Welfare Effect of Farm Input Subsidy Program in the Context of Climate Change: Evidence from Malawi

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Welfare Effect of Farm Input Subsidy Program in the Context of Climate Change: Evidence from Malawi[1]

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Abstract

The Farm Input Subsidy Program (FISP) in Malawi was introduced in 2005/06 season against the background of bad weather affecting production, prolonged food shortages and high input prices in the absence of soft farm input loans for smallholder farmers. The primary purpose of the program was to increase resource-poor smallholder farmers' access to improved agricultural farm inputs to achieve food self-sufficiency and increased income through increased maize and legume production. This paper uses a recently released panel data of nationally representative sample households combined with geo-referenced climate and administrative data to analyze FISP targeting effectiveness and the program's impact on a broad set of welfare outcome variables including consumption, caloric intake, marketed surplus and crop productivity, within a context of climate variability. Our study finds that Malawi's FISP targeting needs to improve if the primary target is to reach resource-poor and climate-constrained households. Moreover, results show that the program is positively associated with household welfare, food security and productivity. Heterogeneity analysis also suggests that the program benefits households residing in areas characterized by higher climate variability, with a stronger impact for a larger level of treatment.

Keywords: Farm Input Subsidy Program, program evaluation, targeting, climate change, Malawi, Africa

JEL: O13, O22, Q18, Q54

[1] We would also like to acknowledge the World Bank for sharing the Malawi Third Integrated Household Survey (IHS3) panel dataset with us and particularly Mr Talip Kilic for his valuable support during the construction of the dataset. We are grateful to Giulio Marchi, Geospatial Analyst at FAO, for his valuable support for the extraction of the climate data. Errors are the responsibility only of the authors, and this paper reflects the opinions of the authors, and not the institutions, which they represent or with which they are affiliated.

1. Introduction

Farm Input Subsidy Program (FISP) was first implemented in Malawi in 2005/06 against the background of bad weather affecting production, prolonged food shortages and high input prices in the absence of soft farm input loans for smallholder farmers. The primary purpose of the program was to increase resource poor smallholder farmers' access to improved agricultural farm inputs to achieve food self-sufficiency and increased income through increased maize and legume production. While the FISP has generally been successful at dispensing subsidized inputs, it has also been criticized on its effectiveness and efficiency in improving maize productivity, on the quality of its targeting and on the timely delivery of fertilizer to local outlets (e.g., Holden and Lunduka, 2012; Lunduka *et al*., 2013; Ricker-Gilbert *et al*. 2013, Kilic *et al*., 2015). There has been concern within the Ministry of Agriculture, Irrigation and Water Development (MoAIWD) that the FISP may not have been fully exploited due to a number of factors, including low contribution to the program by farmers, inefficient procurement, poor beneficiary targeting, inefficient fertilizer retailing, uncertainty as to the availability of funds for paying the service providers and failure to develop a graduation plan for the program beneficiaries. To that end, the MoAIWD is exploring options to improve the effectiveness of the program, including enhancing efficiency, targeting farmers and fertilizer applications to maximize productivity increases, improving the efficiency of the delivery system, reducing long term dependency on the program and enhancing "graduation" rates, as well as reducing the focus on maize and enhancing program support to diversification.

Literature on the FISP in Malawi has not considered yet the FISP's combined effects with climate variability and our analysis seeks to add value to this stream of evolving literature by using a unique dataset that combines the newly released panel data of the Malawi Integrated Household Survey (LSMS-IHS) with a novel set of climatic variables based on geo-referenced data on historical rainfall as well as higher level institutional and election results. This paper contributes to the debate on the FISP's targeting effectiveness and by evaluating the impact of the program on consumption, food security and productivity, with a particular focus on the role of climate variability. By giving particular emphasis to long-term climate variability, we aim to address three main objectives. In other words, we seek to assess whether being exposed to higher climate variability has an effect on the probability of receiving a FISP coupon. We evaluate the impact of FISP coupon receipt on household welfare (i.e., households' consumption (food and non-food), crop productivity and food and nutrition security) through a panel fixed effects model, exploring the heterogeneous impact on climate variability and a set of policy variables. Finally, to investigate whether the impact of the FISP changes depending on the total value per capita of the FISP coupons received by the beneficiaries, we adopt an alternative empirical strategy provided by Cerulli (2014) where a Dose-Response Function (DRF) is implemented amid units with diverse treatment intensity.

2. Data and descriptive statistics

The main source of data is represented by the Malawi Integrated Household Survey (IHS), which was conducted by the Central Statistics Authorities (CSA) in collaboration with the World Bank in 2010/11 and 2012/13. The IHS questionnaire is representative at the national, urban/rural and regional levels and includes household, agriculture, fishery, and community questionnaires. The first wave of the panel includes 3,247 households interviewed from March to November 2010 as part of the larger IHS. Individuals were tracked over time, and once split-off individuals were located, the new households formed since 2010 were included into the second wave. The total number of households interviewed between April and December 2013 was 4,000 households, 3,104 of which could be traced back to baseline. Our final panel at household level thus is comprised of 6,208 households and includes only households that did not split over time. Moreover, we shift to a plot-level analysis to assess the impact of the program on maize productivity, keeping among the selected households only the plots cultivated with maize that we were able to track across time. The resulting dataset at plot level consisted of 5,242 observations. All households were geo-referenced and responded to different questions on topics ranging from demographic information to income, food consumption, food expenditure, and asset ownership.

Since the data in our panel are geo-referenced at household and EA-level with latitude and longitude coordinates obtained through hand-held global-positioning system (GPS) devices, we were able to merge the socio-economic data with climate data (our second main source of data) to control for the effects of rainfall variability on household welfare. Rainfall data are extracted from the Africa Rainfall Climatology version 2 (ARC2) of the National Oceanic and Atmospheric Administration's Climate Prediction Centre (NOAA-CPC) for each dekad covering the period 1983-2013. ARC2 data are based on the latest estimation techniques on a daily basis and have a spatial resolution of 0.1 degrees (~10km).[2] Based on the extracted data we construct two indicators to define exposure to weather risk using the Coefficient of Variation (CoV) of rainfall between years and the total average rainfall occurring in the three years before each wave. In order to capture intra-annual rainfall variability we built the CoV by calculating the standard deviation of the mm of precipitation per dekad at EA level[3] and dividing it by the mean calculated over the same period (1983-2013).

We use community-level data that capture issues related to collective action, access to information, and infrastructure including market and roads, as well as institutional variables such as access to micro-finance, access to the Malawi Social Action Fund (MASAF[4]), and the implementation of irrigation schemes in the community and household population. We finally merge our dataset with another unique database comprised of 2009 election results in Malawi in order to control for the effects of voting patterns on household participation in the Malawi FISP. In 2009, the Democratic Progressive Party (DPP) was the ruling party at the time and the main opposition party was the Malawi Congress Party (MCP). The variables created include the DPP votes as a share of total votes cast.

Table 1 as well as Figure 1 (panels (a)-(d)) report descriptive statistics on the proportion of households receiving a coupon as well as dependent and control variables employed in our study.

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[2] Average of a 10 km radius buffer of the dekadal sum of daily values per enumeration area centroid. For more details on ARC2 algorithms, see:
http://www.cpc.ncep.noaa.gov/products/fews/AFR_CLIM/AMS_ARC2a.pdf

[3] From 1983-2010 for the first wave and from 1983-2013 for the second wave.

[4] MASAF is a project designed to finance self-help community projects and transfer cash through safety net activities

3. Empirical approach

We employ the Random Effect Mundlak (Mundlak, 1978) framework to examine the effectiveness of the targeting procedure. Applying a Fixed Effect (FE) model would drop from the estimation households that have similar treatment status in the period of analysis (since they do not have variation in the dependent variable). The so-called Mundlak correction considers these households, allowing one to assume correlation between household specific effects and the observed control variables. After this correction, the model becomes identical to a fixed effects specification (Hsiao, 2003) and expressed as follows.

$$y_{it}^{*} = \beta_0 + \beta_1 \mathbf{X}_{it} + \beta_2 \mathbf{C}_{it} + \beta_3 \mathbf{L}_{it} + \beta_4 \mathbf{W}_{it} + \beta_5 \mathbf{Z}_{it} + c_i + \varepsilon_{it} \quad (1)$$

The dependent variable y_{it}^{*} is either a dichotomous variable capturing the likelihood of receiving a coupon or a count variable capturing the number of coupons issued to the household. In the latter case, our data shows that the variable ranges from 0 to 12 and an ordered logit model when the Mundlak correction is applied. The first vector of variables **X** contains the characteristics of the household as well as those of the head of household i at time t, including household size, the household average education level, hectares of owned land, the age of the household head and a binary variable capturing whether the household head is female. Vector **C** defines the long and short-run geo-referenced climatic indicators, the long-term CoV of rainfall and the average total rainfall calculated in the three years before the wave. Vector **L** accounts for a set of factors characterizing the location of the household: distance (km) from the original position in 2010, distance (km) from the nearest road and two binary variables indicating whether the household resides in the northern region and in the southern region, respectively. **W** represents index capturing households' access to infrastructure and two binary variables capturing the bottom 20% percent of households within the distribution of two wealth indexes (a nonagricultural wealth index and an agricultural wealth index).[5] Finally, we include a vector **Z** of political and service variables. This vector includes a dummy variable for the presence of an extension officer within the community, as we postulated that the possibility of having access to information would have influenced coupon receipt. As reported by Chinsinga and Poulton (2014) "a common result of weak targeting is that much subsidized fertilizer tends to go to well-connected individuals." In order to control for an effect of political opportunism we include a variable at EA level controlling for the share of votes given to the Democratic Progressive Party (DPP) (the ruling party at the time of the survey) during the 2009 political elections, and a variable controlling for whether the household answered as having paid additional money to obtain the coupon. By including the share of votes to the DPP party and whether the household head had to pay extra money to obtain the voucher, we control for eventual bias in coupon assignment. β_n are the coefficients associated with the covariates, c_i the random effects and ε_{it} the error term. All continuous variables are expressed in natural logarithmic form with the exception of the infrastructure index and the CoV of rainfall.

To model the effects of coupon receipt on consumption and productivity we use panel fixed-effect specification, which can address endogeneity to the extent that the selection of

[5] The three indexes are constructed using the Principal Component Analysis.

coupon recipients is generated by the unobserved time invariant household characteristics[6]. The fixed effect model is specified as follows:

$$\ln Y_{it} = \pi_0 + \pi_1 FISP_{it} + \pi_2 \mathbf{X}_{it} + \pi_3 \mathbf{C}_{it} + \pi_4 \mathbf{L}_{it} + \pi_5 \mathbf{W}_{it} + \pi_6 \mathbf{P}_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (2)$$

Our dependent variable is now constituted by (i) total consumption expenditure, (ii) food consumption expenditure, (iii) non-food consumption expenditure, (iv) food caloric intake, (v) total marketed surplus and (vi) total value of production, for which we consider different specifications. $FISP$ is the variable defining the number of coupons received by the household per cropping season. As a robustness check, we replicate the analysis, substituting the $FISP$ continuous variable with a binary variable denoting coupon receipt. In this specification of the model, we complete the vector of household characteristics with the dependency ratio and the population residing in the community. Finally we include a vector of institutional variables $\mathbf{P}$ consisting of a set of binary variables indicating whether the household (i) is involved in microfinance, (ii) participates in the MASAF program, (iii) is included within an irrigation scheme and (iv) is engaged in agricultural collective actions.

To investigate whether the subsidy program is effective in reducing the negative welfare effects of weather variability, whether it has a joint effect with relevant policy variables (i.e. social safety net and credit) and whether households owning a higher amount of land would benefit more from the program, we also estimate a second set of impact estimations with different interaction variables. The model specification is as follows:

$$\ln Y_{it} = \pi_0 + \pi_1 FISP + \pi_2 (FISP\ x\ CoVRain) + \pi_3 (FISP\ x\ SSN) + \pi_4 (FISP\ x\ Credit) + \pi_5 (FISP\ x\ Land) + \pi_6 \mathbf{X}_{it} + \pi_7 \mathbf{C}_{it} + \pi_8 \mathbf{L}_{it} + \pi_9 \mathbf{W}_{it} + \pi_{10} \mathbf{P}_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (3)$$

To test the sensitivity of our results to different specifications, we also estimated a dose response function (DRF) using a non-parametric continuous treatment effect approach (see Cerulli, 2014 for detail). In our case, we are interested in investigating empirically how household welfare outcomes change in relation to the amount of FISP coupons received. Although the setting is analogous to the binary treatment case, here the effects are allowed to vary with the intensity of treatment. Exposure to different numbers of FISP coupon receipts triggers responses of different magnitudes in welfare outcomes, thus creating a continuous relationship between the two. By comparing the welfare outcomes of households that beneficiated a given amount of FISP coupon receipts with the welfare outcome of households that received nothing from the FISP, we are able to identify the Average Treatment Effect on the Treated (ATT) for that particular amount of FISP coupon receipts.

4. Results and discussion

4.1 FISP targeting effectiveness

Table 2 reports results for the logit and ordered logit with the RE-Mundlak correction for FISP coupon receipt for the agricultural household sample.[7] We show the marginal effects for

[6] In order to control for potential endogeneity, we have also tried to implement a 2SLS Fixed Effect Instrumental Variable (IV) strategy, using the voting variable (DPP share of votes) as identifying instruments but the tests (the weak identification test and over identification test) do not support the validity of our selection instruments.

the two alternative dependent variables - binary and count - of coupon receipt. For the count variable, we calculate the margins separately for each number of coupons received.

We find evidence of negative correlations between households situated at the bottom 20% quantile of the agricultural and non-agricultural wealth distributions and the likelihood of fertilizers and maize seed coupon receipt, a result that confirms the findings of Ricker-Gilbert *et al.*, (2011), Chibwana *et al.*, (2012), Kilic *et al*. (2015), and Fisher and Kandiwa (2014). While favorable soil conditions are often used as a proxy for agricultural production potential in the literature (Kilic *et al*. 2015), we believe that given good soil quality, it is weather variability that plays a much more relevant role in driving the production potential. We speculate that areas with much more favorable weather conditions are more likely to receive a coupon because they have greater agricultural potential. The CoV of rainfall is in fact negatively associated with the likelihood of receiving a coupon: the riskier the environment in terms of successfully harvesting crops, the less likely are households to receive the coupon. This finding reveals the contradictions in the targeting criteria, since farmers facing weather instability are much more vulnerable than their counterparts in weather-stable areas. Our estimates are robust, as the sign and significance of the control variables are coherent across the logit and the ordered logit model specifications. The location variables coefficients confirm that the distance to the nearest road and the distance of the household from the original location are not constraints to program participation. At the same time, northern residents are less likely to receive a coupon with respect to residents in the central region. As expected, the results confirm the positive role of information on coupon distribution; the presence of extension advice on the territory is found to be crucial for effective coupon receipt, since awareness of important program information from extension officers and the media increased the likelihood that a farmer would be present during the coupon distribution. Interestingly, results show that political vote also drives FISP coupon distribution: the coefficient is positive and statistically significant. In addition, households paying additional money were more likely to have received a coupon. Finally, we do not find a statistically significant difference in the probability of FISP coupon receipt between female-headed household and male-headed households. Summing up, the latest data available for Malawi enforce the evidence already underlined by the previous literature about the failure of the program to meet the targeting guidelines.

<TABLES 2 ABOUT HERE>

4.2 Average impacts of FISP

To measure the potential advantages from participation in the program, we start our analysis within a productivity context by estimating plot-level maize yield and maize harvested response functions to the number of coupons received. We then analyze the direct impact of the FISP on households' welfare and food security.

Maize yield and maize harvested variables are both expressed in logarithms, and the results are provided in Table 3. The maize yield specification, although portraying mostly non-statistically significant coefficients, shows a significant relationship between maize productivity and the number of coupons obtained by the household. The same conclusion can

[7] RE-Mundlak correction for FISP coupon receipt for the overall household sample can be available from authors upon request. The results are qualitatively very similar with the agricultural households' sample.

be drawn for the logarithm of harvested maize. The results are consistent between the two specifications. We find that households receiving one more coupon face an increase in yield of about 4%. Our results confirm the findings of Holden and Lunduka (2010)[8] and Chibwana *et al*. (2014) who also found a significant positive effect on maize yields because of access to subsidized fertilizers. As found in Asfaw *et al.* (2014), climatic variables play a central role in explaining the variation of yield. As expected, a higher average precipitation occurring in the three years before each wave significantly increases yield. Social safety nets also increase both maize yield and quantity of maize harvested. Generally, beneficiaries allocate transfers to food consumption, increasing the demand for food; this may act as a stimulus for producers who can use the transfers as a complement to other subsidies to invest in technology and inputs, thus improving farm productivity. Credit and the presence of extension services are positively related with harvested maize, while among the plot characteristics only the poor quality of the soil seems to decrease the quantity of maize harvested.

<INSERT TABLE 3 ABOUT HERE>

Tables 4 and 5 present results from the Fixed Effects panel estimates of the impact of the FISP on total consumption, food/non-food consumption, daily caloric intake, marketed surplus and total value of production for agricultural households. We seek to identify the positive spillovers from increased productivity in both consumption and diet. We conduct the estimates for agricultural households as coupon beneficiaries were supposed to be landowners. As a robustness check we run the same regressions using both the binary and count variables for the number of coupons received by the household and we replicate the estimates for the full sample.[9] We expect positive coefficients for the FISP variable in both specifications. To save space, we discuss the model results jointly.

We find evidence in all specifications of a positive and statistically significant coefficient associated with the number of coupons in eleven out of twelve specifications. This result is consistent when controlling for the binary variable indicating inclusion into the program. Although the impacts are not large, they indicate that households benefit from receiving subsidized inputs at reduced prices, which result in significant increases for per capita consumption (+5.6%), food consumption (+6.0%), and non-food consumption (+5.0%). The positive coefficient (+6.0%) associated with daily caloric intake tells us that the higher the number of vouchers received by the household, the more the household is shielded against food insecurity. Participating in the FISP improves maize supply from home production, leading to higher overall value of production (+9.1%) and a higher marketed surplus (+5.1%), which is mainly driven by maize. We observe that results are consistent across the specifications.

The reported estimates show strong negative associations between the coefficient of variation of rainfall and total/food/non-food per capita consumption. Regarding the full sample, an increase in rainfall variability leads to a drop in consumption, and a slightly lower drop is registered for the agricultural households. A possible explanation behind the negative

[8] Holden and Lunduka (2010) found descriptive evidence of a positive trend in maize yields from 2006 to 2009, estimating an increase in mean yields of about 600 kg/ha from 1,440 to 2,040 kg/ha for hybrid maize, and from 1,120 to 1,680 kg/ha for local maize.

[9] Full estimation results including the overall sample are available upon request.

effect of weather riskiness on consumption could be attributed to a drop in production that in turn affects market prices and households' purchasing power. With respect to daily caloric intake, we do not find any significant impact of the coefficient of variation of rainfall, while a negative relationship arises with respect to total marketed surplus. Average total rainfall calculated in the short-term increases marketed surplus, indicating that a higher amount of rainfall is desirable to generate higher productivity.

Moving to the institutional variables, we expect that the presence of agricultural extension services improve the agronomic performance of the farmers. The presence of extension services increases marketed surplus and total value of production only for the overall sample by 6.6% and 9.5%, respectively. Benefiting from social cash transfers leads to a growth in consumption (total, food and non-food) evident only within the full sample, perhaps because most beneficiaries engage less in agricultural activities and reside in urban areas. We also find a positive contribution from microfinance, which improves consumption (among agricultural households) as well as food caloric intake (in both specifications).

<INSERT TABLE 4 AND 5 ABOUT HERE>

4.3 Heterogeneous effects of FISP

In this section, we report the analysis of the heterogeneous impact of the FISP coupon receipts on household welfare and productivity. The main objective of this section is to assess whether obtaining a coupon helps households to mitigate the negative effects of the rainfall variability. Moreover, we are also interested in investigating (i) whether receiving credit and being targeted by FISP has a positive effect on our outcome variables; (ii) if there is a joint effect of social safety nets and the FISP in providing a given level of protection from hunger and (iii) whether the number of coupons increases welfare for an increasing quantity of land owned. Towards this understanding, we replicate the estimates shown in the previous section, reporting the same set of variables introduced previously, plus a set of variables based on the interaction between the FISP with (i) CoV of rainfall, (ii) microcredit, (iii) social safety nets, and (iv) land owned, respectively (Table 6).[10] As done previously, we conduct regressions for the overall sample and agricultural households separately, and we check the robustness of our results with a specification that includes the binary variable for coupon receipt. A summary of the main findings is reported in the table below.

The interacted variables exhibit no effect in most of the model specifications with only few exceptions (see table below). The interaction term between the CoV of rainfall and number of coupon receipts, for instance, turns out to be positive and statistically significant in both total and food consumption's specifications for agricultural households. These results suggest that participation in the program mitigates the negative effect of climate variability. This effect is also consistent when interacting the number of coupons with climate variability. Therefore, not only does participating in the FISP scheme have a beneficial effect, but so too does increasing the number of vouchers. Even though the impact of the number of coupons turns out to decrease food consumption for agricultural households, the overall impact including the interaction term is still positive. When the dependent variable is the value of production, the coefficient of the interaction term between the number of coupons received and land size is negative and significant at the 1% level; the larger the area owned, the

[10] Full estimation results are available upon request from authors.

weaker the performance of the FISP. Keeping the amount of fertilizer fixed, having a larger land would reduce the quantity per hectare of fertilizers employed. Interestingly, when combining social safety nets and the FISP we also find an inverse relationship on marketed surplus for both samples analyzed.

<INSERT TABLE 6 ABOUT HERE>

4.4 Sensitivity analysis

We dig one layer deeper and conduct DRFs for our outcomes of interest as a robustness check. We report the corresponding plots in Figure 2a to 2h, using the *ctreatreg* STATA routine to estimate dose-response treatment models under continuous treatment and heterogeneous response to observable confounders. The charts show the DRFs of the impact for per adult equivalent value of FISP coupon receipts on the outcome variables previously introduced in the econometric analysis. In each of the diagrams, the x-axis indicates the intensity of the treatment (expressed in percentiles) and the y-axis measures the ATET on our set of different outcome variables. Once the continuous nature of the treatment is taken into account, one can observe its effects on consumption and productivity. Within the plots, green and red dots represent respectively significance at the 10% level and non-significance. The real value of the coupon is estimated by dividing the total amount spent by the household to redeem the subsidized coupons by the household size in adult equivalents. The higher the ratio between these two dimensions, the higher the expenditure per capita.

Figure 2 (a) shows the effect of increasing treatment intensity on the total consumption indicator. There is a linear and increasing relationship with a peak registered at very high dose levels. The effect on total consumption is positive and statistically significant for higher levels of the treatment. The DRF for food/non-food consumption expenditure (2b & 2c) sets out a similar pattern with respect to overall consumption but some differences arise when looking at the level of the treatment necessary to have a positive effect: between the two, a higher dose is needed to have a positive ATE for non-food consumption. A positive and slightly increasing shape is registered for food caloric intake.

Interesting results arise when estimating the dose-response effect for marketed surplus and total value of production. Overall, the impact of the FISP on marketed surplus is positive and statistically significant regardless of the dose. The relative function increases, reaches a peak and afterwards shows a slightly declining behavior (see Figure 2e). Regarding the total value of production, the shape of the function is always positive and slightly increasing until a peak at half of the distribution, declining afterwards. The impact of different doses of treatment on maize yield is overall positive. Looking at the curve, the first half the shape is slightly similar to a parabola: for small amounts of treatment, the yield response is stable, while in the second half of the curve it starts to decline. In the last panel (h) where we plot the DRF for harvested maize, the values of the ATET are positive, meaning that the treatment increases total harvested maize. However, we are not able to explain the shape of the curve, which is negatively sloped for small values of the treatment and is steeper for higher values.

5. Conclusions

This paper examines the targeting effectiveness of Malawi's FISP, as well as the impact on welfare and productivity and their variability by the extent of treatment, taking climate uncertainty explicitly into account. This paper makes use of a unique dataset consisting of (i) a two-wave household and plot-level panel dataset merged with a (ii) geo-referenced climatic dataset and a (iii) 2009 Malawi Political Election database.

We find that the program enhances consumption, food security and productivity but that the targeting outcomes are far from satisfactory. We confirm the findings of the previous literature on targeting effectiveness: it is still not clear how resource-poor smallholder farmers are identified within the community, even when using the latest available data on large-scale program implementation. We find evidence that targeting is not oriented towards the bottom 20% quantile of the wealth distribution and that female-headed households received disproportionately fewer subsidized inputs. Since climate variability has historically been a crucial issue for Malawian farmers, affecting both production decisions and total output, we framed FISP targeting analysis within a climate change context. Interestingly, results showed that the likelihood of receiving the transfer is lower for households living in areas much more subject to climate variability. Another main finding of this paper is the positive effect of FISP implementation on consumption and productivity. We provide evidence that being involved in the program has a direct positive effect on all our outcome variables apart from marketed surplus (among agricultural households). In addition, we find evidence of a systematic negative impact of the CoV of rainfall on consumption for both overall and agricultural households. In some cases, we find a positive relationship of land, total social safety nets, and microfinance on our variables of interest. When shifting to a plot-level analysis we find that being part of the FISP increases both maize yield and maize productivity. Finally when addressing the heterogeneous impact of the FISP, we show a positive interaction between FISP receipt and the CoV of rainfall for consumption and food consumption, demonstrating the positive role played by the FISP in improving welfare for households much more subject to climate distress events. Interestingly we do not find any significant joint effect when interacting the FISP with social safety nets, casting some doubts on the effectiveness of a complementary adoption of both systems. When re-designing the program, the MoAIWD should consider this issue explicitly.

The results have important implications for future research. Even though the FISP scheme could support climate change adaptation and mitigation through the Agriculture Sector Wide Approach, our paper suggests that much effort is needed to improve the actual implementation of the FISP with regards to the negative effects of climate risk. For example, in order to limit the negative effects of climate variability a strategy could be to increase the number of extension services to provide necessary information to farmers on the timing and quantity of input subsidies to be applied in the field. Another strategy would be to redefine the typology of issued coupons in light of a strategy of crop diversification, such as coupons for more drought-tolerant crops and providing farmers with improved varieties of seeds.

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Table 1 – Summary statistics for control and outcome variables

	2010			2013		
Variable	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Ln (Mean Total Rain) (Short Term)	3104	6.67	0.12	3104	6.69	0.10
CoV Rainfall (Long Run)	3104	0.94	0.08	3104	0.94	0.08
Ln (Age HH head)	3104	3.68	0.37	3104	3.74	0.37
Ln (Dependency Ratio)	3104	0.09	0.59	3104	0.12	0.62
Ln (Distance from original position (km))	3104	0	0	3104	-1.83	2.78
Ln (HH size (Adult Equivalents))	3104	1.28	0.49	3104	1.36	1.85
Ln (Population)	3104	7.77	1.07	3104	8.15	1.25
Ln (Household Average Education)	3104	1.47	0.64	3104	1.49	0.59
Female Headed HH | 1=YES	3104	0.24	0.42	3104	0.24	0.43
Ln (Land Area (ha))	3104	0.26	0.79	3104	0.22	0.86
Index of Access to Infrastructure	3104	-0.02	0.98	3104	-0.03	0.98
Ln (Distance to the nearest Road (km))	3104	1.80	1.01	3104	1.79	1.06
Agricultural Wealth Index	3104	0.08	0.98	3104	-0.04	1.01
Non Agricultural Wealth Index	3104	-0.09	0.87	3104	0.01	1.02
HH AG wealth index bottom 20% quantile| 1=YES	3104	0.22	0.42	3104	0.21	0.40
HH Non-Ag wealth index bottom 20% quantile| 1=YES	3104	0.25	0.43	3104	0.26	0.44
Extension Services | 1=YES	3104	0.37	0.48	3104	0.59	0.49
Ln(Total Social Safety Nets MWK) (Cash/In-Kind)	3104	0.31	1.34	3104	1.63	2.93
Microfinance | 1=YES	3104	0.09	0.28	3104	0.18	0.38
MASAF | 1=YES	3104	0.19	0.40	3104	0.66	0.47
Irrigation | 1=YES	3104	0.14	0.34	3104	0.11	0.31
Agriculture Collective Action | 1=YES	3104	0.35	0.48	3104	0.26	0.44
Member of Parliament is Resident | 1=YES	3104	0.15	0.35	3104	0.15	0.36
Share DPP vote over total	3104	0.64	0.25	3104	0.64	0.25
HH Paying money to get the coupon |1=YES	3104	0.01	0.09	3104	0.01	0.09
Maize Hybrid | 1=YES	2621	0.46	0.50	2621	0.41	0.49
Organic Fertilizer | 1 = YES	2621	0.14	0.35	2621	0.18	0.38
Ln (Pesticide use (Kg))	2621	0.00	0.22	2621	0.00	0.21
Soil-Water Conservation System | 1 = YES	2621	0.43	0.50	2621	0.53	0.50
Irrigation | 1 = YES	2621	0.17	0.37	2621	0.15	0.36
Ln (Total Consumption per capita)	3104	11.67	0.72	3104	11.70	0.68
Ln (Food consumption per capita)	3104	11.10	0.71	3104	11.16	0.68
Ln (Non Food consumption per capita)	3104	11.65	0.71	3104	11.67	0.69
Ln (Caloric Intake)	3104	7.48	0.61	3104	7.52	0.62
Ln (Marketed Surplus)	3104	4.51	2.63	3104	4.65	2.59
Ln (Total Value of Production) (MKW)	3104	8.39	3.15	3104	9.46	3.52
Ln (Maize Productivity) (kg/acre)	2621	6.51	1.68	2621	5.78	2.46
Ln (Maize Harvested) (kg)	2621	5.59	1.25	2621	5.71	1.19

Note: Number of observations for maize productivity and maize harvested are plot level while the rest outcomes are at household level

Table 2- RE-Mundlak regressions for determinants of FISP coupon receipt (Agricultural Households)

	Mundlak RE - Logit	*Mundlak RE - Ordered Logit*					
	Dependent: HH Received FISP Coupon (0/1)	Dependent: Number of Coupons Received					
			Marginal Effects				
	Marginal Effects	Coefficient Estimator	0 Coupons	1 Coupon	2 Coupons	3 Coupons	>3 Coupons
Ln Mean Total Rain (Short Term)	-2.124***	-0.626	0.14	-0.009	-0.04	-0.047	-0.04
	(0.544)	(0.373)	(0.083)	(0.006)	(0.024)	(0.028)	(0.024)
CoV Rainfall	-11.371***	-7.052***	1.571***	-0.099***	-0.453***	-0.527***	-0.451***
	(1.08)	(0.711)	(0.153)	(0.016)	(0.048)	(0.055)	(0.047)
HH Paid somebody to get the coupon |1=YES	20.349***	1.970***	-0.439***	0.028***	0.127***	0.147***	0.126***
	(0.454)	(0.372)	(0.082)	(0.007)	(0.024)	(0.027)	(0.024)
Share DPP vote over total	1.814***	1.303***	-0.290***	0.018***	0.084***	0.097***	0.083***
	(0.248)	(0.17)	(0.037)	(0.003)	(0.011)	(0.013)	(0.011)
Ln Age HH head	0.005	0.176	-0.039	0.002	0.011	0.013	0.011
	(0.313)	(0.235)	(0.052)	(0.003)	(0.015)	(0.018)	(0.015)
Ln HH size	0.211	0.218	-0.049	0.003	0.014	0.016	0.014
	(0.193)	(0.144)	(0.032)	(0.002)	(0.009)	(0.011)	(0.009)
Ln Distance from original position	0.101***	0.031	-0.007	(0.000)	0.002	0.002	0.002
	(0.021)	(0.017)	(0.004)	(0.000)	(0.001)	(0.001)	(0.001)
Ln Household Average Education	0.036	0.108	-0.024	0.002	0.007	0.008	0.007
	(0.145)	(0.111)	(0.025)	(0.002)	(0.007)	(0.008)	(0.007)
Female Headed HH	0.084	0.091	-0.02	0.001	0.006	0.007	0.006
	(0.104)	(0.072)	(0.016)	(0.001)	(0.005)	(0.005)	(0.005)
Ln Land Area (ha)	0.245***	0.208***	-0.046***	0.003***	0.013***	0.016***	0.013***
	(0.048)	(0.032)	(0.007)	(0.001)	(0.002)	(0.002)	(0.002)
Ln Distance from nearest road	0.088	0.027	-0.006	0.000	0.002	0.002	0.002
	(0.047)	(0.031)	(0.007)	(0.000)	(0.002)	(0.002)	(0.002)
National: index of access to infrastructure	-0.545***	-0.377***	0.084***	-0.005***	-0.024***	-0.028***	-0.024***
	(0.06)	(0.039)	(0.009)	(0.001)	(0.003)	(0.003)	(0.003)
Extension Advice	0.331***	0.395***	-0.088***	0.006***	0.025***	0.030***	0.025***
	(0.08)	(0.059)	(0.013)	(0.001)	(0.004)	(0.004)	(0.004)
HH Rural wealth 1st quantile	-0.481***	-0.428***	0.095***	-0.006***	-0.027***	-0.032***	-0.027***
	(0.126)	(0.093)	(0.021)	(0.001)	(0.006)	(0.007)	(0.006)
HH Non-Ag wealth 1st quantile	-0.424***	-0.325***	0.072***	-0.005***	-0.021***	-0.024***	-0.021***
	(0.104)	(0.072)	(0.016)	(0.001)	(0.005)	(0.005)	(0.005)
Residence in the Northern region	-0.995***	-0.487***	0.109***	-0.007**	-0.031***	-0.036***	-0.031***
	(0.221)	(0.146)	(0.032)	(0.002)	(0.009)	(0.011)	(0.009)
Residence in the Southern region	1.408***	1.308***	-0.291***	0.018***	0.084***	0.098***	0.084***
	(0.152)	(0.098)	(0.021)	(0.002)	(0.006)	(0.008)	(0.007)
Observations	4741	4741	4741	4741	4741	4741	4741

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3 - Panel Fixed Effects Regressions for FISP impact on crop productivity

	Ln(Maize Yield)		*Ln(Harvested Maize)*	
Number of coupons per HH	0.042*		0.040*	
	(0.03)		(0.016)	
HH obtained coupon | 1=YES		0.048*		0.054**
		(0.092)		(0.046)
Ln Mean Total Rain (Short Term)	0.393***	0.398***	0.04	0.046
	(0.844)	(0.848)	(0.362)	(0.364)
CoV Rain (Long term)	-0.48	-0.484	-0.093	-0.104
	(13.641)	(13.621)	(6.29)	(6.282)
Ln Land Area (ha)	0.039	0.042	0.093***	0.095***
	(0.071)	(0.07)	(0.037)	(0.037)
Total Safety Net MWK (Cash/In-Kind)	0.043*	0.046*	0.042*	0.045**
	(0.017)	(0.017)	(0.008)	(0.008)
Microfinance | 1=YES	0.041	0.04	0.040*	0.039*
	(0.121)	(0.121)	(0.054)	(0.054)
Agriculture collective action| 1=YES	0.005	0.005	-0.006	-0.006
	(0.108)	(0.108)	(0.049)	(0.048)
Extension in the EA| 1=YES	0.017	0.018	0.042*	0.042*
	(0.082)	(0.082)	(0.049)	(0.049)
Households' Characteristics	Yes	Yes	Yes	Yes
Plot characteristics	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes
Observations	5242	5242	5242	5242
R-squared	0.098	0.098	0.049	0.051
F	11.97	12.06	4.78	5.032

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Full estimation results are available upon request.

Table 4 - Panel Fixed Effects Regressions for FISP impact on consumption expenditure

	Ln (Consumption)	*Ln (Consumption)*	*Ln (Food Cons.)*	*Ln (Food Cons.)*	*Ln (Non Food Cons.)*	*Ln (Non Food Cons.)*
Number of coupons per HH	0.064***		0.067***		0.057***	
	(0.007)		(0.009)		(0.007)	
HH obtained coupon | 1=YES		0.045**		0.056**		0.041*
		(0.022)		(0.028)		(0.022)
Ln Mean Total Rain (Short Term)	0.026	0.03	0.004	0.009	0.017	0.02
	(0.183)	(0.183)	(0.231)	(0.231)	(0.182)	(0.182)
CoV Rainfall (Long Term)	-1.201**	-1.163**	-0.88	-0.846	-1.184**	-1.151**
	(2.956)	(2.949)	(3.772)	(3.764)	(2.927)	(2.922)
Ln Land Area (ha)	0.070***	0.070***	0.044	0.044	0.062**	0.062**
	(0.014)	(0.014)	(0.017)	(0.017)	(0.014)	(0.014)
Total Safety Net MWK (Cash/In-Kind)	0.028	0.032	0.026	0.03	0.026	0.029
	(0.004)	(0.004)	(0.006)	(0.006)	(0.004)	(0.004)
Microfinance | 1=YES	0.050**	0.049**	0.050*	0.049*	0.048**	0.047**
	(0.034)	(0.034)	(0.046)	(0.046)	(0.033)	(0.033)
MASAF | 1=YES	0.014	0.015	0.014	0.016	0.011	0.012
	(0.023)	(0.023)	(0.03)	(0.03)	(0.023)	(0.023)
Agriculture Collective Action | 1=YES	-0.027	-0.028	0.009	0.008	-0.024	-0.024
	(0.023)	(0.023)	(0.03)	(0.03)	(0.023)	(0.023)
Households' Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4741	4741	4740	4740	4741	4741
R-squared	0.278	0.275	0.185	0.184	0.28	0.277
F	32.94	32.79	20.53	20.22	32.92	32.8

Note: Robust standard errors in parenthesis. *** p<0.01, ** p<0.05, * p<0.1. Full estimation results are available upon request.

Table 5 - Panel Fixed Effects Regressions for FISP coupon receipt – Food Security and Production

	Ln(Caloric intake)	*Ln(Caloric intake)*	*Ln (Marketed surplus)*	*Ln (Marketed surplus)*	*Ln (Total value of production)*	*Ln (Total value of production)*
Number of coupons per HH	0.060*		0.013		0.070***	
	(0.011)		(0.042)		(0.024)	
HH obtained coupon | 1=YES		0.060*		0.041		0.076***
		(0.033)		(0.092)		(0.046)
Ln Mean Total Rain (Short Term)	-0.066	-0.061	0.093*	0.097*	0.047	0.061
	(0.246)	(0.246)	(0.744)	(0.745)	(0.582)	(0.371)
CoV Rainfall (Long Term)	0.433	0.455	-1.584**	-1.602**	-0.351	0.194
	(4.382)	(4.374)	(12.396)	(12.481)	(8.375)	(6.093)
Ln Land Area (ha)	0.047	0.047	0.107***	0.107***	0.194***	0.194***
	(0.021)	(0.021)	(0.063)	(0.063)	(0.042)	(0.042)
Total Safety Net MWK (Cash/In-Kind)	0.003	0.006	0.033	0.032	0.006	0.009
	(0.006)	(0.006)	(0.017)	(0.017)	(0.012)	(0.009)
Microfinance | 1=YES	0.062*	0.061*	0.016	0.015	0.000	0.012
	(0.056)	(0.056)	(0.139)	(0.138)	(0.114)	(0.068)
MASAF | 1=YES	0.02	0.022	0.043	0.044	0.029	0.03
	(0.034)	(0.033)	(0.109)	(0.108)	(0.075)	(0.052)
Agriculture Collective Action | 1=YES	0.033	0.033	0.001	0.003	-0.055*	-0.02
	(0.034)	(0.034)	(0.111)	(0.112)	(0.087)	(0.051)
Households' Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4740	4740	4741	4741	4741	4622
R-squared	0.068	0.068	0.039	0.04	0.362	0.563
F	5.954	5.934	3.097	3.181	50.39	109.1

Note: Robust standard errors in parenthesis. *** p<0.01, ** p<0.05, * p<0.1. Full estimation results are available upon request.

Table 6 – Heterogeneity impact of FISP - Summary

	Consumption	*Food cons.*	*Non food cons.*	*Caloric intake*	*Marketed surplus*	*Total value of production*	*Maize yield*	*Harvested maize*
	Overall sample						*Plot Level*	
# FISP Coupons interacted with:								
...CoV Rainfall	ns	ns	ns	ns	ns	ns	ns	ns
...Land	ns	ns	ns	ns	ns	ns	ns	-
...SSN	ns	ns	ns	ns	ns	ns	ns	ns
...Microfinance	ns	ns	ns	ns	+	ns	ns	ns
FISP Beneficiary (0/1) interacted with:								
...CoV Rainfall	ns	ns	ns	ns	ns	ns	ns	ns
...Land	ns	ns	ns	ns	ns	ns	ns	-
...SSN	ns	ns	ns	ns	-	ns	ns	ns
...Microfinance	ns	ns	ns	ns	+	ns	ns	ns
	Agricultural subsample							
# FISP Coupons interacted with:								
...CoV Rainfall	+	+	ns	ns	ns	ns		
...Land	ns	ns	ns	ns	ns	ns		
...SSN	ns	ns	ns	ns	ns	ns		
...Microfinance	ns	ns	ns	ns	ns	ns		
FISP Beneficiary (0/1) interacted with:								
...CoV Rainfall	+	+	ns	ns	ns	ns		
...Land	ns	ns	ns	ns	ns	-		
...SSN	ns	ns	ns	ns	-	ns		
...Microfinance	ns	ns	ns	ns	ns	ns		

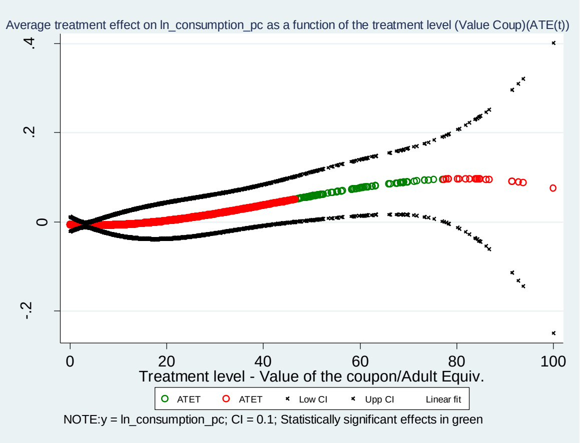
Note: ns is not significant; + is positive impact, and - is negative impact. Full estimation results are available upon request.

Figures

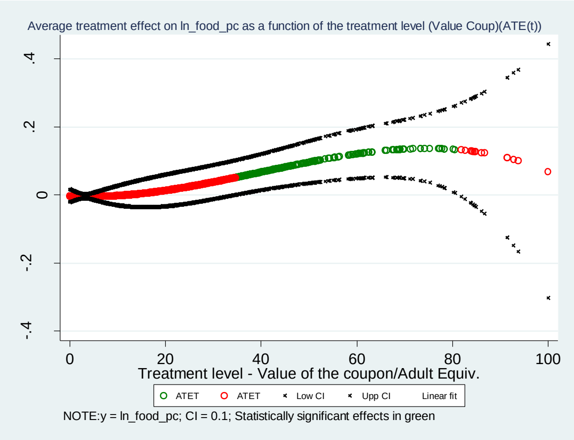
Figure 1: Share of households obtaining coupons, average number per household, share of households redeeming at least a coupon and percentage of households paying additional money to redeem a coupon

Figure 2: Dose-Response Function estimates

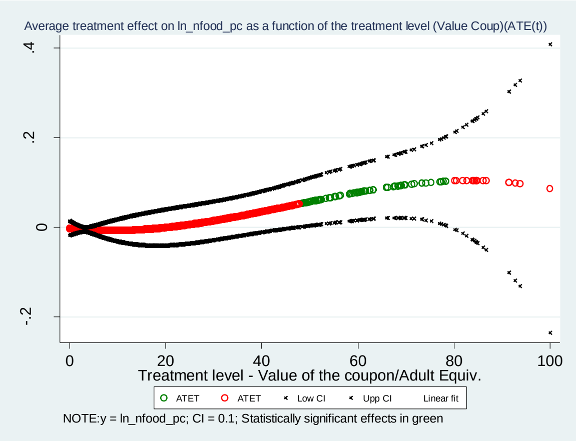
a) ATET on consumption per capita



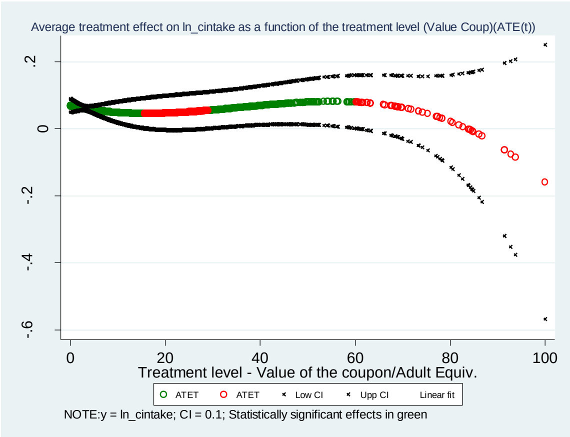
b) ATET on food consumption per capita



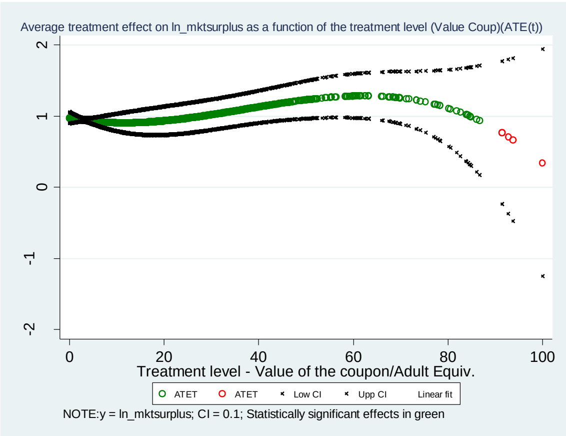
c) ATET on non-food consumption per capita



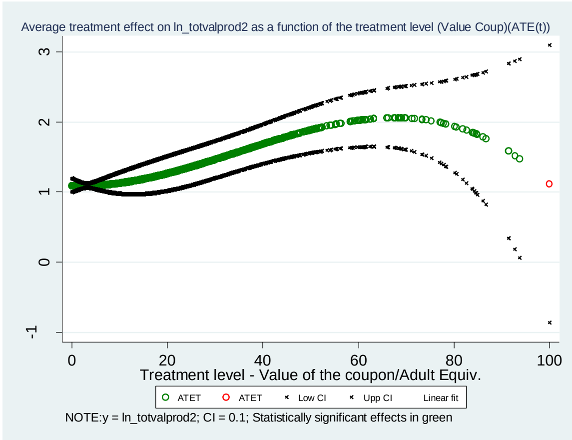
d) ATET on caloric intake per capita



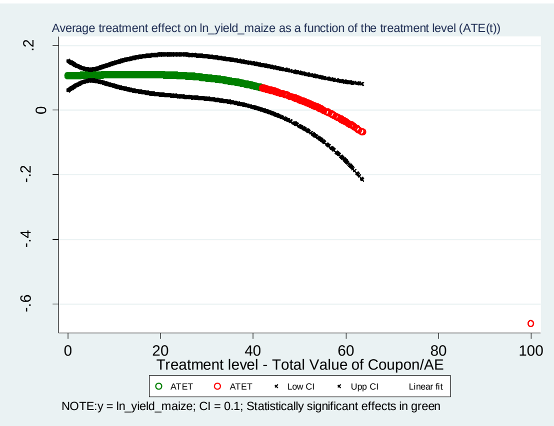
e) ATET on marketed surplus



f) ATET on total value of production



g) ATET on maize yield



h) ATET on harvested maize