Food and Agriculture Organization of the United Nations

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Adjusting the size of the social cash transfer to strengthen resilience to price shocks among small family farmers

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Adjusting the size of the social cash transfer to strengthen resilience to price shocks among small family farmers

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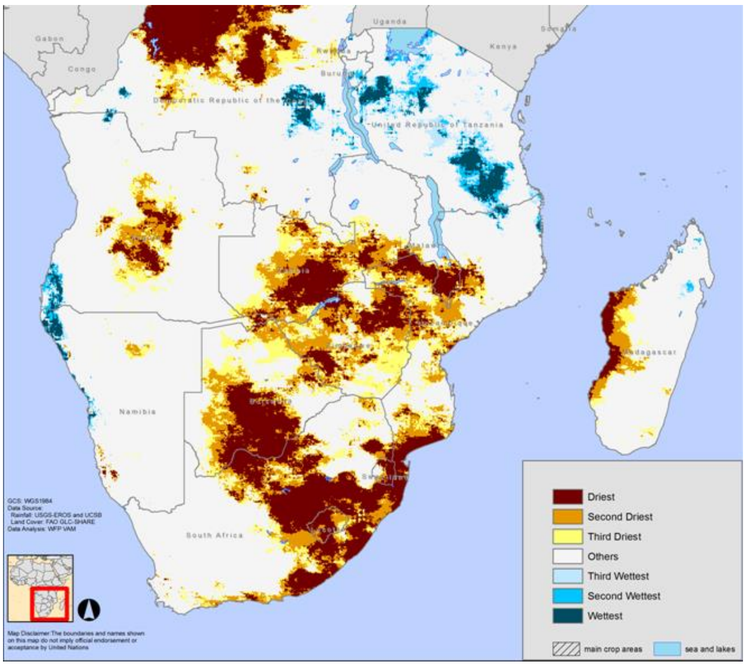
Highlights

- The El Niño-induced drought affecting southern Africa in 2015–2016 has triggered a rise of food prices in the region, especially those of cereals.
- The impact of the price increase of cereals is borne disproportionately by poorer and economically less endowed households.
- In order to maintain cereal consumption among vulnerable households in Zambia, every percentage increase in the price of cereals would have to be matched by a 0.2 percent increase in total income.
- Assuming that increases in total income were to come only from the Social Cash Transfer and that all other sources of income remained stable, the amount of the cash transfer would have to increase by 0.8 percent for every percentage point increase in the price of cereals.
- Since food inflation increased by 20 percent in February 2016 as compared with the previous year, the size of the Social Cash Transfer should be increased by 16 percent.

1. The regional context

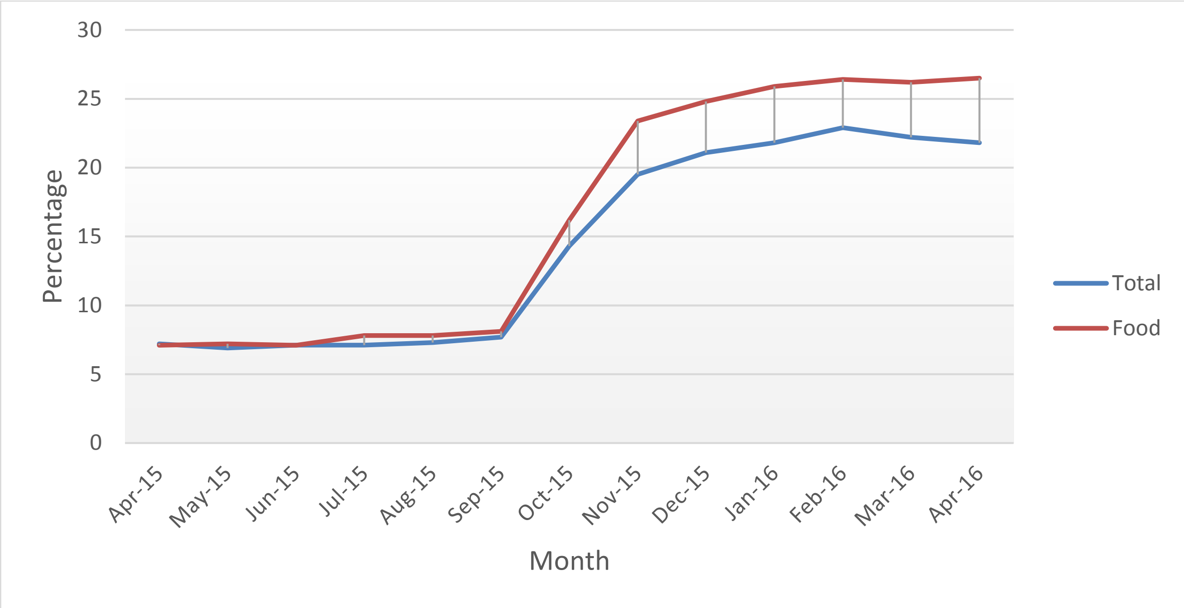
The El Niño weather phenomenon, one of the worst in 50 years, has caused an intense drought in southern Africa that is likely to have a huge impact on the region's food security (FAO, 2016). Across large parts of Botswana, Lesotho, Madagascar, Malawi, Mozambique, South Africa, Zambia and Zimbabwe, the rainy season has so far been the driest in the last 35 years (Figure 1). Much of the region has already experienced delays in planting and very poor conditions for early crop development and pasture regrowth. In many areas, planting has not been possible because of 30- to 50- day delays in the onset of seasonal rains, resulting in widespread crop failure. Seasonal forecasts from a variety of sources, such as the European Centre for Medium-Range Weather Forecasts, the Climate Prediction Centre and the United Kingdom Meteorological Office, among others, unanimously predict a continuation of below-average rainfall and above-average temperatures across most of the region for the remainder of the growing season. The combination of a poor 2014/15 season, an extremely dry early season (October to December) and forecasts for continuing hot and drier-than-average conditions through mid-2016, suggest a scenario of extensive crop failure in the region. Most small family farmers rely exclusively on rains for irrigation – thus their crop production is set to fail. This implies that these small family farmers will increasingly rely on food purchases during 2016 and into 2017. In this setting, changes in food prices will reduce these households' purchasing power and will have an impact on their consumption of food and other essential goods and services (e.g. health, education, etc.).

Figure 1 El Niño effect



Source: FAO, WFP-VAM based on CHIRPS v2.0 rainfall data.

Figure 2 **Total and food inflation in Zambia**



Source: Zamstats.

2. The context of Zambia

The main staple food in Zambia is maize, which is accessed through production and market purchases. In the last seven years, domestic demand for maize was fully satisfied by the country's own production, which was also partially exported to other countries in the region.[1] According to FAO's Global Information and Early Warning System on Food and Agriculture (GIEWS), under normal conditions harvesting of the main cereal crop should begin in April. However, due to the later-than-normal start of seasonal rains, which have delayed plantings, the bulk of the harvest is anticipated to begin only in late May. Since October, rains have been poorly distributed and below-average, particularly in southern areas, reflecting the influence of the prevailing El Niño episode. This has resulted in an overall reduction in cereal planting, especially in the worst affected southern and western provinces, and in delayed crop development as well.

The overall consumer price index (CPI), which refers to the general retail price level, shows an upward trend throughout 2015, as does the food CPI. However, the food CPI is significantly higher than the overall CPI. This implies that food prices are increasing at a higher rate compared with the overall basket that is being monitored. The accumulated inflation of the past 12 months reached 22.9 percent in February 2016; however, while the annual food CPI rose by 26.4 percent, the annual non-food CPI had a smaller 19.1 percent increase (Zambia CSO, 2016). Further, in its monthly bulletin of February 2016, the Zambia Central Office of Statistics reports that maize meal prices have kept

[1] National maize supplies in the 2015/16 marketing year (May/April), despite a 21 percent decrease in the 2015 output, were estimated to be more than adequate for domestic consumption requirements. This reflected the record crop of 2014 that reinforced grain stocks and resulted in large carryover supplies into 2015/16, estimated at close to 1 million tonnes. As a result, between May and October 2015 nearly 500 000 tonnes of maize were exported, the bulk of which was shipped to Zimbabwe.

increasing throughout the year and are currently above last year's average (Zambia CSO, 2016). Price increases have ranged from 17.6 percent for breakfast maize meal, to 21.4 percent for white roller maize meal, and 37.4 for white maize grain. This is probably only the beginning of a series of price increases at the retail level, as increases in wholesale prices may add further inflationary pressure to retail prices. Anecdotal evidence that has recently appeared in the press confirms the skyrocketing of mealie-meal prices.[2] This rise in food prices will likely reduce consumer purchasing power, leading to a deterioration of the food security situation in the country, especially among poor small family farmers who are net food buyers.

In 2003 the Ministry of Community Development and Social Welfare started the Social Cash Transfer (SCT) programme, targeting 159 labour-constrained households in Kalomo district. Since then, the programme has mutated into a national flagship social protection programme, increasing geographical coverage and number of beneficiaries, and implementing four different targeting models: labour-constrained, universal old-age pension, child grant (CG) and multiple categorical targeting (MCT) (Michelo, 2015). Some of these models have been extensively evaluated in recent years (AIR, 2013; AIR, 2014a; AIR, 2014b; Daidone *et al*., 2014). An evaluation of the targeting categories of each model (OPM *et al*., 2015) indicated that the incapacitated (labour-constrained) model had a higher correlation with poverty. Thus, the targeting was streamlined to focus only on the incapacitated household model.

The CG and MCT models mainly focus on households living in rural areas, for whom subsistence agriculture represents the main livelihood and who are likely to be affected by the El Niño-induced rise in the price of cereals. The data used in this report come from the household survey conducted for the impact evaluation of the CG model. However, the CG model has been terminated by the Government of Zambia, leaving the MCT scheme as the best candidate from which an increase in the transfer size would come. Therefore, ideally, the simulations in this study would need to come from the most recent MCT evaluation. Unfortunately, these data were unavailable to us. The two programmes provide a similar transfer size but differ in the targeting mechanism, which leads to the population of beneficiaries having different demographic profiles.[3] However, the two programmes had broadly analogous results on both the production side and – what is most important for this study – the consumption side (AIR, 2014a). The MCT and the CG provide a similar amount of cash, and the share of the transfer on a household's monthly consumption expenditure in the two programmes is also similar. As a result, our conclusions as to the amount of the top-up remain valid for the MCT, despite being based on the CG model evaluation data.

[2] A recent article appearing on 4 March in The Post pointed out that retail prices for mealie-meal in Lusaka have continued to increase to as high as K100, with some traders experiencing shortages of the commodity. See more at: http://www.postzambia.com/news.php?id=16255.

[3] The CG model targets households with at least one child under the age of five or disabled child under 14 years. The MCT model targets households satisfying one of the following conditions: a) households headed by women with at least one orphan; b) households headed by an elderly person with at least one orphan; and c) households with at least one disabled member.

3. Data and empirical strategy

3.1. Data

We used the 24-month impact evaluation data of the CG model of Zambia's SCT programme. The programme reached 20 000 ultra-poor households with children under five years of age in three districts (Shangombo, Kalabo and Kaputa). At the time of the baseline household survey (2010), beneficiary households received 55 Kwacha (ZMK) per month (around US$12) independent of household size. The amount was subsequently increased to 60 ZMK per month, which on average represented 27 percent of their monthly expenditure (Seidenfeld and Handa, 2011). The data allowed us to net out unmeasured time-invariant characteristics that may have affected outcomes (when comparing beneficiaries with the non-beneficiaries group) and helped us account for general trends in the value of the outcome. The data were acquired from the household and community questionnaires carried out in 2010 and 2012. It is important to note that special attention was paid to the process and timing of the data collection, making sure that it was culturally appropriate, sensitive to Zambia's economic cycle and consistently implemented. The data collection at baseline and follow-up were conducted during the same time of the year (between September and October) to avoid seasonal differences across the years. Importantly, given the objective and nature of the programme, these months represent the beginning of the lean season when households face the longest period without a food harvest. During this period the impacts of the programme are likely to be largest (Daidone *et al*., 2014).

The study for the impact evaluation of the CG is based on a randomized controlled trial (RCT) design that uses data drawn from households of 90 communities, who were phased into the programme. A sample of 28 eligible households was randomly selected from each of the 90 communities. This resulted in a final sample size at baseline of more than 2 500 households (Daidone *et al*., 2014). However, a few households were lost when carrying out the follow-up survey (8.8 percent). To avoid biased causal effect estimates due to attrition, we reweighed the sample to account for the non-random nature of the observed attrition, using inverse probability weighting (IPW).

3.2. Summary statistics

The CG model of the SCT provided an unconditional cash transfer to extreme poor households with 95 percent of the beneficiaries falling below the national extreme poverty line. Such households have low levels of consumption and a marginal propensity to consume close to 1 (every additional monetary unit is spent). Hence the cash transfer was expected to have an immediate impact on basic needs such as food, clothing and shelter. Table 1 shows the sample average of several covariates by treatment arm. We note that the sample is balanced across groups, as the majority of the cross-group differences in observed characteristics are not statistically different at the conventional 10 percent significance level.

Table 1 Baseline household characteristics

	Treatment	Control	Total	Diff
Age of household head	29.930	29.530	29.730	0.400
Head is a widow	0.050	0.060	0.060	-0.003
Head is single	0.250	0.280	0.270	-0.030
Number of males	2.660	2.680	2.670	-0.013
Number of females	3.090	2.940	3.020	**0.146**
Number of members	5.760	5.620	5.690	0.134
Number adult equivalent	4.300	4.190	4.240	0.109
Number of orphans	0.330	0.340	0.330	-0.012
Years of education of head	4.290	3.760	4.030	**0.536**
Highest level of education	6.540	6.060	6.300	0.479
Dependency ratio	1.660	1.750	1.710	-0.096
Operated land (hectares)	0.500	0.470	0.490	0.031
Total TLU	0.440	0.280	0.360	0.164
Observations			2,298	

Note: Bold figures indicate a statistically significant difference below the 10 percent level.

4. Findings

4.1. Supply

This section shows estimation results for supply elasticities, i.e. the percentage change in the supply of a commodity (maize, millet, sorghum, roots, legumes, rice) due to a 1 percent change in its own price (own-price elasticity) or in the price of other commodities (cross-price elasticities). The estimate in row *r* and column *c* refers to the percentage change in the supply of good *r* to a 1 percent change in the price of good *c*. Hence, the diagonal elements refer to own-price elasticities, while the off-diagonal elements are the cross-price elasticities.

Table 2 provides an outlook of the supply elasticities for the beneficiaries, where the element in the first row and in the first column shows that a 1 percent increase in the price of maize leads to a decrease in maize production of 0.384 percent. The entry in the first row and in the fifth column shows that a 1 percent increase in the price of legumes would make this commodity relatively more profitable for farmers to grow compared with maize, as the production would therefore fall by 0.124 percent. On the other hand, production of roots that comprise cassava and sweet potatoes appears to be complementary to maize.

Table 2 Supply elasticities for treatment group

	Maize	*Millet*	*Sorghum*	*Roots*	*Legumes*	*Rice*
Maize	**-0.384**	0.010	0.006	0.271	-0.124	0.050
Millet	-0.693	**0.494**	0.016	0.132	0.026	-0.018
Sorghum	-0.666	0.056	**0.342**	-0.013	-0.050	0.020
Roots	-0.580	0.016	-0.301	**0.294**	0.006	0.227
Legumes	-0.516	0.109	-0.112	0.159	**0.213**	0.045
Rice	-0.823	-0.024	0.256	0.207	0.109	**0.610**

Similar elasticities were found for the non-beneficiaries (Table 3), with a greater decrease in maize production (0.557 percent) when its own price increases by 1 percent. Likewise, there is a greater increase in maize production when the price of roots increases by 1 percent.

Table 3 Supply elasticities for control group

	Maize	*Millet*	*Sorghum*	*Roots*	*Legumes*	*Rice*
Maize	**-0.557**	0.016	-0.020	0.269	-0.030	0.255
Millet	-0.679	**0.541**	-0.138	0.140	0.043	0.051
Sorghum	-1.002	-0.795	**0.277**	-0.078	-0.116	-0.046
Roots	-0.582	0.020	0.167	**0.410**	-0.022	0.145
Legumes	-0.617	0.184	-0.315	-0.064	**0.347**	0.082
Rice	-0.617	0.010	0.130	-0.103	-0.019	**0.709**

The most notable difference between the CGP beneficiary and non-beneficiary groups concerns the opposite signs in the cross-price elasticities of maize, millet and roots with respect to sorghum. We also note that beneficiaries have lower own-price elasticities, although for both groups the magnitudes are very close to zero, and most importantly within the (-1,1) range. Therefore, we conclude that the supply is mainly inelastic. The reason for this may be the low degree of commercialization among smallholders.[4] Households may be unable to produce enough for their own needs and may not want to sell anything in the face of price increases. When small family farmers do not engage in market transactions but tend to be self-sufficient, it is harder for changes in market price to translate into production stimuli.

4.2. Demand

Tables 4 and 5 illustrate the price elasticities of demand for the CGP beneficiaries and for the non-beneficiary groups, respectively. The main diagonal refers to own-price demand elasticities, while the off-diagonal elements are the cross-price elasticities. In contrast to what we did for the supply analysis, here we considered market prices at the community level. We used food groups previously presented that are associated with food security and nutrition indicators in the AIR report (2013).

Table 4 shows that a 1 percent increase in the market price of cereals translates into a -0.881 percent decrease in consumption. The same price change is also associated with a smaller decrease in consumption of animal products, inclusive of fish, chicken and beef (-0.163), of dairy (-0.220), and of fats (-0.190). On the other hand, the increase in cereal prices also causes households to substitute away by increasing the consumption of roots and tubers (+0.245) and of fruits and vegetables (+0.058).

Table 4 **Demand elasticities for treatment group**

	Cereals	Roots and tubers	Animal products	Dairy	Fruits and vegetables	Legumes and pulses	Sweets	Fats
Cereals	**-0.881**	0.245	-0.163	-0.220	0.058	-0.027	-0.035	-0.190
Roots and tubers	-0.057	**-1.542**	0.020	0.816	-0.200	-0.120	-0.090	0.637
Animal products	0.000	-0.214	**-0.902**	0.019	0.117	-0.106	-0.205	-0.069
Dairy	-0.936	0.779	-0.171	**-4.392**	0.557	0.775	1.616	-1.146
Fruits and vegetables	-0.143	0.007	0.003	-0.074	**-1.083**	0.054	0.095	-0.115
Legumes and pulses	-0.459	-0.620	0.575	-0.825	0.281	**-0.923**	-0.046	-0.086
Sweets	-0.509	0.096	0.481	-0.072	0.115	0.000	**-1.195**	-1.303
Fats	-0.304	-0.294	0.323	-0.163	0.064	0.103	0.022	**-1.390**

[4] At baseline, only 22 percent of households were engaged in a market transaction for their output. The CG brought about a large increase in the share of households selling their produce, with an increase of 12 percentage points. Despite being relatively large (50 percent compared with the base), the number of farmers involved in a commercial transaction is still low in absolute terms.

Results for the control group are very similar to those of the CGP treatment group, with own-price elasticities being rather equivalent, including those of roots and tubers and of animal products. It may be that the cash transfer is not large enough to substantially influence the behavioural parameters of the consumption function. Moreover, own-price elasticities are very small (almost unity), except for dairy products. We also note that the cross-price elasticity with respect to a one percent increase in the price of cereals (first column) is higher for the control group.

Table 5 Demand elasticities for control group

	Cereals	Roots and tubers	Animal products	Dairy	Fruits and vegetables	Legumes and pulses	Sweets	Fats
Cereals	**-1.051**	0.297	-0.192	-0.343	0.141	0.201	0.008	-0.033
Roots and tubers	-0.058	**-1.585**	0.460	0.582	-0.374	-0.391	-0.214	0.106
Animal products	0.360	-0.141	**-1.045**	-0.171	0.035	0.402	-0.136	-0.343
Dairy	-1.826	1.307	-1.766	**-3.768**	0.524	0.612	-0.085	1.414
Fruits and vegetables	0.180	-0.180	-0.104	0.087	**-0.877**	-0.506	0.164	-0.118
Legumes and pulses	-0.571	-0.023	-0.141	-0.407	-0.057	**-0.703**	0.043	0.016
Sweets	-0.421	-0.279	0.297	0.292	0.037	0.983	**-1.313**	-0.467
Fats	-0.215	-0.115	0.068	0.164	-0.015	0.142	-0.336	**-1.197**

Finally, Table 6 shows the overall demand elasticities using the whole pooled baseline follow-up data. We see that due to the very small difference between beneficiaries and non-beneficiaries, the full sample gives us similar results – i.e. small own-price elasticities (close to unity) – only to note that the roots and tubers group has a slightly bigger negative elasticity, and dairy a decent but also negative elasticity.

Table 6 Demand elasticities, full sample

	Cereals	Roots and tubers	Animal products	Dairy	Fruits and vegetables	Legumes and pulses	Sweets	Fats
Cereals	**-0.956**	0.270	-0.177	-0.264	0.100	0.031	-0.045	-0.148
Roots and tubers	0.010	**-2.729**	0.748	1.782	-0.771	-0.626	-0.315	1.116
Animal products	0.187	-0.143	**-0.975**	-0.084	0.073	0.023	-0.145	-0.217
Dairy	-0.107	0.071	-0.071	**-1.184**	0.031	0.054	0.064	-0.008
Fruits and vegetables	-0.029	-0.152	-0.006	-0.020	**-0.998**	-0.082	0.167	-0.043
Legumes and pulses	-0.615	-0.153	0.169	-0.487	0.125	**-0.875**	-0.097	-0.076
Sweets	-0.547	-0.060	0.388	0.236	0.129	0.131	**-1.454**	-1.191
Fats	-0.329	-0.161	0.152	0.058	0.010	0.092	-0.140	**-1.299**

When a large price elasticity is observed, it is evident that households are not vulnerable to increases in the price of a given commodity (Deaton, 1997); therefore, an elasticity close to unity implies that households struggle to switch from one food group to another. In our context, a price elasticity higher than unity implies that the percentage reduction in quantities consumed will be higher in magnitude than the percentage increase in price, leading to a reduction in the expenditure on that commodity. On the other hand, households with less than unity in price elasticity will be unable to substitute away from the good as it becomes more expensive, and will have to increase expenditure on the good. This would place households in an even more vulnerable position, as they are already allocating 75 percent of their total expenditure to food consumption.

4.3. Expenditure

An increase in income does not necessarily translate into an equal increase in expenditure, which in our case is consumption of a certain commodity. The expenditure elasticity of demand indicates a change in the quantity demanded of a good for a given change in total expenditure. Expenditure elasticity is often used as a proxy for income elasticity, as it is easier to obtain a reliable estimate for total expenditure from household surveys than for total income.

Table 7 shows estimates of expenditure elasticities for the food groups considered in this report. This shows that an increase of 1 percent in expenditure produces a 0.824 percent increase in consumed cereals. The expenditure elasticity of roots and tubers for the beneficiaries is negative, which in theory may indicate that this commodity behaves like an inferior good in our context – i.e. as income increases, households decreases its consumption while moving expenditure towards more nutritious food, such as dairy and animal products.

Table 7 **Expenditure demand elasticities for CGP treatment and control groups**

	Cereals	Roots and tubers	Animal prod.	Dairy	Fruits and vegetables	Legumes and pulses	Sweets	Fats
Treatment	0.902	-1.727	3.869	3.301	2.513	2.829	5.659	1.388
Control	0.468	2.106	3.612	4.040	1.152	3.289	3.068	0.411
Total	0.824	0.123	3.522	3.673	1.539	3.027	5.441	0.912

The rest of our analysis is dedicated to tracing a profile of the households that are most vulnerable to an increase in the price of cereals. To do so, we computed the own-price cereal demand elasticity for each household and compared the characteristics of the households with price elasticities below (more vulnerable) and above the average (less vulnerable). Figure 3 shows a scatter plot of the household-level own-price elasticity of cereal demand vs the own-price elasticity of maize supply. The red lines represent the average price elasticity of demand (horizontal) and the average price elasticity of supply. Most of the sample lies close to the threshold. The average price elasticity of demand splits the sample

in half. According to Ulimwengu and Ramadan (2009), the losers of a food price increase are those households with a below-average demand elasticity and a below-average profit elasticity (here we use the supply elasticity instead of the profit elasticity). Hence, households with a low price elasticity of demand are the most vulnerable to price shocks, and households with a low price supply elasticity are less likely to benefit from a price increase.

Figure 3 **Household level demand elasticities for cereals vs supply elasticities of maize**

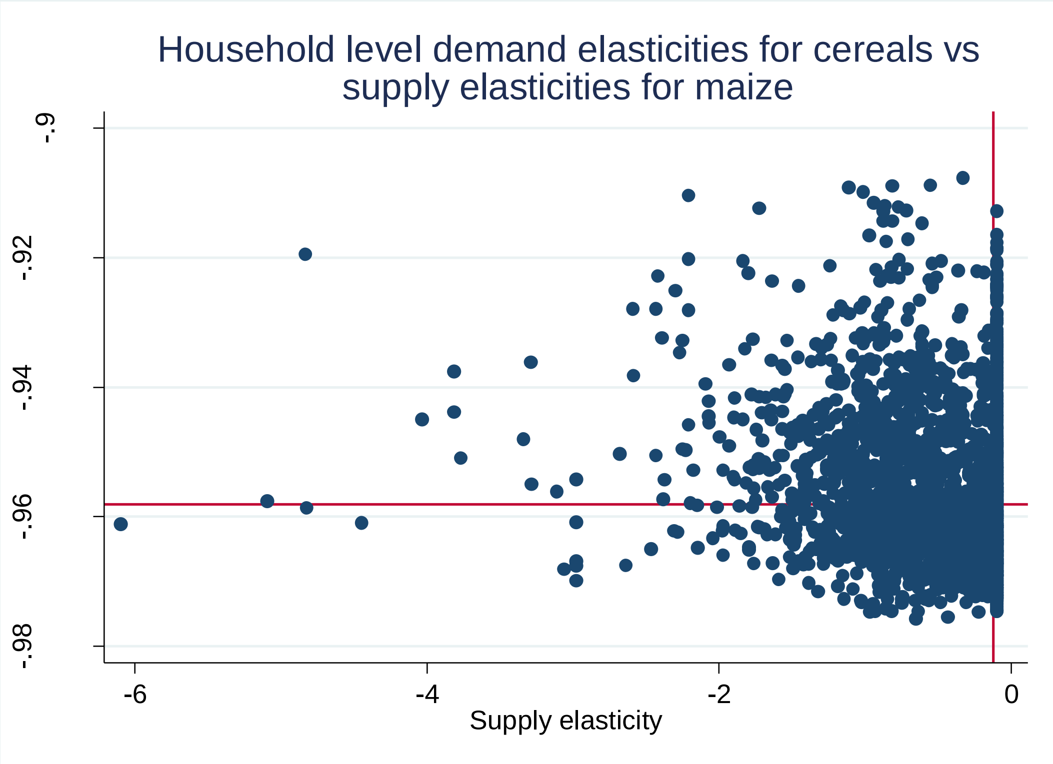


Table 8 shows the baseline characteristics divided into two groups: households with high and low demand elasticity, where the more vulnerable (with low demand elasticity) feature significant differences related to operated land, distance to the market and number of orphans. They also have an older and less educated head of household, a higher dependency ratio, and considerably less land and livestock relative to the less vulnerable group (with high demand elasticity). In addition, they are more likely to be widow-headed and single-headed. This finding clearly indicates that the most vulnerable households are less endowed with factors of production (land, livestock and labour).

Table 8 Demand elasticity and household characteristics

	High demand elasticity	Low demand elasticity	Diff
Treatment	0.53	0.52	0.00
Age of head	28.35	30.85	**2.31**
Head is a widow	0.00	0.10	**0.10**
Head is single	0.22	0.28	**0.06**
Household size (adult equivalents)	4.28	4.32	0.04
Number of orphans	0.00	0.57	**0.58**
Years of education of head	4.72	3.59	**-1.18**
Highest level of education	6.89	6.00	**-0.920**
Dependency ratio	1.58	1.79	**0.20**
Operated land (hectares)	0.95	0.32	**-0.608**
Total tropical livestock units	1.67	0.09	**-1.53**
Nearest market (km)	38.31	14.84	**-22.56**
Kaputa district	0.00	0.49	**0.50**
Kalabo district	0.58	0.24	**-0.35**
Shangombo district	0.42	0.27	**-0.16**
Labour-unconstrained	0.73	0.63	**-0.09**
Moderately labour-constrained	0.24	0.33	**0.09**
Severely labour-constrained	0.03	0.04	0.00
Negative shock	0.00	0.43	**0.44**

Note: Bold indicates that they are significant at $p < .10$.

4.4. Price shock simulations

Income support measures can help to counteract a fall in consumption resulting from the erosion of purchasing power caused by inflation in food prices. In microeconomic theory, the impact of price changes on consumer welfare is generally analysed by the compensating variation (CV) method (Deaton, 1989), which represents the amount of money required to reimburse a household after a price change so that it can keep the same level of utility as before the change occurred.[5]

As shown in Table 9, the CV indicates that an increase in the price of cereals by 20 percent requires a 4 percent increase in income to keep utility unchanged for the full sample (4.2 and 3.7 percent for the treatment and control groups, respectively). Hence, the required average increase in total income for every 1 percent increase in the price of cereals is 0.2 percent. Assuming that this increase was to come only from exogenous transfers the SCT in the case of Zambia, the amount of the transfer would have to increase by 0.8 percent for every percentage point increase in prices in order to keep utility from falling.[6]

[5] The compensating variation for a simulated increase in the price of cereals (+5, 10, 15 and 20 percent) is computed using formula 10 in the methodological appendix.
[6] Multiplying the average income required for every 1 percent change times the size of the cash transfer represented by the percentage of monthly expenditure (which is 27 percent).

We have estimated the impact of each of the simulated cereal price increases on three chosen poverty indicators: the head count ratio (HCR), the poverty gap (PG) index and the Sen Poverty Index. The HCR is the percentage of the population living below the poverty line. The Sen Poverty Index considers simultaneously the HCR and the poverty gap (PG) – i.e. the mean income shortfall with respect to the poverty line, expressed as a percentage of the poverty line – while taking into account the underlying distribution throughout the Gini coefficient of the income distribution of the poor. The higher the percentage/index, the worse the poverty outcome. The individual poverty line here is set at US$1.90 a day (2011 PPP). The HCR and the Sen Poverty Index are first computed for the actual prices and incomes (benchmark scenario). After the shock, households face a new poverty line, which is household-specific and obtained by adding the amount of the compensating variation for each household to the original poverty line. We use this new poverty line to assess the impact of a price shock on poverty.

Table 9 shows welfare changes in the three poverty indicators when price shocks of 5, 10, 15 and 20 percent are introduced. In the case of the HCR, there are consistent jumps when the price is increased by 5, 10, 15 and 20 percent (from 0.845 to 0.852, to 0.857, to 0.861 and finally to 0.864) for the treatment group. Similar but smaller leaps can be seen for the control group (average of 0.003 percentage points - pp.). The Sen Poverty Index shows a similar trend, with a bigger upturn from the benchmark to 5 percent for the CGP beneficiaries and non-beneficiaries. Most of the changes in the poverty indicators occur for smaller price variations, because for higher price variations households adapt their consumption choices.

Table 9 Impact of simulated cereal price shocks on poverty measures

	Benchmark	5% shock	10% shock	15% shock	20% shock
Treatment					
HCR	0.845	0.852	0.857	0.861	0.864
PG	0.438	0.442	0.446	0.450	0.454
Sen	0.532	0.539	0.544	0.549	0.553
CV		0.011	0.022	0.032	0.042
Control					
HCR	0.892	0.894	0.897	0.899	0.900
PG	0.503	0.514	0.517	0.520	0.523
Sen	0.605	0.613	0.617	0.620	0.622
CV		0.010	0.020	0.029	0.037
Full sample					
HCR	0.870	0.876	0.879	0.883	0.886
PG	0.476	0.480	0.484	0.488	0.491
Sen	0.575	0.580	0.585	0.590	0.594
CV		0.011	0.021	0.030	0.040

5. Conclusions and policy implications

The region of southern Africa has experienced considerable price increases in the last twelve months or so as a result of the El Niño phenomenon. The effects of the El Niño are known to adversely affect agriculture, and Zambia has been no exception after seeing a significant drop in its maize production in 2015. The country is, however, in a better position to avoid catastrophic effects such as starvation thanks to good maize harvests in the past. The El Niño-induced drought is directly affecting the level of prices and the income-generating means of households, such as crop production either for own consumption or commercialization. Moreover, this year's poor harvest is affecting household access to cash and in-kind payments that are usually earned through harvesting labour activities during this time. The widespread drought that affected crop production across the region has also significantly affected better-off households who normally provide labour opportunities for poor households in most countries in the region. This is currently depressing income earnings by poor households during a time of the year when households are atypically relying on market purchases for their staple foods.

Regardless of the causes of food price inflation, its most unwelcome effect is clear: a decrease in the consumption of staple foods. Rising food prices reduce consumer access to food. This effect is most severe among poor households, who spend a higher share of their income on food. This is a stylized fact, as in a sample of nine developing countries, 88 percent of rural and 97 percent of urban poor households were net buyers of food (FAO, 2008).

The increasing trend of cereal price has significant implications regarding the supply of food grains as well as feed grains. On the demand side, the price increases for cereals may pose an immediate threat to the country's food security as the purchasing power of poor households is quickly eroded. As a result, it becomes imperative for policies and programmes to respond to the food price shock through measures that are able to counteract the rise in food prices. One possible way to do so is through shock-responsive social protection tools. In our analysis we suggest that adjusting the amount of cash transfer that is currently provided to part of the population, through the SCT, by providing a top-up, would help beneficiaries keep their consumption stable offering them protection from the current shock.

The simulated demand system illustrates the effects of an increase in the price of food commodities, suggesting that if there is a decrease in the total demand for food commodities, Zambia's SCT would help to maintain its current level of consumption. In practical terms we observed that, in order to maintain household utility unchanged, every percentage increase in the price of cereals would need to be matched by a 0.2 percent increase in total income. If increases in total income were to come only from the exogenous component given by the cash transfer while other sources remained stable, the amount of the cash transfer would have to increase by 0.8 percent for every percentage point increase in the price of cereals.

The supply side is generally inelastic (below unity). Demand elasticities are near unity for the most important food groups. As expected, cereals, roots, and fruits and vegetables have smaller own-price elasticities than other food categories, as these are the goods that households rely most heavily on. In the vulnerability analysis we show that the least vulnerable households to price shocks are the ones

that get the cash transfer, offering a clear indication on possible policy actions aimed at countering price increases.

Economic impacts associated with the changes in own prices, cross-prices and household expenditure are yet to be analysed in a wider picture, since this study is limited to the information collected through household surveys (baseline and follow-up) for the purpose of the CG, which targets a specific profile of households and is not country-representative.

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Methodological appendix

The purpose of the proposed evidence generation is to inform the emergency response to the drought-induced increases in food prices. More specifically, this will involve determining the required increase in the size of cash transfer provided via the SCT programme to smoothen beneficiaries' consumption throughout the above-described price increases.

This will be done by quantifying the probable decline in food consumption as a result of the price increases across different parts of the population. In theory, the overall price effect on household consumption comprises the traditional price effect whereby household demand decreases as a result of a price increase, and a supply effect that may lead to an increase in household production and possibly consumption.

To evaluate both demand and supply responses to a given increase in the price of different commodities, we focused on cereal commodities such as maize, millet, sorghum, roots (cassava and sweet potato), legumes (mainly beans) and rice for the supply; and on food diversity groups classified in cereals, roots and tubers, animal products, dairy, fruits and vegetables, legumes and pulses, sweets and oils, and fats and oils for the demand.

We will assess both the demand response and the supply response to a given increase in the price of different commodities. To do so, we will adopt the Augmented Multimarket Approach proposed by Ulimwengu and Ramadan (2009) and Zheng and Rastegari (2010). The multimarket framework incorporates both the production and the consumption sides. We will estimate own- and cross-price supply elasticities from a system of commodity groups representing the staple commodities in Zambia. An increase in agricultural prices would normally create an incentive for farmers to produce more and would increase both the value of production and value of income from sales. On the demand side, we will estimate own- and cross-price demand elasticities from a quadratic Almost Ideal Demand System (AIDS) of main commodity groups. The aim of the latter estimation is to gauge by how much consumption may decrease in each food category given an increase in prices.

Considering a sequential, basic decision-making process model of an agricultural household where the production decisions are determined by maximizing agricultural profit, subsequently the consumption is determined by estimating a complete demand system (Singh *et al*., 1986). Assuming a multi-output and multi-input household producer, a given household that produces n outputs using m inputs chooses the optimal level of output i (y_i) and input j (x_j) to maximize a profit function, given the output prices p_i $i = \{1..n\}$ and the input prices q_j $j = \{1..m\}$:

$$\pi(p, x) = \sum_{i=1}^{n} p_i y_i - \sum_{j=1}^{m} q_j x_j \quad (1)$$

Assuming a logarithmic functional relationship between profits and the vector of output prices and input quantities, we can maximize the above profit function with respect to the output prices and the fixed quantities of inputs. This process yields the following output and fixed input share equations:

$$S_i = a_{i0} + \sum_h a_{ih} lnp_h + \sum_j c_{ij} lnx_j + \varepsilon_i \quad (2)$$
$$R_j = b_{j0} + \sum_k a_{jk} lnx_k + \sum_i c_{ij} lnp_j + \omega_j$$

Where S_i is the share of the output i in the revenue while R_j is the share of input j in the total cost, and the constant terms are modelled as linear indexes of observed characteristics as $a_{i0} = X'\beta_S$ and $b_{j0} = X'\beta_R$ and X includes a column of ones. We control for household size in adult equivalents, female headship (widow, age, single level of education), number of orphans, highest level of education in the household, dependency ratio, area of operated land, tropical livestock units (TLU), and distance in kilometres to the nearest food market. In order to identify all the parameters, some cross-equation constraints need to be imposed on system (2): specifically, adding up constraints, homogeneity constraints and symmetry constraints (see Ulimwengu and Ramadan, 2009; Wadud, 2006).

We compute the elasticity of commodity i with respect to price of commodity h by the following standard formula that uses the share of the outputs and estimated coefficients of system (2):

$$es_{ih} = S_h + \frac{a_{ih}}{S_i} - \delta_{ih} \quad (3)$$

Where δ_{ih} is the Kronecker delta, which is unity if $i = h$, and zero otherwise ($\delta_{ih} = 1[i = h]$).

As pointed out earlier, we augment the traditional multimarket approach with demand elasticities derived from the AIDS, based on expenditure function (Deaton and Muellbauer, 1980). For the estimation of the AIDS and the related compensated and uncompensated demand elasticities, we follow Lambert *et al*. (2006). The presentation here is brief; for an in-depth analysis of consumer behaviour and demand-system analysis, see the classic monographs by Deaton and Muellbauer (1980). We consider a consumer's demand for a set of *k* goods for which the consumer has budgeted *m* units of currency. The quadratic AIDS model of Banks, Blundell and Lewbel (1997) is based on the indirect utility function:

$$lnV(\boldsymbol{p}, m) = [\left\{\frac{lnm - lna(\boldsymbol{p})}{b(\boldsymbol{p})}\right\}^{-1} + \lambda(\boldsymbol{p})]^{-1} \quad (4)$$

Where $\boldsymbol{p}$ is a vector whose i-th element is p_i, the price of good i for i = 1, . . . , k, $\ln(a(\boldsymbol{p}))$ is a transcendental price index given by the linear combination of the commodities price and all their possible interactions, $b(\boldsymbol{p}) = \prod_{i=1}^{k}(p_i)^{\beta_i}$ and $\lambda(\boldsymbol{p}) = \lambda_i lnp_i$. Lowercase Greek letters represent parameters to be estimated. Let Q_i denote the quantity of good *i* consumed by a household, and define the expenditure share for good i as $w_i = p_i Q_i$/m. Applying Roy's identity to (1), we obtain the expenditure share equation for good *i*:

$$w_i = \alpha_i + \sum_{j=1}^{k} \gamma_{ij} lnp_j + \beta_i \ln\left(\frac{m}{a(\boldsymbol{p})}\right) + \frac{\lambda_i}{b(\boldsymbol{p})}\left[\ln\left(\frac{m}{a(\boldsymbol{p})}\right)\right]^2 \quad i = 1,2..k \quad (5)$$

When λ_i= 0 for all *i*, the quadratic term in each expenditure share equation drops out, and we are left with Deaton and Muellbauer's (1980) original AIDS model.

Sociodemographic variables are typically incorporated into demand system analysis via demographic translation. Demographic translation assumes that the constant terms in the share equations vary

across households and that this can be expressed as a linear function of sociodemographic variables. So instead of $\alpha_i$we will have a linear combination of H covariates, $\sum_{j=1}^{H}\alpha_{ij}X_{ij}$.

This set of expenditure share equations requires nonlinear system estimation techniques because of the price index $lna(\boldsymbol{p})$. Therefore, we consider a linear approximation based on the Stone index as in Moschini (1995). Instead of using the translog $\ln(a(\boldsymbol{p}))$, we replace it with $lna^*(\boldsymbol{p})$

$$\ln\big(a^*(p)\big) = \sum_{i=1}^{n}\overline{w}_i\ln(p_i) \qquad (6)$$

where $\overline{w}_i$ is the average budget share of good *i* over all households. Second, we set $b(\boldsymbol{p})$=1 to avoid nonlinearity in the $b(\boldsymbol{p})$. These two assumptions make our system of equations linear in parameters.

The demand estimation employs the consistent two-step estimation procedure for a system of equations with limited variables, proposed by Shonkwiler and Yen (1999), to account for zero expenditure shares from missing values or zero expenditure. The first step involves a probit regression to determine the probability of consuming each commodity. The explanatory variables used in the estimation are demographic variables, logarithms of prices for the commodities described above and household income, controlled with negative shocks and wages at the community level. From the probits the standard normal cumulative distributions (cdf) and the standard normal probability density function (pdf) are calculated for each commodity related to each household. For this model the specifications are as follows:

$$E[\,BS_{ih}] = \Phi({z'}_{ih}\kappa_i)w_{ih} + \theta_i\,\varphi({z'}_{ih}\kappa_i) \qquad (7)$$

where *h* indexes households. Equation (7) provides the basis for the censored quadratic AIDS budget share system.

Finally, we present the formulas for the elasticities for the quadratic AIDS model with demographic variables. The uncompensated (Marshallian) price elasticity of good *i* with respect to changes in the price of good *j* is

$$ued_{ij} = \frac{\mu_{ij}}{E[BS_i]} - \delta_{ij} \text{ where } \mu_i = \frac{\partial E[BS_i]}{\partial\ln(p_j)} \text{ and } \delta_{ij} = 1[i=j] \qquad (8)$$

The expenditure (income) elasticity for good *i* is

$$xed_i = \mu_i/E[BS_i] + 1 \text{ where } \mu_i = \partial E[BS_i]/\partial\ln(m) \qquad (9)$$

Compensated (Hicksian) price elasticities are obtained from the Slutsky equation as

$$ced_{ij} = ued_{ij} + xed_iE[BS_j]\ .$$

If the own-price elasticity of demand is equal to 1 (*ed* = 1) the demand is defined as being unit elastic; on the other hand, if the demand is defined as being *ed* > 1 it is elastic, and inelastic if *ed* < 1. Thus, *ed* = 1 means that a price increase of 1 percent will reduce demand for a good by 1 percent. The expense on a good will, however, remain the same when the demand is unit elastic. If the demand is inelastic and there is a price increase, the decrease in the purchased quantity will be

relatively smaller than the increase in price – hence the consumer's total expense for the good in question will increase. For a price increase of a good where the demand is elastic, the opposite will be the case.

The compensating variation represents the amount of money required to compensate the household after a price change occurs, such that the household keeps the same level of utility as before the change in price. The compensating variation per household is computed here as a second-order Taylor series expansion approximation (Friedman and Levinsohn, 2002):

$$\Delta \ln(CV_h) \approx \sum_{i=1}^{n} w_{ih} \Delta \ln(p_{ih}) + 0.5 \sum_{i=1}^{n} \sum_{i=1}^{n} w_{ih} ued_{ij} \Delta \ln(p_{ih}) \Delta \ln(p_{jh}) \qquad (10)$$

For further analysis we estimate three arbitrary scenarios of price shocks to show how households would face a negative price shock with respect to poverty indicators. First, we estimate an individual-specific poverty line by adding the amount of the compensating variation for each individual to the original poverty line.[7] We use this new poverty line to assess the impact of a price shock on welfare using three poverty indicators: (i) the head count ratio (HCR); (ii) the poverty gap (PG) index; and (iii) the Sen (1976, 1997) Poverty Index. The HCR is the percentage of the population living below the poverty line. The PG is the mean income shortfall with respect to the poverty line, expressed as a percentage of the poverty line (households above the poverty line are not considered): $PG = 1/G \sum_{i=1}^{G} (\frac{p - y_g}{p})$, where G is the total population of poor, p is the poverty line and y_g is the income of poor household g. The Sen Index considers simultaneously both the HCR and the PG while taking into account the underlying distribution throughout the Gini coefficient of the income distribution of the poor. The higher the percentage/index, the worse the poverty outcome: Sen = HCR [PG + (1 – PG) Gini].

[7] The poverty line is defined as individuals living under US$1.9 adjusted to Zambia's PPP according to the World Bank, which is estimated by multiplying the adult equivalents per household.

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FAO, together with its partners, is generating evidence on the impacts of social protection on poverty reduction, food security, nutrition and resilience and is using this to provide related policy, programming and capacity development support to governments and other actors. Countries include Kyrgyzstan, Lebanon, Lesotho, Malawi, Rwanda, Senegal, Zambia, Zimbabwe.

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