exclusion restriction condition such that $cov(Z_i, \varepsilon_i) = 0$, that is, the instrument does not directly affect household welfare. The first-stage equations using share district share of FISP received, and district share of FISP interacted with negative rainfall shock are shown below:

$$Dummy\ of\ FISP_{ht} * Shock_{ht} = \alpha_0 + \alpha_1 Z * Shock_{ct} + \alpha_2 X'_{ht} + \varepsilon_{ht} \quad (3)$$

$$Dummy\ of\ FISP_{ht} = \alpha_0 + \alpha_1 Z_{ct} + \alpha_2 X'_{ht} + \varepsilon_{ht} \quad (4)$$

Table 1A in the appendix shows the results of the first-stage regressions for the relationship between receipt of FISP voucher redeemed by households and the district shares of FISP received. The first-stage results show positive and strong correlation between the dummy variable for FISP voucher redeemed by households and the share of FISP received in a district.

The first condition for the relevance of the instrument is established in the first-stage estimations. The second requirement for an instrumental variable is the validity or exclusion restriction, is that the instrument should have no effect on household welfare other than through the first-stage channel. Moreover, the F-statistics of the excluded instrument suggest that district shares of FISP received is not a weak instrument as the value ranges between 114.07 and 85.57 for the Cragg-Donald Wald F statistic and Kleibergen-Paap rk Wald F statistic. See Table A1 in the appendix for details. In addition, we present the results of the reduced form regression in Table A2 in the appendix. The results show significant relationship between district level receipt of vouchers and the household welfare.

5 Results and Discussions

The discussion of the result begins by presenting the relationship between negative rainfall shocks and food security in Table 3. Using different measures of welfare, we show that exposure to negative rainfall shocks reduce household welfare. Column 1 shows 10 percent increase in negative deviation of rainfall from the historical rainfall average which leads to an approximately 7 percent reduction in per capita total consumption expenditure. Column 2 shows that a 10 percent increase in negative deviation of rainfall from the historical rainfall average lowers the per capita food consumption expenditure by around 5 percent.

Also, from Column 3, the result shows that a 10 percent increase in negative deviation of rainfall from the historical rainfall average reduces per capita non-food consumption expenditure by 9 percent. Also, Food Consumption Score reduces by 50 percent for a 10 percent increase in negative deviation of rainfall from the historical rainfall.

Table 4 presents OLS and IV-2LS results of the conditioning role of FISP vouchers on the relationship between negative rainfall shocks and the indicators of household welfare. The OLS results from Column (1) show that a 10 percent increase in negative deviation of rainfall from the historical rainfall average leads to about 9 percent reduction in per capital total consumption expenditure for households without FISP vouchers, but a decline of about 4 percent in consumption expenditure for households that received FISP vouchers. The IV-2SLS results in Column (1) reveal that a 10 percent increase in negative deviation of rainfall from the historical rainfall average leads to a 29 percent reduction in per capita consumption expenditure for non-recipient of FISP vouchers, but an increase of about 36 percent in per capita total consumption expenditure for households are recipients of FISP vouchers.

In Column (2), the OLS results show that a 10 percent increase in negative deviation of rainfall from the historical rainfall average leads to about 7 percent reduction in per capita food consumption expenditure for non-recipient of FISP vouchers but leads to a decline of about 5 percent in per capita food consumption expenditure for households that are recipients of FISP vouchers. The IV-2SLS results in Column (2) show a 10 percent increase in negative deviation of rainfall from the historical rainfall average leads to 23 percent decline per capita food consumption expenditure for non-recipients of FISP voucher but a 24 percent increase in per capita food consumption expenditure for recipients of FISP vouchers.

Furthermore, in Column (3), the OLS results of the interaction between FISP vouchers and negative shocks has no statistically significant effect on non-food consumption expenditure. The IV-2SLS results from Column (3) show that a 10 percent increase in negative deviation of rainfall from the historical rainfall average leads to 0.11 percent decline in per capita non-food consumption expenditure for non-FISP recipient households, but an increase in non-food expenditure by 1.3 percent for recipients of FISP vouchers.

Further, Table 4 and Column (4), OLS result shows that households that are exposed to negative rainfall shocks and which received FISP voucher report 2 percent increase in food consumption score relative to households without FISP vouchers. However, the IV-2SLS results in Column (4) reveal no statistically significant effect of the interaction of FISP voucher with negative rainfall shock on food consumption score.

Table 5 presents the results from the instrumental variable analysis on disaggregated food categories or classes consumed over number of days in a week. The results show that an increase in negative deviation of rainfall from the historical rainfall average lead to increase in number of days in a week of cereals consumption but a decline in number of days in a week of nuts/pulses, milk, meat, fats and oil, and sugar/processed that are consumed. However, households' receipt of FISP vouchers mitigates the adverse effects of negative rainfall shocks and increases the number of days the listed disaggregated food categories are consumed. We find statistically significant effect of the interaction between FISP receipt and negative rainfall shocks on nuts/pulses, meat/fish, milk, fats/oil, and sugar/processed sugar.

The results from Table 5 also reveal that, besides the mitigating role of FISP voucher receipts against negative rainfall shocks, we find that FISP receipts have direct effect on disaggregated food categories such as nuts/pulses, milk, and sugar/processed sugar. The implication of this finding is that FISP can lead to an increase in household food security status.

5.2 Potential pathways

We identify potential pathways or mechanisms through which FISP mitigates the effects of negative rainfall shocks on household welfare.

From Table 6, the results show that households that redeemed farm input subsidy vouchers are more likely to have the following: (i) sold harvested crops (ii) stored harvested crops. We estimate the relationship between receipt of FISP vouchers and the outcomes (sold harvested crops and stored harvested crops) using linear probability model.

The outcomes are binary variables, and the estimated coefficient are interpreted in terms of likelihoods or probabilities. Specifically, the receipt of farm input subsidy (FISP) vouchers is positively associated with the likelihood of having harvested crops for sale by 22 percentage points. Also, the receipt of FISP vouchers is positively associated with households, having stored harvested crops by 42 percentage points respectively.

5.3 Robustness Check

We conduct a robustness check for the negative rainfall shock used in our analysis. The shock variable used in the previous analysis lumps the positive rainfall deviation and zero deviation.

The aim of the robustness check is to investigate whether the results are consistent with those obtained in Table 4. Hence, we exclude the observations with positive deviation in the shock variable used in the robustness check. The results from Table A3 are consistent with those obtained in Table 4.

However, we find negative effect of dummy of FISP voucher on welfare outcomes for Columns (2) and (3). Although these results from FISP receipts dummy in Columns (2) and (3), are counterintuitive, they are not the focus of our analysis in this study. The focus of our analysis is on the coefficient of negative rainfall shocks, and the interaction of FISP with negative rainfall shock. The negative coefficients of FISP dummy in Columns (2) and (3) may be driven by the reduced sample size used in the regressions after excluding observations with positive deviations. These findings are unlikely to detract the policy implications of this study because the emphasis is on the mitigating impact of FISP receipts on household's welfare in Malawi.

5.4 Discussion

The decreasing effect on food consumption expenditure and non-food expenditure as a result of exposure to negative rainfall shocks is expected and aligns with the narrative of the devastating effect of weather shocks on Malawian households (Asfaw and Maggio, 2018).

The findings from the various estimations, suggesting that Malawian FISP programme have a cushioning role against the harsh consequences of rainfall shock on households, which is seen in their food consumption and on the overall food security has important implications. Overall, these findings support the hypothesis that households require social protection policies to efficiently and effectively cope with weather related shocks. This is especially for most vulnerable households like those in the rural areas and even poor smallholder agricultural households.

Further, we find from our result that, in terms of overall household consumption, food consumption, and non-food consumption beneficiaries of the FISP programme tends to be better off when confronted with weather shocks than non-beneficiaries of the programme. These results are in tandem with (Asfaw and Carraro, 2016; Daidone *et al*., 2017) who find similar outcome that FISP programme tends to improve the welfare outcome of beneficiary households. This result is consistent with the foundational philosophy of the FISP programme, which is mainly to influence the production decisions of farmers through enhanced access to improved agricultural inputs (Dorwad and Chirwa, 2011; Lunduka *et al*., 2013) by the provision of vouchers and coupons for the purchase of agricultural inputs (Dorward and Chirwa, 2011; Harou, 2018). It is logical to expect that in the provision of these inputs to farmers, those who are exposed to agricultural related shocks are most likely to maintain improved crop production for both subsistence and market sale for the following reasons:

First, weather shock experiences for households participating in the FISP programme could be less of a problem (as the data suggest) because there is an economic support for these farmers to maintain their production capacity, even if it might be slightly negative compared to instances where there are no weather shocks. However, the maintenance of the production capacity by these farmers may well affect food consumption of the household through subsistence means. Although, these farmers may still face slight decrease in their food consumption, the magnitude is better off compared to those farmers who do not participate in the FISP programme. As a result, these farmers are able to have more food for subsistence purposes despite the weather shocks.

Second, noting that households who have received the FISP programme and are exposed to shock may not be as affected as those who are non-beneficiaries of the FISP programme, meaning that their farm produce are not as severely affected as the comparison group, then, such produce can still be sold to generate income for household consumption (both food and non-food). As highlighted in Herrmann *et al*. (2018), income from the sale of farm produce is a key determinant of food access and food security in Malawi. In addition, the beneficiary households, with a relatively stable production and income from the sale of their farm produce, have tendency to experience better food consumption compared to the non-beneficiary households.

6 Conclusion

This study investigates the potential implications of agricultural input programme on the effect of weather shocks on household welfare, which include food security indicators as used in the study. The potential implication of such agricultural policy for consumption, food consumption, non-food consumption, and food consumption scores for households that experience weather shocks is an important issue for agricultural and rural development, especially in Malawi, where majority of rural dwellers are smallholder farmers. Our analysis builds on this by studying the potential household-level linkages between the Farm Input Subsidy Programme (FISP), rainfall shocks and welfare outcomes. We focused on both households that are beneficiaries of the programme and those that are not, while controlling for the year fixed-effect to improve the efficiency of the regression analysis.

We find that, on the average, households’ welfare is negatively affected by rainfall shocks. More so, households that participate in the FISP programme significantly experience higher total consumption, food and non-food consumption even when confronted with weather shocks. Moreover, for the food consumption score, we find significant effect of the FISP when exposed to weather shocks. We consider disaggregated food diversity categories, we find that access to FISP increases the likelihood of consumption of exotic foods such as meat/fish, milk, fats/oil and sugar. These results support the claim that agricultural programmes could have significant effects on households coping mechanisms with weather related shocks.

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Table 1: Summary Statistics

	2010/2011		2012/2013		2010-2013	
Variables	Mean	S.D	Mean	S.D	Mean	S.D
Household outcomes						
Total consumption expenditure	2851.37	20147.74	6054.286	40273.78	4452.828	31879.74
Food consumption	2010.286	2757.88	4982.604	6523.003	3496.445	5223.203
Non-food consumption	317.4394	788.5426	653.2363	1348.029	485.337	1116.890
Food Consumption Score (FCS)	49.944	18.661	51.541	18.483	50.742	18.588
Control variables (Household and EA)						
Household head age	42.583	16.198	45.311	15.691	43.951	16.003
Household head has chronic illness (=1)	0.085	0.279	0.111	0.315	0.098	0.297
Household head can read English (=1)	0.415	0.492	0.417	0.493	0.416	0.492
Household head can read and write Chichewa (=1)	0.688	0.463	0.713	0.452	0.701	0.457
Household head is separated or divorced (=1)	0.087	0.281	0.073	0.260	0.080	0.271
Household head is male (=1)	0.760	0.320	0.800	0.480	0.780	0.450
HH completed above primary education (=1)	0.211	0.408	0.202	0.401	0.207	0.405
Number of elderly people in the HH (above 65 years)	0.252	0.542	0.281	0.565	0.266	0.554
Number of adult males	1.268	0.892	1.420	0.984	1.344	0.942
Number of adult females	1.343	0.779	1.488	0.889	1.416	0.839
HH has electricity (=1)	0.089	0.285	0.101	0.302	0.096	0.294
Number of children in the HH (below 15 years)	2.322	1.708	2.463	1.689	2.393	1.700
Household size	4.936	2.380	5.411	2.376	5.173	2.390
Household received cash or food aid (=1)	0.096	0.295	0.181	0.385	0.139	0.346
Someone in HH redeemed input voucher	0.530	0.499	0.428	0.494	0.459	0.498
Number of FISP voucher redeemed by HH	1.033	1.219	1.028	1.440	1.031	1.334
Distance to road	8.034	9.047	7.943	9.160	7.988	9.103
MASAF program in the community (=1)	0.178	0.383	0.674	0.468	0.427	0.494
Commercial bank in community (=1)	0.037	0.190	0.129	0.335	0.083	0.276
Land/farm size (acres)	2.028	2.629	2.144	8.585	2.086	6.348
HH planted crops in previous season	0.898	1.457	0.879	2.321	0.889	0.314
Rainfall Measures						
Average annual rainfall (mm) in the past year	798.993	129.796	844.2566	121.267	821.625	127.615
12-year average rainfall	872.286	96.100	866.091	90.966	869.189	93.610
Rainfall log-deviation (Rainfall shock)	-0.094	0.097	-0.030	0.103	-0.0625	0.105
Negative rainfall shock (absolute deviation)	0.099	0.091	0.057	0.075	0.078	0.086
Number of Observations	2029		2029		4058	

Notes: Authors' computation from the Malawi Integrated Household Panel Survey 2010-2013

Table 2: Test of Mean Difference of Household Characteristics and Receipt of FISP

Variable	Without FISP(b_0)	With FISP(b_1)	Test=(b_0-b_1)
HH planted crops in previous season	0.834	0.952	-0.118***
	(0.007)	(0.004)	(0.008)
Household head age	44.116	43.755	0.362
	(0.305)	(0.336)	(0.454)
HH has chronic illness	0.092	0.105	-0.013*
	(0.005)	(0.006)	(0.008)
HH can read English	0.417	0.414	0.003
	(0.009)	(0.010)	(0.013)
HH completed above primary educ.	0.212	0.199	0.013
	(0.007)	(0.008)	(0.011)
Household has electricity	0.099	0.091	0.008
	(0.005)	(0.005)	(0.008)
Household size	5.238	5.098	0.140**
	(0.046)	(0.048)	(0.067)
Household distance to road	7.912	8.078	-0.165
	(0.175)	(0.188)	(0.257)
MASAF program in the community	0.459	0.388	0.071***
	(0.009)	(0.010)	(0.013)
Commercial bank in the community	0.101	0.062	.038***
	(0.005)	(0.005)	(0.007)
Farm size (acres)	1.892	2.32	-0.424**
	(0.155)	(0.068)	(0.179)

***, ** and * represent significant levels at 1 percent, 5 percent and 10 percent respectively.

Table 3: Impact of Rainfall Shock on Household Welfare (OLS Regressions)

Variables	Consumption (1)	Food consumption (2)	Non-food consumption (3)	Food Cons. Score (FCS) (4)
Negative rainfall shock	-0.709*	-0.508**	-0.921***	-5.017*
	(0.178)	(0.214)	(0.156)	(2.672)
Household controls	Yes	Yes	Yes	Yes
Community controls	Yes	Yes	Yes	Yes
Year Fixed effect	Yes	Yes	Yes	Yes
Constant	5.357***	5.791***	2.896***	42.285***
	(0.077)	(0.088)	(0.137)	(1.291)
R-squared	0.389	0.421	0.252	0.249

The regressions comprise 4058 observations. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significant levels at 1 percent, 5 percent and 10 percent respectively. Control variables used in the regression include: age of household head, household head has chronic illness, household head read English, household head read and write Chichewa, household head is a male, household head completed at least primary education, household head is divorced or separated, number of elderly above 65 years in the household, number of adult females in the household, number of children below 15 years in the household, household has access to electricity, household head is monogamous, household size, household received cash or food aid, farm size, household distance to road, MASAF program in the community and commercial banks available in the community.

Table 4: Rainfall Shock on Household Welfare and the Role of Farm Input Subsidy-OLS and IV Results

Variable	Consumption (1)		Food consumption (2)		Non-food consumption (3)		Food Cons. Score (FCS) (4)	
	OLS	IV-2LS	OLS	IV-2SLS	OLS	IV-2LS	OLS	IV-2SLS
Negative rainfall shock	-0.922***	-2.940***	-0.666**	-2.334***	-0.832**	-0.011*	-7.037**	-9.893
	(0.214)	(0.713)	(0.250)	(0.749)	(0.345)	(0.006)	(3.183)	(9.991)
Shock*voucher dummy	0.543**	6.609***	0.170*	4.776***	0.062	0.141**	7.209*	29.007
	(0.279)	(1.651)	(0.073)	(1.7021)	(0.056)	(0.057)	(4.355)	(23.851)
Dummy voucher	0.138**	0.194	0.141*	0.122*	0.133*	0.210	0.198	8.394***
	(0.056)	(0.178)	(0.073)	(0.075)	(0.082)	(0.358)	(0.513)	(3.229)
Constant	5.351***	4.956***	5.786***	5.693***	2.884***	2.641***	42.205***	34.645
	(0.080)	(0.119)	(0.089)	(0.129)	(0.141)	(0.231)	(1.291)	(2.065)
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Community controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.381	0.2885	0.421	0.417	0.253	0.252	0.250	0.196

The regressions comprise 4058 observations. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significant levels at 1 percent, 5 percent and 10 percent respectively. Control variables are same as in Table 3.

Table 5: The Mitigating of FISP Voucher against Rainfall Shock on Dietary Diversity (IV Results)

Variables	Cereals	Nuts/pulses	Vegetables	Meat/Fish	Fruits	Milk	Fats/Oil	Sugar/processed
Negative rain shock	0.066**	-0.006*	-0.466	-3.494***	1.284	-2.187**	-4.093**	-5.776***
	(0.031)	(0.003)	(1.169)	(1.249)	(1.409)	(1.083)	(1.603)	(1.825)
Shock*voucher	0.930	0.068**	0.128	8.026***	-3.080	5.859**	6.629**	14.606***
	(0.672)	(0.033)	(2.731)	(2.991)	(3.225)	(2.619)	(3.726)	(4.279)
Dummy voucher	0.029	0.732*	0.022	0.096	0.123	0.143**	0.146	1.369**
	(0.097)	(0.441)	(0.072)	(0.444)	(0.459)	(0.060)	(0.108)	(0.624)
Constant	6.766***	1.923***	5.790***	2.067***	1.173***	0.147	2.007***	2.924***
	(0.068)	(0.281)	(0.247)	(0.282)	(0.283)	(0.246)	(0.362)	(0.404)
Household controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Community controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The regressions comprise 4058 observations. Robust standard errors clustered at the household level are reported in parentheses. ***, ** and * represent significant levels at 1 percent, 5 percent and 10 percent respectively. Control variables are same as Table 3.

Table 6: Potential mechanisms

Variable	Sold harvested crops	Stored harvested crops
HH redeemed input subsidy voucher	0.220***	0.416***
	(0.067)	(0.060)
Constant	0.303***	0.576***
	(0.053)	(0.049)
Household controls	Yes	Yes
Community controls	Yes	Yes
Year Fixed Effect	Yes	Yes

The regressions comprise 4058 observations. Robust standard errors (clustered at the household level) are reported in parentheses. ***, ** and * represent significant levels at 1 percent, 5 percent and 10 percent respectively. Control variables are same as Table 3.