Impact of El Niño on Staple Food Prices in East and Southern Africa

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PRELIMINARY DRAFT

1 Overview of the effects of El Niño in East and Southern Africa

This paper presents evidence on the impact of the El Niño-Southern Oscillation (ENSO) phenomenon on staple food prices in East and Southern Africa, highlighting differences across markets within these regions in relation to geography and market access and pointing to its lagged effects. These findings contribute to strengthening capacities for early warning of vulnerability to food insecurity in these regions.

El Niño, a recurrent warming of the central and eastern Pacific's intertropical waters, typically causes a shift in rainfall patterns worldwide resulting in important, yet mixed effects on agricultural production and local and international agricultural prices. With El Niño, rainfall normally increases in the southern United States and South America, whereas Central America, Indonesia, Australia, India, and South Africa tend to experience dry spells. Because some of those countries and regions produce and exports large amounts of food commodities, El Niño translates into fewer exports and higher export prices. Research showed statistically and economically significant effects on international food commodity prices with abnormally high prices, especially eight to 16 months after the onset of El Niño (see Brunner, A.D. El Niño and world primary commodity prices: Warm water or hot air? *The Review of Economics and Statistics*, February 2002, 84(1): 176 – 183.) El Niño events tend to occur every four to seven years and to last 12 to 18 months. They typically peak towards the end of the calendar year.

El Niño generally brings about anomalous rainfall throughout Africa (see Figures 1 through 3, based on various measures). El Niño events usually coincide with above-average precipitation in the Horn of Africa and in Central Africa, although there are exceptions. In Southern Africa, the tendency is for El Niño to be associated with below-average precipitation, especially in the eastern part of the region. Other regions of Africa are also concerned, albeit to a lesser extent. The Gulf of Guinea region of West Africa tends to experience dryer-than-normal weather, whereas the Sahel region may receive more precipitation than normal. However, there are large variations from one El Niño event to another, and within region, there are significant differences as well.

During El Niño events, rainfall tends to be above-normal in most of East Africa—especially during the October-December period and in the eastern and central parts of this region (see Figure 4). However, some areas are generally unaffected, and others affected by below-normal rainfall (the western part of Ethiopia, parts of Sudan, and areas of western Kenya notably) or early cessation of rainy seasons. For instance, in Ethiopia and in parts of Sudan in 2009, rainfall during the June – September rainy season was poor, erratic, and ceased earlier than normal, which led to a poor *meher* harvest in October – December.

Additional rainfall can be beneficial to East Africa as it is chronically subject to drought conditions. It brings about a rise in cereal production in the Lake Victoria basin and in flood-recession cropping areas (flood-prone areas of southern Sudan and southern Somalia for instance), leading to lower prices. Reduced demand for feed and lower feed prices benefit pastoral and agro-pastoral areas, especially in the eastern part of the region (southeastern lowlands and coastal areas of Kenya, southern and southeastern Ethiopia, south and central Somalia). It can also improve access to drinking water and hydroelectric power generation. However, excessive, unseasonal rainfall following El Niño can damage standing crops and induce greater post-harvest losses, especially when it occurs during the *meher* harvest, in Ethiopia, and in the northern Rift Valley area of Kenya and in western and southwestern Uganda during the long-rains harvests and second harvests, respectively, during the period October – December. It can also lead to flooding, inflicting further crop losses. This possibility concerns lowlands like the Juba and Shabelle basins in Somalia. Excessive rainfall and flooding can also favor the emergence of epizooties like the Rift Valley fever

In Southern Africa, El Niño tends to bring about prolonged dry spells between January and March, in the midst of the rainy season, when rainfall is most critical for cereal crops, thus adversely affecting crop production, leading to a deterioration of pastoral conditions, and lower demand for agricultural labor. There is some evidence that when SST anomalies are high in the central and eastern Pacific, maize production is relatively low in Southern Africa (Cane, Eshel and Buckland 1994). The most affected areas generally are in the southern half of the Southern Africa region, that is, southern Malawi, southern Mozambique, Zimbabwe, Lesotho, South Africa, Swaziland, Botswana, and Namibia. In Tanzania, however, like in East Africa, El Niño is generally associated with above-normal rainfall between October and December, leading to above-normal crop production.

La Niña, a phase of cooling of the central and eastern Pacific's intertropical waters that usually follows El Niño, also affects rainfall throughout Africa. In East Africa, it typically leads to good precipitation early during the rainy season October – December, but rainfall being erratic later during that rainy season and ending early (FEWS NET, 2010). It also affects negatively the main rainy season in the region, from March to May. La Niña events are usually associated with dryer-than-normal conditions in the eastern part of East Africa, and with wetter-than-normal conditions in the western and northern sector of the region.

Given its impact of local agro-climatic conditions, the impact of the ENSO cycle on staple crop prices in East Africa could be complex. Food commodity prices in most of East Africa exhibit little integration with international export markets. However, as one gets closer to the coast, prices show more co-movement with international prices. Because El Niño also affects international prices, and thus, indirectly, prices in East Africa, its total effect is ambiguous a priori. Maize is the main staple crop in the region (see Figure 5). It is provides a good case study, especially as it is an internationally traded commodity.

2 Data analysis

This study is based on retail prices for maize, millet, sorghum, and wheat from markets in Burundi, Ethiopia, Kenya, Malawi, Mozambique, Tanzania, Rwanda, Somalia, Uganda, Zimbabwe, and Zambia compiled by the Famine Early Warning System Network. The Oceanic Nino Index (ONI) data are from the National Weather Service Climate Prediction Center. The primary question of interest is whether a relationship exists between local cereal prices and a measure of ENSO. To analyze the influence of ENSO on cereal prices, a series of time-series tests and models are applied to unravel the structure of the data and the potential relationship between ENSO and cereal prices.

As a first pass in our analysis, we start by considering prices in both real terms (deflated by national consumer price indices) and in terms where the month and market fixed-effects are removed, essentially transforming price levels into price anomalies (or deviations from the long-run mean by month and market). Both series of prices are then tested for unit roots using an augmented Dickey-Fuller test methodology explained in Enders (1995).

With both sets of data we then apply cross correlegrams between ONI and cereal prices from each market, across various countries. The results from this analysis are found in Figure 6. The most striking results from the cross correlogram summary appear to be found in Tanzania as a strong cyclical pattern is observed. Negative peaks occur first at about 3 lags followed by a much stronger, positive peak near 18 lags. In other words, it appears that there is a rather strong relationship between the ONI data and maize prices in Tanzania. The negative correlation in the short-term could indicate that El Nino leads to lower prices, as rainfall conditions improve. But in the longer term, El Nino is followed by a La Nina event, which leads to lower rainfall, leading to a reduction in yields and higher prices. Hence, the effects appear to reverse themselves as the lag length grows.

The relationship between cereal prices and ONI in Kenya and Uganda appear to exhibit a similar relationship, in terms of the shape of the lag pattern, however the magnitude is much smaller from that in Tanzania. Similarly, for Malawi, the degree of correlation is very weak.

Cereal prices in Zambia, on the other hand, and ONI appear to be positively correlated and the magnitude of the correlation appears to be the greatest in Kasama. The positive correlation between ONI and prices seem to be consistent with the fact that El Nino typically leads to dryness in Southern Africa, lower yields, and higher maize prices.

3 Further analysis (TBC)

Autoregressive models are used where a price anomaly (in levels) is regressed on the contemporaneous Oceanic Niño Index (ONI), a measure of ENSO based on a three-month moving average of sea surface temperature (SST) anomalies in a zone of the eastern equatorial Pacific, lagged ONI values at multiple horizons, and lagged values of the price anomaly. Various specifications are employed for robustness check. Future work may include the use of vector autoregressions (VARs) to account for the interdependence among commodity prices from different markets, within a region or across market sheds.

Preliminary results based on the analysis of maize price anomalies in Tanzania suggest that ENSO substantially influences maize prices, but at a considerable lag (after 12 months). Positive ONI realizations, that is, an El Niño episode, appear to exert upward pressure on maize prices but with a 12-month lag, while negative ONI realizations exert downward pressure on prices at a similar lag.

4 Implications for early warning and food security analysis

References

Enders, W. 1995. Applied Econometric Time Series, John Wiley & Sons, Inc. USA.

Famine Early Warning Systems Network. "Pre-emptive livelihood support could mitigate La Nina impacts in the eastern Horn." *East Africa Food Security Alert.* Washington, November 2, 2010.

Tables

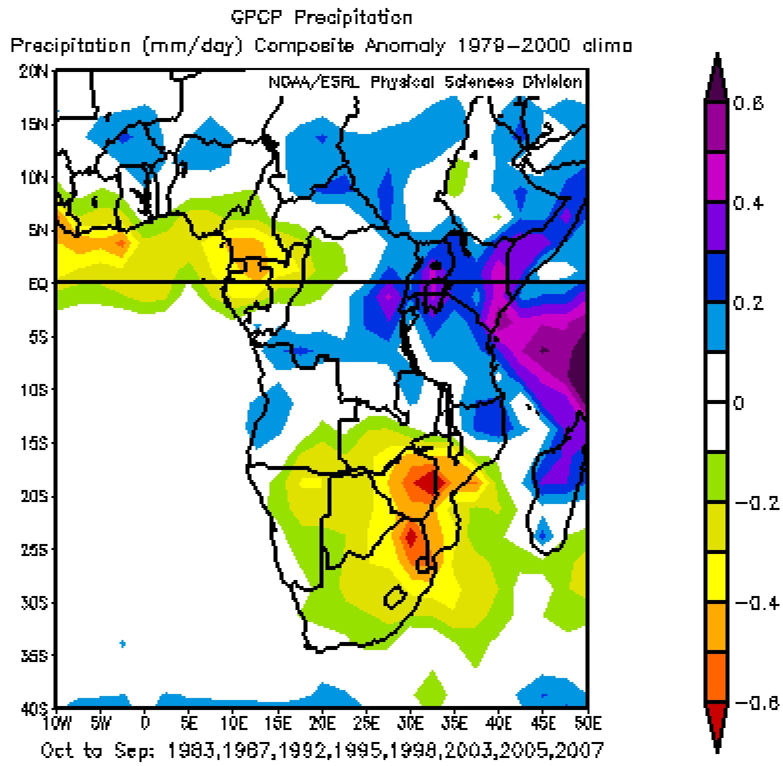
Table 1. Augmented Dickey-Fuller Test results

	Type	ADF Test Statistic	Critical value	Critical value	Critical value
			1%	5%	10%
Kenya					
Nairobi	level	-2.907	-4.018	-3.441	-3.141
Nairobi	f.d.	-7.365	-4.018	-3.441	-3.141
Mombasa	level	-3.007	-4.018	-3.441	-3.141
Mombasa	f.d.	-7.295	-4.018	-3.441	-3.141
Malawi					
Mzuzu	level	-4.99	-3.991	-3.43	-3.13
Lilongwe	level	-3.491	-4.004	-3.436	-3.136
Rwanda					
Kigali	level	-2.551	-4.033	-3.447	-3.147
Kigali	f.d.	-7.846	-4.033	-3.447	-3.147
Tanzania					
Dar Es Salaam	level	-4.205	-4.018	-3.441	-3.141
Mbeya	level	-4.421	-4.016	-3.441	-3.141
Songea	level	-5.496	-4.018	-3.441	-3.141
Uganda					
Kampala	level	-2.846	-4.028	-3.445	-3.145
Kampala	f.d.	-7.974	-4.028	-3.445	-3.145
Zambia					
Kasama	level	-4.427	-4.011	-3.438	-3.138
Kalulushi	level	-4.611	-4.012	-3.439	-3.139
Lusaka Urban	level	-4.037	-4.013	-3.439	-3.139

*f.d. = first difference

Figures

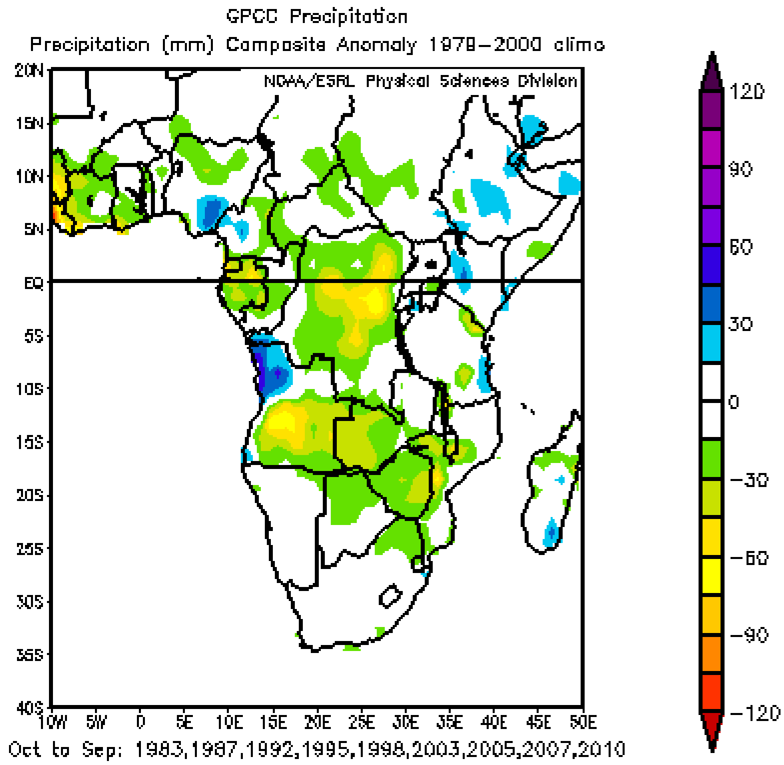
Figure 1: GPCP precipitation anomalies during El Nino years, October to September



Source: Image provided by the NOAA/ESRL Physical Sciences Division, Boulder Colorado from their Web site at http://www.esrl.noaa.gov/psd/.

Note: Precipitation anomalies are deviations from long-term averages. Precipitation data are from the Global Precipitation Climatology Project (GPCP).

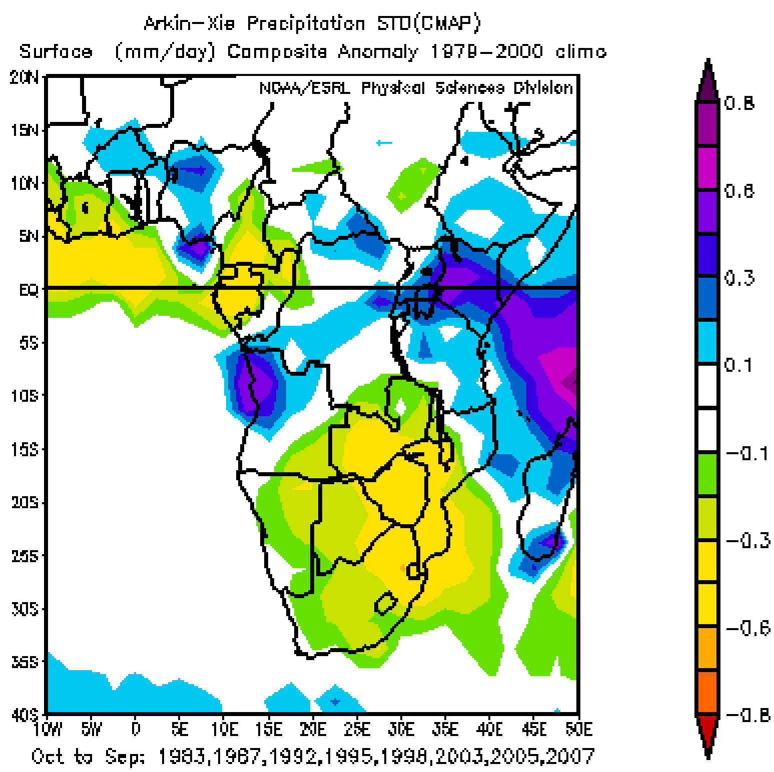
Figure 2: GPCC precipitation anomalies during El Nino years, October to September



Source: Image provided by the NOAA/ESRL Physical Sciences Division, Boulder Colorado from their Web site at http://www.esrl.noaa.gov/psd/.

Note: Precipitation anomalies are the deviations from long-term averages. Precipitation data are from the Global Precipitation Climatology Centre (GPCC).

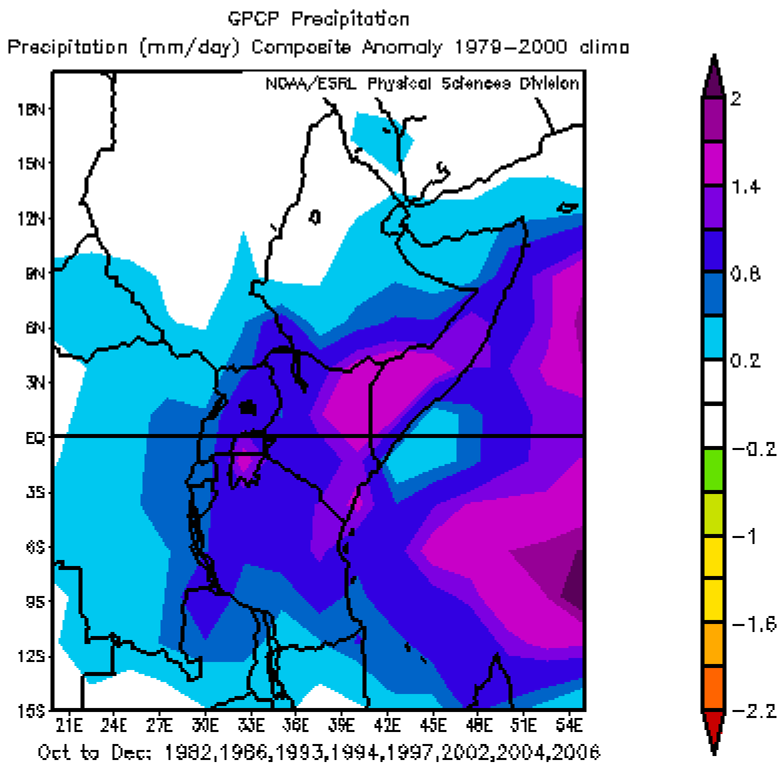
Figure 3: Arkin-Xie precipitation anomalies during El Nino years, October to September



Source: Image provided by the NOAA/ESRL Physical Sciences Division, Boulder Colorado from their Web site at http://www.esrl.noaa.gov/psd/.

Note: Precipitation anomalies are the deviations from long-term averages.

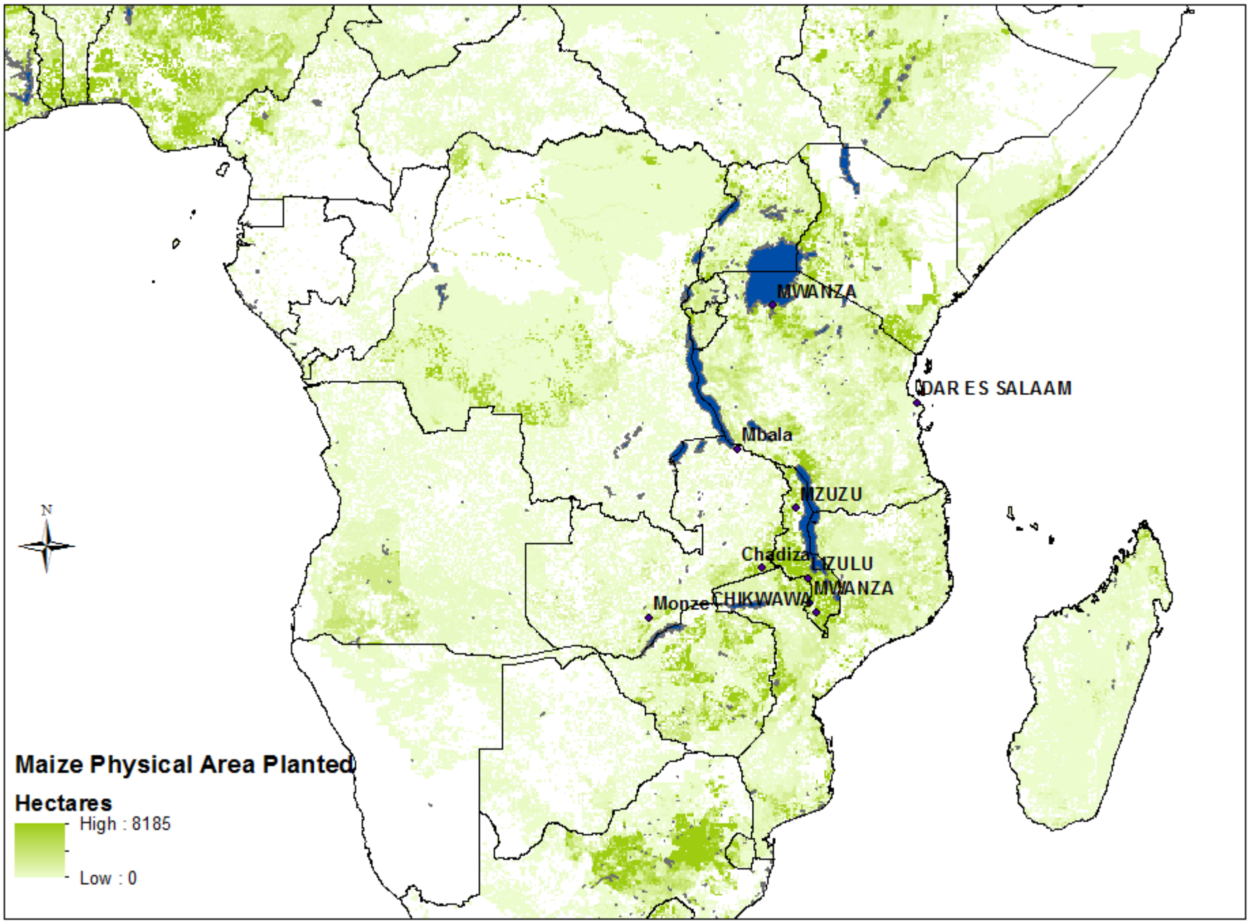
Figure 4: GPCP precipitation anomalies during El Nino years, October to December



Source: Image provided by the NOAA/ESRL Physical Sciences Division, Boulder Colorado from their Web site at http://www.esrl.noaa.gov/psd/.

Note: Precipitation anomalies are the deviations from long-term averages. Precipitation data are from the Global Precipitation Climatology Project (GPCP).

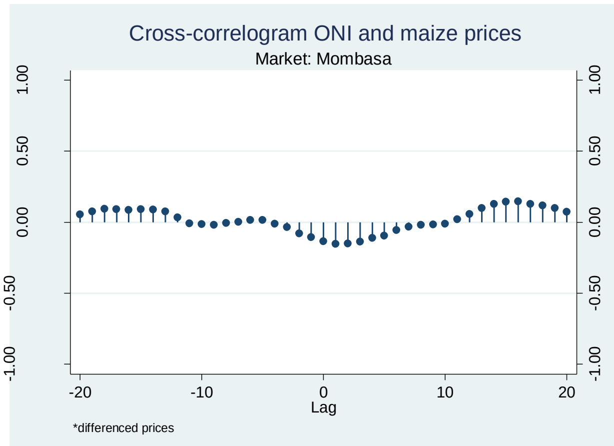
Figure 5: Maize producing areas in East and Southern Africa

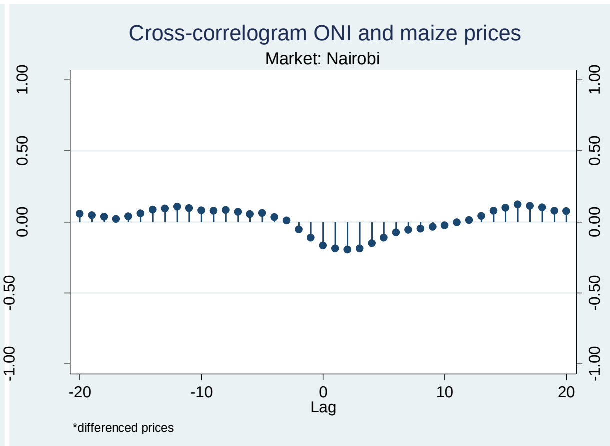


Source: Data on area planted are from *HarvestChoice*.

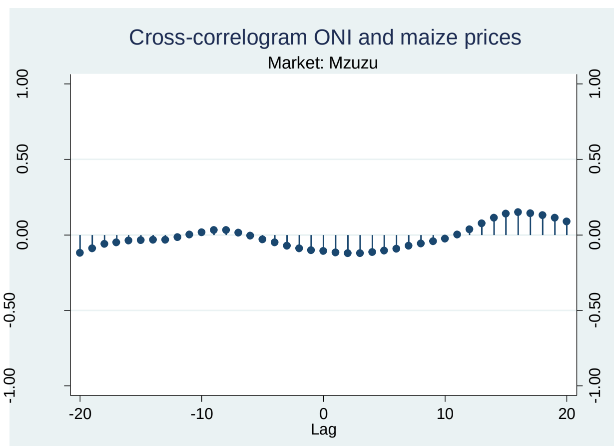
Figure 6: Cross-correlograms

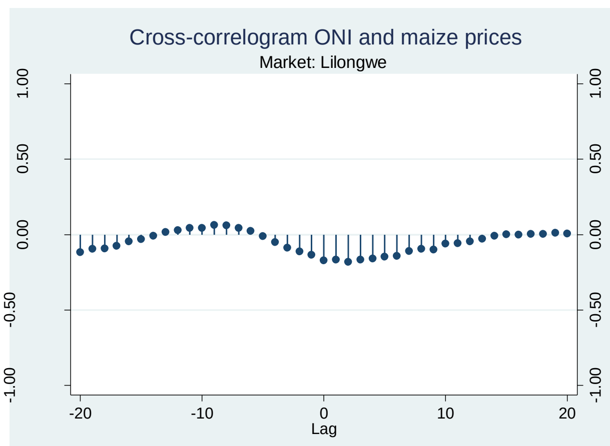
Kenya



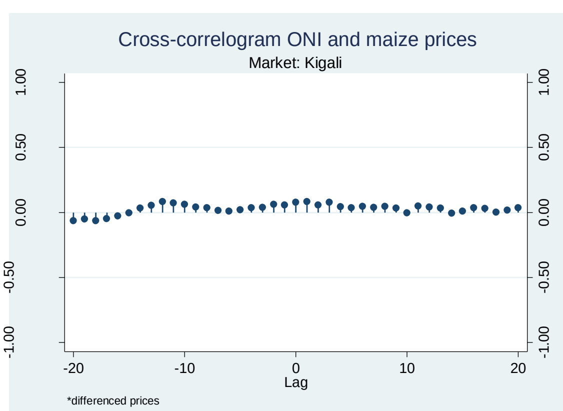


Malawi

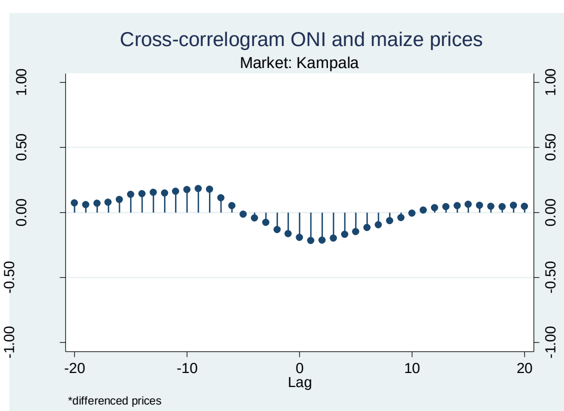




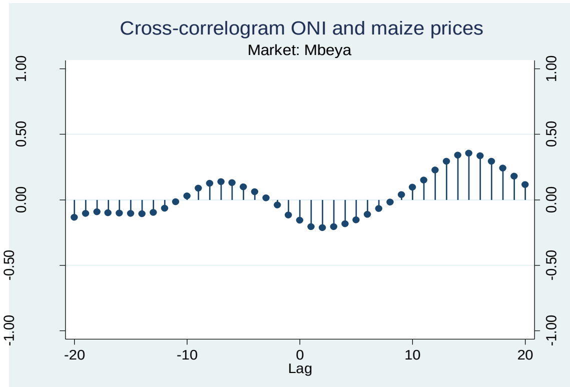
Rwanda

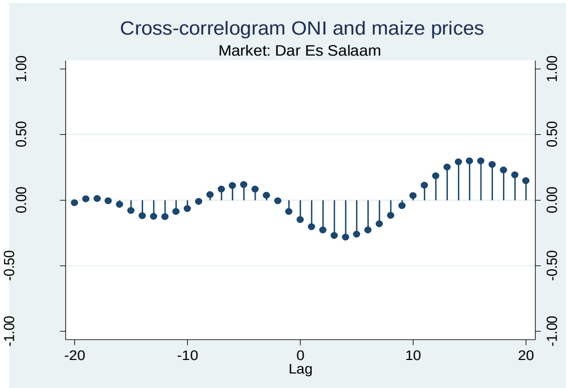


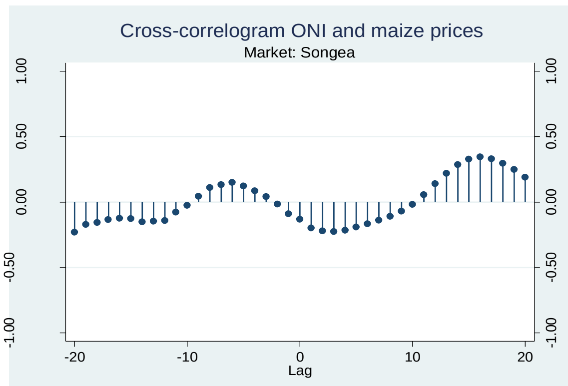
Uganda



Tanzania







Zambia