A Study Report on
Cereal Market Integration in Somalia

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FSNAU Team

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LIST OF ACRONYMS USED

CPI	Consumer Price Index
ECM	Error Correction Model
FAO	Food and Agriculture Organization of the United Nations
FEWSNET	Famine Early Warning System Network
FSNAU	Food Security and Nutrition Analysis Unit
Kcal	kilocalorie
HH	Household
IRF	Impulse Response Function
SoSh	Somali Shilling
SlSh	Somaliland Shilling
USD	United States Dollar
WFP	World Food Programme

EXECUTIVE SUMMARY

Access to food through markets in Somalia is a crucial determinant of food security. In some cases, market-based intervention strategies have been the only feasible way to respond to conditions of food insecurity. While small-scale cash transfers have been used in Somalia through the past decade, they became a major option during the humanitarian crisis in 2011 and this led to their drastic scaling up.

The use of market-based intervention strategies and their scaling-up were based on the assumption that the Somali market system is robust and therefore able to handle the increased demand generated through a demand-based strategy. Over time some reviews were made of the structure, conduct and performance of the cereal market and some attempts were made as well to provide a basic assessment of its integration. These analyses provided support to the choice and design of intervention strategy.

Understanding the extent of cereal market integration is useful for understanding the functioning of cereal markets and for designing market based food security and agricultural policies and strategies. Accordingly, the Food Security and Nutrition Analysis Unit (FSNAU) commissioned a study on cereal markets integration in Somalia.

Results from the study are highlighted below.

The analysis of price transmission among market centers has highlighted a varied degree of market functioning and interconnection throughout Somalia. Better-functioning markets and poorly functioning ones coexist.

Overall, a stronger network of cointegrating links has been found for rice than for sorghum. In particular, for both commodities a higher number of cointegrating relationships was found in Southern Somalia. This is justified by the denser sample of markets considered, as well as by shorter distances between markets.[1]

The largest and strongest networks of markets interconnected in terms of sorghum price transmission were found in the regions of Lower Shabelle, Bay and Bakool. They are the most productive area of the sorghum belt where the main trading centers are located.

Besides Merka and Baidoa, other major price makers for sorghum have been identified in Qansah Dere, Dinsor, Wanle Weyne, Dolo and Lugh. With the exclusion of Merka, all major market centers along the coast (Mogadishu, Kismayo, Hara Dhere, Bosasso) are prevalently price takers.

The transmission of sorghum price signals gets weaker when moving to the Central and to the Northern zones.

Compared to sorghum, the network of cointegrated markets for rice price transmission is denser and the location of the markets which play a major price-making role in this case is more geographically spread. Along the imported nature of red rice, the main price makers are major ports – Bosasso and Merka. On a secondary level, also a few market centers along the transport routes between North and South – e.g. Hara Dhere and Beletwein – play some price-making role.

For both red sorghum and red rice the strength of price transmission is rather diversified when considered at market level. Nevertheless, average values are quite similar, both geographically and when comparing the two cereals against each other. The speed of transmission of price signals is significantly higher for rice than for sorghum throughout Somalia, with the exception of a few regions in the sorghum belt such as Hiiran and Bakool.

Table ES.1 provides the average values estimated in relation to the two aspects of price transmission: the strength of price transmission and the speed of adjustment.

Within the Southern zone, the regions of Middle Shabelle, Middle Juba, Bay and Hiiran record the highest capacity of sorghum price transmission. Since coefficients can be interpreted in this case as elasticities, the high values of the coefficient recorded in these regions show that price changes in dominant markets within the region tend to get more than fully transmitted in the long run to integrated markets within the same region. For all other regions in the South, coefficient values range around unity, confirming again a substantial price transmission, with the exception of Bakool where the average intensity of price transmission is lower. In the Central zone, average values in Galgadud and Mudug reflect the same pattern. In Nugal and in the Northern zone, there is a general reduction of adjustment, highlighting a weaker – although still significant – transmission of price signals. The only exception is Galbeed, which reflects a very strong market connection between Hargeisa and Togwajiale.

Some of those regions in the South which record the largest values of strength of adjustment record also the lowest values in terms of speed of adjustment, and the opposite otherwise. This is the case of Middle Juba and Middle Shabelle, which register the lowest average speed of adjustment, as well as of Bakool, which in this case registers one among the highest values of speed. The same inconsistency is evident in the North, with Galbeed recording lower average speed than Sanaag and Awdal. A region which seems to combine a relatively large price adjustment and a high speed is Hiiran, which in this study is covered only by Beletwein.

Table ES.1: Average estimates of price transmission

	Strength of adjustment				Speed of adjustment			
	Red sorghum		Red rice		Red sorghum		Red rice	
Region / Zone	average	range	average	range	average	range	average	range
Lower Juba	1.15	0.58 - 1.84	0.97	0.89 - 1.03	0.25	0.16 - 0.35	0.28	0.26 - 0.31
Middle Juba	1.94	1.41 - 2.47	1.05	1.05 - 1.05	0.08	0.08 - 0.08	0.30	0.26 - 0.35
Gedo	1.17	0.79 - 1.72	0.96	0.68 - 1.35	0.16	0.09 - 0.25	0.29	0.17 - 0.47
Bay	1.81	1.69 - 1.95	1.05	0.99 - 1.12	0.16	0.09 - 0.25	0.22	0.16 - 0.26
Bakool	0.52	0.36 - 0.69	0.79	0.61 - 0.97	0.24	0.18 - 0.30	0.17	0.15 - 0.19
Hiiran	1.68	1.68 - 1.68	0.97	0.97 - 0.97	0.25	0.25 - 0.25	0.13	0.13 - 0.13
Lower Shabelle	1.19	1.05 - 1.38	1.08	1.05 - 1.12	0.18	0.12 - 0.22	0.20	0.15 - 0.23
Middle Shabelle	2.40	0.86 - 3.94	0.93	0.79 - 1.07	0.06	0.02 - 0.11	0.20	0.17 - 0.22
Mogadishu	1.10	1.10 - 1.10	1.85	1.85 - 1.85	0.24	0.24 - 0.24	0.20	0.20 - 0.20
Galgadud	1.00	0.69 - 1.47	0.88	0.73 - 1.03	0.15	0.10 - 0.22	0.17	0.13 - 0.22
Mudug	1.30	1.14 - 1.47	1.27	1.06 - 1.48	0.16	0.16 - 0.16	0.16	0.08 - 0.23
Nugal	0.66	0.66 - 0.66	0.79	0.79 - 0.79	0.16	0.16 - 0.16	0.23	0.23 - 0.23
Bari			0.25	0.25 - 0.25			0.08	0.08 - 0.08
Sool	0.86	0.86 - 0.86	0.90	0.90 - 0.90				
Sanaag	0.83	0.83 - 0.83	1.36	1.36 - 1.36	0.16	0.16 - 0.16	0.13	0.13 - 0.13
Galbeed	2.57	1.33 - 3.81	1.40	1.03 - 1.77	0.12	0.12 - 0.12	0.15	0.06 - 0.24
Awdal	0.88	0.82 - 0.94	1.76	1.75 - 1.78	0.27	0.27 - 0.27	0.23	0.21 - 0.25
North	12.76	3.09 - 34.10	1.06	0.27 - 2.73	0.12	0.03 - 0.26	0.29	0.17 - 0.43
Center	0.74	0.29 - 1.39	1.00	0.21 - 2.89	0.14	0.05 - 0.28	0.18	0.08 - 0.31
South	0.75	0.17 - 1.80	1.19	0.15 - 5.01	0.21	0.10 - 0.47	0.27	0.06 - 0.73
All	0.88	0.52 - 1.87	1.37	0.11 - 4.73	0.12	0.08 - 0.24	0.28	0.12 - 0.60

Note: Estimations have been conducted with two different approaches. Regional estimates are averages of coefficients derived through bivariate cointegration, while zonal and national estimates are averages of coefficients derived through multivariate cointegration.

Data source: At regional level: Tables A.6 and A.7. At zonal level: Tables 9-12.

About red rice, coefficients of long-term adjustment seem to be generally lower than the ones reported above for sorghum in the South. This hints to a less intense process of price transmission and adjustment for rice than for sorghum in the South. At the same time, the degree of price adjustment is slightly larger in the North than in the South. Both considerations were somehow expected considering that rice is one of the food staples in the North, but not in the South. Nevertheless, two remarkable exceptions are the minimum value of Bosasso in the North and the maximum value of Mogadishu.

In terms of speed of adjustment, a certain increase in speed rates is found in southern regions compared to the values recorded for sorghum. Contrary to what considered earlier on about the speed of sorghum price adjustment in Beletwein, the speed of price adjustment in Beletwein is in this case only faster than Bosasso.

At a higher degree of aggregation, average values indicate similar strength of price transmission for red rice through the various zones and the entire Somalia as a whole. The same applies for sorghum, with the exception of the Northern zone, where an excessively high price transmission rate was found. The speed of adjustment is higher in the South for red sorghum and lower for red rice in the Central zone.

The comparison of the two commodities against each other highlights that average values of the strength of adjustment are equal in the Central and Southern zones and throughout Somalia taken as a whole, while the speed of adjustment is higher for red rice in the North and in the country as a whole.

Overall, average values in Table ES.1 reflect a good level of price transmission, although they hide a remarkable range of variation. From an aggregate perspective, approximately between 94% and 137% of price signals get on average transmitted and the time required for transmission is on average double for red sorghum than for red rice (approximately 8 months for the former against 4 months for the latter).

In order to consider the results of this study in relative terms, estimates of price transmission have been compared against similar estimates in neighbouring countries. Average values of strength and speed of price transmission are in line with similar estimates for other basic food commodities in remote areas in neighbouring countries.

Overall, the immediate implications of the findings of this study refer to their contribution towards the design of transfer interventions in response to food insecurity. The effectiveness and efficiency of market-based intervention strategies are increased when operated in presence of functioning and integrated markets. Therefore, the analysis conducted in this study is expected to assist in the design of interventions and in their geographical targeting. The best functioning market centers are found in Southern Somalia, particularly in the regions of Middle Shabelle, Lower Shabelle, Hiiran, Bay and Middle Juba. A good degree of market functioning is found also in the Northern zone, although weaker than in the South. A structural problem in the Northern zone, as well as in the Central zone, is given by the long distances between market centers. Along this line of thought, a group of well integrated market centers is found in West Galbeed and Awdal. Sadly, the lack of information about Berbera does not allow us to get a full grasp of the market networks in the North. Following from these considerations, it is reasonable to say that, considering everything else equal, including security conditions, the regions identified in the South provide the highest degree of market functionality currently available in Somalia and therefore the most appropriate conditions for market-based interventions. In the North as well as in the Center, the degree of market functionality is generally lower; in this case market-based interventions are expected to be less efficient and effective than if operated in the South.[1]

Cash-based interventions – including FAO's cash for work programme and similar cash transfer interventions operated by FAO partners and other organizations – are expected to maximize their

1 Of course, this consideration is based solely on the expected degree of market functioning, while it is understood that a proper analysis of intervention strategy should take into account a whole set of other factors which are ignored here. It is to be considered as well that, even limiting the discussion to market functioning, an eventual decision to implement market-based strategies in presence of modestly functioning markets may be justified by a long-term strategy of local development.

effectiveness and efficiency if focused on the Southern zone. Similar interventions in the Northern and Central zones, and in general in the surroundings of poorly integrated markets, are less recommended and, if justified by other reasons, they should be implemented on a small scale.

In terms of monitoring activities, efforts should be made to increase market coverage in the Northern and Central zones, as well as in areas throughout Somalia identified as poorly integrated.

1. INTRODUCTION

This section provides some background about market integration in Somalia and describes the rationale of the present report.

1.1 Scope of work

Access to food through markets in Somalia is a crucial determinant of food security. In some cases, market-based intervention strategies have been the only feasible way to respond to conditions of food insecurity. While small-scale cash transfers have been used in Somalia through the past decade, they became a major option during the humanitarian crisis in 2011 and this led to their drastic scaling up.[3]

The use of market-based intervention strategies and their scaling-up were based on the assumption that the Somali market system is robust[4] and therefore able to handle the increased demand generated through a demand-based strategy. Over time some reviews were made of the structure, conduct and performance[5] of the cereal market and some attempts were made as well to provide a basic assessment of its integration.[6] These analyses provided support to the choice and design of intervention strategy.

Nevertheless, as market price data is among the best and most reliable data sets currently available on Somalia, it is felt that the studies conducted so far have made only limited use of the resources available. Furthermore, the consideration that the analysis of market integration can provide useful insights into the degree of market functioning justifies further efforts are made.

Finally, a major limitation of the analysis conducted so far is its use of nominal prices. Considering that the available price dataset spans over almost two decades, and in view of the high inflation rates estimated in Somalia, it is reasonable to expect that the analysis conducted on nominal prices may be misleading.

Following from the above, the purpose of this study is to assess the degree of the cereal market integration in Somalia. In particular, this study will make use of the Consumer Price Index (CPI) recently developed to deflate the market price series. Such deflated long-term time series will be treated with appropriate econometric techniques presented below.

1.2 Current knowledge about market integration in Somalia

Very limited knowledge is available about market integration in Somalia.

An assessment of market integration in Southern Somalia is conducted by FEWSNET (2011a; 2011b). This is based on visual assessment and on tests of correlation, although the results of the latter are not reported. The general finding is of a reasonable degree of integration. More in detail:

a) Prices of white maize are found to be historically well correlated within Southern Somalia, particularly within the Juba valley. However, Gedo remains the most isolated area.

b) Sorghum prices are relatively well correlated across most of the Sorghum Belt (Bay, Bakool, Gedo and Hiiran regions). Even in this case, markets in Gedo, as well as in Hiiran, appear to be less integrated from the rest of the sorghum belt.

c) Strong integration is found between imported red rice prices across monitored reference markets in Southern Somalia. A good degree of correlation is reported also between the evolution of rice prices in Somalia and of those in international export markets.

[3] The response to the crisis in 2011 was considered as the largest cash-based program ever undertaken by NGOs in response to a humanitarian emergency (Ali and Gelsdorf, 2012). However, this was not the case more recently, in light of declining amounts of cash interventions and, more in general, of humanitarian assistance in Somalia.
[4] See Longley *et al.*, 2012
[5] See WFP, 2009.
[6] See FEWSNET, 2011a and 2011b, and Sanogo, 2011.

The findings listed above from the FEWSNET study are reflected in the analysis conducted by Sanogo (2011), which provides a picture of progressive globalization of the Somali economy, as justified by the heavy reliance on food imports, by the livestock-dominated exports and by the amount of remittances to the national economy. In the specific case of Southern Somalia this is reflected in a good degree of integration of cereal markets with global and regional markets.

On the contrary, the same analysis highlights how domestic cereal market integration has been hampered by trade restrictions from neighbouring countries and internal trade restrictions. The weakest degrees of market integration were found within Gedo region, as well as between the districts of Adanyabal, Lugh and Belet Hawa and the rest of Southern Somalia. A deterioration of market integration between Mogadishu and the rest of Middle Shabelle since 2008 compared to 2003-2007 was also reported.

The analysis of price correlations between imported cereals (rice and wheat flour) and locally produced cereals (maize and sorghum) leads Sanogo (2011) to conclude that the degree of integration between imported cereal markets and locally produced cereal markets is weak.[7] This is somehow supported by the identification of different groups of price-making markets for imported and locally produced commodities. In fact, notwithstanding other price determinants, the Granger causality tests conducted by Sanogo (2011) indicate that markets located along the major coastal routes in the Shabelle Valley (i.e. Jowhar, Wanle Weyne, Buale, Mogadishu, Qorioley, Merka, Kismayo, Jamame and Jilib) were responsible for maize price transmission to the rest of Southern Somalia. On the contrary, Hudur, Qansah Dere and Dinsor in the Sorghum Belt and Afgoi and Merka in the Shabelle Valley tend to transmit sorghum price signal to other areas of Southern Somalia, as presented in Figure A.2 in the Annexes. Table 1 provides Sanogo's list of summary findings according to region in Southern Somalia.

Table 1: Sanogo's general findings about market integration in Southern Somalia

Gedo	Poor integration of maize and sorghum markets within the region. Low integration with the rest of Southern Somalia
Bakool	Low integration with the rest of Southern Somalia
Hiiran	High integration with the rest of Somalia and Ethiopia
Bay	High integration with Mogadishu. Cereal markets are integrated within the region
Lower Shabelle	High integration with Mogadishu. Cereal markets are integrated within the region
Middle Shabelle	High integration with Central Somalia, but integration of the sorghum market has deteriorated within the region
Middle Juba	Cereal markets are integrated with the rest of the Juba trade basin
Lower Juba	High price integration

Source: Sanogo, 2011

Finally, additional insight on market integration in Somalia is provided by Brenton et al. who conducted a comparative study on the relevance of road infrastructure for food trade. They found Somalia to record one among the lowest degrees of market integration within a sample of thirteen African countries. Major determinants of such a poor performance were envisaged in poor infrastructure, large market distance and poor security conditions.

[7] Coefficients of correlation estimated by Sanogo are reported in Table A.1 in the Annex.

2. METHODOLOGY

This section provides background information on the methodological approach followed for the analysis of market integration in the literature and presents the methodology applied in this study for data preparation and analysis.

2.1 Spatial market integration and its measurement in the literature

Spatial price transmission is an issue that has been widely analyzed in the context of the 'law of one price', which assumes that if two markets are linked by trade in an efficient market, the movement of prices in one market will be equalized with the movement in the other in the long run, while allowing for deviations in the short run (Margarido et al., 2007). An increase in price will therefore lead to an equally proportional increase, at all points in time, assuming the markets are perfectly integrated (Mundlak and Larson, 1992). In this context, 'spatial price transmission' means the process and degree to which markets for homogeneous commodities at spatially separated locations share long-run market information (McNew, 1996; Amikuzuno, 2009). It has been highlighted how price analysis tells us little or nothing about actual trading behaviour and market efficiency (Baulch, 1997; Barrett et al., 2002). Nevertheless, it is common practice to analyse price transmission to assess market integration, with the implicit or explicit assumption that lack of market integration implies market inefficiency (Rashid et al., 2010). This is done with the understanding that price transmission is not the same as market integration and that one can occur without the other. In fact, there may be market integration without price transmission if transaction costs are non stationary, and there may be price transmission between two markets without market integration if there is a third market explaining price making in the other two.

Depending on the environment in which markets operate, two prices can be related in many different ways, adjusting completely or partially, slowly or instantaneously, or in a linear or nonlinear manner (Ihle et al., 2009). According to Rapsomanikis et al. (2003), the notion of price transmission can be better understood as being based on three main components: co-movement of adjustment, speed of adjustment and asymmetry of response. 'Co-movement of adjustment' means that a change in the price of an agricultural commodity in one market is reflected in the price change of the commodity in other markets at all points in time, 'speed of adjustment' means the rate at which changes in prices in one market are transmitted to other markets, and 'asymmetry of response' means the process in which transmission differs according to whether prices are increasing or decreasing (Prakash, 1999; Balcombe and Morrison, 2002; Rapsomanikis et al., 2003; Meyer and von Cramon-Taubadel, 2004).

The literature on spatial price transmission has identified three main types of barrier that constrain the transmission of prices from one market to another: transaction costs, trade policy mechanisms and imperfect competition. If transaction costs are prohibitively high (often because of poor infrastructure, high transport costs and deficient communication services), price changes will be transmitted only partially or not at all (Abdulai, 2000; Conforti, 2004). Trade policy mechanisms such as import tariffs, tariff rate quotas, export subsidies and exchange rate policies can isolate domestic markets and obstruct the transmission of international price signals (Rapsomanikis et al., 2003; Conforti, 2004). Imperfect competition, due to the concentration of market power of different actors in the supply chain, may result in higher price differences, hindering the full transmission of price signals (Abdulai, 2000; Rapsomanikis et al., 2003).

A substantial body of literature has attempted to measure market integration in order to assess market performance. The empirical methods have evolved from simple price correlation between market locations, which was common practice in the 1970s to early 1980s, to lagged regression methods in the late 1980s and 1990s (Ravallion, 1986), to cointegration methods in the 1990s (Alderman, 1992; Goletti and Babu, 1994).

Cointegration methods are not immune of limitations (Barrett and Li, 2002; Rapsomanikis et al., 2003), however they are currently considered as the most appropriate approach for analysing spatial market relationship (Rapsomanikis et al.). A comprehensive analytical framework for this econometrics approach can be found in Balcombe and Morrison (2002), and Rapsomanikis et al. (2003). Cointegration methods take into account the fact that prices be non-stationary, which otherwise would cause standard regression analysis to give misleading results.[8] Co-integration between the price series analyzed implies that two prices may behave in a different way in the short run, but that they will converge toward a common behaviour in the long run. If this property is verified, the characteristics of the dynamic relationship between the prices can be described by an Error Correction Model (ECM). The short-run adjustment parameter of this type of model can be interpreted as a measure of the speed of price transmission, while the long run multiplier can be interpreted as a measure of the degree of price transmission of one price to the other (Prakash, 1999). The properties of co-integrated series also imply the existence of a causality relation, as defined by Granger, that can be tested by assessing if the evolution of one of the two price series predicts the one of the other series.

Cointegration has been extensively discussed and applied in the literature and therefore a presentation of the methodological framework is beyond the scope of the present study. The concept of cointegration (Granger, 1981) and the methods for estimating a cointegrated system (Engle and Granger, 1987; Johansen, 1988, 1991, 1995) provide a framework for estimating and testing for equilibrium relationships between non-stationary integrated variables. A number of time series techniques can be used to test each of the components of price transmission (cointegration, causality, error correction mechanism, and symmetry). As a reference, Figure 1 provides a tree diagram, although the actual combination and order of time series techniques can actually vary from case to case.

The analysis of spatial market integration can be applied to virtually any commodity or group of commodities[9]. However, one of its most common applications refers to the market of agricultural commodities and, in particular, to the case of staple food. Table 2 provides a short list of relevant studies in African countries.

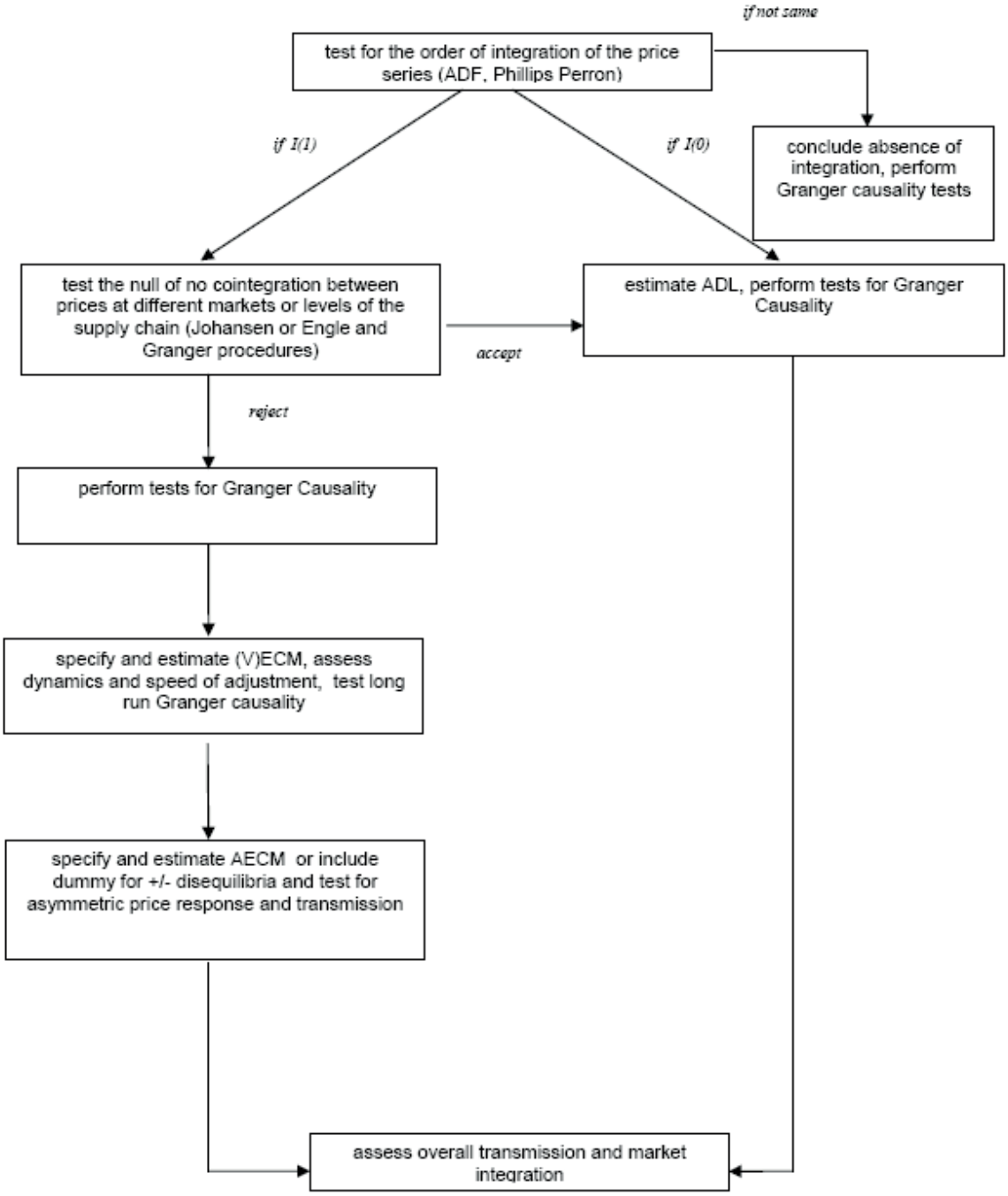
Table 2: Selected literature on market integration in Africa

Author	commodity	geographical coverage
Goletti and Babu (1994)	maize	Malawi
Lutz et al. (1994)	maize	Benin
Dercon (1995)	teff	Ethiopia
Negassa (1998)	teff, maize and wheat	Ethiopia
Badiane and Shively (1998)	maize	Ghana
Chirwa (2000)	maize	Malawi
Rapsomanikis et al. (2003)	coffee	Ethiopia, Uganda and Rwanda vs the international market
Rapsomanikis et al. (2003)	wheat	Egypt vs the international market
Rashid (2004)	maize	Uganda
Tostao and Brorsen (2005)	maize	Mozambique
van Campenhout (2007)	maize	Tanzania
Meyers (2008)	maize	Malawi
Moser et al. (2009)	rice	Madagascar
Jaleta and Gebremedhin (2009)	teff and wheat	Ethiopia

[8] Non-stationary variables do not have a constant mean or variance over time, one example being the “random walk” which has no tendency to return to a central value. This violates one of the assumptions behind regression analysis. The result is that regression analysis of non-stationary variables will often show a “relationship” where none exists.

[9] Among other studies, Cecchetti *et al.* (2002) looks at the convergence of aggregate prices (consumer price indices) for U.S. cities, Thapa (2002) assesses the convergence of real exchange rates in Nepal, Morshed *et al.* (2005) assesses the convergence of consumer price indices in India, Goldberg and Verboven (2003) assesses the integration of the European car market.

Figure 1: Tree diagram for the analysis of cointegration



Source: Rapsomanikis et al., 2003

In this study the analysis of market integration makes use of price time series data. The basic principle is the assumption that the closer the changes in prices experienced in two markets, the more integrated the two markets can be seen to be. In order to study the interdependence of price time series between any pair of markets *i* and *j*, we can refer to a linear relationship of the type:

$$p_{it} = \theta_1 + \theta_2 \, p_{jt} + u_t \qquad (1)$$

where:

p_{it}	represents the retail price prevalent on market *i* at time *t*;
p_{jt}	represents the retail price prevalent on market *j* at time *t*;
u_t	represents the error term;
θ_1 and θ_2	represent the coefficients to be estimated.

Once the condition of stationarity of the series and their co-integration are verified through *ad hoc* tests as the Augmented Dickey-Fuller test or the Phillips-Perron tests, the Error-Correction Model is adopted:

$$\Delta p_{it} = \alpha_1 + \alpha_2 \, \Delta p_{jt} + \alpha_3 \left(p_i - \theta_1 - \theta_2 \, p_j\right)_{t-1} + u_t \qquad (2)$$

Where Δp indicates the change in price in market *i* or *j* between one period and the previous one (*t* and *t-1*).

This model can be interpreted by considering how traders adjust the price of their merchandise (Δp_{it}) from one period to the next in response to changes in concurrent prices on other relevant markets (Δp_{jt}) as well as to the previous disequilibrium between the price prevalent on their market *i* and on market *j*. From this perspective α_2 measures the short-run effect in the process of price change and α_3 measures the speed of adjustment of price on market *i* to a discrepancy between p_i and the price prevalent on the reference market (p_j) in the previous period. The greater the value of α_3, the more integrated are the two markets.

The error-correction term $\left(p_i - \theta_1 - \theta_2 \, p_j\right)_{t-1}$ can be interpreted as the deviation from the long-term equilibrium between the prices on two markets, where the coefficient θ_2 measures the long-term effect in the process of adjustment – i.e. how much change in one price is determined by the change in the other. The greater the value of θ_2, the more integrated are the two markets, and at a larger scale, the more functional is expected to be the local market.

In addition to the above, the Granger causality test is used to assess the presence and direction of price transmission. Per each couple of markets it can test: 1) whether price changes experienced in one market have induced or influenced price changes in another market; 2) whether any influence is unidirectional or bilateral. With reference to the two equations:

$$Y_t = \sum_{i=1}^{m} \alpha_i Y_{t-i} + \sum_{j=1}^{m} \beta_j X_{t-j} + u_t \quad (3)$$

$$X_t = \sum_{i=1}^{m} \gamma_i Y_{t-i} + \sum_{j=1}^{m} \delta_j X_{t-j} + v_t \quad (4)$$

there are four possible cases:

(1) Unidirectional causality from X to Y (X is said to "Granger-cause" Y):
In this case past values of X have an effect on current values of Y (i.e. $\beta_i's\ not\ all\ zero$), but past values of Y have no effect on X (i.e. $\delta_i's\ all\ zero$).

(2) Unidirectional causality from Y to X (Y is said to "Granger-cause" X):
$\beta_i's\ all\ zero$; $\delta_i's\ not\ all\ zero$.

(3) Bilateral causality:
$\beta_i's\ not\ all\ zero$; $\delta_i's\ not\ all\ zero$.

(4) Independence:
$\beta_i's\ all\ zero$; $\delta_i's\ all\ zero$.

The use of vector autoregression models allows to move from bi-variate to multi-variate co-integration to analyse the interaction of several time series. In this case the Error-Correction Model becomes:

$$\Delta p_t = \mu + \alpha\theta' p_{t-1} + \sum_{i=1}^{n-1} \Gamma_i \Delta p_{t-i} + u_t \quad (5)$$

where:

p_t is a multi-dimensional vector whose components are the market prices at time *t*;
Δp_t is the difference between p_t and p_{t-1};
α is the speed of adjustment matrix;
θ is a matrix whose columns are linearly independent co-integrating vectors with $\theta' p_{t-1}$ representing the long-run equilibrium errors.

The number of linearly cointegrating relationships, *r*, lies between 0 and K-1, where K is the number of dependent variables in p_t. Furthermore, *r* is the rank of $\alpha\theta'$.

2.3 The data and its preparation

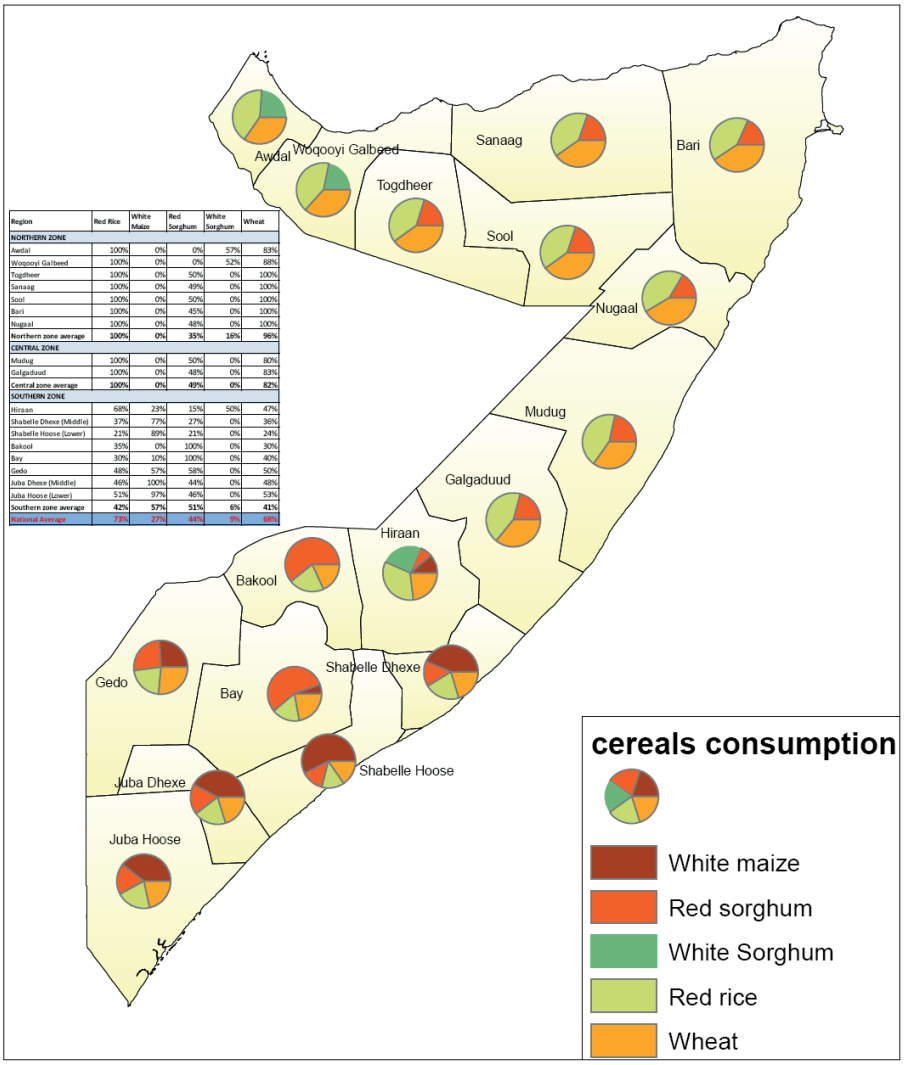
2.3.1 Selection of commodities

This study covers two commodities. A usual consideration is that cereal traders would normally handle all cereals, as well as other food commodities, for which there is demand and supply.

Under that perspective, the analysis of one commodity would suffice for a general assessment of the degree of market integration. In our case, the rationale for considering two commodities is that consumption patterns seem to be strongly diversified due to a strong difference in consumers' preference. Therefore, in order to optimize the use of available data, the selection of the two commodities should not just rely on data availability, but should aim at capturing such different preference.

Ideally, we are interested in quantities of food, not in number of consumers; although the two criteria are expected to reflect each other. In particular, we are interested in the cereals which are exchanged in the highest number of markets. This does not necessarily reflect the overall consumption and therefore the number of consumers. The spread over geographical areas is probably the most important criterion because it gives an idea of how many markets are involved in the exchange of the same cereal. In fact, the purpose of this study is to assess how different local markets behave (i.e. how much and how fast each market reacts to price changes in other markets), and that is independent of quantities exchanged and of number of consumers.

Figure 2: Cereal consumption



Region	Red Rice	White Maize	Red Sorghum	White Sorghum	Wheat
NORTHERN ZONE					
Awdal	100%	0%	0%	57%	83%
Woqooyi Galbeed	100%	0%	0%	52%	88%
Togdheer	100%	0%	50%	0%	100%
Sanaag	100%	0%	49%	0%	100%
Sool	100%	0%	50%	0%	100%
Bari	100%	0%	45%	0%	100%
Nugaal	100%	0%	48%	0%	100%
Northern zone average	100%	0%	35%	16%	96%
CENTRAL ZONE					
Mudug	100%	0%	50%	0%	80%
Galgaduud	100%	0%	48%	0%	83%
Central zone average	100%	0%	49%	0%	82%
SOUTHERN ZONE					
Hiraan	68%	23%	15%	50%	47%
Shabelle Dhexe (Middle)	37%	77%	27%	0%	36%
Shabelle Hoose (Lower)	21%	89%	21%	0%	24%
Bakool	35%	0%	100%	0%	30%
Bay	30%	10%	100%	0%	40%
Gedo	48%	57%	58%	0%	50%
Juba Dhexe (Middle)	46%	100%	44%	0%	48%
Juba Hoose (Lower)	51%	97%	46%	0%	53%
Southern zone average	42%	57%	51%	6%	41%
National Average	73%	27%	44%	9%	68%

Source: FSNAU

The criteria mentioned above help to cut down the number of eligible commodities. As shown in Figure 2, prepared by FSNAU along estimates from its experts, white sorghum can be excluded because consumed (here used as proxy for exchanged) only in few areas (and therefore in few markets). White maize is concentrated in the south and gives a limited coverage of the national market. Although it is important to recognize its major role in the south, it would not help much in assessing market integration in the central region and in the north. Red rice and wheat are exchanged throughout Somalia. They seem to have equal share of food consumption. They are mainly consumed in the north, but their relevance gets highly reduced in the south. Finally, red sorghum is the third most consumed commodity. In the south it is equally consumed as red rice and wheat, with the exception of some regions where it is the most consumed, as in Bay and Bakool. However, red sorghum is not consumed in Awdal and Galbeed.

Taking stock of the considerations above, two combinations are considered to be preferable:
A) red rice and wheat
B) red sorghum and either red rice or wheat.
While A) would assure that all areas are covered, B) would help to balance the geographical distribution, by giving a little bit more relevance to markets in the south.

Overall, in agreement with FSNAU it was felt that B) would give a better return. The first commodity (red rice or wheat) would ensure that all areas are covered. The second commodity (red sorghum) would help to reflect higher consumption in the south, while the first commodity would reflect higher consumption in the north and in the central region. Finally, red rice was preferred over wheat based on the criterion of data availability.

2.3.2 Selection of markets

The dataset managed by the FSNAU includes time series of prices of a multitude of commodities, which have been monitored across 48 urban markets and 51 rural trading centres, most of which since 1995 up to date. The present study is focused on urban markets and does not covers rural trading centres.

In order to optimize the use of available data, markets where data collection was started after 2007 were not included in the analysis. In addition, Burao market was dropped for inconsistency of price data. After accounting for the reductions mentioned above, the dataset utilized for this study accounts for 38 market centres: Abudwak, Adanyabal, Afgoi, Afmadow, Baidoa, Bardera, Belet Hawa, Beletwein, Boroma, Bosasso, Buale, Dinsor, Doblei, Dolo, Dusamared, El Barde, El Der, Elwak, Erigavo, Galkayo, Garowe, Hagar, Hara Dhere, Hargeisa, Hudur, Jamaame, Jilib, Jowhar, Kismayo, Lasanod, Lugh, Merka, Mogadishu Bakara, Qansah Dere, Qorioley, Togwajiale, Wanle Weyne and Zeilac Lawayacado.

This study is limited to domestic market integration, since price data for the two commodities dealt with in this study could not be found either in neighboring countries or on the international scene with reference to the timeframe specified above.

2.3.3 Deflation of prices

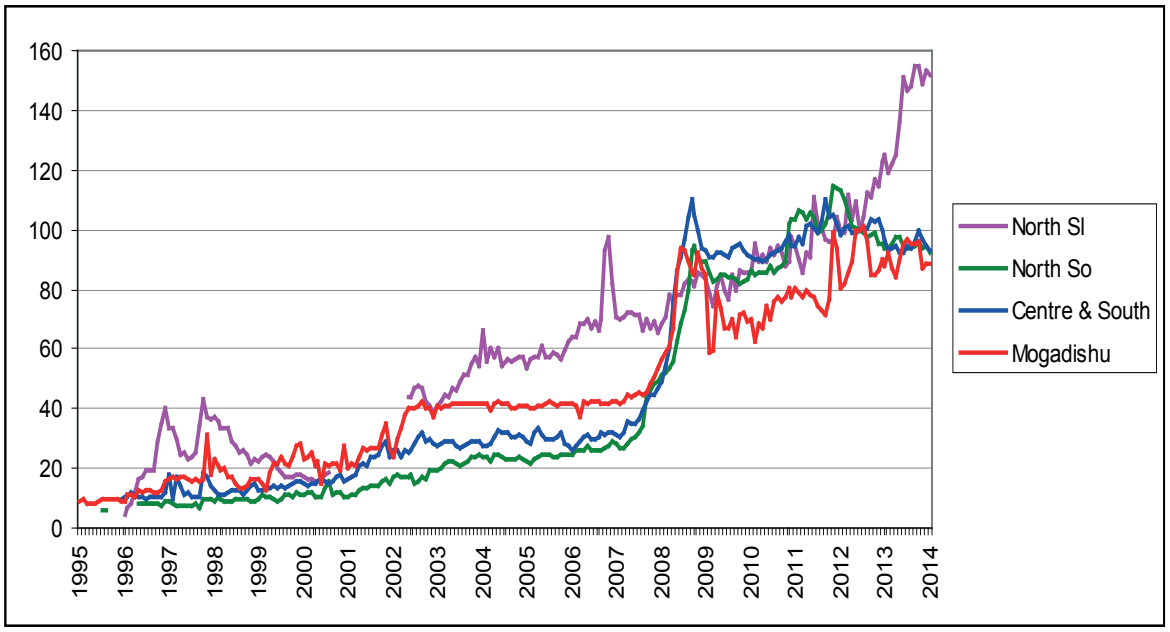
This study covers a time span of almost two decades. In normal settings the analysis of market prices recorded over a much shorter period requires price deflation in order to be able to make sense of value comparisons over time. Such reasoning is even more justified when dealing with countries regularly affected by high inflation rates, as it is the case of Somalia.

In order to deflate the market prices of the two commodities it has been made use of the CPI recently developed.[10] Three main options can be considered for deflating prices: full CPI, food CPI, non-food CPI. The choice is mainly determined by the scope of the analysis:

a) When dealing with a general process of price rise and we are trying to analyse or take account of the inflationary process, the full CPI is the preferred approach.
b) When trying to assess the movement of prices of specific categories of items, the use of sectorial CPIs is preferable. In this case, if we want to assess the changes of food prices compared to changes in non-food prices, it would be appropriate to use the non-food CPI. This approach would give an idea of the evolution of the terms of trade, which can be particularly useful if one category of households regularly sells one category of items (for instance non-food) and buys another category of items (for instance food).
c) When the price rise is limited to a category of items (in our case food), than we may decide to use a food-only CPI, because otherwise our analysis would be biased downwards and would not capture the full price rise which has affected or is affecting food commodities.
In this case the full CPI is preferable, since we are dealing with a general price rise. An additional reason to prefer the full CPI is the consideration that the commodity basket used for the development of the CPIs includes only a limited component of non-food items. Furthermore, in this case the evolution of full CPI and of food CPI is quite similar, with the rate of correlation between the two deflators ranging between 0.93 (Mogadishu) and 0.99 (Centre and South). Therefore, we can expect that any of the three approaches would lead to reasonably similar results.

Rather than using the national CPI, market prices were deflated using the zonal – i.e. Northern, Central and Southern, Mogadishu – CPIs because better reflective of local market exchanges and of local inflationary processes. Furthermore, in order to take into account local peculiarities due to the use of different currency, markets in the Northern zone were diversified according to the currency used and prices were deflated through the respective CPIs. Overall, the following four deflators were utilized: Northern SlSh, Northern SoSh, Central and Southern, Mogadishu. Their evolution is reported in Figure 3.

Figure 3: CPIs utilized as deflators



Source: FSNAU, CPI report, 2015

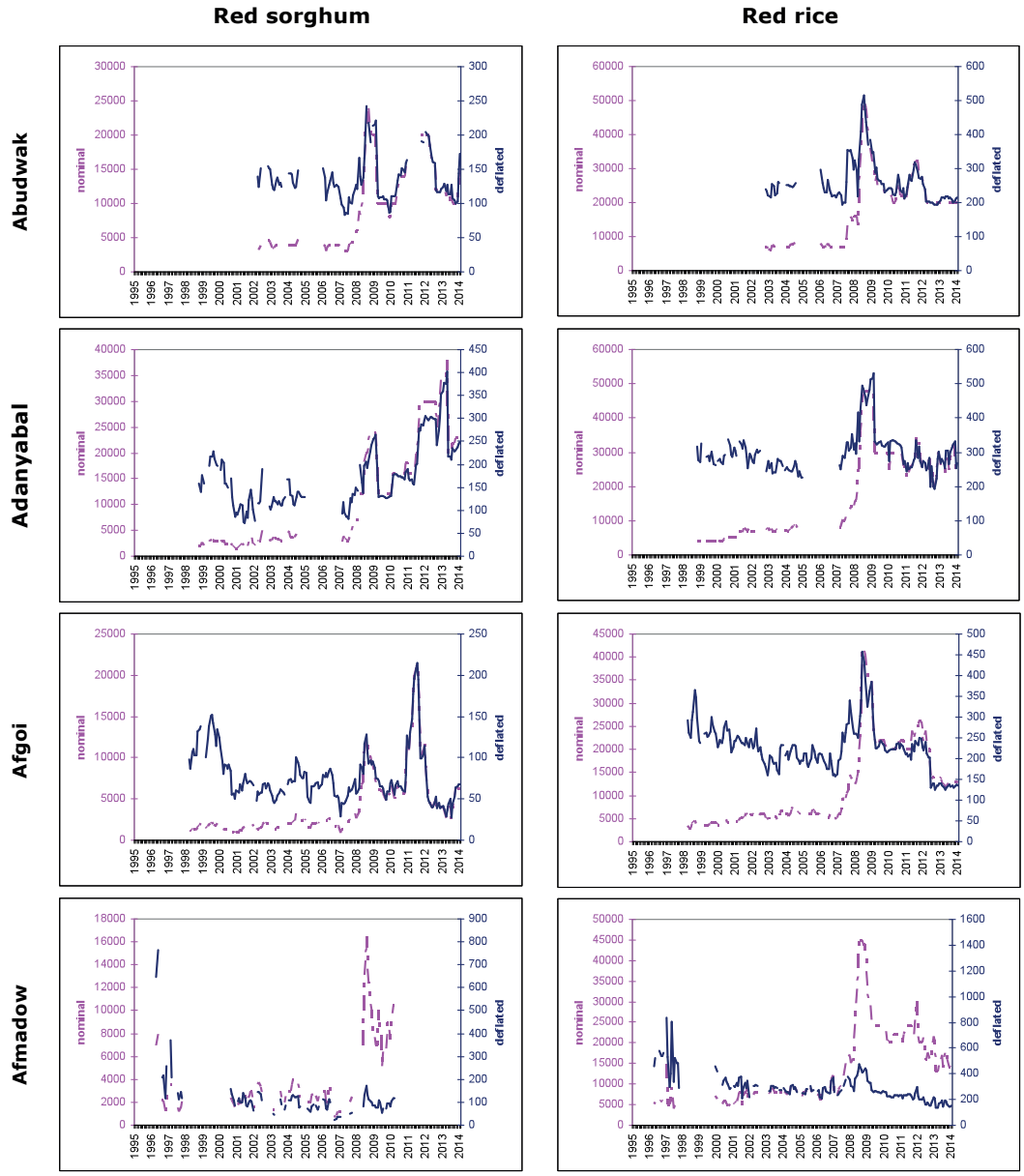
[10] See FSNAU, CPI report, 2015

Figure 4 reports the price evolution for the two commodities recorded in all the markets included in this study. Prices are reported in the local currency – either Somali Shilling (SoSh) or Somaliland Shilling (SlSh) – both in nominal (in light color) and real – i.e. deflated – (in dark color) values.

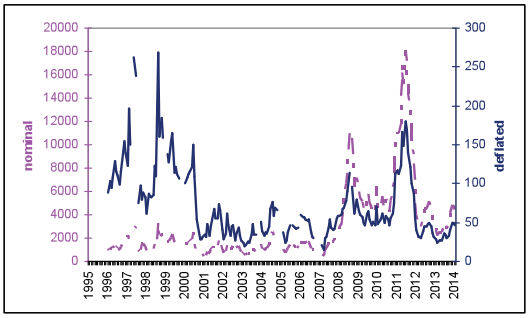
Price volatility is a common feature of graphs in Figure 4. However, the most important consideration about Figure 4 is that price movements show a rather different pattern whether their evolution is considered in real terms or in nominal terms. The general and structural process of price rises which has been going on since the global financial crisis occurred in 2007-08 – which is the main striking feature of nominal price evolution – is also reflected in the evolution of real prices. However, its relevance is reduced and balanced by a rather stable long-term trend. In some cases, such trend is even decreasing, revealing that often real prices have not increased – or have rather decreased – in the long run, contrary to the misleading impression given by the evolution of nominal prices.

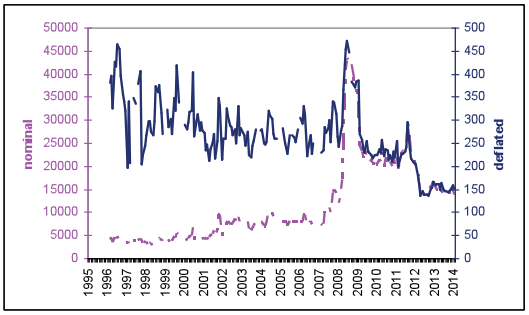
Unless indicated otherwise, the following part of the analysis will make use of deflated price data.

Figure 4: Nominal and real prices of red sorghum and red rice



Baidoa





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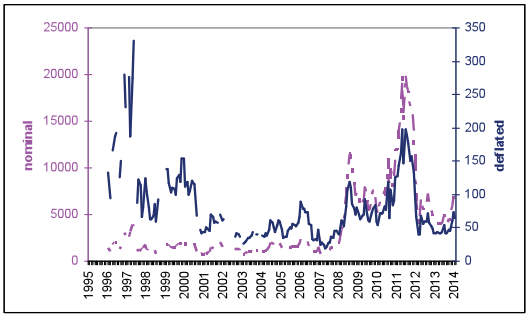

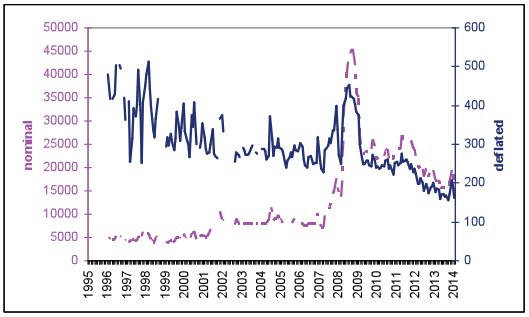

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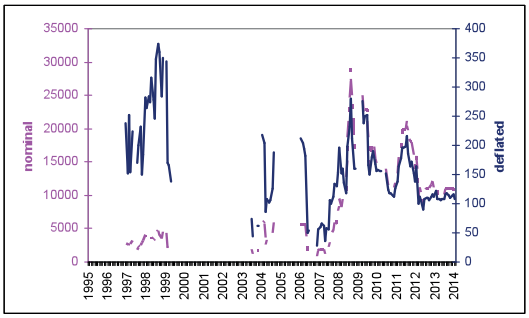

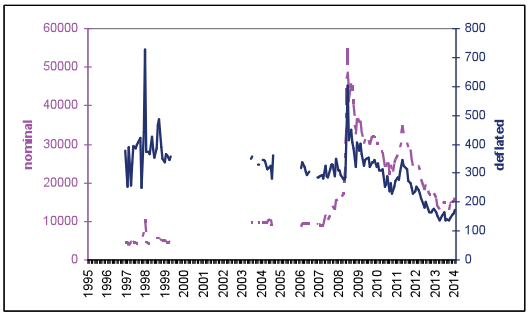

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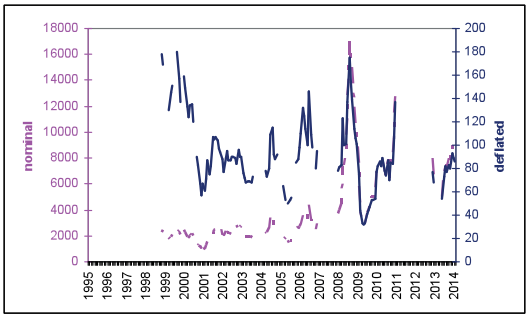
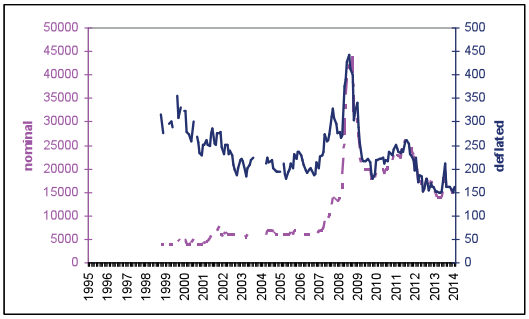
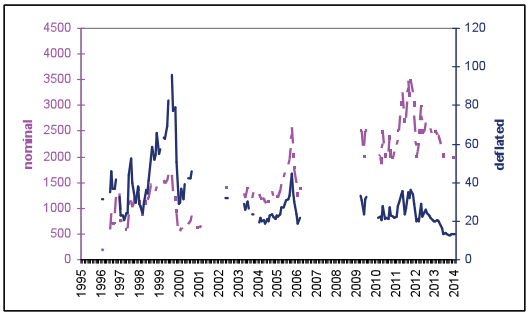
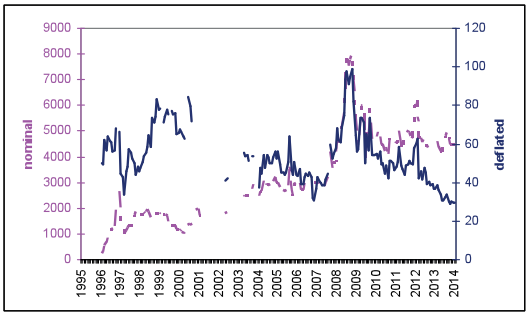




Boroma





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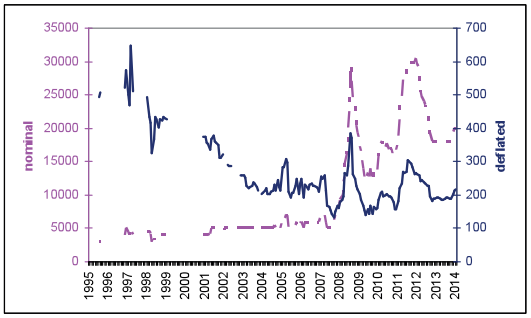

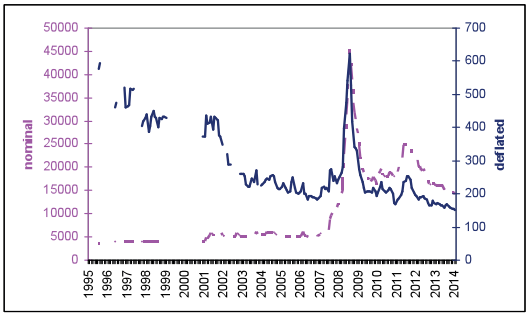

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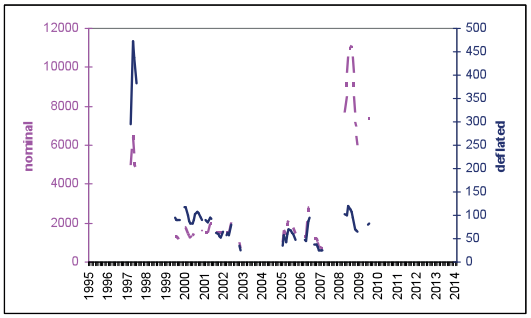

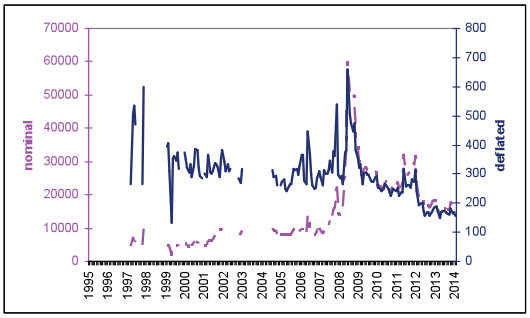

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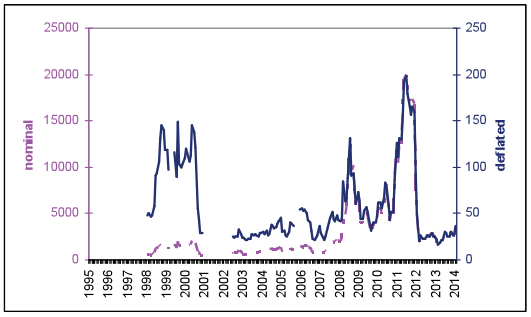

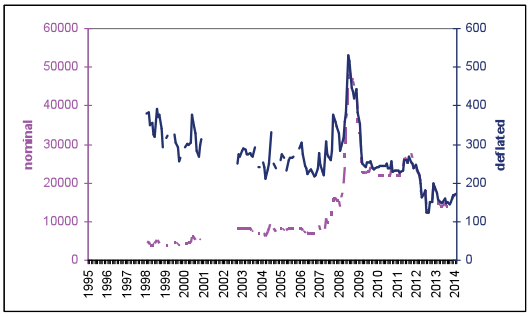

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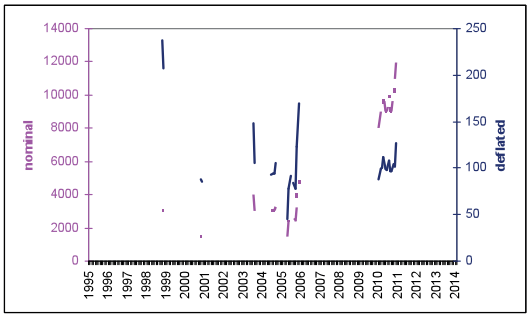

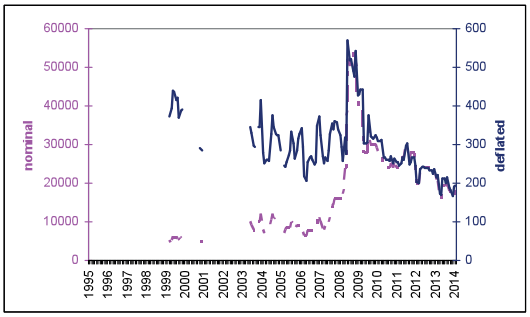

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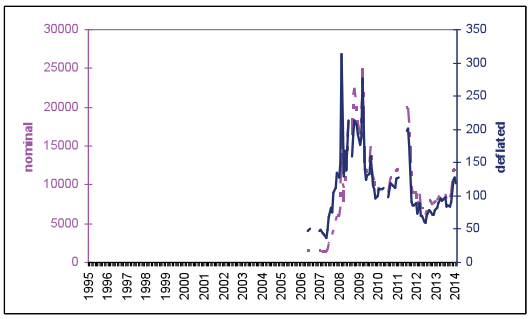

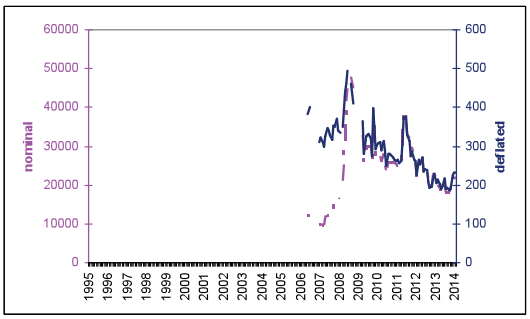

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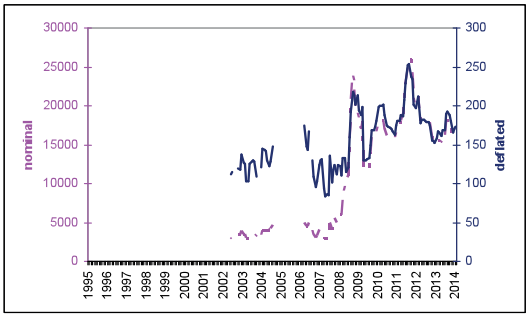

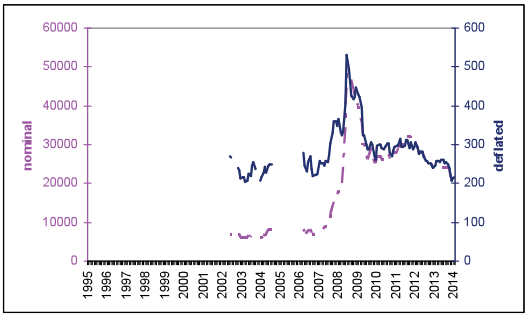

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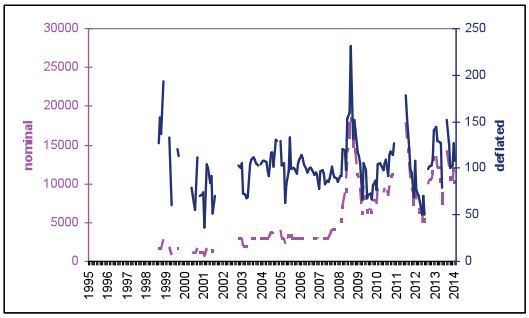

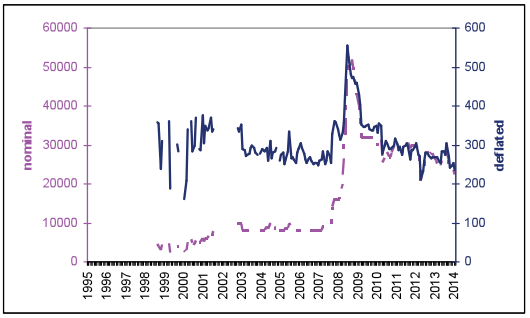

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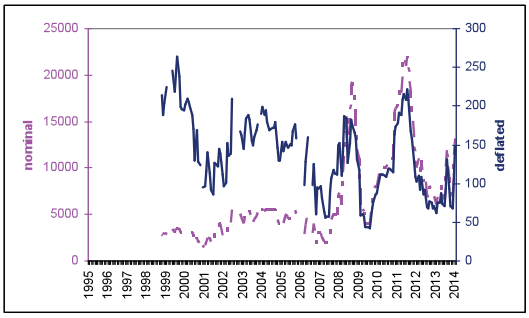

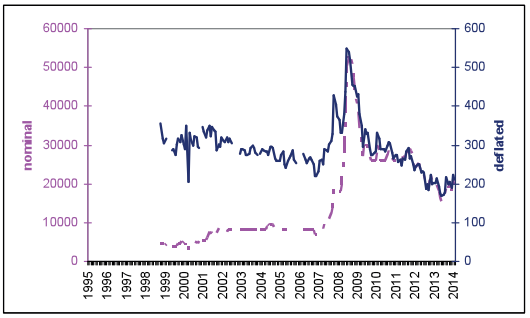

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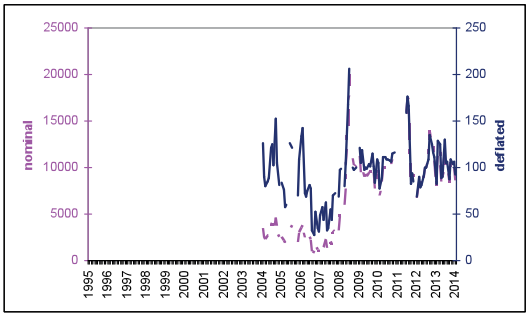

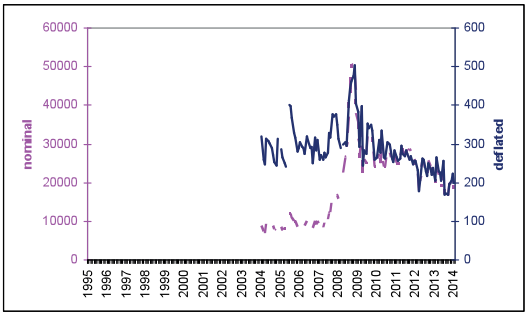

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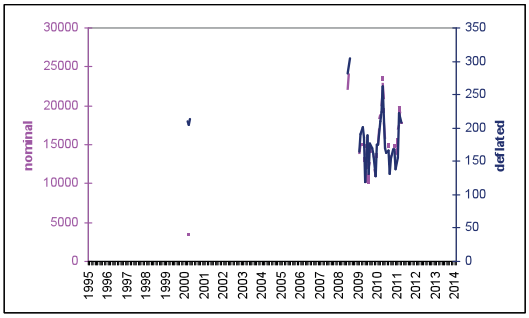

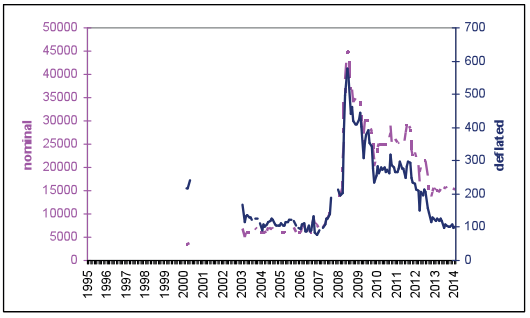

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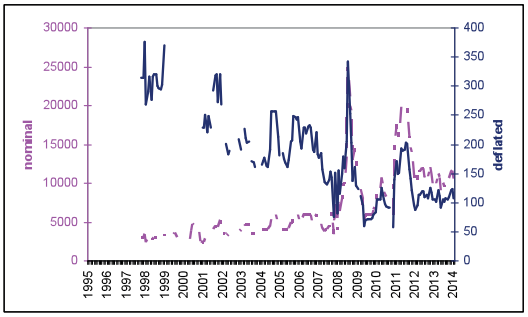

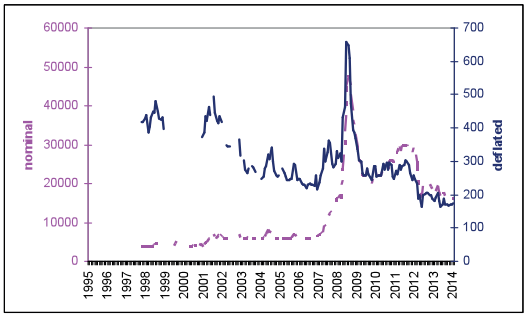

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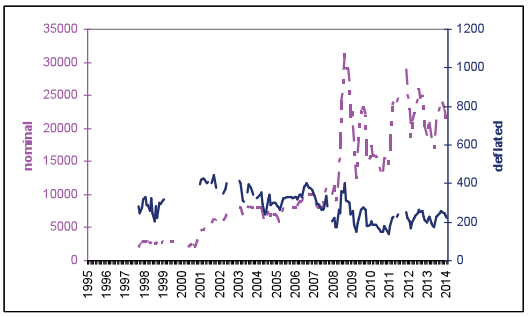

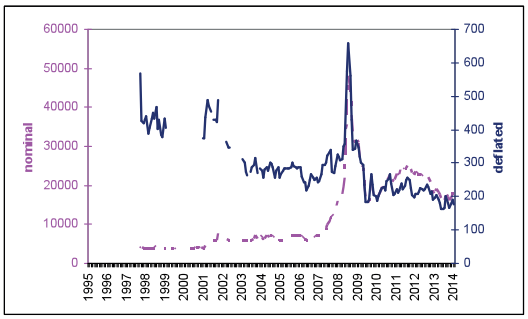

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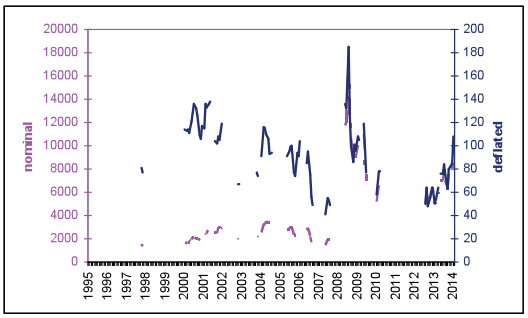

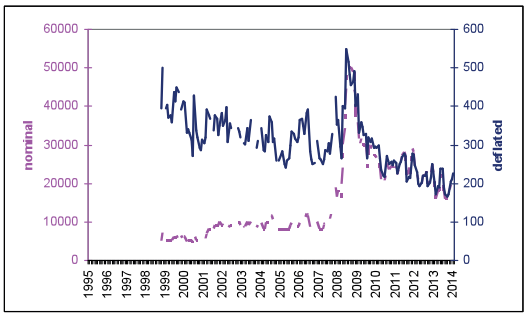

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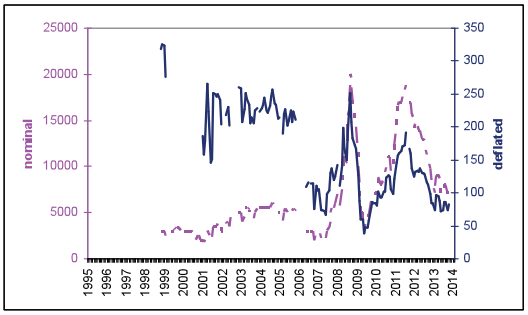
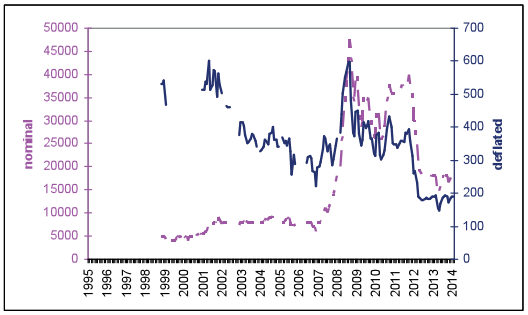
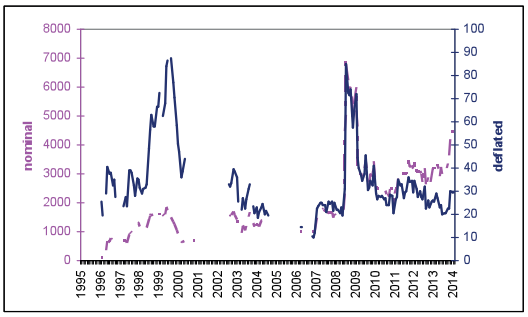
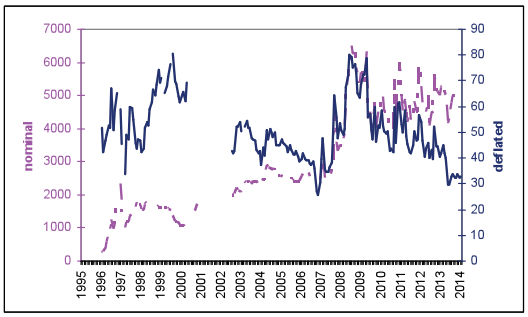




Hargeisa





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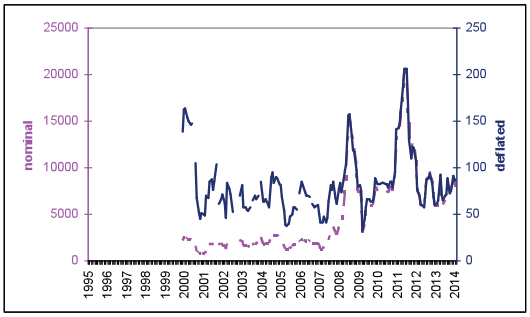

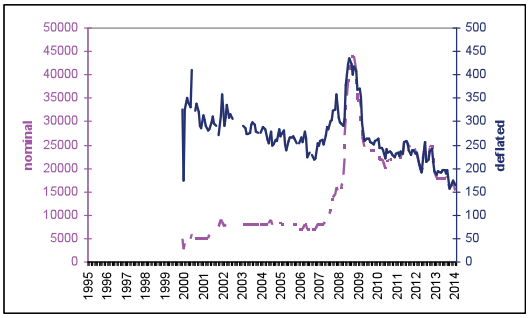

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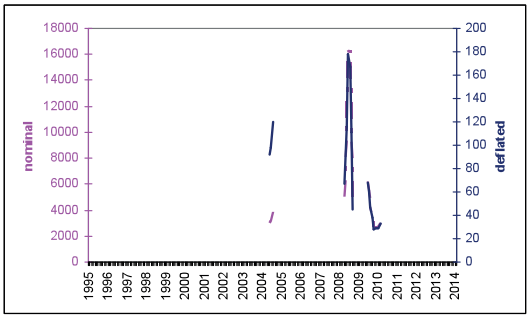

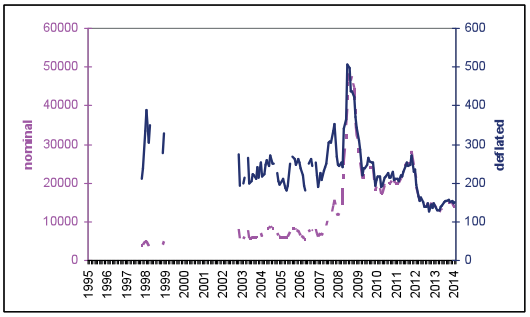

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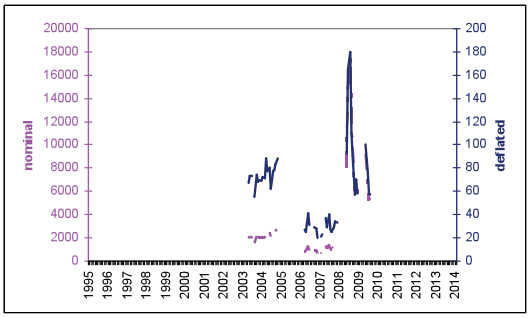

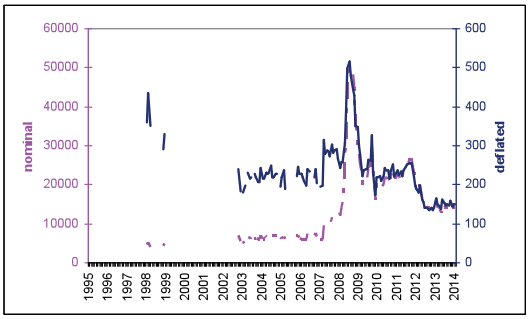

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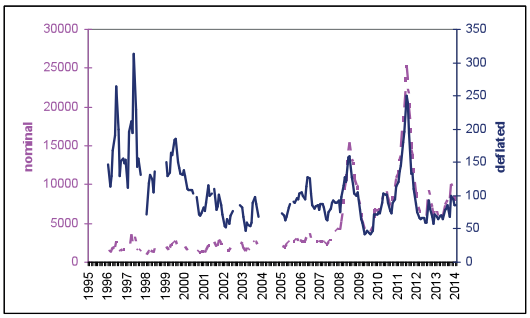

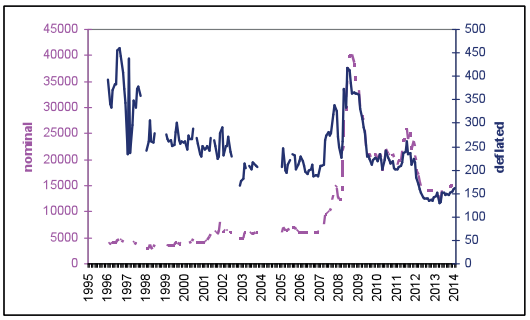

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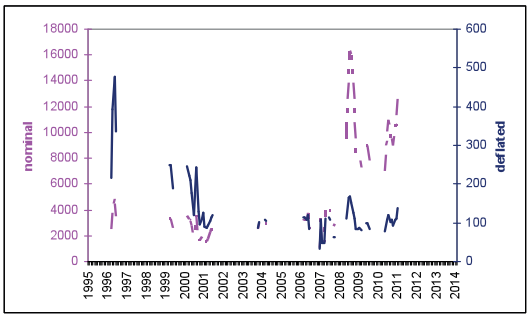

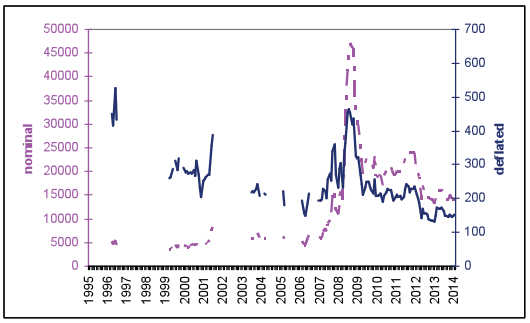

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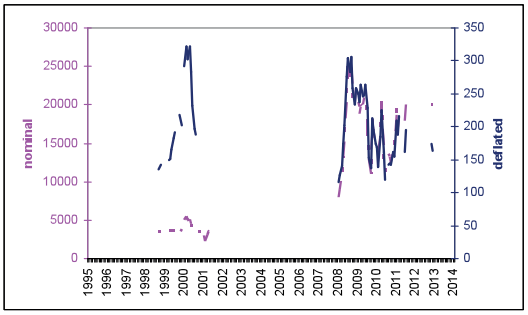

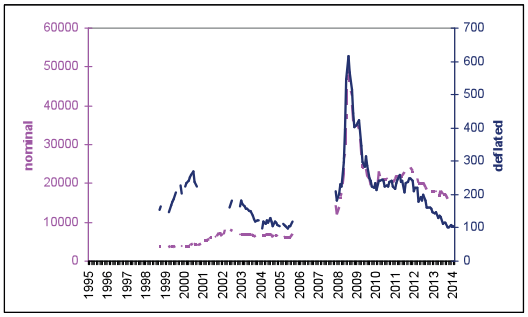

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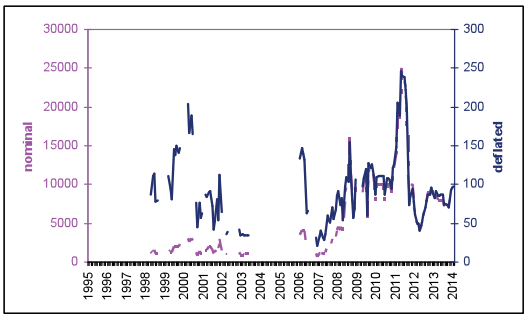

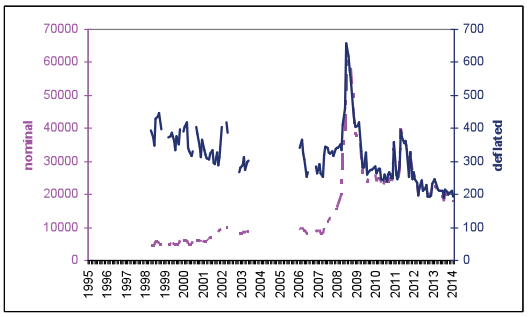

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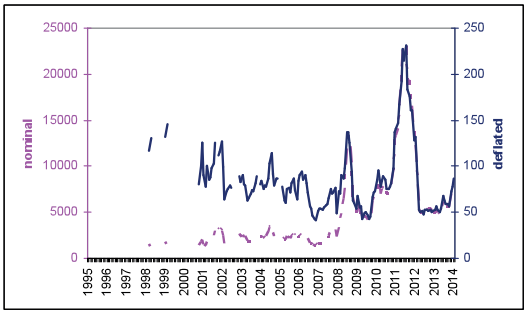

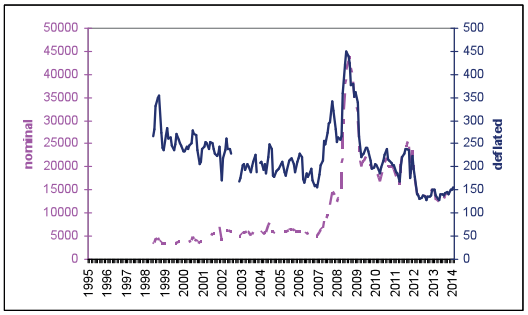

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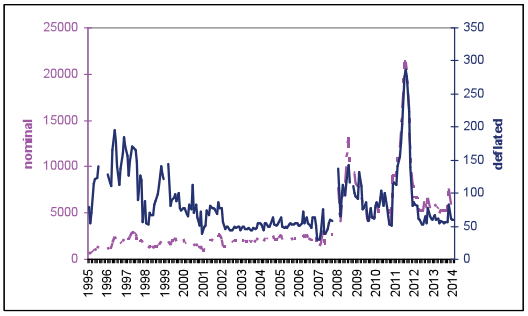

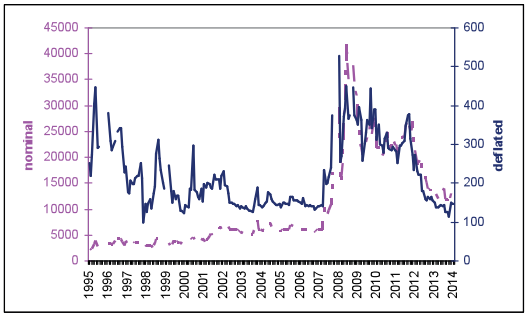

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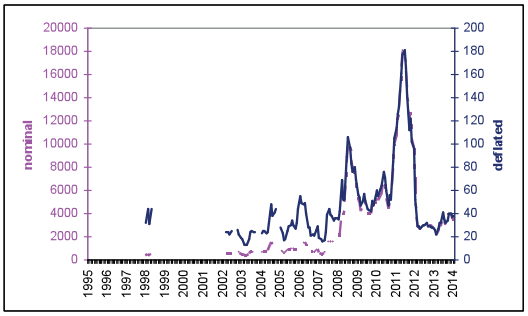
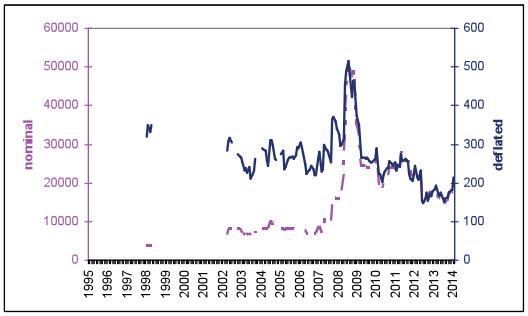
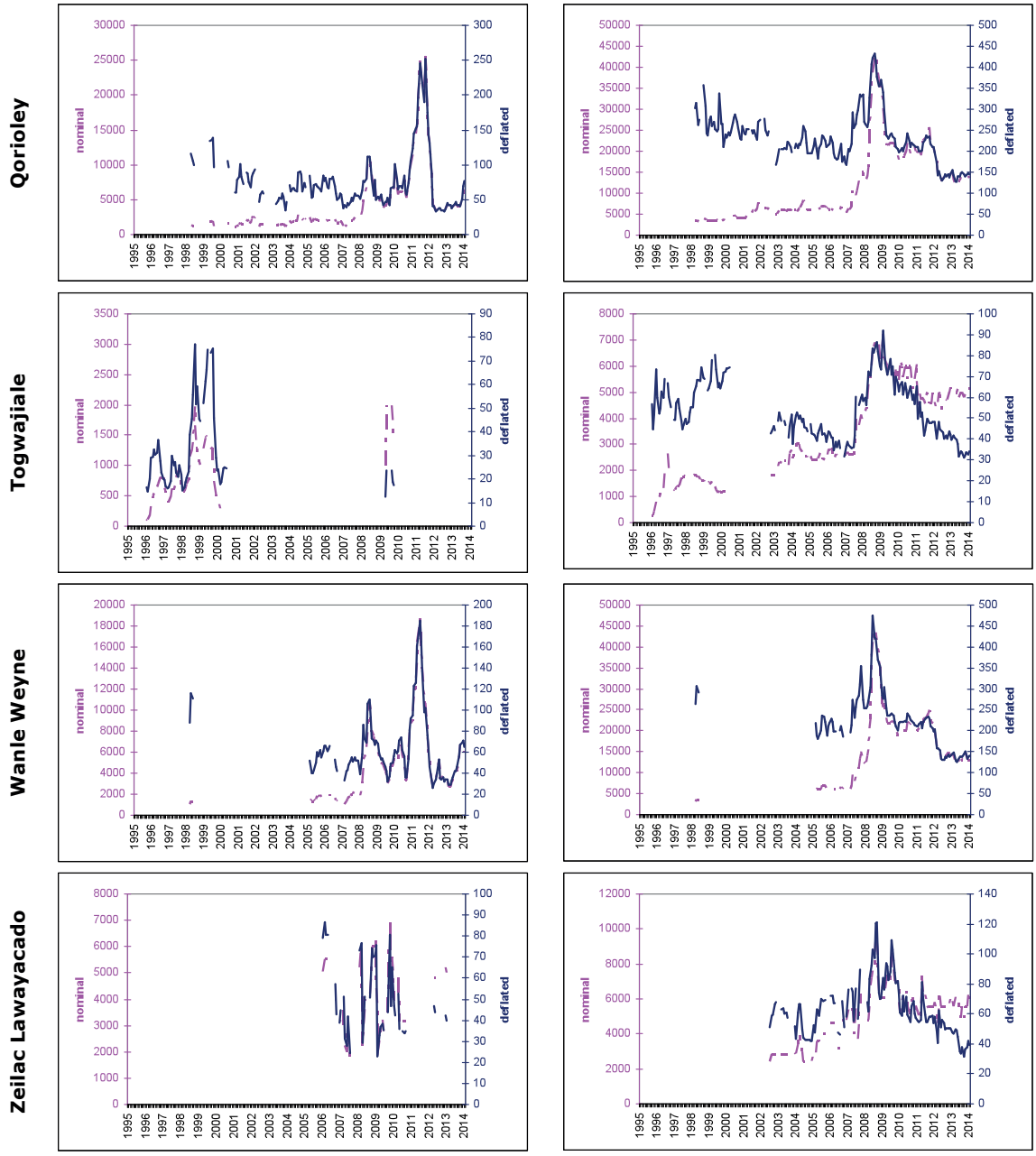






Data source: FSNAU

3. FINDINGS

3.1 Descriptive statistics

Understanding price variability is important as it gives an insight of price behavior within the study period. In normal contexts price variability can be a result of natural factors, such as weather variability, or economic factors, such as the structure of the market – e.g. transport costs, the number of market agents involved, and the length of different marketing channels. In the case of Somalia, besides these regular factors, price variability – and more in general market functioning – is heavily affected by a highly unstable security environment. The 38 markets which were selected for this study are spread across wide distances through areas signed by different degrees of physical security, political stability, economic performance, natural resource availability, climatic severity and drought risk. All such factors are expected to affect at different degrees price variability.

Table 3 provides descriptive statistics. In order to contain the limitations due to missing data, the analysis is restricted to prices reported after 2002. In order to optimize comparability, all prices are expressed in one currency: the Somali Shilling (SoSh). For those markets where trading takes place through the Somaliland Shilling (SlSh), prices have been converted into a SoSh through a SoSh-SlSh exchange rate inferred from the exchange rates of the two currencies against the USD.

The large gap between average prices of rice and sorghum is due to the imported nature of the former compared to the mainly local production of the latter. Prices of rice are generally high throughout Somalia. Surprisingly, the lowest prices are recorded in the North and particularly in the Northwest, where rice is the major staple food together with wheat. Rice is as well the main staple in Central Somalia, and markets in this area record the highest average market prices. This difference is very likely linked to the different currencies used in the two areas. In the South the lowest average price is recorded in Merka which is one of the main ports of entry[11]. Prices increase as the commodity moves inland into the so called 'maize belt' and increase further through the 'sorghum belt'.

In the case of sorghum, as expected the lowest prices are in the main producing areas of Bay. Prices tend to increase along transport costs, with no major difference on average between the sorghum belt and the maize belt. Average sorghum prices double when comparing markets in the South against those in the Center and in the North. This is reflected in a drastic drop in demand, as already seen in Figure 2.

Rice price variability in the North is double the one in the rest of the country (52% versus 26%, respectively). In fact, both maximum and minimum values are recorded in northern markets. With the only exception of the North, price variability is generally higher for sorghum than for rice. This is expected considering that the former is mainly locally produced while the latter is imported. The major factor of variability is seasonality and Figure 6 provides a graphical representation of seasonality indices[12]. Prices are at their lowest in February and March and at their highest in July.

[11] It is necessary to keep in mind that the recent Al Shabab occupation caused a drastic reduction of activities in Merka port.

[12] The seasonality index is estimated by dividing monthly averages by annual averages. An index value for a month of, say, 80% means that prices for that particular month are 20% lower than the annual average. Similarly, an index value of, say, 120% means that prices for that month are 20% higher than the annual average price. Figure 6 presents the national average seasonality price indices.

Table 3 Descriptive statistics of prices in SoSh for the period Jan 03 – Jan 14

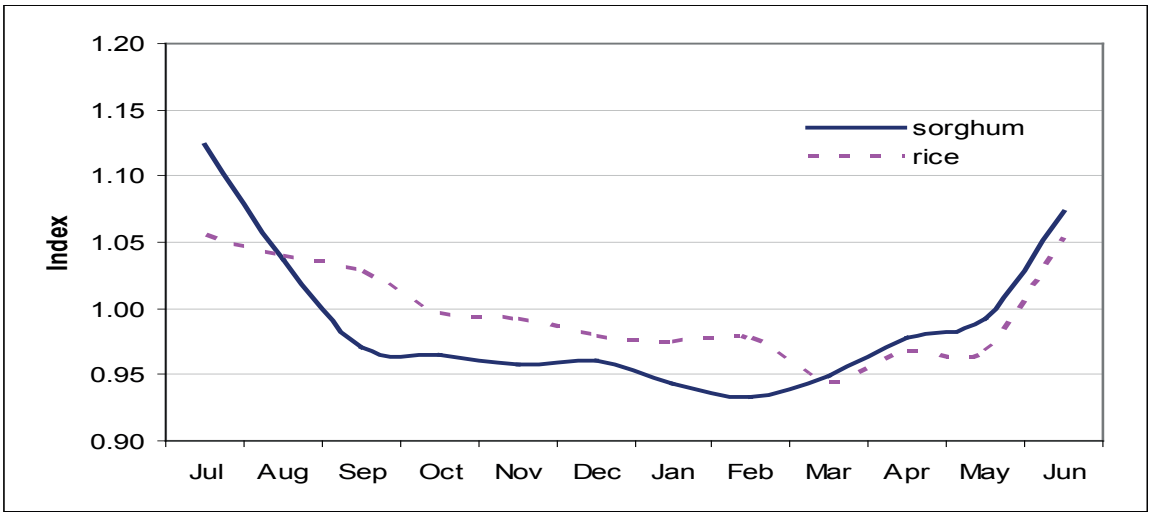
		Red Sorghum				
Market	Obs	Mean	Std. Dev.	Min	Max	Coeff. of Var.
Abudwak	101	134.45	33.38	83.50	242.00	24.82
Adanyabal	106	189.32	74.80	81.90	402.90	39.51
Afgoi	132	72.56	33.14	28.20	214.90	45.67
Afmadow	61	86.89	29.59	21.80	169.90	34.05
Baidoa	122	55.81	31.18	15.70	179.80	55.86
Bardera	130	65.86	36.88	18.50	198.30	56.01
Belet Hawa	103	137.10	53.36	28.40	279.90	38.92
Beletwein	85	85.18	27.95	32.40	175.10	32.82
Boroma	88	90.27	48.16	39.40	278.10	53.35
Bosasso	132	216.87	43.24	131.70	385.80	19.94
Buale	31	70.25	38.96	23.90	218.20	55.46
Dinsor	130	51.74	39.21	16.70	198.30	75.78
Doblei	33	99.22	25.78	32.80	169.60	25.98
Dolo	83	112.87	52.31	36.20	313.50	46.35
Dusamared	111	159.09	37.70	83.50	253.70	23.70
El Barde	123	103.96	26.01	50.00	231.00	25.02
El Der	126	125.84	46.22	42.70	221.60	36.73
Elwak	105	95.90	31.62	28.10	206.00	32.97
Erigavo	33	177.83	50.51	89.60	304.40	28.40
Galkayo	126	153.70	54.83	58.70	341.40	35.67
Garowe	124	268.66	69.45	140.10	415.00	25.85
Hagar	62	83.68	26.49	41.50	185.40	31.66
Hara Dhere	120	144.30	59.78	38.30	256.60	41.43
Hargeisa	108	122.66	86.00	22.60	509.80	70.11
Hudur	129	81.13	32.21	33.10	206.10	39.70
Jamaame	18	75.40	47.66	27.90	178.00	63.21
Jilib	48	62.61	33.54	19.70	180.20	53.57
Jowhar	119	90.80	35.25	41.60	250.90	38.83
Kismayo	45	100.72	26.69	32.50	167.30	26.50
Lasanod	45	194.64	53.70	104.80	306.40	27.59
Lugh	97	92.88	47.22	20.60	246.10	50.85
Merka	130	82.19	37.61	42.00	231.70	45.76
Mogadishu Bakara	129	76.20	44.99	30.60	286.70	59.03
Qansah Dere	129	48.94	34.68	13.20	181.00	70.87
Qorioley	128	72.80	42.58	33.10	251.30	58.49
Togwajiale	8	94.86	37.04	37.40	143.70	39.04
Wanle Weyne	102	61.94	30.90	26.40	185.10	49.90
Zeilac Lawayacado	49	195.19	90.06	76.50	415.30	46.14

Red Rice

Market	Obs	Mean	Std. Dev.	Min	Max	Coeff. of Var.
Abudwak	111	258.53	62.46	193.50	514.90	24.16
Adanyabal	107	301.75	68.79	193.50	530.80	22.80
Afgoi	132	217.21	60.28	125.10	458.00	27.75
Afmadow	122	259.68	67.98	139.10	473.70	26.18
Baidoa	122	245.07	67.65	135.50	471.70	27.60
Bardera	130	266.07	61.65	156.50	453.10	23.17
Belet Hawa	108	282.86	78.91	135.60	603.30	27.90
Beletwein	126	225.04	57.46	148.40	442.80	25.53
Boroma	127	193.28	112.57	74.20	632.70	58.24
Bosasso	132	227.33	70.49	151.30	621.40	31.01
Buale	114	276.38	84.42	149.90	658.20	30.55
Dinsor	124	253.54	71.57	123.00	532.00	28.23
Doblei	127	292.38	75.62	165.20	570.40	25.86
Dolo	84	293.80	71.65	187.80	493.60	24.39
Dusamared	112	287.16	63.48	204.70	532.00	22.11
El Barde	131	301.88	58.10	212.20	554.00	19.24
El Der	128	284.05	70.44	168.30	548.50	24.80
Elwak	118	287.38	60.99	169.00	503.10	21.22
Erigavo	126	199.56	114.43	76.70	577.40	57.34
Galkayo	128	272.48	80.28	164.30	659.50	29.46
Garowe	131	263.07	71.60	161.70	659.00	27.22
Hagar	126	289.78	73.04	166.90	548.50	25.20
Hara Dhere	124	328.26	91.96	148.10	598.40	28.02
Hargeisa	119	189.46	99.94	56.50	514.20	52.75
Hudur	130	261.23	53.36	156.50	435.10	20.43
Jamaame	128	231.10	69.19	125.80	507.40	29.94
Jilib	121	232.33	70.44	135.40	514.90	30.32
Jowhar	118	223.59	63.69	128.40	416.90	28.49
Kismayo	103	224.75	70.21	132.80	466.00	31.24
Lasanod	106	207.09	106.95	97.60	614.80	51.64
Lugh	99	298.22	88.44	190.10	658.20	29.66
Merka	132	213.58	65.83	127.20	449.80	30.82
Mogadishu Bakara	129	223.36	97.13	114.50	529.00	43.49
Qansah Dere	129	259.24	70.12	147.50	514.90	27.05
Qorioley	131	220.25	62.93	127.20	432.50	28.57
Togwajiale	126	197.60	114.29	70.00	528.30	57.84
Wanle Weyne	102	220.95	68.04	125.10	474.40	30.80
Zeilac Lawayacado	117	244.33	135.10	87.20	779.60	55.30

Data source: FSNAU

Figure 6: Seasonality indices



Data source: FSNAU

After the seasonal component, it is interesting to assess whether price data reveal the presence of any long-term changes. Trend analysis captures long-term changes that may significantly alter seasonal patterns. This analysis involves the calculation of a trend factor by regressing the time series on a time dummy variable. The results are presented in Table 4.

Goodwin (1994) noted that a trend is of enough significance if the trend analysis suggests that time alone explains as much as 15% of the variation in the price series. Along this line, in only eight markets the trend component explains 15% or more of price variation. Interestingly, for half of them – Adanyabal, Bardera, Dusamared and Togwajiale – the trend coefficients are positive, while the others – Galkayo, Garowe, Hara Dhere and Jamaame – show a negative sign. For all other markets the value of R^2 is below the threshold. This indicates that time trend has limited influence on the evolution of sorghum prices, and wherever found, this influence has a local nature.

The case of rice is quite different. In this case, the trend component explains 15% or more of price variation in 16 markets, just below half of our market sample. Moreover, results are quite consistent, showing a decreasing trend in 15 markets – Afmadow, Baidoa, Bardera, Belethawa, Buale, Dinsor, Doblei, Dolo, Elwak, Garowe, Hagar, Hara Dhere, Hudur, Lugh and Wanle Weyne – and an increasing trend in only one market – Hargeisa.

Table 4: Results of regressing prices on trend variable

	Red sorghum			Red rice		
Market	Trend coeff.	t-stat of linear trend	R^2	Trend coeff.	t-stat of linear trend	R^2
Abudwak	0.11	0.09	0.01	-0.29 *	0.16	0.03
Adanyabal	1.36 ***	0.13	0.51	0.12	0.17	0.00
Afgoi	0.07	0.08	0.01	-0.31 **	0.14	0.04
Afmadow	0.06	0.14	0.00	-0.92 ***	0.14	0.27
Baidoa	0.19 **	0.07	0.05	-0.96 ***	0.13	0.30
Bardera	0.37 ***	0.08	0.15	-0.85 ***	0.12	0.27
Belet Hawa	0.09	0.15	0.00	-1.38 ***	0.17	0.38
Beletwein	-0.02	0.08	0.00	-0.30 **	0.14	0.04
Boroma	0.29 **	0.12	0.07	0.62 **	0.26	0.04
Bosasso	-0.15	0.10	0.02	-0.47 **	0.16	0.06
Buale	0.60	0.40	0.07	-1.38 ***	0.20	0.29
Dinsor	0.28 ***	0.09	0.08	-0.80 ***	0.15	0.18
Doblei	-0.09	0.12	0.02	-0.78 ***	0.17	0.15
Dolo	-0.20	0.21	0.01	-1.80 ***	0.21	0.47
Dusamared	0.62 ***	0.08	0.38	0.22	0.16	0.02
El Barde	0.08	0.06	0.01	0.01	0.13	0.00
El Der	-0.50 ***	0.10	0.18	-0.50 **	0.16	0.07
Elwak	0.23 **	0.08	0.07	-0.76 ***	0.15	0.19
Erigavo	0.58	0.48	0.05	0.80 **	0.26	0.07
Galkayo	-0.90 ***	0.10	0.38	-0.60 ***	0.18	0.08
Garowe	-1.25 ***	0.12	0.48	-0.82 ***	0.15	0.19
Hagar	-0.16 **	0.08	0.06	-0.94 ***	0.15	0.24
Hara Dhere	-1.05 ***	0.11	0.46	-1.11 ***	0.19	0.22
Hargeisa	0.45 **	0.22	0.04	1.55 ***	0.23	0.29
Hudur	0.29 ***	0.07	0.12	-0.62 ***	0.11	0.20
Jamaame	-1.00 **	0.44	0.24	-0.60 ***	0.15	0.11
Jilib	-0.01	0.20	0.00	-0.51 **	0.16	0.08
Jowhar	0.13	0.09	0.02	-0.55 ***	0.15	0.10
Kismayo	0.13	0.16	0.02	-0.72 ***	0.19	0.12
Lasanod	-1.07 **	0.50	0.10	0.41	0.25	0.02
Lugh	0.38 **	0.14	0.07	-1.14 ***	0.25	0.18
Merka	0.12	0.09	0.01	-0.41 **	0.15	0.06
Mogadishu Bakara	0.42 ***	0.10	0.13	0.75 ***	0.21	0.09
Qansah Dere	0.34 ***	0.08	0.14	-0.68 ***	0.15	0.14
Qorioley	0.18 *	0.10	0.03	-0.48 ***	0.14	0.08
Togwajiale	1.79 **	0.38	0.78	0.84 ***	0.26	0.08
Wanle Weyne	0.06	0.10	0.00	-1.05 ***	0.19	0.23
Zeilac Lawayacado	-0.01	0.56	0.00	0.66 **	0.32	0.04

Significance: *** = 0.01, ** = 0.05, * = 0.1

Data source: FSNAU

3.2 Stationarity and bivariate cointegration

The price series from the 38 markets under study were tested individually for stationarity, thus they were tested for presence of unit roots. The Augmented Dickey Fuller (ADF) test was applied to carry out this test. In all cases the resulting residuals follow the white noise process. The results of the ADF test are presented in Tables A.2 and A.3 for sorghum and rice respectively. They indicate that all price series are non-stationary processes integrated of order one I(1).

Given that all the time series analyzed are non-stationary I(1) processes, and taking into account cointegration theory, which states that two or more non-stationary series are long-term cointegrated if both series are integrated of the same order and their linear combination yields a disturbance term that is stationary, we proceed to test for long-run cointegration. The results of the Johansen test (Tables A.4 and A.5) identify the market pairs for which there is evidence to reject the null hypothesis of no cointegration, suggesting that a long-run cointegrating relationship between prices exists.

A quick view at Tables A.4 and A.5 highlights the existence of a higher number of cointegrating relationships for red rice than in the case of red sorghum. In fact, when considering all relationships which record at least a 0.1 significance level, 70% of all combinations are significant in the case of rice, while only 58% in the case of sorghum. Furthermore, the degree of significance is generally higher for rice than for sorghum.

For both commodities, more than two thirds of the identified cointegrating relationships are found in the South. This was somehow expected since the majority of markets considered here are in the South. In order to take account of such disparity, Table 5 reports the number of relationships recorded on average by each market according to its geographic distribution. Even after taking into account the geographical distribution of the 38 markets considered in this study, the largest average number is still found in the South. Once again, this was expected for sorghum, since a large share of sorghum traded throughout Somalia is produced in the sorghum belt in the South. But a large number of cointegrating links is found in the South also in the case of red rice, which is an imported commodity and which is mainly consumed in the Central and in the Northern zones. Clearly, the shorter distances between markets in the South than in the rest of the country strongly facilitate market exchange and support market functioning in general.

It is expected that the protracted conditions of insecurity, particularly in the South, have not provided a favourable environment for the development of trading activities. Nevertheless, results indicate that there is price transmission even despite unstable security conditions. This highlights how markets can work effectively even under severe security conditions.

Table 5: Average number of cointegrating relationships

	Zone of at least one of the two markets		
	South	Central	North
Red sorghum	22.52	20.50	18.14
Red rice	27.96	22.50	20.86

Data source: Tables A.4 and A.5

It is necessary to consider that cointegration between two variables implies the existence of causality between them in at least one direction. As such, cointegration by itself cannot be used to make inferences about the direction of causation, and therefore it is necessary to establish causality through an appropriate test. In order to determine whether there are any causal relationships in prices among cointegrated markets, the Granger causality test was carried out[13] and only cointegrating relationships

for which a clear direction of causality can be identified are retained. Test results are presented in the last column of Tables A.6 and A.7. Following the consideration that distances influence the volume of trade, in order to realistically restrict the number of possible pairs, prices in each market were compared against prices in each other market in its zone and against each market in the neighboring zone. This means that each market in the Southern and in the Northern zones was compared against each other market within the same zone as well as in the Central zone. Each market in the Central zone was compared against all other markets considered in this study.

Both unidirectional and bidirectional causality are found. In particular, the frequency of bidirectional causality is significantly larger in the case of rice than for sorghum. This suggests that while the market structure of the former is more balanced and mature, it is instead more fragmented for the latter. Interestingly, in the South, where sorghum is the staple food and is locally produced, 34% of the cointegrating relationships identified within the same zone for rice are bidirectional, while only 23% of those identified for sorghum are bidirectional. Table 6 provides a summary list of number and direction of causality of cointegrating relationships identified for each market within its own zone. The total number of relationships combined with the direction of causality can help to summarize the cointegrating capacity as well as the role played by a market. While the former helps to identify the size of the network referred to each market center, the latter helps to define the price-making or price-taking role played by a market. Data in Table 6 help to identify the most (least) relevant markets as well as the most (least) influential in the price-making process.

Starting with sorghum trade in the South, the centers with largest network of markets interconnected through the transmission of price signals are mostly found in Lower Shabelle, Bay and Bakool. In order to identify for each market its role in price making, we can use the ratio between the number of markets being influenced versus the number of influential markets (see column →/←). Qansah Dere, Baidoa and Dinsor, all of them located in Bay region, can be considered as the main price makers, followed by Dolo and Lugh, located in Gedo region along one of the main corridors within the sorghum belt. El Barde and Kismayo are the main price takers; Mogadishu seems to play the same role.

Moving to the Central zone, the number of cointegrating links gets reduced both due to the smaller number of markets as well as due to the larger distances between markets. No real price makers or price takers can be found. Both Abudwak and Galkayo appear to be the two major transit points both receiving and transmitting price signals. The same applies to all other markets considered, with the exclusion of Garowe, which plays a role of price taker.

Moving further North, there seems to be a rather poor degree of price transmission, as signaled by the lack of integrating links involving the main markets of Bosasso and Hargeisa.

As mentioned above, the rice market is characterized by a denser network than found for sorghum. In the South, contrary to the case of sorghum, the main network centers are spread throughout the zone. They can be identified in Afmadow, Beletwein, Bardera, and also Elwak and Lugh. Interestingly, Beletwein, which seems to be rather irrelevant for sorghum price formation and transmission, appears to be one of the key centers in the case of rice trading. In fact, this is one of the most relevant price makers in the South. This is supported by the consideration that rice is mainly consumed in the North and in the Central zone and therefore Beletwein is a sort of entry point of the main rice trading routes which move from the North and Central zone into the South. Surprisingly, data in Table A.6 show the existence of bidirectional influence between Beletwein and Galkayo, but show unilateral influence from Beletwein to all other markets in the central zone. Merka is another major price-maker in the South, besides being another major entry point of rice imports.

[13] For each market pair the appropriate lag length (l) for the specification of the causality test was determined as the one on which converged the majority among the following: the Akaike's information criterion (AIC), the Shwartz's Bayesian information criterion (SBIC), the Hannan and Quinn's information criterion (HQIC), the final prediction error (FPE) and the likelihood-ratio test statistic (LR).

The main price takers are Elwak, Doblei, Hagar, but also El Barde, Afmadow and a few others among the most distant centers from the main entry points. Again, Mogadishu is essentially a price taker.

As seen for sorghum, even in the case of rice the number of cointegrating links gets reduced when moving to the Central and Northern zones. As mentioned above, this is justified by the lower number of markets monitored and consequently by the longer distances between market centers. Nevertheless, since in these parts of Somalia red rice is much more relevant than red sorghum in consumption and trade, we can get now a clearer picture than the one seen above. In particular, Hara Dhere plays mainly a price-making role, while Abudwak is mainly a price taker. Abudwak is influenced both by Hara Dhere and by the two main markets on the route towards the North, supporting what said above about the transmission of price signals from the Northern zone to the Southern zone.

In the North, Bosasso is one of the main entry points of rice imports and plays a critical role as price maker. Other significant contributions to price making are provided by Hargeisa and Togwajale. Actually, both Togwajiale and Hargeisa are influenced – directly the former and indirectly the latter – by Bosasso. Boroma and Zeilac Lawayacao play a price-taking role. Having said the above, a consideration is to be made: a major node in the process of rice price transmission in the North is not covered by this study. In fact, Berbera is the entry point for rice imports into North West areas, has a good port and good transport connection with major market centers in the area. All these are good reasons to assume that Berbera plays a price-making role in the rice trade. Unfortunately Berbera is not monitored by FSNAU and therefore such lack of data has forced to keep this market out of this study.

Table 6: Number and direction of causality of cointegrating relationships – Red sorghum

	Total number of cointegrating relationships	Number of cointegrating relationships in which the market is price-taker or/and price-maker ‡ ← ↔ →			Ratio between price-making and price-taking relationships →/←
Northern zone					
Boroma	1	0	0	1	∞
Bosasso	0	0	0	0	∞
Erigavo	4	0	1	3	∞
Hargeisa	0	0	0	0	∞
Lasanod	1	0	0	1	∞
Togwajiale	1	1	0	0	0.00
Zeilac Lawayacado	1	1	0	0	0.00
Central zone					
Abudwak	5	2	1	2	1.00
Dusamared	3	1	0	2	2.00
El Der	3	1	1	1	1.00
Galkayo	4	2	0	2	1.00
Garowe	2	2	0	0	0.00
Hara Dhere	2	1	0	1	1.00
Southern zone					
Adanyabal	3	3	0	0	0.00
Afgoi	14	8	2	4	0.50
Afmadow	5	1	0	4	4.00
Baidoa	15	2	6	7	3.50
Bardera	13	4	6	3	0.75
Belet Hawa	7	5	2	0	0.00
Beletwein	2	1	0	1	1.00
Buale	3	0	1	2	∞
Dinsor	14	3	2	9	3.00
Doblei	4	2	2	0	0.00
Dolo	8	2	0	6	3.00
El Barde	13	12	0	1	0.08
Elwak	6	2	2	2	1.00
Hagar	3	1	0	2	2.00
Hudur	12	2	4	6	3.00
Jamaame	2	1	0	1	1.00
Jilib	3	0	0	3	∞
Jowhar	12	3	2	7	2.33
Kismayo	10	8	1	1	0.13
Lugh	10	2	2	6	3.00
Merka	13	6	4	3	0.50
Mogadishu Bakara	13	7	5	1	0.14
Qansah Dere	12	1	2	9	9.00
Qorioley	12	7	2	3	0.43
Wanle Weyne	14	7	5	2	0.29

‡ The three arrows ← → ↔ identify the relationships in which the market plays respectively a price-taking role, a price-making role, or both.
Data source: Table A.6

Table 7: Number and direction of causality of cointegrating relationships – Red rice

	Total number of cointegrating relationships	Number of cointegrating relationships in which the market is price-taker or/and price-maker ‡			Ratio between price-making and price-taking relationships
		←	↔	→	→/←
Northern zone					
Boroma	4	4	0	0	∞
Bosasso	3	0	0	3	∞
Erigavo	3	2	1	0	∞
Hargeisa	4	1	0	3	∞
Lasanod	1	0	0	1	∞
Togwajiale	5	1	0	4	4.00
Zeilac Lawayacado	4	3	0	1	0.33
Central zone					
Abudwak	5	3	1	1	0.33
Dusamared	0	0	0	0	…
El Der	4	1	2	1	1.00
Galkayo	4	1	2	1	1.00
Garowe	0	0	0	0	…
Hara Dhere	3	0	1	2	∞
Southern zone					
Adanyabal	13	11	0	2	0.18
Afgoi	11	5	3	3	0.60
Afmadow	23	12	10	1	0.08
Baidoa	18	1	10	7	7.00
Bardera	22	1	10	11	11.00
Belet Hawa	9	6	1	2	0.33
Beletwein	23	0	7	16	∞
Buale	18	8	4	6	0.75
Dinsor	18	1	12	5	5.00
Doblei	16	15	0	1	0.07
Dolo	15	11	1	3	0.27
El Barde	16	10	3	3	0.30
Elwak	20	19	1	0	0.00
Hagar	17	13	3	1	0.08
Hudur	4	1	0	3	3.00
Jamaame	9	2	4	3	1.50
Jilib	15	0	9	6	∞
Jowhar	13	0	8	5	∞
Kismayo	16	7	6	3	0.43
Lugh	20	7	8	5	0.71
Merka	18	0	10	8	∞
Mogadishu Bakara	9	8	0	1	0.13
Qansah Dere	19	10	5	4	0.40
Qorioley	15	1	10	4	4.00
Wanle Weyne	16	1	9	6	6.00

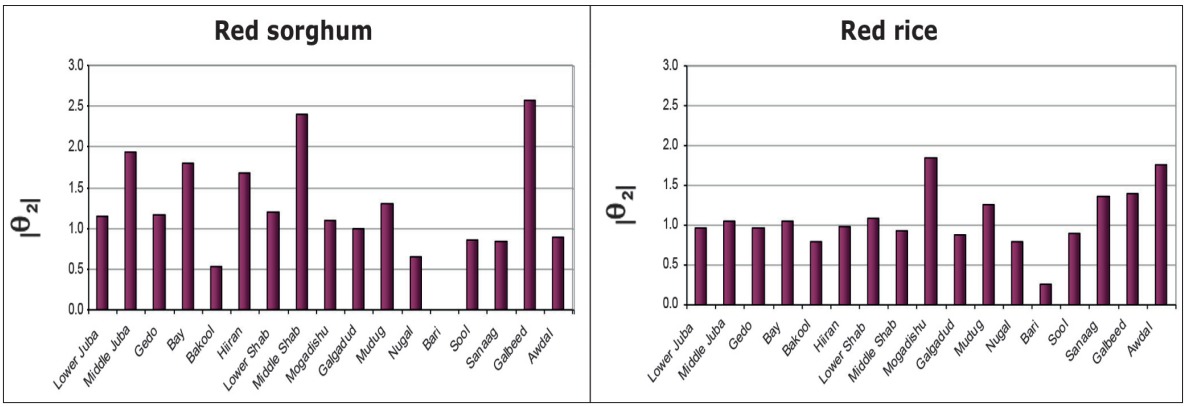
‡ The three arrows ← → ↔ identify the relationships in which the market plays respectively a price-taking role, a price-making role, or both.

Data source: Table A.7

After establishing the direction of causality, this study has attempted to model the long-term price relationship between each market pair for which a cointegrating relationship has been identified. Estimates of the coefficients of long-term effect of the adjustment process (θ_2) and of the speed of adjustment (α_3) described in section 2.2 are presented in Tables A.6 and A.7.

First of all, a test has been run to check whether the patterns of market integration of the two commodities are significantly different from each other. In order to do so, the distribution of θ_2 and α_3 haven been compared against each other. This test has been run both at individual market level and on regional averages. In all cases the test has confirmed that the patterns of market integration of the two commodities are significantly different[14].

Figure 7: Average values of long-term adjustment



Data source: Tables A.6 and A.7

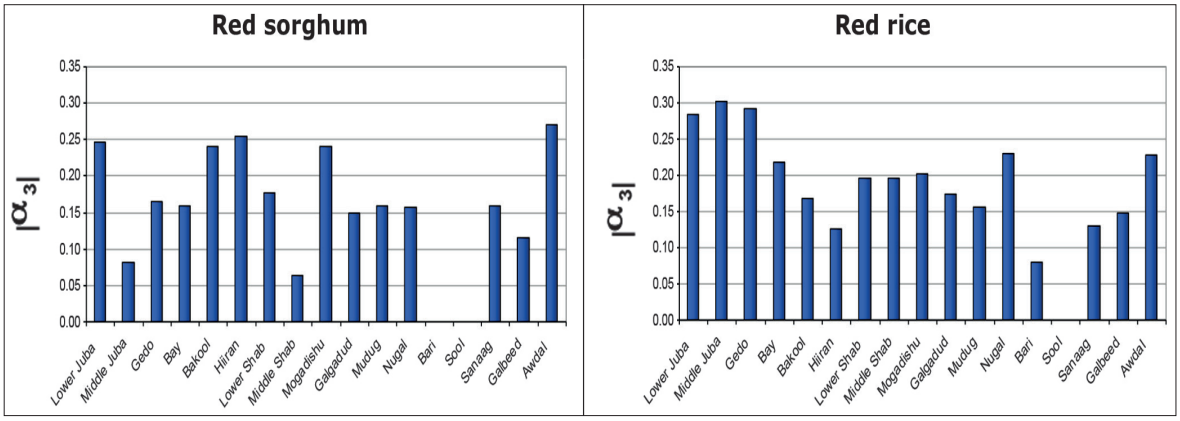
Within the Southern zone Middle Shabelle, Middle Juba, Bay and Hiiran record the highest capacity of sorghum price transmission. Since coefficients can be interpreted in this case as elasticities, the high values of the coefficient recorded in these regions show that price changes in dominant markets within the region tend to get more than fully transmitted in the long run to integrated markets within the same region. For all other regions in the South, coefficient values range around unity, confirming again a substantial price transmission, with the exception of Bakool where the average intensity of price transmission is lower. These results are generally in line with Sanogo's (2011), with the exception of a certain improvement in Gedo's performance. In the Central zone, average values in Galgadud and Mudug reflect the same pattern of a substantial price transmission. In Nugal and in the Northern zone, there is a general reduction of θ_2, highlighting a weaker – although still significant – transmission of price signals. The only exception is Galbeed, which reflects a very strong market connection between Hargeisa and Togwajiale.

The values of θ_2 are not necessarily consistent with those of α_3. In fact, Figure 8 remarks how some of those regions in the South which record the largest values for the former seem to record the lowest values for the latter, and the opposite otherwise. This is the case of Middle Juba and Middle Shabelle, which register the lowest average speed of adjustment, as well as of Bakool, which in this case registers one among the highest values of speed. The same inconsistency is evident in the North, with Galbeed recording lower average speed than Sanaag and Awdal. Anyway, there is nothing wrong with the highlighted inconsistency. In fact, the degree of price transmission and the speed of adjustment are two complementary aspects of the same process: in principle, it is acceptable –

[14] Coefficients of correlation for θ_2 and α_3 are -0.07 and 0.21 respectively. The t-test rejects the hypothesis of equality of means at 0.1 and 0.05 level for θ_2 and α_3 respectively.

though not necessary – that a larger price gap may require a longer period to complete the adjustment process. However, in this case it seems unlikely that prices take so long to adjust; they seem more likely to show incomplete but fast transmission than slow but complete transmission. A region which seems to combine a relatively large price adjustment and a high speed is Hiiran, which in this study is covered only by Beletwein.

Figure 8: Average values of speed of adjustment



Data source: Tables A.6 and A.7

Moving on to the second commodity, it is interesting to consider how values of θ_2 seem to be generally lower than the ones reported above for sorghum in the South. This leads to think of a less intense process of price transmission and adjustment for rice than for sorghum in the South. At the same time, the degree of price adjustment is slightly larger in the North than in the South. Both considerations were somehow expected considering that rice is one of the food staples in the North, but not in the South. Nevertheless, two remarkable exceptions are the minimum value of Bosasso in the North and the maximum value of Mogadishu.

In terms of speed of adjustment, a certain increase in speed rates is found in southern regions compared to the values recorded for sorghum. Contrary to what considered earlier on about the speed of sorghum price adjustment in Beletwein, the speed of price adjustment in Beletwein is in this case only faster than Bosasso.

All the analysis conducted in this section has focused on the process of price transmission between market pairs. This has provided interesting insights, despite some apparent inconsistency related to different aspects of the process of price adjustment. The following section will further deepen the analysis of spatial market integration through the combined analysis of multiple markets.

3.3 Multivariate cointegration

Multivariate cointegration techniques have been applied initially to each zone taken separately and afterwards to the three zones combined.

The combined analysis of an increasing number of time series has imposed some restrictions. In particular, the number of markets taken from the southern zone has been reduced. This reduction has served various purposes: a) to contain the limitations imposed by the gaps in the dataset, and b) to contain the high prevalence of southern markets in the overall sample. Market selection has been inspired by market relevance and data availability. The following markets have been retained for the analysis of multivariate cointegration:

- North: Boroma, Bosasso, Erigavo, Hargeisa, Lasanod, Togwajiale and Zeilac Lawayacado;
- Center: Abudwak, Dusamared, El Der, Galkayo, Garowe, Hara Dhere;
- South: Adanyabal, Baidoa, Beletwein, Hudur, Jowhar, Kismayo, Merka, Mogadishu, Qansah Dere, Qorioley, Wanle Weyne.

The analysis of the aggregate sample covers 11 markets: two from each zone which the analysis above has identified as the most relevant centers in the process of price transmission (Baidoa, Merka, Galkayo, Hara Dhere, Bosasso and Hargeisa) plus five additional markets from the Southern zone (Beletwein, Jowhar, Kismayo, Lugh and Wanle Weyne).

For comparative purposes the analysis has been conducted for both commodities on the same samples of markets.

Table 8: Number of cointegrating equations

Zone	H_0: rank = r	Red sorghum	Red rice	Critical value (5%)
North	r = 0	149.693	176.600	124.24
	r ≤ 1	97.474	120.157	94.15
	r ≤ 2	59.512 *	75.865	68.52
	r ≤ 3	38.539	42.887 *	47.21
	r ≤ 4	21.435	22.822	29.68
	r ≤ 5	11.228	6.639	15.41
Center	r = 0	120.987	136.493	94.15
	r ≤ 1	84.255	84.860	68.52
	r ≤ 2	48.883	47.733	47.21
	r ≤ 3	28.208 *	21.036 *	29.68
	r ≤ 4	10.595	9.019	15.41
	r ≤ 5	3.279	2.751	3.76
South	r = 0	367.549	368.078	277.71
	r ≤ 1	282.780	288.428	233.13
	r ≤ 2	216.281	215.863	192.89
	r ≤ 3	160.751	165.108	156.00
	r ≤ 4	117.497 *	121.019 *	124.24
	r ≤ 5	85.761	86.276	94.15
All	r = 0	295.964	370.650	277.71
	r ≤ 1	230.528 *	277.155	233.13
	r ≤ 2	184.850	218.301	192.89
	r ≤ 3	147.993	168.637	156.00
	r ≤ 4	113.045	124.749	124.24
	r ≤ 5	83.913	86.948 *	94.15

Note: The symbol * identifies the number of cointegrating equations detected through the test.

Table 8 presents the results of the trace test.[15] The test results confirm the existence of a higher number of cointegrated links in the rice market than in the one for sorghum. At the zonal level, this higher integration of the rice market is evident in the North, where three cointegrating equations have been identified for rice, against only two for sorghum. No difference is detected either in the Central zone or in the South, where three and four equations have been detected respectively. However, a higher number of cointegrating equations is found for red rice than for red sorghum when analyzing the three zones through a combined approach.

[15] The trace test or Johansen test is applied through the analysis of multivariate cointegration to identify the number of cointegrating relationships. A higher number of cointegrating relationships signals a more structured network of cointegrated markets.

Table 9: Coefficients of Multivariate Cointegration - Nothern Zone

Red sorghum					Red rice						
	c.e. 1		c.e. 2			c.e. 1		c.e. 2		c.e. 3	
series	θ_2	α_3	θ_2	α_3	series	θ_2	α_3	θ_2	α_3	θ_2	α_3
Bosasso	1	-0.03 **		-0.06 **	Bosasso	1	-0.035		0.02		-0.074
		(0.01)		(0.02)			(0.02)		(0.06)		(0.06)
Hargeisa		-0.12 ***	1	-0.20 **	Hargeisa		0.03	1	-0.31 **		-0.04
		(0.03)		(0.04)			(0.04)		(0.11)		(0.11)
Erigavo	-34.10 ***	-0.03	21.76 ***	-0.06 *	Erigavo		0.05		0.071	1	-0.433 ***
	(4.23)	(0.02)	(2.68)	(0.03)			(0.04)		(0.10)		(0.10)
Boroma	12.92 ***	0.00	-9.67 ***	0.01	Boroma	-2.731 ***	0.22 ***	-0.125	0.322 ***	-0.151	-0.086
	(2.84)	(0.03)	(1.80)	(0.04)		(0.40)	(0.04)	(0.13)	(0.11)	(0.13)	(0.10)
Lasanod	8.56 ***	-0.02	-5.56 ***	-0.03	Lasanod	0.57 *	0.02	-0.267 **	0.101	-0.07	0.00
	(2.33)	(0.02)	(1.48)	(0.03)		(0.34)	(0.03)	(0.11)	(0.07)	(0.11)	(0.07)
Togwajiale	2.30	-0.08 ***	-1.62	-0.12 **	Togwajiale	2.29 ***	0.03	-0.971 ***	0.17 *	-0.654 ***	0.07
	(1.74)	(0.02)	(1.10)	(0.04)		(0.36)	(0.03)	(0.12)	(0.09)	(0.12)	(0.09)
Zeilac L.	6.4 **	-0.18 ***	-3.09 **	-0.26 ***	Zeilac L.	-0.535 *	0.06	0.43 ***	-0.17	-0.112	0.08
	(2.31)	(0.03)	(1.46)	(0.05)		(0.33)	(0.05)	(0.11)	(0.13)	(0.11)	(0.12)

Note: c.e. stands for cointegrating equation. Significance: *** = 0.01, ** = 0.05, * = 0.1. Standard errors in brackets.

Data source: FSNAU

Table 10: Coefficients of Multivariate Cointegration - Central Zone

Red sorghum							Red rice						
	c.e. 1		c.e. 2		c.e. 3			c.e. 1		c.e. 2		c.e. 3	
series	θ_2	α_3	θ_2	α_3	θ_2	α_3	series	θ_2	α_3	θ_2	α_3	θ_2	α_3
Galkayo	1	-0.278 ***		-0.123 **		0.03	Galkayo	1	-0.30 ***		0.10 **		-0.20 **
		(0.08)		(0.06)		(0.10)			(0.09)		(0.05)		(0.08)
Hara Dhere		0.007	1	-0.084 **		0.05	Hara Dhere		0.16 **	1	-0.113 **		-0.02
		(0.06)		(0.04)		(0.08)			(0.09)		(0.05)		(0.08)
Abudwak		-0.013		-0.087 **	1	-0.175 ***	Abudwak		0.24 ***		-0.044	1	-0.305 ***
		(0.04)		(0.03)		(0.06)			(0.08)		(0.04)		(0.07)
Dusamared	-0.07	-0.008	0.81 ***	-0.053 *	-0.55 ***	0.19 ***	Dusamared	0.01	0.25 ***	1.08 ***	-0.108 ***	-0.28 **	0.08 *
	(0.15)	(0.04)	(0.25)	(0.03)	(0.14)	(0.05)		(0.16)	(0.06)	(0.35)	(0.03)	(0.13)	(0.05)
El Der	-0.39 ***	0.06	-1.39 ***	0.09	-0.29 ***	-0.028	El Der	-1.10 ***	0.15 **	-2.89 ***	0.02	-0.40 **	0.10
	(0.09)	(0.08)	(0.14)	(0.06)	(0.08)	(0.10)		(0.18)	(0.07)	(0.39)	(0.04)	(0.15)	(0.06)
Garowe	-1.03 ***	0.18 ***	0.29	-0.078 **	0.01	-0.031	Garowe	0.01	0.12	1.02 ***	-0.107 **	-0.21 *	0.01
	(0.14)	(0.05)	(0.23)	(0.03)	(0.13)	(0.06)		(0.13)	(0.10)	(0.30)	(0.05)	(0.11)	(0.08)

Note: c.e. stands for cointegrating equation. Significance: *** = 0.01, ** = 0.05, * = 0.1. Standard errors in brackets.

Data source: FSNAU

Table 11: Coefficients of multivariate cointegration – Southern zone

	Red sorghum								Red rice							
	c.e. 1		c.e. 2		c.e. 3		c.e. 4			c.e. 1		c.e. 2		c.e. 3		c.e. 4	
series	θ_2	α_3	θ_2	α_3	θ_2	α_3	θ_2	α_3	series	θ_2	α_3	θ_2	α_3	θ_2	α_3	θ_2	α_3
Merka	1	-0.23 **		0.06		-0.04		-0.28 ***	Merka	1	0.017		0.03		-0.12 *		0.08 **
		(0.10)		(0.05)		(0.05)		(0.06)			(0.15)		(0.09)		(0.07)		(0.04)
Baidoa		0.15	1	-0.14 **		0.13 **		-0.28 ***	Baidoa		0.42 ***	1	-0.35 ***		0.00		-0.02
		(0.11)		(0.05)		(0.06)		(0.07)			(0.15)		(0.09)		(0.07)		(0.04)
Kismayu		0.21		0.12 *	1	-0.32 ***		0.15 *	Kismayu		0.36 **		0.10	1	-0.28 ***		0.11 **
		(0.14)		(0.07)		(0.07)		(0.09)			(0.16)		(0.10)		(0.08)		(0.05)
Beletwein		-0.07		-0.06		0.12 **	1	-0.42 ***	Beletwein		0.26 *		-0.04		0.05	1	0.02
		(0.09)		(0.05)		(0.05)		(0.06)			(0.14)		(0.08)		(0.07)		(0.04)
Adanyabal	-0.20 ***	0.14 *	0.63 ***	0.01	0.44 ***	-0.10 **	0.37 ***	0.02	Adanyabal	-0.15 ***	0.53 ***	0.18 *	0.02	-0.70 ***	0.21 ***	-0.32	-0.03
	(0.05)	(0.08)	(0.15)	(0.04)	(0.16)	(0.04)	(0.08)	(0.05)		(0.05)	(0.16)	(0.10)	(0.10)	(0.13)	(0.08)	(0.29)	(0.05)
Hudur	-0.06	0.14	-1.80 ***	0.12 **	-1.17 ***	0.04	-1.11 ***	-0.13 *	Hudur	-0.17 **	0.25 **	-0.13	-0.09	-0.23	0.12 **	1.02 **	-0.06 **
	(0.11)	(0.11)	(0.31)	(0.05)	(0.33)	(0.06)	(0.17)	(0.07)		(0.08)	(0.10)	(0.17)	(0.06)	(0.22)	(0.05)	(0.49)	(0.03)
Jowhar	-0.13	0.24 **	1.15 ***	-0.04	0.13	-0.01	-0.82 ***	-0.12 *	Jowhar	-0.46 ***	0.36 ***	-1.20 ***	0.09	1.90 ***	-0.16 ***	4.79 ***	0.02
	(0.10)	(0.10)	(0.28)	(0.05)	(0.30)	(0.05)	(0.16)	(0.06)		(0.11)	(0.12)	(0.23)	(0.07)	(0.30)	(0.06)	(0.67)	(0.03)
Mogadishu B.	0.17 **	0.07	-1.04 ***	0.23 ***	-0.55 **	0.01	0.21 *	-0.28 ***	Mogadishu B.	-0.02	0.28	0.20 ***	-0.13	0.03	0.06	0.06	-0.04
	(0.08)	(0.15)	(0.21)	(0.07)	(0.23)	(0.08)	(0.12)	(0.09)		(0.03)	(0.22)	(0.05)	(0.13)	(0.07)	(0.11)	(0.15)	(0.06)
Qansah Dere	-0.05	0.15	0.72 ***	-0.06	0.30	0.06	-0.05	-0.25 ***	Qansah Dere	0.00	0.65 ***	-0.29 *	0.19 **	-0.19	0.08	-0.87 *	0.09 **
	(0.08)	(0.13)	(0.24)	(0.06)	(0.26)	(0.07)	(0.13)	(0.08)		(0.08)	(0.15)	(0.16)	(0.09)	(0.21)	(0.07)	(0.48)	(0.04)
Qorioley	-0.84 ***	0.47 ***	-0.46 **	0.07	-0.73 ***	-0.04	-0.07	-0.15 **	Qorioley	-0.62 ***	0.73 ***	1.45 ***	0.04	-0.65 *	-0.09 *	-5.01 ***	0.15 ***
	(0.08)	(0.12)	(0.22)	(0.06)	(0.24)	(0.06)	(0.13)	(0.07)		(0.14)	(0.11)	(0.28)	(0.06)	(0.36)	(0.05)	(0.82)	(0.03)
Wanle Weyne	0.03	0.14	-0.12	0.21 ***	0.97 ***	-0.17 ***	0.79 ***	-0.23 ***	Wanle Weyne	0.26 **	0.46 ***	-1.20 ***	0.31 ***	-1.46 ***	0.09	-0.34	0.09 ***
	(0.10)	(0.10)	(0.29)	(0.05)	(0.32)	(0.05)	(0.17)	(0.06)		(0.13)	(0.12)	(0.26)	(0.07)	(0.33)	(0.06)	(0.75)	(0.03)

Note: c.e. stands for cointegrating equation. Significance: *** = 0.01, ** = 0.05, * = 0.1. Standard errors in brackets.

Data source: FSNAU

Table 12: Coefficients of multivariate cointegration – All zones

Red sorghum			Red rice									
	c.e. 1			c.e. 1		c.e. 2		c.e. 3		c.e. 4		c.e. 5	
series	θ_2	α_3	series	θ_2	α_3	θ_2	α_3	θ_2	α_3	θ_2	α_3	θ_2	α_3
Merka	1	0.08 **	Merka	1	-0.114		-0.17 *		0.12 *		0.04		0.08
		(0.04)			(0.11)		(0.09)		(0.07)		(0.12)		(0.08)
Baidoa	0.94 ***	0.00	Baidoa		0.10	1	-0.45 ***		0.23 ***		-0.09		0.02
	(0.22)	(0.04)			(0.12)		(0.09)		(0.07)		(0.12)		(0.08)
Beletwein	-0.52 ***	0.09 **	Beletwein		-0.04		0.08	1	-0.05		0.09		-0.02
	(0.20)	(0.04)			(0.11)		(0.09)		(0.07)		(0.12)		(0.08)
Jowhar	0.95 ***	0.05	Galkayo		0.06		-0.03		0.20 ***	1	-0.60 ***		0.27 ***
	(0.28)	(0.04)			(0.11)		(0.09)		(0.07)		(0.12)		(0.08)
Kismayu	-0.68 ***	0.13 **	Bosasso		0.22 **		-0.06		0.06		-0.02	1	-0.07
	(0.17)	(0.05)			(0.10)		(0.08)		(0.06)		(0.11)		(0.07)
Lugh	-0.01	0.02	Jowhar	-1.70 ***	0.33 ***	0.59 ***	0.03	2.04 ***	0.08	0.16	-0.17	-1.50 **	-0.01
	(0.11)	(0.06)		(0.33)	(0.10)	(0.22)	(0.08)	(0.50)	(0.06)	(0.22)	(0.10)	(0.64)	(0.07)
Wanle Weyne	-1.87 ***	0.24 ***	Kismayu	-0.97 ***	0.30 **	0.75 ***	-0.24 **	0.91 **	0.29 ***	-0.78 ***	0.03	-1.88 ***	0.03
	(0.21)	(0.03)		(0.23)	(0.12)	(0.15)	(0.10)	(0.36)	(0.08)	(0.16)	(0.13)	(0.45)	(0.09)
Galkayo	0.93 ***	-0.02	Lugh	-0.47 **	0.14	-0.34 **	0.22 **	0.26	0.26 ***	-0.75 ***	-0.02	-1.88 ***	0.28 ***
	(0.18)	(0.05)		(0.20)	(0.12)	(0.13)	(0.10)	(0.31)	(0.07)	(0.14)	(0.13)	(0.39)	(0.09)
Hara Dhere	-0.55 ***	0.09 **	Wanle Weyne	2.28 ***	0.34 ***	-2.28 ***	0.14 *	-4.73 ***	0.23 ***	0.64 **	0.01	4.60 ***	-0.04
	(0.15)	(0.04)		(0.37)	(0.09)	(0.25)	(0.07)	(0.57)	(0.05)	(0.25)	(0.10)	(0.72)	(0.06)
Bosasso	-0.60 **	0.09 ***	Hara Dhere	-0.38 **	0.12	0.17	0.11	0.96 ***	-0.05	-0.34 ***	0.15	-0.65 **	-0.06
	(0.29)	(0.02)		(0.17)	(0.12)	(0.11)	(0.10)	(0.26)	(0.07)	(0.12)	(0.13)	(0.33)	(0.08)
Hargeisa	0.12	0.16 ***	Hargeisa	0.03	0.23	0.11 ***	-0.33 **	-0.13	0.43 ***	-0.03	-0.08	0.00	0.17
	(0.10)	(0.05)		(0.06)	(0.17)	(0.04)	(0.14)	(0.09)	(0.11)	(0.04)	(0.19)	(0.12)	(0.12)

Note: c.e. stands for cointegrating equation. Significance: *** = 0.01, ** = 0.05, * = 0.1. Standard errors in brackets.

Data source: FSNAU

The main parameters in the analysis of multivariate cointegration – i.e. the coefficients of long-term adjustment θ_2 and speed of adjustment α_3 – are reported in Tables 9-12. Overall, the general interpretation of the results reveals a higher degree of cointegration for the rice market than for sorghum.

Starting from the sorghum market in the Northern zone, Table 9 shows extremely high values of θ_2 for all market centers with the only exception of Togwajiale, which is insignificant. However, such high values are generally associated with very low values of adjustment speed. This occurs when either Bosasso or Hargeisa are taken as reference markets. The exception is given by Zeilac Lawayacado which manages to combine high rates of adjustment and reasonably good rates of adjustment speed to price changes in both reference markets. In this case, prices require 3.8 and 5.5 months[16] to adjust to price changes in Bosasso and Hargeisa respectively.

Three reference markets have been considered in the case of rice, since three cointegrating relationships have been identified. Bosasso, Hargeisa and Erigavo have been selected as reference market centers[17]. In this case, values of θ_2 are more reasonable than the excessive values seen above. Significant absolute values range between 0.26 (Lasanod) and 2.73 (Boroma). Boroma and Togwajiale record the highest values. However, while in the latter prices are significantly affected by price changes in all three reference markets, prices in the former seem to react only to price changes in Bosasso. Prices in both Lasanod and Zeilac Lawayacado are reactive to price changes in both Bosasso and Hargeisa, while only prices in Togwajiale are reactive to price changes in Erigavo. Boroma records the highest speed to price changes in reference markets: 3.1 and 4.5 months to adjust to price changes in Hargeisa and Bosasso respectively. Adjustment speed is lower in all other markets. As expected, prices in both Towajale and Zeilac Lawayacado adjust faster to price changes in Hargeisa than in Bosasso, although it is necessary to highlight how some of the values involved are insignificant.

The equal number of cointegrating equations identified in the Central zone gives the impression of a rather balanced degree of integration when comparing between the two commodities. Nevertheless, results in Table 10 reveal significantly higher values of θ_2 and α_3 for rice. Significant values of θ_2 range between 0.28 and 1.39 for sorghum and between 0.21 and 2.89 for rice, with 0.74 and 1.00 as respective average values. Therefore, this reveals a stronger process of price transmission for rice than for sorghum. At the same time, price transmission appears to be generally slow, although once again faster for rice than for sorghum. The highest values of θ_2 are recorded for both commodities by El Der and this occurs in both occasions with reference to price changes in Hara Dhere. Having said that, El Der scores substantial θ_2 values with all three reference markets considered, and values of the coefficient are regularly higher for rice than for sorghum. Dusamared is well connected for both commodities with Abudwak and Hara Dhere, but apparently not with Galkayo. Finally, price transmission reveals a good degree of market connection between Garowe and Galkayo only for sorghum, while in the case of rice Garowe shows a good degree of connection with Hara Dhere.

In the Southern zone Merka, Baidoa, Kismayo and Beletwein were selected as reference markets for both commodities. As shown in Table 11, the highest θ_2 values are recorded by Qorioley and Jowhar about rice price transmissions between them and Beletwein. However, besides such excessively high values, values of θ_2 are on average still higher for rice than for sorghum.

[16] The time required for price adjustment can be estimated as $1/\alpha_3$.
[17] As remarked earlier on, it is necessary to consider how this analysis is somehow incomplete due to the unavailability of data about market prices in Berbera, which is assumed to be the major entry point of rice imports into the North West.

Among the reference markets, Baidoa has an equal number of connections for the two commodities, but on average a larger share of sorghum price changes get transmitted to connected markets: 97% against 75% for rice. This confirms Baidoa as one of the major price makers for sorghum. Sorghum price changes occurred in Baidoa get transmitted above parity to Hudur, Jowhar and Mogadishu, while 63% and 46% of price changes get transmitted to Adanyabal and Qorioley, respectively. However, only the transmission of sorghum price changes between Baidoa and Mogadishu occurs at an interesting speed (corresponding to around 4.3 months) while the process is much slower in all other cases.

Also rice prices reveal that Baidoa is well connected to other markets, as highlighted by remarkable values of θ_2. However, in this case, we assume that the price signal proceeds from coastal markets towards Baidoa, in line with the imported nature of red rice. This is supported by the results of the Granger causality test which are shown in Table A.9. These results highlight that rice price changes in Baidoa are influenced by rice price changes in Mogadishu and Merka. These price signals are transmitted both directly and through Qansah Dere and Wanle Weyne. Although the analysis of causality shows that price transmission between Baidoa and Wanle Weyne is bidirectional, it seems justified to assume that the main flow of price transmission is towards Baidoa. The transmission of price signals between Wanle Weyne and Baidoa is particularly interesting because such a high impact occurs also at a high speed: in just above three months.

Price changes occurring in Merka seem to have a lower impact on connected markets than what has been just considered about Baidoa. Nevertheless, results reveal a good degree of integration between Merka and Qorioley; in fact, 84% of sorghum price changes occurring in Merka get transmitted prices in Qorioley in just above two months. This is also the case of rice, in which case 62% of price changes get transmitted in 1.3 months. As seen for Qorioley, also for all other significant market connections with Merka the transmission process is faster when dealing with rice than with sorghum.

Price signals from Kismayo have a stronger impact for rice than for sorghum, although remarkable in both cases: 117% against 77% respectively. Nevertheless, the transmission of price signals remains slow. The fastest transmission of price signals are towards Wanle Weyne for sorghum (almost six months) and Adanyabal and Jowhar for rice, where respectively 4.7 and 6.2 months are required.

As seen earlier on in terms of direction of causality and number of markets interconnections, the relevance of Beletwein in the transmission of price signals is much stronger when dealing with rice than with sorghum. The transmission of rice price signals towards Qorioley and Jowhar is particularly strong, but also rather slow or even insignificant. The combination of high values of θ_2 and low values of α_3 seems to have few exceptions, such as the transmission of sorghum price changes towards Wanle Weyne. In this case almost 80% of price changes occurring in Beletwein get transmitted to prices in Wanle Weyne in 4.3 months. In all other cases price transmission seems to have either lower impact or to be much slower.

At this point, after considering each zone on its own, Table 12 provides the results of the multivariate analysis conducted on market samples from the three zones in an aggregated manner. Baidoa is taken as reference center for the sorghum market and five centers – Baidoa, Merka, Beletwein, Galkayo and Bosasso, one for each cointegrating equation – for the rice market.

With the exception of Lugh, southern markets reveal a good degree of integration, with the absolute value of θ_2 ranging between 0.55 and 1.98. The strongest reaction to price changes in Baidoa is recorded by Wanle Weyne, where also price adjustment occurs significantly faster than in the other market centers considered. As expected, the transmission of price changes gets weaker as distance increases and the value of θ_2 tends to reduce when considering the price changes in central and northern markets in reaction to price changes in Baidoa. Nevertheless, price adjustment in Hargeisa occurs significantly faster than in most of the other markets considered.

Hargeisa records a high speed of adjustment also to rice price changes in Baidoa. The speed of adjustment is double than for sorghum: the price adjustment requires approximately three months rather than the six months estimated for sorghum and the degree of price adjustment in both cases is quite similar. As seen for sorghum, the degree of price adjustment is smaller than for all other markets considered. This recalls the argument of possible price transmission without market integration and therefore it is necessary to take this result with caution in view of the long distance involved. It is hard to think that any exchange actually occurs between Baidoa and Hargeisa. In this case, instead, the link in price transmission is expected to be related to price changes occurred on the international market which are transmitted to all main market ports, such as Mogadishu, Merka and Kismayo in the South and Bosasso and Berbera in the North.

Through most of the cointegrating equations, Wanle Weyne records the strongest price reactions to rice price changes in the reference market. Together with Jowhar and Kismayo, Wanle Weyne records high values of θ_2 and α_3 with reference to price changes in Merka. A good degree of price transmission occurs also between Beletwein and Hara Dhere. However, despite the quite longer distances involved, price transmission is significantly faster between Beletwein and Kismayo than between the former and Hara Dhere. This seems to support the consideration that rice market is well integrated in the South even though this commodity is not a staple food in the zone. Having said that, the highest speed of rice price transmission is found between Beletwein and Hargeisa: it takes on average 2.3 months for price changes occurring in Beletwein to get fully transmitted to prices in Hargeisa. Finally, all southern and central markets considered are well connected to Bosasso; however, the adjustment is generally slow, with the exception of Galkayo and Lugh.

At this point, Table 13 helps to provide a comparative view of findings described above by summarizing the results shown in Tables 9 – 12. Average values indicate similar strength of price transmission for red rice through the various zones and the entire Somalia as a whole. The same applies for sorghum, with the exception of the Northern zone, where an excessively high price transmission rate was found. This is confirmed by the results of statistical tests shown in Table A.10. Test results also confirm that the speed of adjustment is higher in the South for red sorghum and slower for red rice in the Central zone.

The comparison of the two commodities against each other highlights that average values of θ_2 are equal in the Central and Southern zones and throughout Somalia taken as a whole, while the speed of adjustment is higher for red rice in the North and in the country as a whole.

Overall, average values in Table 13 reflect a good level of price transmission, although they hide a remarkable range of variation. Approximately between 94% and 137% of price signals get on average transmitted and the time required for transmission is on average double for red sorghum than for red rice (approximately 8 months for the former against 4 months for the latter). These estimates are in line with estimates provided in other studies for other cereals in remote areas of neighbouring countries. As a reference, De Matteis (2014) estimated values of θ_2 ranging between 0.23 and 6.52 for maize prices in Kenyan districts neighbouring the Somali border and Jaleta *et al.* estimated ranges between 0.24 and 2.33 for wheat and between 0.14 and 1.30 for teff in Tigray in Northern Ethiopia. The speed of adjustment in the former study was estimated to range between 0.06 and 0.75, while no estimates were provided in the latter.

Table 13: Average values of coefficients of cointegration

	θ_2				α_3			
	Red sorghum		Red rice		Red sorghum		Red rice	
Zone	average	range	average	range	average	range	average	range
North	12.76	3.09 - 34.10	1.06	0.27 - 2.73	0.12	0.03 - 0.26	0.29	0.17 - 0.43
Center	0.74	0.29 - 1.39	1.00	0.21 - 2.89	0.14	0.05 - 0.28	0.18	0.08 - 0.31
South	0.75	0.17 - 1.80	1.19	0.15 - 5.01	0.21	0.10 - 0.47	0.27	0.06 - 0.73
All	0.88	0.52 - 1.87	1.37	0.11 - 4.73	0.12	0.08 - 0.24	0.28	0.12 - 0.60

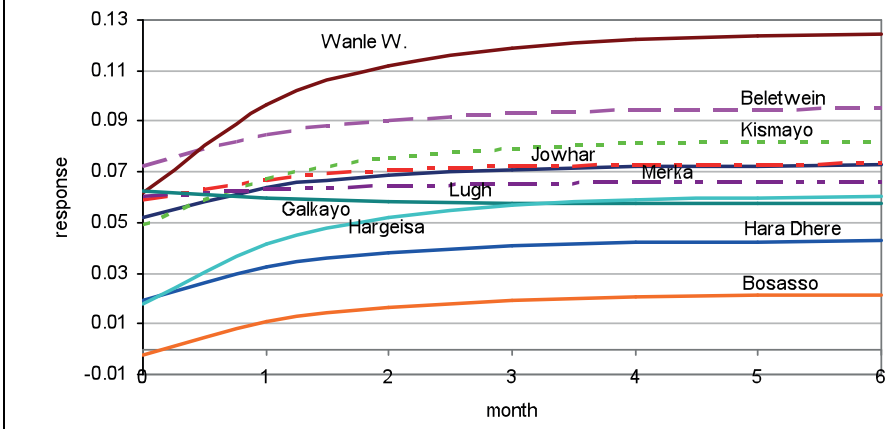
Data source: Tables 9 - 12.

So far the process of price transmission has been broken down into its components and scrutinized in terms of size and speed of adjustment to price changes in reference markets. Results have provided very interesting insights. Nevertheless, as seen above, in some cases different aspects of the process of price transmission may provide conflicting results, such as the combination of high impact of price transmission and a slow transmission process. Such apparent inconsistency can be sorted out through the analysis of impulse response functions (IRF) which help to synthesize the evolution of price transmission. Therefore, the estimation of IRFs and in particular their visualization can help to bring some additional clarity on the results of this analysis.

IRFs have been estimated for all cointegrating equations considered above in Tables 9-12. The estimated IRF data and graphs are reported in the Annex. In order to facilitate a comparative perspective, all IRFs related to each cointegrating equation have been combined in Figures 9-16. The drawback in this case is a certain degree of visual congestion; nevertheless the availability of individual data and graphs in the Annex ensures the identification of each IRF. While data and graphs in the Annex cover a 12-month period, Figures 9-16 cover only the initial 6-month period following a price shock.

Figure 9: Response to a sorghum price shock

Reference market: **Baidoa**

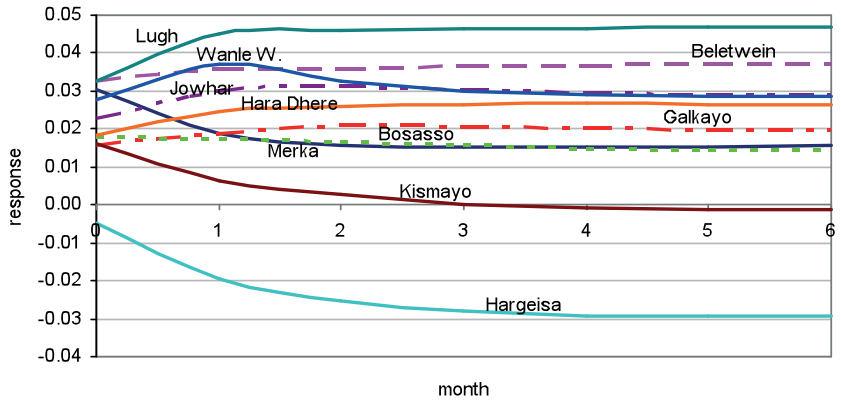


Data source: FSNAU

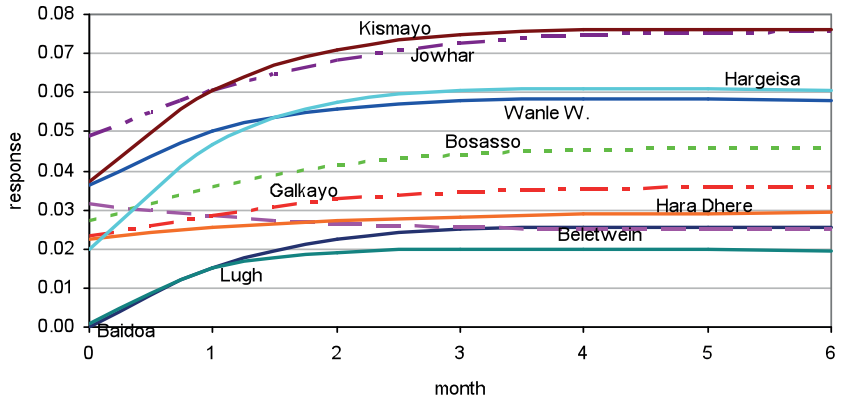
Figure 9 presents price reactions to sorghum price changes in Baidoa. With the exception of Galkayo, in all markets cointegrated with Baidoa the impact of an eventual price rise in Baidoa tends to increase. As expected, the largest changes occur in southern markets and the smallest ones in the North. All reactions are long-lived. For all cointegrated markets most of the price adjustment following the shock occurs with the initial couple of months. In addition to achieving one of the strongest – although still generally modest – reactions, Wanle Wayne records the fastest reaction during the initial couple of months, as documented by the steeper curve. Also Hargeisa and, to a lower extent, Bosasso and Hara Dhere provide some of the fastest adjustments to price changes in Baidoa, although their response remain among the smallest reported[18].

Figure 10: Response to a rice price shock

Reference market: **Baidoa**



Reference market: **Merka**



Reference market: **Beletwein**

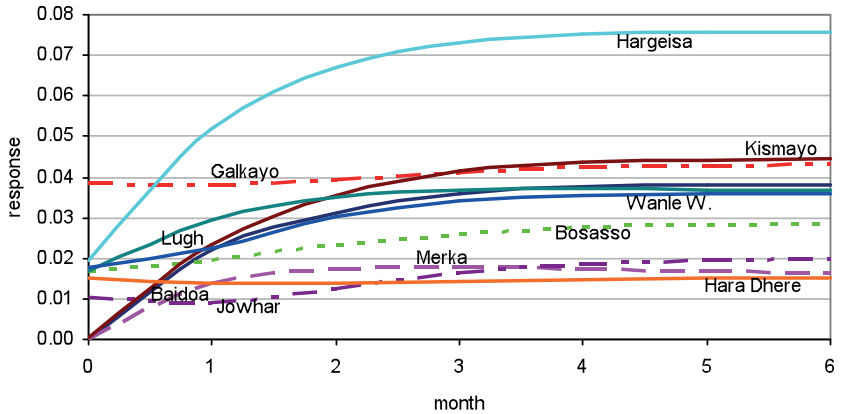
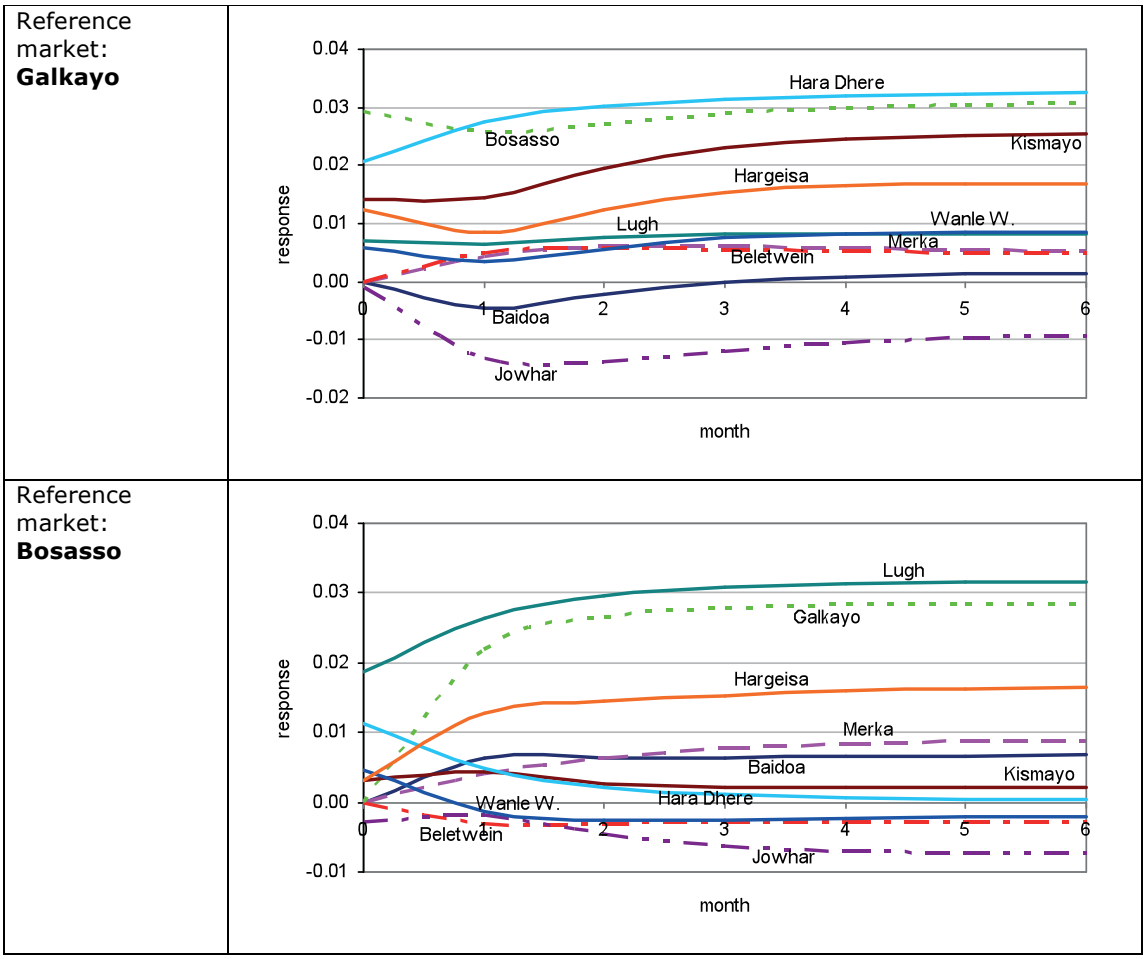


Figure 10: Response to a rice price shock *(continued)*



Data source: FSNAU

Moving to consider the rice market in Figure 10, it is remarkable how all responses remain below 10%. In general, the reaction to a price shock in Merka seems to be more coherent than the one to a shock in Baidoa or any other reference market considered. In the latter case, any mild impact on the price in Kismayo and in Merka either dies out or gets drastically reduced within two months. Any reaction in Jowhar and Wanle Weyine is long-lived, although low. On the contrary, any modest reaction to price changes in Merka increases in Jowhar and in Wanle Weyne and even gets double in Kismayo within the initial three months.

All markets cointegrated with Beletwein show small reactions to price changes. The strongest and fastest reaction is recorded by Hargeisa. This is supported by the causality test between the two centers.

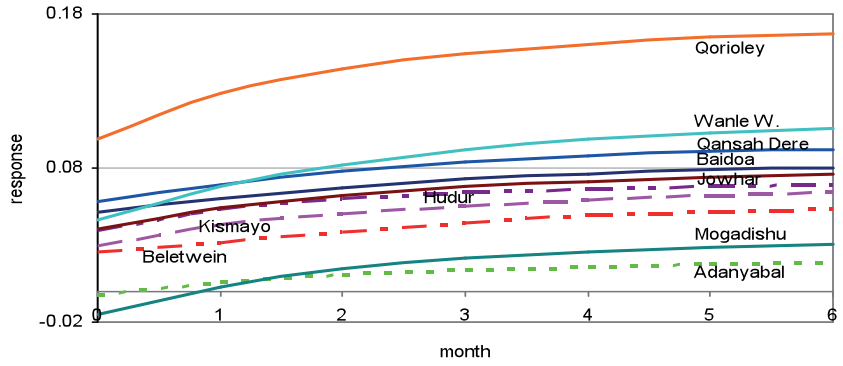
As further reported in Figure 10, all markets show only small reactions to price changes in Galkayo and Bosasso. Of relevance is the fast increase of the impact of price changes in Bosasso over prices in Galkayo.

Within the Southern zone, all market centers react coherently to sorghum price shocks occurring in Merka, Impacts of such shocks continue increasing through the six months after the shock. The strongest impact is recorded in the neighbouring centers as Qorioley and at lower degree Wanle Weyne. Along the opinion that price transmission is influenced by geographical distance, in this case price changes tend to vary along distances from Merka, with the major exception of Mogadishu where response remains negligible.

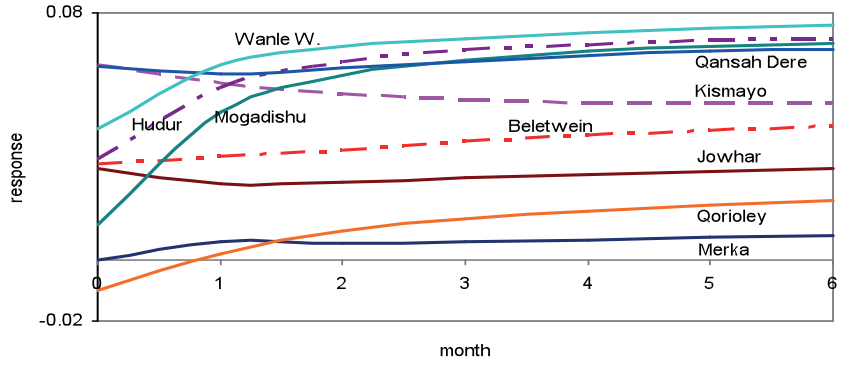
Mogadishu appears to be rather under the influence of Baidoa. In fact, the impact of sorghum price changes in Baidoa on Mogadishu is initially rather small but increases quickly and is among the strongest and fastest responses together with Wanle Weyne and Hudur.

Figure 11: Response to a sorghum price shock in the Southern zone

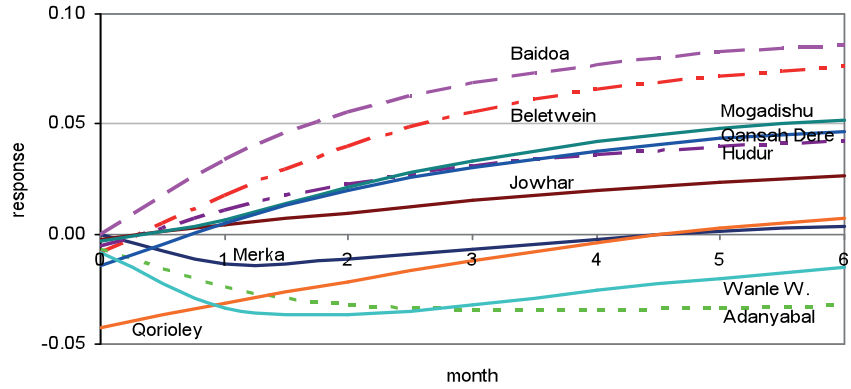
Reference market: **Merka**



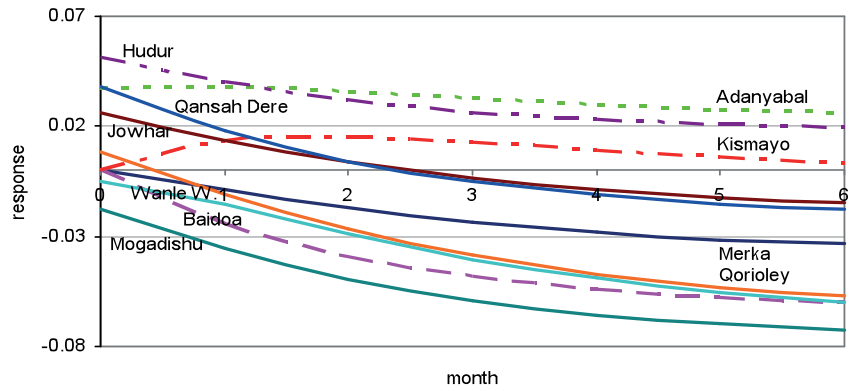
Reference market: **Baidoa**



Reference market: **Kismayo**



Reference market: **Beletwein**



Data source: FSNAU

Reactions to price changes in Kismayo are small and slow. The strongest impact occurs in Baidoa and Beletwein.

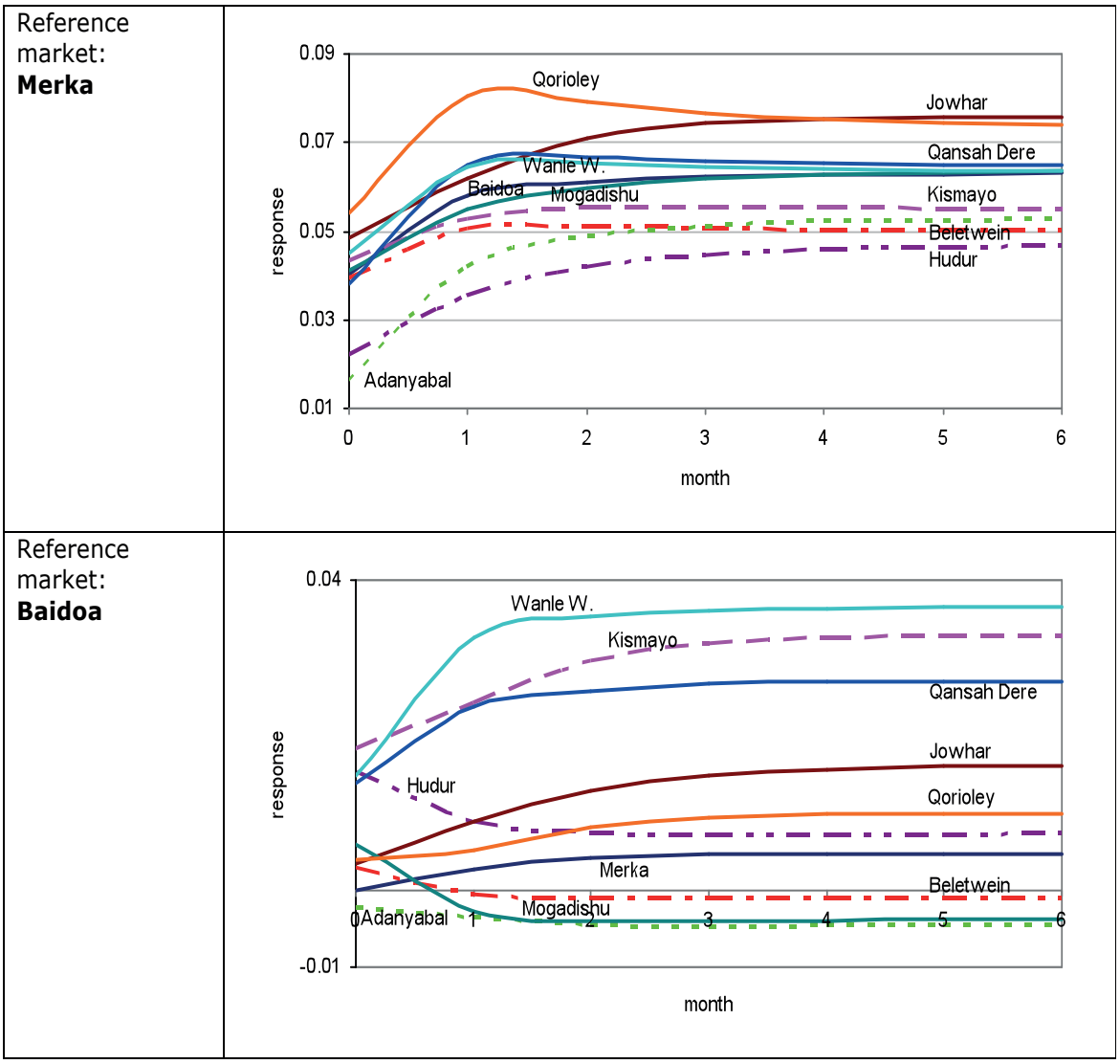
A price increase in Beletwein is generally followed by protracted price reductions in the other markets.

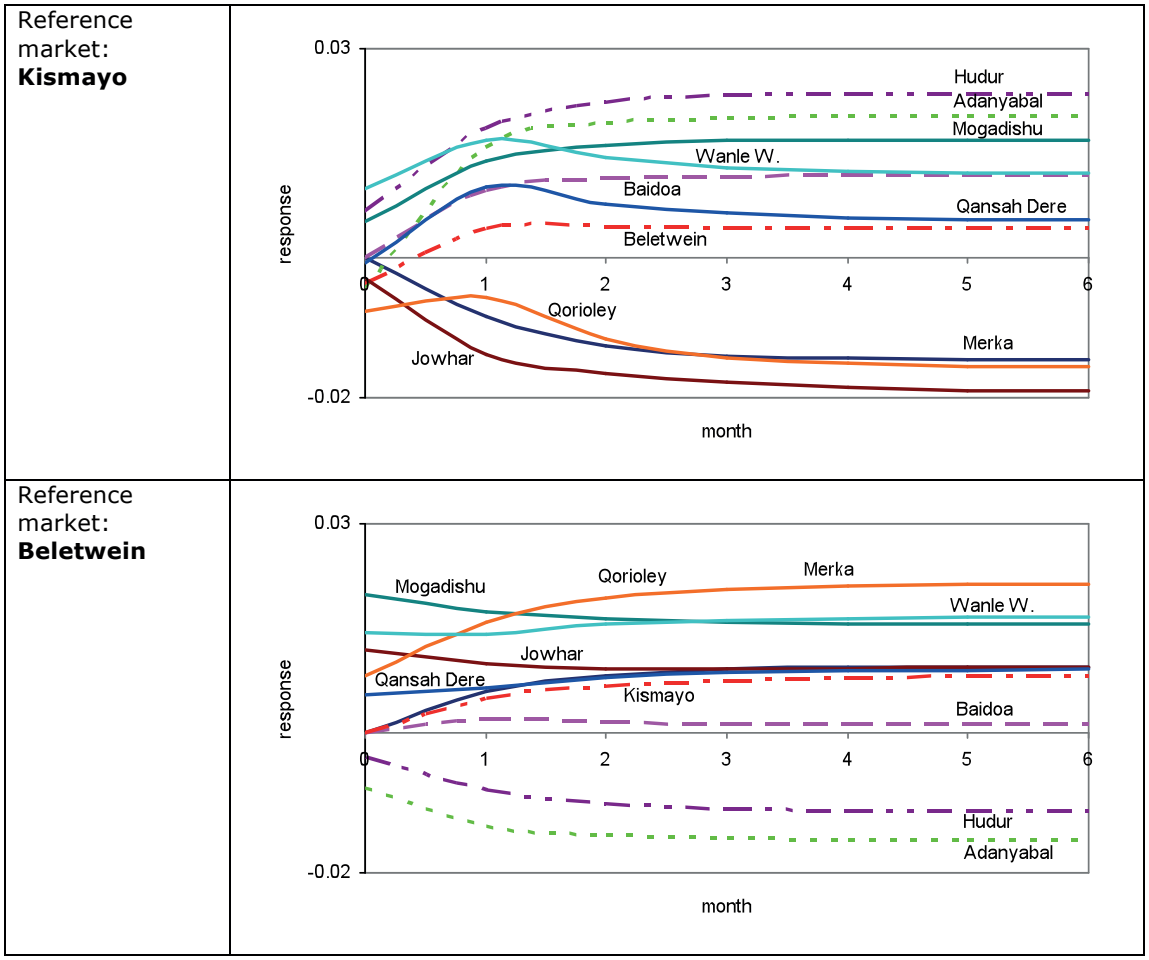
Moving to the rice market, reactions to price shocks in Merka appear to be faster than what seen above for sorghum. Full adjustment occurs within the initial two months and remains stable afterwards. Qorioley and Jowhar are the most reactive markets.

Reactions to price changes in Baidoa are diversified, with some of the cointegrated markets showing either an increasing or decreasing impact. The size of response is in this case generally smaller than the one considered in the sorghum market. This is in line with the prevalent role of this market in the sorghum trade.

The size of reaction to price changes occurring in both Kisimayo and Beletwein is quite small.

Figure 12: Response to a rice price shock in the Southern zone





Data source: FSNAU

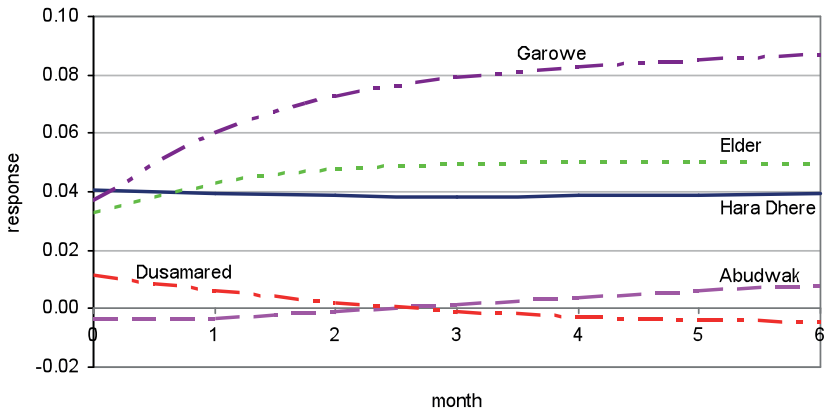
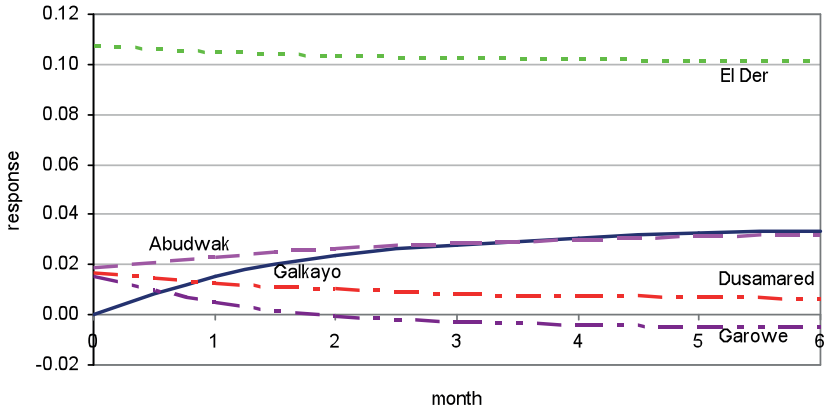
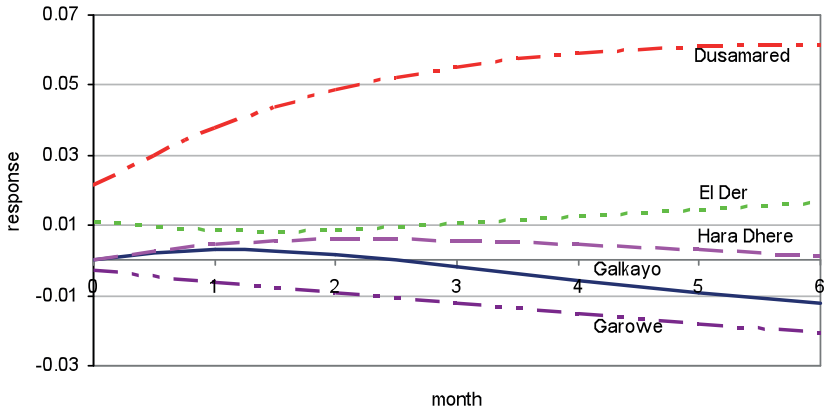
Figure 13 shows the evolution of the impact of sorghum price changes in the Central zone. The three reference markets considered seem to have their well-defined area of influence. Price changes in Galkayo show an interesting response only in Garowe; the impact is initially low but it rises continuously over the initial six months. Price changes in Hara Dhere generate a significant response only in El Der. Initial response is around 10% and remains stable around this value throughout the period considered. Price changes in Abudwak have an impact on prices in Dusamared.

Figure 14 shows that Garowe is the main market of influence for Galkayo even about rice. The relevance of the influence exercised by Hara Dhere over El Der and by Abudwak over Dusamared is in this case drastically reduced.

Finally, in the Northern zone there does not seem to be any influence between Bosasso and Hargeisa in terms of sorghum price making. The main response to sorghum price changes occurring in Bosasso and Hargeisa is reported in Boroma. In general, Boroma is more reactive to price changes in Hargeisa than in Bosasso. The stronger and faster response shown in the former case is somehow justified by the shorter distances. Erigavo is approximately equally influenced by price changes in the two main centers. On the contrary, Togwajiale and Zeilac Lawayacado seem to be influenced only by price changes in Hargeisa. In particular, in the latter case any initial influence gets reduced after three months, while any initial influence over Zeilac Lawayacado dies out within the same period.

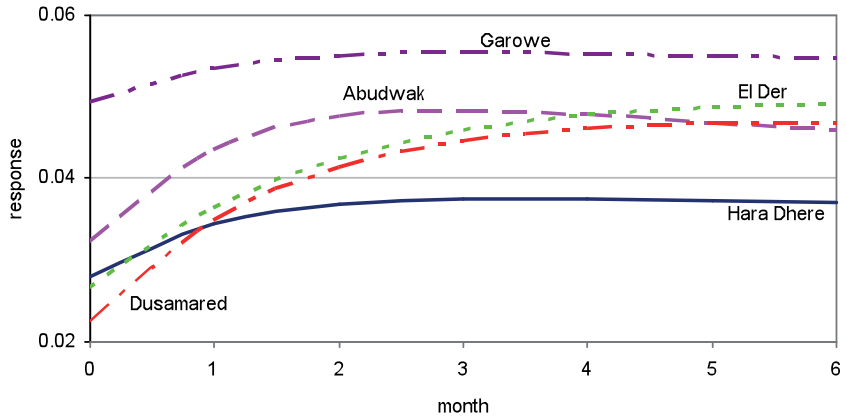
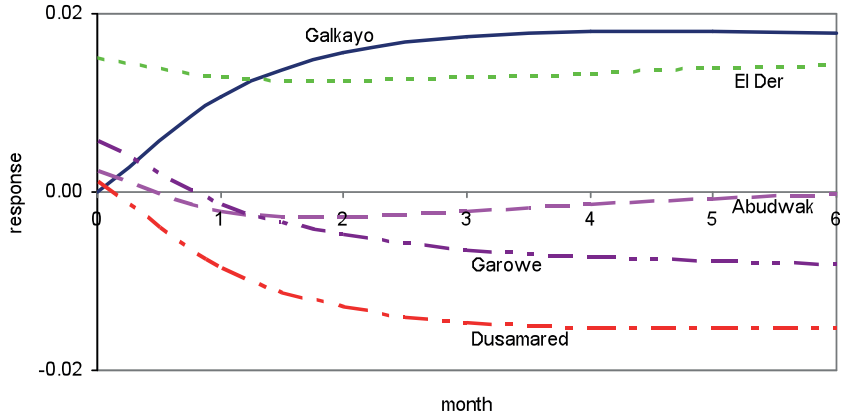
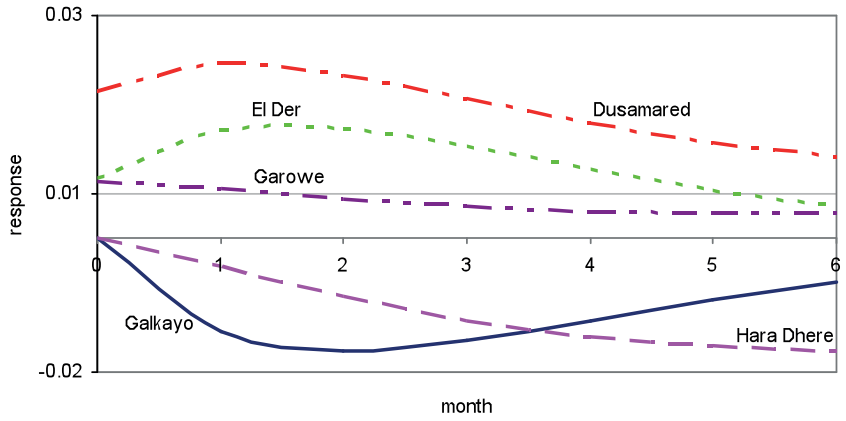
The influence of both Bosasso and Hargeisa over the other northern markets increases somehow when focusing on rice. Boroma remain the main market of influence for both reference markets.

Figure 13: Response to a sorghum price shock in the Central zone

Reference market: **Galkayo**	
Reference market: **Hara Dhere**	
Reference market: **Abudwak**	

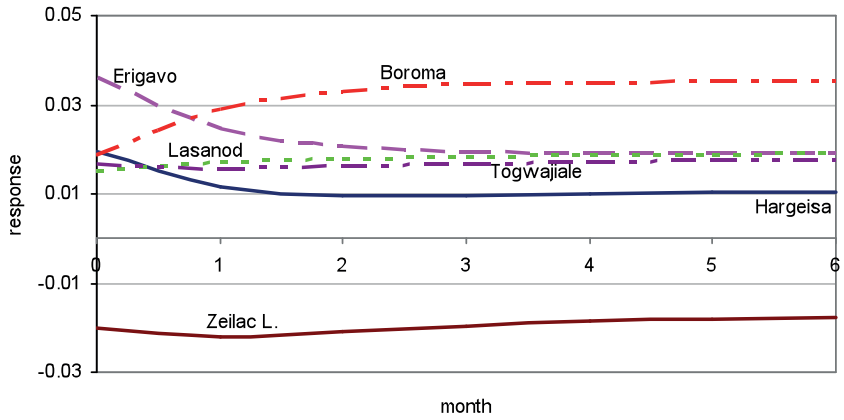
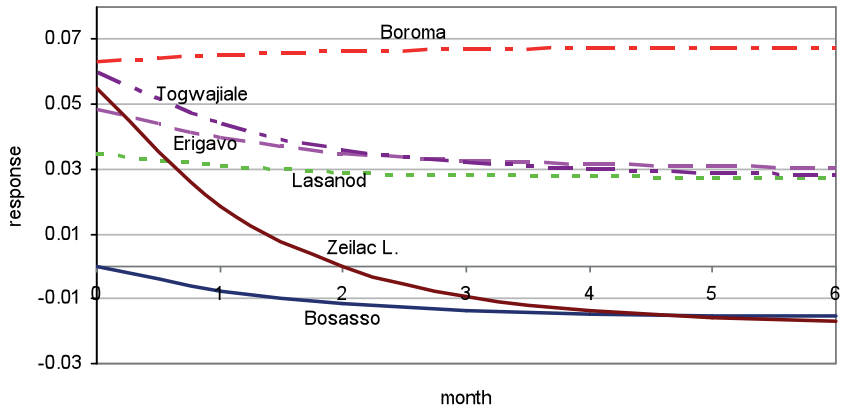
Data source: FSNAU

Figure 14: Response to a rice price shock in the Central zone

Reference market: **Galkayo**	
Reference market: **Hara Dhere**	
Reference market: **Abudwak**	

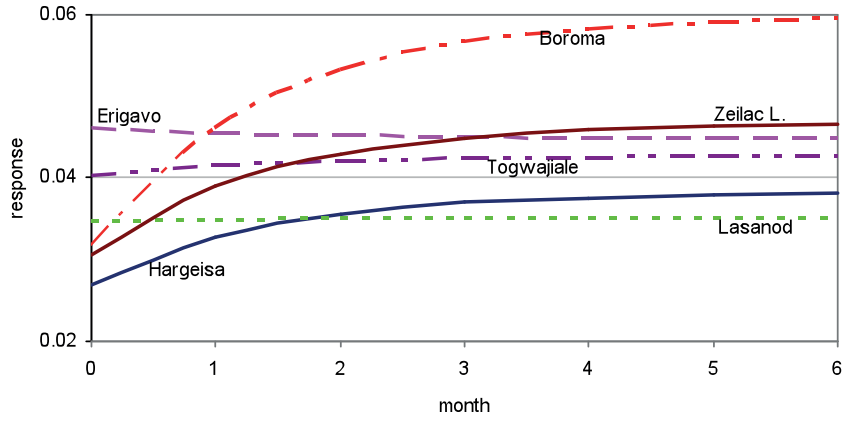
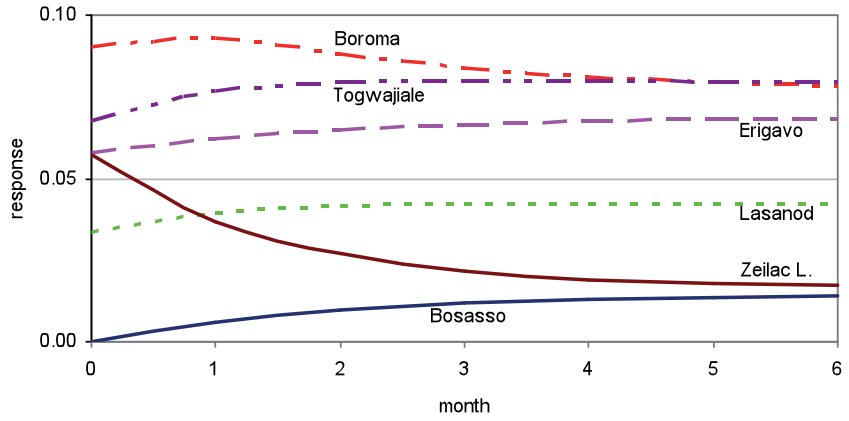
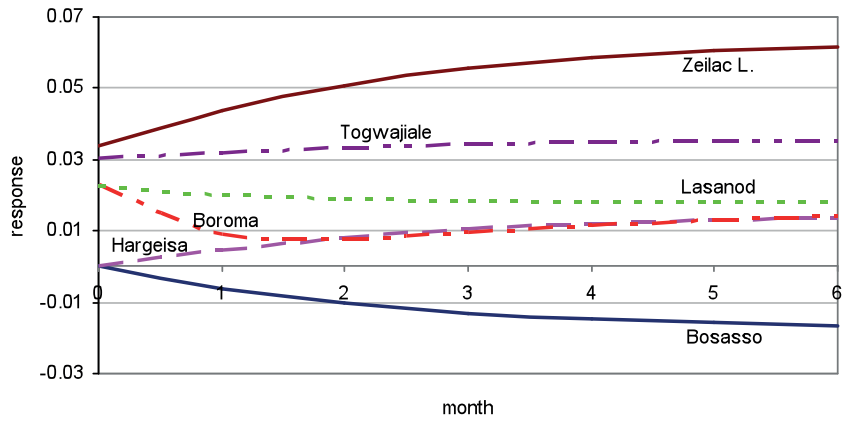
Data source: FSNAU

Figure 15: Response to a sorghum price shock in the Northern zone

Reference market: **Bosasso**	
Reference market: **Hargeisa**	

Data source: FSNAU

Figure 16: Response to a rice price shock in the Northern zone

Reference market: **Bosasso**	
Reference market: **Hargeisa**	
Reference market: **Erigavo**	

Data source: FSNAU

4. CONCLUSIONS

The price transmission of the two main staples in Somalia, red sorghum and red rice, has been analysed through both bivariate and multivariate techniques using price data from the main market network regularly monitored by FSNAU. The analysis has highlighted both similarities and differences for the price transmission of the two cereals.

The analysis of price transmission among market centers has highlighted a varied degree of market functioning and interconnection throughout Somalia, remarking how better-functioning markets coexist side-by-side poor-functioning ones.

Overall, a stronger network of cointegrating links has been found for rice than for sorghum. In particular, for both commodities a higher number of cointegrating relationships was found in the South. This is justified by the denser sample of markets considered, as well as by shorter distances between markets. Clearly, shorter distances between markets in the South than in the rest of the country strongly facilitate market exchange and support market functioning in general.

The largest and strongest networks of markets interconnected in terms of sorghum price transmission were found in the regions of Lower Shabelle, Bay and Bakool. They are the most productive area of the sorghum belt where the main trading centers are located.

Besides Merka and Baidoa, other major price makers for sorghum have been identified in Qansah Dere, Dinsor, Wanle Weyne, Dolo and Lugh. With the exclusion of Merka, all major market centers along the coast (Mogadishu, Kismayo, Hara Dhere, Bosasso) are prevalently price takers.

The transmission of sorghum price signals gets weaker when moving to the Central and to the Northern zones.

Compared to sorghum, the network of cointegrated markets for rice price transmission is denser and the location of the markets which play a major price-making role in this case is more geographically spread. Along the imported nature of red rice, the main price makers are major ports – Bosasso and Merka. On a secondary level, also a few market centers along the transport routes between North and South – e.g. Hara Dhere and Beletwein – play some price-making role.

For both red sorghum and red rice the strength of price transmission is rather diversified when considered at market level. Nevertheless, average values are quite similar, both geographically and when comparing the two cereals against each other. The speed of transmission of price signals is significantly higher for rice than for sorghum throughout Somalia, with the exception of a few regions in the sorghum belt such as Hiiran and Bakool.

Overall, markets appear to be reasonably integrated, particularly when taking into account the difficult environment in which they operate, characterized by poor infrastructure and by a high degree of insecurity and uncertainty. Table 14 provides the average values estimated in relation to the two aspects of price transmission: the strength of price transmission and the speed of adjustment.

Table 14: Average estimates of price transmission

	Strength of adjustment				Speed of adjustment			
	Red sorghum		Red rice		Red sorghum		Red rice	
Region / Zone	average	range	average	range	average	range	average	range
Lower Juba	1.15	0.58 - 1.84	0.97	0.89 - 1.03	0.25	0.16 - 0.35	0.28	0.26 - 0.31
Middle Juba	1.94	1.41 - 2.47	1.05	1.05 - 1.05	0.08	0.08 - 0.08	0.30	0.26 - 0.35
Gedo	1.17	0.79 - 1.72	0.96	0.68 - 1.35	0.16	0.09 - 0.25	0.29	0.17 - 0.47
Bay	1.81	1.69 - 1.95	1.05	0.99 - 1.12	0.16	0.09 - 0.25	0.22	0.16 - 0.26
Bakool	0.52	0.36 - 0.69	0.79	0.61 - 0.97	0.24	0.18 - 0.30	0.17	0.15 - 0.19
Hiiran	1.68	1.68 - 1.68	0.97	0.97 - 0.97	0.25	0.25 - 0.25	0.13	0.13 - 0.13
Lower Shabelle	1.19	1.05 - 1.38	1.08	1.05 - 1.12	0.18	0.12 - 0.22	0.20	0.15 - 0.23
Middle Shabelle	2.40	0.86 - 3.94	0.93	0.79 - 1.07	0.06	0.02 - 0.11	0.20	0.17 - 0.22
Mogadishu	1.10	1.10 - 1.10	1.85	1.85 - 1.85	0.24	0.24 - 0.24	0.20	0.20 - 0.20
Galgadud	1.00	0.69 - 1.47	0.88	0.73 - 1.03	0.15	0.10 - 0.22	0.17	0.13 - 0.22
Mudug	1.30	1.14 - 1.47	1.27	1.06 - 1.48	0.16	0.16 - 0.16	0.16	0.08 - 0.23
Nugal	0.66	0.66 - 0.66	0.79	0.79 - 0.79	0.16	0.16 - 0.16	0.23	0.23 - 0.23
Bari			0.25	0.25 - 0.25			0.08	0.08 - 0.08
Sool	0.86	0.86 - 0.86	0.90	0.90 - 0.90				
Sanaag	0.83	0.83 - 0.83	1.36	1.36 - 1.36	0.16	0.16 - 0.16	0.13	0.13 - 0.13
Galbeed	2.57	1.33 - 3.81	1.40	1.03 - 1.77	0.12	0.12 - 0.12	0.15	0.06 - 0.24
Awdal	0.88	0.82 - 0.94	1.76	1.75 - 1.78	0.27	0.27 - 0.27	0.23	0.21 - 0.25
North	12.76	3.09 - 34.10	1.06	0.27 - 2.73	0.12	0.03 - 0.26	0.29	0.17 - 0.43
Center	0.74	0.29 - 1.39	1.00	0.21 - 2.89	0.14	0.05 - 0.28	0.18	0.08 - 0.31
South	0.75	0.17 - 1.80	1.19	0.15 - 5.01	0.21	0.10 - 0.47	0.27	0.06 - 0.73
All	0.88	0.52 - 1.87	1.37	0.11 - 4.73	0.12	0.08 - 0.24	0.28	0.12 - 0.60

Note: Estimations have been conducted with two different approaches. Regional estimates are averages of coefficients derived through bivariate cointegration, while zonal and national estimates are averages of coefficients derived through multivariate cointegration.

Data source: At regional level: Tables A.6 and A.7. At zonal level: Tables 9-12.

Within the Southern zone, the regions of Middle Shabelle, Middle Juba, Bay and Hiiran record the highest capacity of sorghum price transmission. Since coefficients can be interpreted in this case as elasticities, the high values of the coefficient recorded in these regions show that price changes in dominant markets within the region tend to get more than fully transmitted in the long run to integrated markets within the same region. For all other regions in the South, coefficient values range around unity, confirming again a substantial price transmission, with the exception of Bakool where the average intensity of price transmission is lower. In the Central zone, average values in Galgadud and Mudug reflect the same pattern. In Nugal and in the Northern zone, there is a general reduction of adjustment, highlighting a weaker – although still significant – transmission of price signals. The only exception is Galbeed, which reflects a very strong market connection between Hargeisa and Togwajiale.

Some of those regions in the South which record the largest values of strength of adjustment record also the lowest values in terms of speed of adjustment, and the opposite otherwise. This is the case of Middle Juba and Middle Shabelle, which register the lowest average speed of adjustment, as well as of Bakool, which in this case registers one among the highest values of speed. The same inconsistency is evident in the North, with Galbeed recording lower average speed than Sanaag and Awdal. A region which seems to combine a relatively large price adjustment and a high speed is Hiiran, which in this study is covered only by Beletwein.

About red rice, coefficients of long-term adjustment seem to be generally lower than the ones reported above for sorghum in the South. This hints to a less intense process of price transmission and adjustment for rice than for sorghum in the South. At the same time, the degree of price adjustment is slightly larger in the North than in the South. Both considerations were somehow expected considering that rice is one of the food staples in the North, but not in the South. Nevertheless, two remarkable exceptions are the minimum value of Bosasso in the North and the maximum value of Mogadishu.

In terms of speed of adjustment, a certain increase in speed rates is found in southern regions compared to the values recorded for sorghum. Contrary to what considered earlier on about the speed of sorghum price adjustment in Beletwein, the speed of price adjustment in Beletwein is in this case only faster than Bosasso.

At a higher degree of aggregation, average values indicate similar strength of price transmission for red rice through the various zones and the entire Somalia as a whole. The same applies for sorghum, with the exception of the Northern zone, where an excessively high price transmission rate was found. The speed of adjustment is higher in the South for red sorghum and lower for red rice in the Central zone.

The comparison of the two commodities against each other highlights that average values of the strength of adjustment are equal in the Central and Southern zones and throughout Somalia taken as a whole, while the speed of adjustment is higher for red rice in the North and in the country as a whole.

Overall, average values in Table 14 reflect a good level of price transmission, although they hide a remarkable range of variation. From an aggregate perspective, approximately between 94% and 137% of price signals get on average transmitted and the time required for transmission is on average double for red sorghum than for red rice (approximately 8 months for the former against 4 months for the latter).

Overall, price changes induced by price transmission in cointegrated markets tend to be long lived.

In order to consider the results of this study in relative terms, estimates of price transmission have been compared against similar estimates in neighbouring countries. Average values of strength and speed of price transmission are in line with similar estimates for other basic food commodities in remote areas in neighbouring countries.

Overall, the immediate implications of the findings of this study refer to their contribution towards the design of transfer interventions in response to food insecurity. The effectiveness and efficiency of market-based intervention strategies are increased when operated in presence of functioning and integrated markets. Therefore, the analysis conducted in this study is expected to assist in the design of interventions and in their geographical targeting. In particular, transfer programmes can have important side effects in addition to their direct effect of increasing recipients' income and welfare. Cash transfers increase the demand for normal goods, and if supply is not perfectly elastic, the price of these goods is expected to rise. In-kind transfers have a corresponding cash value and, therefore, they also have an income effect. However, in addition, an in-kind transfer programme can increase supply. When responding to an emergency, the price effects of the intervention are an unintended consequence; however, they may significantly enhance or diminish the programme goal of assisting those in need. This is of particular relevance when the intervention is put in place while a process of generalised food price rise is ongoing. In such conditions the capacity of the system to respond to the increased demand will determine the price rise. The higher such a capacity, the lower the gap between increase in demand and increase in supply. Such a gap will determine the degree of the price rise, that may significantly enhance or diminish the programme goal (De Matteis, 2014). Of course, this consideration is based solely on the expected degree of market functioning, while it

is understood that a proper analysis of intervention strategy should take into account a whole set of other factors which are ignored here. It is to be considered as well that, even limiting the discussion to market functioning, an eventual decision to implement market-based strategies in presence of modestly functioning markets may be justified by a long-term strategy of local development.

In the attempt to reflect the considerations above into the case of Somalia, it is necessary to consider that the best functioning market centers are found in Southern Somalia, particularly in the regions of Middle Shabelle, Lower Shabelle, Hiiran, Bay and Middle Juba. A good degree of market functioning is found also in the Northern zone, although weaker than in the South. A structural problem in the Northern zone, as well as in the Central zone, is given by the long distances between market centers. Along this line of thought, a group of well integrated market centers is found in West Galbeed and Awdal. Sadly, the lack of information about Berbera does not allow us to get a full grasp of the market networks in the North. Following from these considerations, it is reasonable to say that, considering everything else equal, including security conditions, the regions identified in the South provide the highest degree of market functionality currently available in Somalia and therefore the most appropriate conditions for market-based interventions. In the North as well as in the Center, the degree of market functionality is generally lower; in this case market-based interventions are expected to be less efficient and effective than if operated in the South. Therefore, within the perspective highlighted above, cash-based interventions – including FAO's cash for work programme and similar cash transfer interventions operated by FAO partners and other organizations – are expected to maximize their effectiveness and efficiency if focused on the Southern zone. Similar interventions in the Northern and Central zones, and in general in the surroundings of poorly integrated markets, are less recommended and, if justified by other reasons, they should be implemented on a small scale.

The considerations provided above have implications also in terms of market monitoring. The dataset of market prices managed by FSNAU currently does not allow a geographically balanced coverage. More efforts should be made to increase market coverage in the Northern and Central zones, as well as in areas throughout Somalia identified as poorly integrated. At the same time, current monitoring efforts in a few of the most integrated markets could be reduced, particularly among those in the Southern zone which are also geographically close to each other. In very few cases, once defined clear functional links between markets in terms of price making, it would be advisable to replace regular data collection with a system of functional estimation through econometric techniques. Finally, it should be made sure that key market centers, such as Berbera, are included in the monitoring system.

REFERENCES

Abdulai, A., 2000. Spatial price transmission and asymmetry in the Ghanaian market. Journal of Development Economics, 63(2): 327-349

Alderman, H., 1992. Food security and grain trade in Ghana. Working Paper No.28, Food and Nutrition Policy Program, Cornell University, Ithaca.

Ali, D. and K. Geldorf, 2012. Risk-averse to risk-willing: learning from the 2011 Somalia cash response. Global Food Security. 1(1): 57-63

Amikuzuno, J., 2009. Spatial price transmission and market integration in agricultural markets after liberalization in Ghana: evidence from fresh tomato market. PhD thesis, Department of Agricultural Economics and Rural Development, Gottingen University.

Badiane, O. and G. Shively, 1998. Spatial integration, transport costs, and the response of local prices to policy change in Ghana. Journal of Development Economics. 56(2): 411-431

Balcombe, K., and J. Morrison, 2002. Commodity price transmission: a critical review of techniques and an application to selected tropical export commodities. Economic and Social Development Department, FAO, Rome.

Barrett, C.B. and J.R. Li, 2002. Distinguishing between Equilibrium and integration in spatial price analysis. American Journal of Agricultural Economics. 84(2): 292-307

Baulch, B.J. 1997. Testing for Food Market Integration Revisited. Journal of Development Studies. 33(4): 512-534.

Brenton P., A. Portugal-Perez, and J. Regolo. 2014. Food prices, road infrastructure and market integration in Central and Eastern Africa. Policy Research Working Paper N.7003, World Bank, Washington DC.

Cecchetti, S.G., Mark, N.C. and R.J. Sonora, 2002. Price index convergence among United States cities. International Economic Review. 43(4): 1081-1099

Chirwa, E.W., 2000. Food marketing reforms and integration of maize and rice markets in Malawi. Working Paper, School of Economics, University of East Anglia. Norwich.

Conforti, P., 2004. Price transmission in selected agricultural markets. Working Paper No.7, Commodity and Trade Policy Research, FAO, Rome.

De Matteis, A. 2014. Preferred Form of Food Assistance in Remote Resource-Poor Areas: the Case of Arid Lands in Kenya. Journal of Development Effectiveness. 6(2): 167-195

FSNAU, 2015. A Study Report on the Construction of a New Consumer Price Index (CPI) for Somalia.

Dercon, S., 1995. On market integration and liberalization: method and application to Ethiopia. Journal of Development Studies. 32: 112-143

Engle, R.F., and C.W.J. Granger, 1987. Cointegration and error correction: representation, estimation and testing. Econometrica. 55: 251-276

FEWSNET, 2011a. Special Brief: Market functioning in Southern Somalia. July.

FEWSNET, 2011b. Special Report: Market functioning in Southern Somalia. December.

Goldberg, P.K. and F. Verboven, 2003. Market Integration and Convergence to the Law of One Price: Evidence from the European Car Market. Available at: http://www.econ.yale.edu/~pg87/convp.pd

Goletti, F., and S. Babu, 1994. Market liberalization and integration of maize markets in Malawi. Agricultural Economics, 11: 311-324

Goodwin, J.W., 1994. Agriculture Price Analysis and Forecasting. John Wisley and Sons Inc., New York.

Granger, C.W.J., 1981. Some properties of time series data and their use in econometric model specification. Journal of Econometrics. 16: 121-130

Ihle, R., von Cramon-Taubadel, S. and S. Zorya, 2009. Markov-switching estimation of spatial maize transmission processes between Tanzania and Kenya. American Journal of Agricultural Economics. 91(5): 1432-1439

Jaleta, M. and B. Gebermedhin, 2009. Price cointegration analyses of food crop markets: the case of wheat and teff commodities in Northern Ethiopia. Contributed Paper at the International Association of Agricultural Economists Conference, August 16-22 2009, Beijin.

Johansen, S., 1991. Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. Econometrica. 59: 1551-1580

Johansen S., 1995. Likelihood-based inference in cointegrated vector-autoregressions. In Advanced Texts in Econometrics, Oxford University Press, Oxford.

Johansen, S., 1988. Statistical analysis of cointegration vectors. Journal of Economic Dynamics and Control. 12: 231-254

Longley, C., Dunn, S., and M. Brewin, 2012. Monitoring results of the Somalia cash and voucher transfer program. Humanitarian Exchange Magazine. 55: 40-41

Lutz, C., van Tilburg, A. and B. van der Kamp, 1995. The process of short- and long-term price integration in the Benin maize market. European Review of Agricultural Economics. 22: 191-211

Margarido, M., Turolla, F. and C. Bueno, 2007. The world market for soybeans: price transmission into Brazil and effects from the timing of crop and trade. Nova Economia. 17(2): 241-268

McNew, K., 1996. Spatial market integration: definition, theory and evidence. Agricultural and Resource Economics Review. 25(1): 1-11

Meyer, J. and S. von Cramon-Taubadel, 2004. Asymmetric price transmission: a survey. Journal of Agricultural Economics. 55(3): 581-611

Meyers, R., 2008. Evaluating the efficiency of inter-regional trade and storage in Malawi maize markets. Report for the World Bank. Michigan State University, East Lensing, MI.

Morshed, A.K.M., Ahn, S.K. and M. Lee, 2005. Price Convergence Among Indian Cities: A Cointegration Approach. Available at: http://ssrn.com/abstract=877335

Moser, C., Barrett, C. and B. Minten, 2009. Spatial integration at multiple scales: rice markets in Madagascar. Agricultural Economics. 40: 281-294

Mundlak, Y., and D. Larson, 1992. On the transmission of world agricultural prices. World Bank Economic Review. 6(3): 399-422

Negassa, A., Vertical and spatial integration of grain markets in Ethiopia: implications for grain market and food security policies. Working Paper No.9, Grain Market Research Project, Ministry of Economic Development and Cooperation. Addis Ababa.

Prakash, A., 1999. The transmission of signals in a decentralized commodity marketing system: the case of the UK pork market. Working Paper, Wye College, University of London.

Rapsomanikis, G., Hallam, D. and P. Conforti, 2003. Market integration and price transmission in selected food and cash crop markets of developing countries: review and applications. In FAO, Commodity market review 2003-2004. FAO, Rome.

Rashid, S., 2004. Spatial integration of maize markets in post-liberalized Uganda. Journal of African Economies. 13(1): 103-133

Rashid S. and N. Minot, 2010. Are Staple Food Markets in Africa Efficient? Spatial Price Analyses and Beyond. Paper presented at the COMESA policy seminar “Food price variability: Causes, consequences, and Policy Options”, 25-26 January 2010, Maputo.

Ravallion, M., 1986. Testing market integration. American Journal of Agricultural Economics. 68(2): 292-307

Sanogo, I., 2011. Food market and supply situation in Southern Somalia. WFP.

Thapa, N.B., 2002. An econometric analysis of the impact of real effective exchange rate on economic activities in Nepal. NRB Economic Review. 14: 17-36

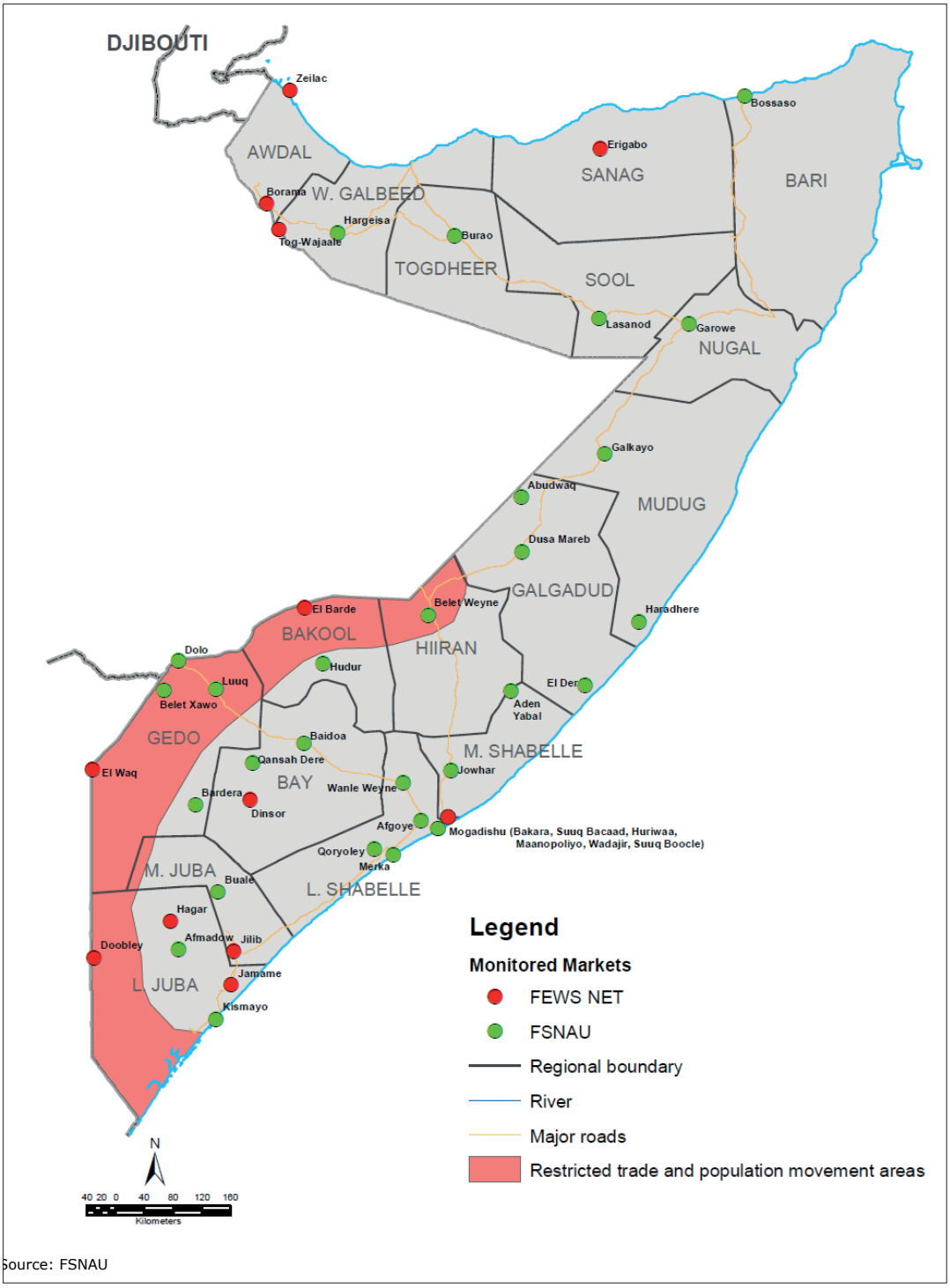
Tostao, E. and B.W. Brorsen, 2005. Spatial price efficiency in Mozambique’s post-reform maize markets. Agricultural Economics. 33(2): 205-214

van Campenhout, B., 2008. Modelling trends in food market integration: method and an application to Tanzanian maize markets. Food Policy. 32: 112-127

WFP, 2009. An Analysis of the structure, conduct and performance of cereal and sugar markets in Somalia: understanding the impacts of food aid on market performance. WFP.

ANNEXES

Figure A.1 Monitored Markets



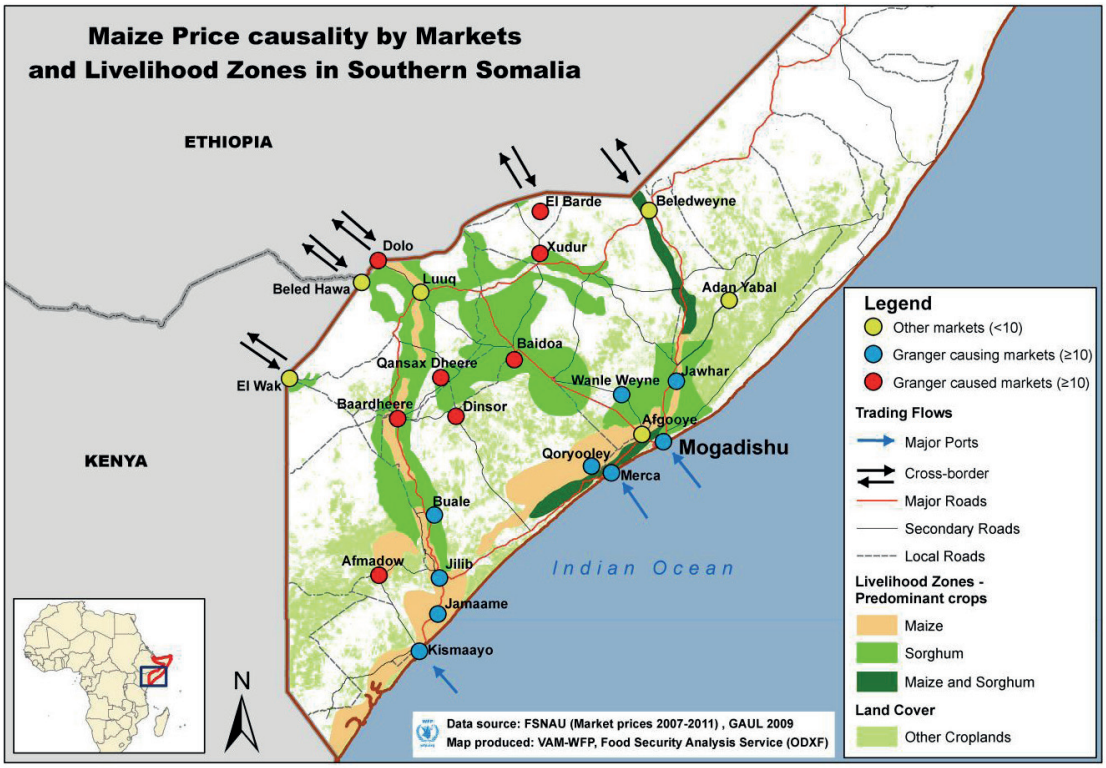
Source: FSNAU

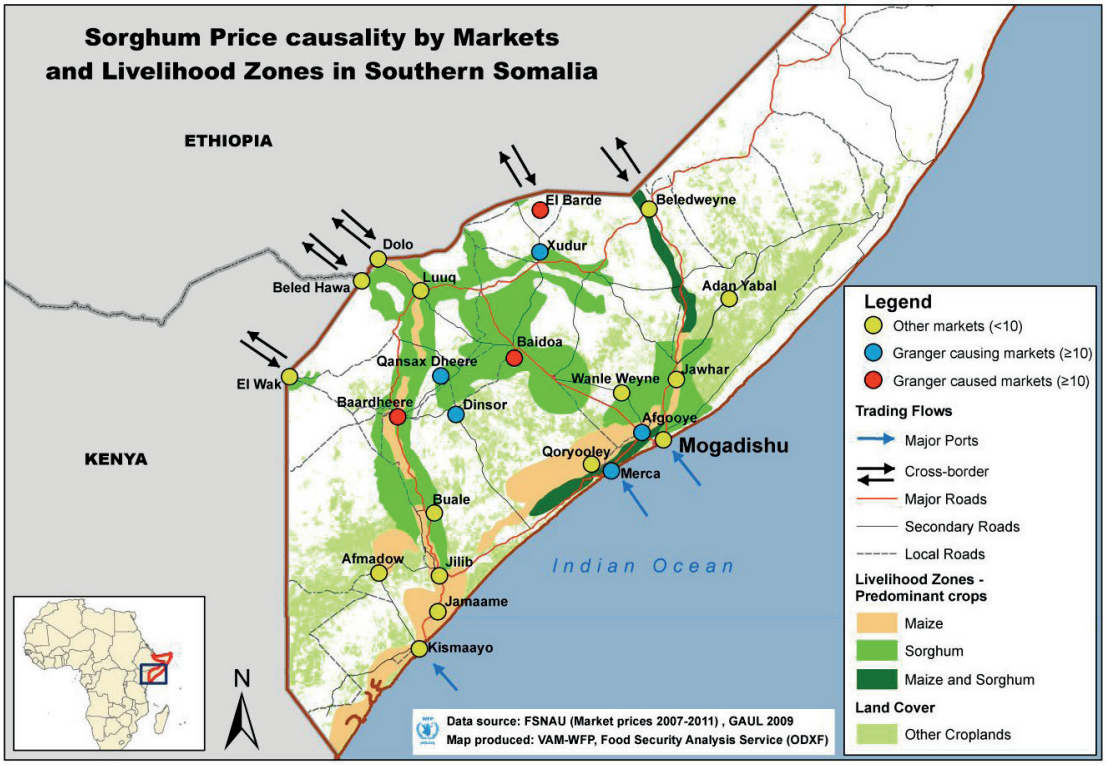
Table A.1: Coefficients of price correlation among market pairs (Sanogo, 2011)

Region	Market Pairs	Coefficients of Correlation							
		2003-2007				2008-2011			
		White Maize	Red Sorghum	Rice	Wheat Flour	White Maize	Red Sorghum	Rice	Wheat Flour
Bakool	El Barde/Xudur	0.49	0.70	0.93	0.95	0.87	0.85	0.96	0.91
Bay	Baidoa/Diinsor	0.69	0.58	0.92	0.94	0.92	0.96	0.97	0.95
	Baidoa/Qansax-Dheere	0.67	0.57	0.94	0.92	0.88	0.96	0.95	0.90
	Diinsor/Qansax-Dheere	0.88	0.94	0.94	0.88	0.92	0.98	0.97	0.96
Gedo	Bardera/Belet-Xaawa	0.37	0.46	0.94	0.93	0.25	0.45	0.75	0.53
	Bardera/El Wak	0.92	0.62	0.94	0.80	0.78	0.86	0.72	0.56
	Bardera/Doolow	-	0.49	0.92	0.86	-	0.47	0.89	0.80
	Bardera/Luuq	-	0.09	0.94	0.95	-	0.88	0.93	0.85
	Doolow/Luuq	-	-0.19	0.88	0.91	-	0.30	0.86	0.76
	Doolow/El Wak	-	0.75	0.90	0.64	-	0.53	0.69	0.46
	Doolow/Belet-Xaawa	-	0.98	0.91	0.91	-	0.42	0.77	0.42
	El Wak/Belet-Xaawa	0.56	0.72	0.88	0.67	0.02	0.48	0.65	0.40
	Luuq/El Wak	-	-0.38	0.86	0.69	-	0.79	0.65	0.57
	Luuq/Belet-Xaawa	-	-0.18	0.91	0.92	-	0.50	0.82	0.57
Lower Shabelle	Afgooye/Merca	0.93	0.76	-	0.99	0.93	0.94	-	0.96
	Afgooye/Wanle-Wayne	-	0.86	-	0.99	-	0.98	-	0.98
	Afgooye/Qorioley	0.90	0.70	-	0.99	0.94	0.94	-	0.97
	Qorioley/Merca	0.96	0.62	0.98	0.99	0.98	0.97	0.99	0.98
	Merca/Wanle-Wayne	-	0.81	-	0.99	-	0.96	-	0.97
	Qorioley/Wanle-Wayne	-	0.68	-	0.99	-	0.95	-	0.99
Middle Shabelle	Jowhar/Adan-Yabal	-	0.71	0.97	0.75	-	0.48	0.89	0.76
	Jowhar/Mogadishu	0.91	0.65	0.96	0.98	0.93	0.95	0.85	0.93
	Mogadishu/Adan-Yabal	-	0.65	0.92	0.72	-	0.47	0.81	0.69
Lower Juba	Afmadow/Jamame	0.67	-	0.80	0.65	0.84	-	0.84	0.84

Source: Sanogo, 2011

Table A.1: Coefficients of price correlation among market pairs (Sanogo, 2011)





Source: Sanogo, 2011

Table A.2: Stationarity of series – Red sorghum

	Levels		First differences	
series	ADF statistic	Critical value 1%	ADF statistic	Critical value 1%
Abudwak	-0.031	-2.599	-9.462	-2.599
Adanyabal	0.677	-2.599	-10.433	-2.599
Afgoi	-0.137	-2.596	-11.548	-2.596
Afmadow	-0.126	-2.609	-7.654	-2.610
Baidoa	0.126	-2.596	-9.963	-2.597
Bardera	0.081	-2.596	-12.911	-2.596
Belet Hawa	0.082	-2.599	-10.656	-2.599
Beletwein	-0.132	-2.596	-10.069	-2.596
Boroma	-0.453	-2.597	-11.014	-2.597
Bosasso	-0.268	-2.596	-10.805	-2.596
Buale	-0.629	-2.646	-4.263	-2.650
Dinsor	-0.306	-2.596	-9.344	-2.597
Doblei	-0.351	-2.596	-12.234	-2.596
Dolo	-0.134	-2.605	-11.078	-2.606
Dusamared	0.000	-2.598	-10.460	-2.599
El Barde	-0.050	-2.596	-15.066	-2.596
El Der	0.015	-2.596	-11.372	-2.597
Elwak	-0.412	-2.597	-12.037	-2.597
Erigavo	-0.440	-2.596	-14.427	-2.596
Galkayo	-0.528	-2.596	-15.253	-2.596
Garowe	-0.591	-2.596	-10.716	-2.596
Hagar	0.003	-2.596	-10.129	-2.596
Hara Dhere	-0.288	-2.597	-10.573	-2.597
Hargeisa	-0.203	-2.596	-11.343	-2.596
Hudur	0.005	-2.596	-9.856	-2.596
Jamaame	-0.605	-2.596	-12.464	-2.596
Jilib	-0.576	-2.260	-8.389	-2.626
Jowhar	-0.055	-2.597	-9.645	-2.598
Kismayo	-0.205	-2.602	-13.827	-2.604
Lasanod	-0.224	-2.599	-9.764	-2.599
Lugh	-0.196	-2.600	-11.289	-2.601
Merka	-0.230	-2.596	-10.315	-2.596
Mogadishu Bakara	-0.577	-2.596	-12.949	-2.597
Qansah Dere	0.013	-2.596	-8.658	-2.596
Qorioley	-0.024	-2.596	-11.554	-2.596
Togwajiale	-0.021	-2.596	-11.361	-2.596
Wanle Weyne	0.186	-2.600	-7.388	-2.600
Zeilac Lawayacado	-0.780	-2.597	-14.984	-2.598

Data source: FSNAU

Table A.3: Stationarity of series – Red rice

series	Levels		First differences	
	ADF statistic	Critical value 1%	ADF statistic	Critical value 1%
Abudwak	-0.229	-2.599	-9.100	-2.599
Adanyabal	-0.170	-2.599	-14.476	-2.599
Afgoi	-0.492	-2.596	-10.878	-2.596
Afmadow	-0.621	-2.596	-11.695	-2.596
Baidoa	-0.529	-2.596	-12.377	-2.597
Bardera	-0.694	-2.596	-11.080	-2.596
Belet Hawa	-0.308	-2.599	-14.142	-2.599
Beletwein	-0.392	-2.596	-11.623	-2.596
Boroma	-0.269	-2.597	-11.645	-2.597
Bosasso	-0.664	-2.596	-8.458	-2.596
Buale	-0.524	-2.598	-13.750	-2.598
Dinsor	-0.638	-2.596	-10.497	-2.597
Doblei	-0.522	-2.596	-12.144	-2.596
Dolo	-0.706	-2.605	-10.455	-2.606
Dusamared	-0.230	-2.598	-8.771	-2.599
El Barde	-0.301	-2.596	-12.247	-2.596
El Der	-0.554	-2.596	-11.319	-2.597
Elwak	-0.441	-2.597	-14.778	-2.597
Erigavo	-0.451	-2.596	-12.342	-2.596
Galkayo	-0.646	-2.596	-11.368	-2.596
Garowe	-0.599	-2.596	-9.404	-2.596
Hagar	-0.366	-2.596	-12.669	-2.596
Hara Dhere	-0.850	-2.597	-9.642	-2.597
Hargeisa	0.431	-2.596	-12.220	-2.596
Hudur	-0.793	-2.596	-10.949	-2.596
Jamaame	-0.332	-2.596	-11.662	-2.596
Jilib	-0.252	-2.596	-11.868	-2.596
Jowhar	-0.102	-2.597	-11.204	-2.598
Kismayo	-0.442	-2.602	-10.154	-2.604
Lasanod	-1.102	-2.599	-9.224	-2.599
Lugh	-0.477	-2.600	-11.542	-2.601
Merka	-0.340	-2.596	-10.280	-2.596
Mogadishu Bakara	-0.361	-2.596	-14.125	-2.597
Qansah Dere	-0.243	-2.596	-11.846	-2.596
Qorioley	-0.445	-2.596	-9.741	-2.596
Togwajiale	-0.167	-2.596	-12.456	-2.596
Wanle Weyne	-0.614	-2.600	-9.505	-2.600
Zeilac Lawayacado	-0.687	-2.597	-12.097	-2.598

Data source: FSNAU

Table A.4: Stationarity of residuals – Red sorghum

i \ j	Abudwak	Adanyabal	Afgoi	Afmadow	Baidoa	Bardera	Belet Hawa	Beletwein	Boroma	Bosasso	Buale	Dinsor	Doblei	Dolo	Dusamared	El Barde	El Der	Elwak	Erigavo
Abudwak		*	**		*	**	***						***	*	**	*	**	**	**
Adanyabal	*						*			*			***		***	***		***	**
Afgoi	***	*'		***	***	***	***			***	**	***	***	**	**'	***	***	***	**
Afmadow					*	*	*				*		*		*'	**		**	***
Baidoa	***		***	**		***	***				*	***		**	**'	***		**	*
Bardera	***		***	**	***		***		*	**	**	***		**	***	***	**	***	**
Belet Hawa			*		**	***						*		***		***		***	
Beletwein	**		*	**												***	***'		**'
Boroma					*	**	*				*		**	**		***		***	*
Bosasso	***	**'	**	**	**	**	***						*	*	*	***	**	**	***
Buale			**	***		**							***					*	
Dinsor	**	*'	***	**	***	***	***			**			***	**	**	***	*	***	***'
Doblei		***'				**'								***					
Dolo	**		***		**	**	***			**		**				***	*	***	
Dusamared	**	***	*	*	*	***	***			*			***			***		***	**
El Barde	**		***	**	***	***	***	**		*		**	**	**	*'		**	**	***
El Der	***	*'	***	*	*	**	***	**		***			***	**	*'	***		***	**
Elwak	***	**'	***	**	**	***	***				*		*'		**	***	**		**
Erigavo		*'		***		*'									***	*		**	
Galkayo	*		*	**	*	*	***	**		***			***	**		***	***	**	**
Garowe	**			*		*	***			*		*	***		*	***		**	*
Hagar	**		**	*	*	**				*					*	**			***
Hara Dhere	**			*		*	***			**			***	**		***	***	**	**
Hargeisa	**		*		*	**	***		**			*	***	**	**	***		***	***
Hudur	***		***	**	***	***	***			**		***	***	**	***'	***	**'	***	**
Jamaame				***	***									**				*	
Jilib			**	*		**	***						***			**		***	**
Jowhar	**		***	*	***	**	***	***		***		**	***	*	**'	***	***	**	***'
Kismayo			**									*'	***					**	**'
Lasanod							**							**		*			**
Lugh			**	**	**	***	***			*		*	**	**	**	***		***	
Merka	***	*'	***	**	***	***	***			***		***	**	*	**'	***	***	***	***'
Mogadishu Bakara	***		***	***	***	***	***		*			***	***	***	***	***		***	**
Qansah Dere	**		***	**	***	***	***			**		***	**	***	***'	***	*	***	**
Qorioley	**	*'	***	***	***	***	***	*		***		***	***	*	**	***	***	***	**
Togwajiale	***	***	**		***	***	***			***		***		***				***	
Wanle Weyne	**		***	*	***	**	**					***	*	**	*'	***	**		***'
Zeilac Lawayacado	**			*	***	**						*	***	**		***		***	***

cont

Table A.4: Stationarity of residuals – Red sorghum *continued*

i \ j	Galkayo	Garowe	Hagar	Hara Dhere	Hargeisa	Hudur	Jamaame	Jilib	Jowhar	Kismayo	Lasanod	Lugh	Merka	Mogadishu Bakara	Qansah Dere	Qorioley	Togwajiale	Wanle Weyne	Zeilac Lawayacado
Abudwak	***'		**			*			*	***		**	**	***		***	***		*
Adanyabal	***	**	*			**					*'	*					***		
Afgoi	***	**	***		*	***			***	***	*	***	***	***	***	***	***	***	*
Afmadow			**							***	**'	**	*			***			**
Baidoa	**'	*	**			***			**	*	*	***	***	***	***	***	***	***	*
Bardera	***'	**	**		**	***			**	***		***	***	***	***	***	***	**	**
Belet Hawa	**	**'	*		**	***		*		***	***	***		***	***		***		
Beletwein	***'		**			*			***				**	**		***	***	**	**
Boroma		*'			***'	**		*						**	*				
Bosasso	***	*	***			*			**	***		**	*	**		**	***	*	
Buale										***	*					**			
Dinsor	***	**	*		**	***		*	**	***		***	***	***	***	***	***	***	*
Doblei		*'	**					***		***		**				*			***
Dolo	***	**	**		***	***	*		**	***	**	***		***	**	*	***	**	**
Dusamared	***	***	**		*	***				***		***		***	**				**
El Barde	**'	*'	*		*	***			***	***		***	***	***	**	***	***	***	
El Der	***	**	**	***'		**'			***	***		**	***	**		**	***	**	*
Elwak			*		**	***		**	**	***		***	**	***	**	**	***	**	**
Erigavo			***'		***			**									***		**
Galkayo		***	**	***		**			***	***	*	**		**			***	**	
Garowe	***		*			*				***	**	*	*	**		*	**		
Hagar	*			**		**			***			**	**			***		**	
Hara Dhere	***	**	**							***							***		
Hargeisa	**	*	**	**		**				***	**	**		***	**		***		*
Hudur	***	**	**		*				**	***		***	***	***	***	***	**	**	*
Jamaame												***							***
Jilib		**		**		**						**		**'	**'				
Jowhar	***	*	**		*	***'				***		***	***	***		***	***	***	
Kismayo						*	***'	*				*		*		**			
Lasanod		**	**		**							**		*			***		*
Lugh	***	**	*		**	***			**	***			**	***	**		***	*	
Merka	***	**	***	*'		***			***	***		***		***	***	***	***	***	
Mogadishu Bakara	*	**	*		***	***			***	***	*	***	***		***	***	***	***	**
Qansah Dere	***'	**	**		**	***			**	***		***	***	***		***	***	**	**
Qorioley	***	**'	***			***			***	***		***	***	***	***		***	***	*
Togwajiale	***											**		***	***	*		***	
Wanle Weyne	***		***			***			***	**		***	***	***	**	***	***		
Zeilac Lawayacado					*	*				***		*		*	**	**			

Notes: Significance: *** = 0.01, ** = 0.05, * = 0.1, ' = with trend.
Data source: FSNAU

Table A.5: Stationarity of residuals – Red rice

i \ j	Abudwak	Adanyabal	Afgoi	Afmadow	Baidoa	Bardera	Belet Hawa	Beletwein	Boroma	Bosasso	Buale	Dinsor	Doblei	Dolo	Dusamared	El Barde	El Der	Elwak	Erigavo
Abudwak		***		***	***	**		***			***	***		*		***	**	***	
Adanyabal	***			***'		***'							**'			*		***'	*'
Afgoi	***	***		***	*	**	*	**	**		***	***	*	*		**	***	**	*
Afmadow	***	***	**		**	**	*	***	***'	**'	***	**	**	*	**	**	**	**	**
Baidoa	***	***		***		**		***		**'	***	***	*	**		**	*	***	
Bardera	***	**	*	***	**		***	**	***	**	***	***	**	**		**	***	***	**
Belet Hawa	***	**	*	***	*	***		**	*		**	**	**	***		**	***	***	*
Beletwein	***	***	**	***	***	**	*		*	*	***	**	**	**		***	**	***	*
Boroma	***	***	**	***	*	***	*	**			**	*	**			**	*	***	
Bosasso	***	***	*	***	**	***	*	***	*		**		***	**		**	***	***	**
Buale	***	***	**	***	***	***	*	***	**	*		***	*	*		***	**	***	
Dinsor	***	***	**	***	***	***	*	***			***		*	**		**	***	***	
Doblei	***	***		**		**		**	*	**				*		**	*	***	**
Dolo	***	***	*	**	**	**	**	**		*	**	**	**			**	***	***	
Dusamared	***	***		***		***		*			*		**			**		***	*
El Barde	***	***		**		*'		**	**'		*'		*'		**'			***'	*'
El Der	***	***	***	***	*	***	***'	**	**	*	**	***	*'	***		*		**	**
Elwak	***	***		**	**	**	*	*	**'	**'	*		**	*		**	*		***'
Erigavo	**	***	*	***		***	*	**		*	**		***	*	*	**	***	***	
Galkayo	***	***	*	***	***	***	**	***		**	***	**	**	*		***	***	***	
Garowe	***	***		**		*							***			**	*	***	*
Hagar	***	***		**		**'	**'	*	**'		**'	*	*	*		**	***	***	**'
Hara Dhere	**	**		***	***	**		***			***	**	*	**		**	**	***	
Hargeisa	**	***		*	*	**		**	**		**					**	**	*	
Hudur	**	***		**		*		*					***			**		***	**
Jamaame	***	***		***	***	*		***			***	***		*		**	**	**	
Jilib	***	***	*	***	***	***		***			***	***		**		**	**	***	
Jowhar	***	***		***	***	**		***			***	***		**		**	**	**	
Kismayo	***	***	*	***	**	**		***	*'		***	**		*		**	*	***	*'
Lasanod	**	***		***		**		*	*'		*		***		*	**	**	***	
Lugh	***	***		**	***	**	**	***		**	**	**	**	**		**	**	***	*
Merka	***	***		**	***	***'		***			***	***		**		**	**	***	
Mogadishu Bakara	**	***	***	***	**	***	**	**	*	**	***	**	**	***		**	***	***	*
Qansah Dere	***	***	*	***	***	**'	**	*			**	***		**		**	***	***	
Qorioley	***	***		***	***	**		***			***	***	*	*		***	**	***	
Togwajiale	**	***	*	***		***	**	**	***	**	**	**	**	**		**	**	***	**
Wanle Weyne	***	***	*	***	***	***		***			***	***	*	**		**	**	***	
Zeilac Lawayacado	***	***	*	***	*	***	**	**	**	*	**	*	***	**		**	**	***	**

cont

Table A.5: Stationarity of residuals – Red rice *Continued*

i \ j	Galkayo	Garowe	Hagar	Hara Dhere	Hargeisa	Hudur	Jamaame	Jilib	Jowhar	Kismayo	Lasanod	Lugh	Merka	Mogadishu Bakara	Qansah Dere	Qorioley	Togwajiale	Wanle Weyne	Zeilac Lawayacado
Abudwak	**		**	***	**		***	***	***	***		***	***	**	**	***	**	***	
Adanyabal		*'	*			**'					**'	*'							**'
Afgoi	*		**		**			*		*		*	*	***	**		**	*	*
Afmadow	**		**	**		*	*	**	*	**	**'	*	*	**	**	**	**	**	***'
Baidoa	***		**	***	*		***	***	***	**		***	***	**'	***	***		***	**'
Bardera	***	*	***	**	**	*		**	*	*	*	***	**	***	**	*	***	***	***
Belet Hawa	**		***		*							**		**	**	*	**		**
Beletwein	**		***	***	**		***	***	***	**		***	***	*	*	***	**	**	*
Boroma		*	***		**	*		*		**		**		*	*		***		**
Bosasso	**	*	**	*		*		**		*		***		**		*	***	*	**
Buale	**		***	***	**		***	***	**	***		**	***	***	**	***	**	***	**
Dinsor	*		***	**			**	***	**	**		**	***	**	***	***	**	***	*
Doblei	**	***	**			***					**	**		*			**		**
Dolo	*		***	*				**	*	*		***	**	**	***	*	**	**	*
Dusamared			**			**					*	*					*		
El Barde	***'		**		*'						*'	*'							**'
El Der	**		**	**	**		*	**	*			**	**	***	***	**	**	**	**
Elwak	***'	*	***			**		*			***'	**	*	**'	*		***'		***
Erigavo		**	**			**		*		*		**		*			***		**
Galkayo		*	***	**	*	**	*	**		**		***	**	**	*	**	***	**	**
Garowe			**			**					*'						*		
Hagar	**'					*'					**'	**'		*'	*		**'		***'
Hara Dhere	**		**		*		***	***	**	*		***	***		**	**		***	
Hargeisa			*			*	*	*		*	*'	*			**		***	**	**
Hudur	*	**	**								**'	*					**		**
Jamaame	*		**	***	**			***	***	**		**	***	*	*	***		***	
Jilib	**		**	***	**		***		***	**		***	***	**	***	***	*	***	*
Jowhar	*		**	**	**		***	***		**		***	***		**	***		***	
Kismayo	**		**	*	**		**	**	*			**	**	**	**	**	**	**	**'
Lasanod		**	**		**	**						*					***		**
Lugh	***		***	**				***	**	*			***	**	**	**	**	***	**
Merka	***'		**	***	*		***	***	***	**		***		*'	**	***	*	***	
Mogadishu Bakara	**		***				*	**		**		***	*		**		**	*	**
Qansah Dere			***	*	**			**	**	**		**	**	*'			**'		
Qorioley	**		**	**	*		***	***	***	**		**	***		*			***	
Togwajiale	**	*	***		**	*		*		*	**	**		**	*			*	***
Wanle Weyne	**		**	***	**		***	***	***	**		***	***	*	**	***	*		
Zeilac Lawayacado	**	*	***		**	**		*		**	*	**		*			***		

Notes: Significance: *** = 0.01, ** = 0.05, * = 0.1, ` = with trend.
Data source: FSNAU

Table A.6: Coefficients of bivariate cointegration and direction of causality – Red sorghum

Independent variable (J)	Dependent variable (I)	α_3	θ_2	λ	direction of causality
abudwaq	adanyabal	-0.127 **		1	⇨
abudwaq	afgoi	-0.196 ***	-0.582 ***	1	⇦
abudwaq	baidoa	-0.198 ***	-0.382 ***	1	⇦
abudwaq	bardera	-0.164 ***	-0.434 ***	1	⇦
abudwaq	beletwein	-0.196 ***	-0.712 ***	1	⇦
abudwaq	bosasso	-0.119 **	-1.268 ***	1	⇔
abudwaq	dinsor	-0.189 ***	-0.241 ***	1	⇦
abudwaq	dusamared		-0.916 ***	1	⇨
abudwaq	elder	-0.202 ***	-0.531 ***	1	⇔
abudwaq	elwak	-0.054 **	-1.211 ***	1	⇦
abudwaq	galkayo	-0.067 **	-0.830 **	1	⇦
abudwaq	garowe	-0.078 **	0.853 **	2	⇦
abudwaq	haradhere	-0.173 ***	-0.306 **	1	⇨
abudwaq	hudur	-0.191 ***	-0.615 ***	1	⇦
abudwaq	jowhar	-0.179 ***	-0.735 ***	2	⇦
abudwaq	merka	-0.275 ***	-0.571 ***	3	⇔
abudwaq	mogadishu bakara	-0.134 ***	-0.556 ***	1	⇦
abudwaq	qansahdere	-0.178 ***	-0.201 **	1	⇦
abudwaq	qorioley	-0.214 ***	-0.440 ***	1	⇦
abudwaq	wanle weyne	-0.189 ***	-0.520 ***	1	⇦
abudwaq	zeilac lawayacado	-0.070 **	-0.867 ***	1	⇦
adanyabal	abudwaq		-4.014 ***	1	⇦
adanyabal	dusamared	-0.045 *	-2.178 ***	1	⇨
adanyabal	elwak	-0.031 *	-2.014 ***	1	⇦
adanyabal	merka	-0.012 **	-5.858 ***	1	⇦
afgoi	abudwaq		-1.719 ***	1	⇨
afgoi	baidoa	-0.348 ***	-0.773 ***	1	⇦
afgoi	buale	-0.402 ***	-0.518 ***	1	⇦
afgoi	dinsor	-0.295 ***	-0.592 ***	1	⇦
afgoi	dusamared		-1.542 ***	1	⇨
afgoi	elbarde		-3.615 ***	2	⇨
afgoi	elder	-0.152 ***	-0.900 ***	1	⇦
afgoi	hudur	-0.187 ***	-1.095 ***	1	⇦
afgoi	jilib	-0.270 ***	-0.348 **	1	⇦
afgoi	jowhar	-0.183 ***	-1.124 ***	1	⇦
afgoi	kismayo	-0.132 ***	-1.498 ***	1	⇔
afgoi	lugh	-0.127 ***	-0.877 ***	1	⇦
afgoi	merka	-0.254 ***	-0.947 ***	2	⇔
afgoi	mogadishu bakara	-0.109 **	-0.919 ***	1	⇨
afgoi	qansahdere	-0.187 **	-0.567 ***	2	⇦
afgoi	qorioley	-0.175 **	-0.838 ***	1	⇨
afgoi	wanle weyne	-0.213 *	-0.962 ***	1	⇨
afmadow	afgoi		-1.683 ***	1	⇨
afmadow	baidoa	-0.232 ***	-0.657 ***	2	⇨
afmadow	elbarde	-0.108 ***	2.559 ***	2	⇨
afmadow	elwak	-0.342 ***	-0.851 ***	3	⇦
afmadow	lugh	-0.269 ***	-0.367 **	2	⇨
baidoa	abudwaq		-2.619 ***	1	⇨
baidoa	afgoi		-1.294 ***	1	⇨
baidoa	bardera	-0.122 *	-1.006 ***	1	⇔
baidoa	belethawa		-1.151 ***	1	⇨
baidoa	dinsor	-0.215 **	-0.745 ***	2	⇔
baidoa	dolo	-0.091 **	-1.072 ***	1	⇨
baidoa	el barde		-3.286 ***	1	⇨
baidoa	el der	-0.065 **	-1.215 ***	1	⇨
baidoa	galkayo	-0.017 **	5.445 **	1	⇨
baidoa	hagar		-7.275 ***	1	⇦
baidoa	hudur		-1.606 ***	2	⇔
baidoa	jamaame	-0.108 ***	-0.94 ***	1	⇦
baidoa	lugh	-0.071 *	-1.129 ***	1	⇨
baidoa	merka	-0.082 *	-1.204 ***	1	⇨
baidoa	mogadishu bakara	-0.161 ***	-1.093 ***	2	⇔
baidoa	qansahdere	-0.238 ***	-0.735 ***	2	⇔
baidoa	qorioley		-1.113 ***	1	⇨
baidoa	wanle weyne	-1.175 ***		1	⇔
bardera	abudwaq		-2.304 ***	1	⇨
bardera	baidoa	-0.294 **	-0.993 ***	1	⇔
bardera	buale	-0.314 ***	-0.936 ***	1	⇔
bardera	dinsor	-0.223 ***	-0.762 ***	1	⇦
bardera	el wak	-0.096 **	-1.877 ***	2	⇔
bardera	garowe	-0.099 ***	1.887 ***	1	⇦
bardera	hagar	-0.013 *	7.655 ***	2	⇦
bardera	haradhere	-0.097 **		1	⇨
bardera	hudur		-1.810 ***	2	⇔
bardera	jowhar	-0.089 **	-1.470 ***	1	⇨
bardera	lugh	-0.188 ***	-1.051 ***	1	⇦
bardera	merka	-0.101 **	-1.180 ***	1	⇨

cont.

Table A.6: Coefficients of bivariate cointegration and direction of causality – Red sorghum *Continued*

cont.

Independent variable (J)	Dependent variable (I)	α_3	θ_2	λ	direction of causality
bardera	mogadishu bakara	-0.198 ***	-1.171 ***	1	⟺
bardera	qansahdere	-0.350 ***	-0.774 *	1	⟸
bardera	qorioley		-1.075 ***	1	⟹
bardera	wanle weyne		-1.605 ***	2	⟺
belet hawa	afmadow	-0.112 ***	-1.835 ***	2	⟺
belet hawa	baidoa	-0.196 ***	-0.869 ***	1	⟸
belet hawa	dolo	-0.214 ***	-0.918 ***	1	⟸
belet hawa	el wak	-0.147 ***	-1.457 ***	1	⟺
belet hawa	jilib	-0.170 **	-1.025 ***	1	⟸
belet hawa	lugh	-0.103 *	-1.105 ***	1	⟸
belet hawa	qansahdere	-0.184 ***	-0.408 **	2	⟸
beletwein	el barde		-2.402 ***	2	⟹
beletwein	el der	-0.108 **	-0.722 ***	1	⟹
beletwein	galkayo		-1.121 ***	1	⟹
beletwein	jowhar	-0.254 ***	-0.957 ***	1	⟸
boroma	hargeisa		-0.944 ***	1	⟹
bosasso	elder	-0.214 ***	-0.397 ***	1	⟸
bosasso	galkayo	-0.170 ***	-0.518 ***	1	⟸
bosasso	haradhere	-0.192 ***	-0.241 **	1	⟸
buale	afgoi		-1.929 ***	1	⟹
buale	bardera		-1.068 ***	1	⟺
buale	el wak		-1.217 ***	1	⟹
dinsor	afgoi		-1.689 ***	1	⟹
dinsor	baidoa	-0.208 ***	-1.267 ***	1	⟸
dinsor	bardera		-1.313 ***	1	⟹
dinsor	belet hawa		-1.957 ***	1	⟹
dinsor	dolo	-0.105 ***	-1.361 ***	1	⟸
dinsor	el barde		-4.932 ***	1	⟹
dinsor	garowe	-0.029 **	4.943 ***	1	⟹
dinsor	hudur		-2.433 ***	2	⟹
dinsor	jowhar	-0.065 *	-2.081 ***	1	⟹
dinsor	kismayo		-2.714 ***	1	⟹
dinsor	merka		-1.614 ***	1	⟹
dinsor	mogadishu bakara	-0.091 *	-1.485 ***	1	⟺
dinsor	qansahdere	-0.176 **	-0.981 ***	1	⟸
dinsor	qorioley		-1.396 ***	1	⟺
dinsor	wanle weyne		-1.669 ***	2	⟹
doblei	abudwaq	-0.262 ***	-0.684 ***	1	⟹
doblei	afgoi	-0.275 ***	-0.383 **	1	⟸
doblei	buale	-0.611 ***	-0.524 ***	1	⟺
doblei	el wak	-0.379 ***	-0.588 ***	2	⟺
doblei	kismayo	-0.214 ***	-0.746 ***	1	⟸
dolo	bardera		-1.034 ***	1	⟹
dolo	belet hawa		-1.089 ***	1	⟹
dolo	dinsor	-0.085 *	-0.735 ***	1	⟹
dolo	hudur	-0.115 ***	-1.610 ***	1	⟸
dolo	jamaame		-0.997 ***	1	⟹
dolo	mogadishu bakara	-0.098 **	-1.238 ***	1	⟹
dolo	qansahdere	-0.104 **	-0.782 ***	1	⟹
dolo	wanle weyne	-0.069 *	-1.090 **	1	⟸
dusamared	abudwaq	-0.136 ***	-1.092 ***	1	⟸
dusamared	adanyabal	-0.151 ***	-0.459 ***	1	⟸
dusamared	afgoi	-0.117 ***	-0.649 ***	1	⟸
dusamared	baidoa	-0.195 ***	-0.396 ***	1	⟸
dusamared	bardera	-0.250 ***	-0.464 ***	1	⟸
dusamared	dinsor	-0.174 ***	-0.280 ***	1	⟸
dusamared	el barde	-0.041 **	-2.515 ***	1	⟸
dusamared	elder		0.625 **	1	⟹
dusamared	elwak	-0.126 ***	-0.844 ***	1	⟸
dusamared	garowe	-0.059 **	1.059 ***	1	⟹
dusamared	hagar	0.003 *	14.861 ***	1	⟸
dusamared	hargeisa	-0.163 ***	-0.262 **	1	⟸
dusamared	hudur	-0.193 ***	-0.688 ***	1	⟸
dusamared	jowhar		3.556 **	2	⟸
dusamared	lugh	-0.186 ***	-0.512 ***	1	⟸
dusamared	merka	-0.144 ***	-0.524 ***	1	⟸
dusamared	mogadishu bakara	-0.101 **	-0.606 ***	1	⟸
dusamared	qansahdere	-0.236 ***	-0.299 ***	1	⟸
dusamared	qorioley	-0.151 ***	-0.457 ***	1	⟸
dusamared	wanle weyne	-0.150 **	-0.446 ***	1	⟸
el barde	afgoi	-0.270 ***	-0.276 **	2	⟸
el barde	baidoa	-0.340 ***	-0.304 ***	1	⟸

cont.

Table A.6: Coefficients of bivariate cointegration and direction of causality – Red sorghum *Continued*

cont.

Independent variable (J)	Dependent variable (I)	α_3	θ_2	λ	direction of causality
el barde	bardera	-0.314 ***	-0.278 ***	1	⇐
el barde	belet wein	-0.285 ***	-0.416 **	2	⇐
el barde	dinsor	-0.315 ***	-0.203 ***	1	⇐
el barde	dusamared	-0.261 **	-0.397 **	1	⇒
el barde	el wak	-0.302 ***	-0.580 ***	1	⇐
el barde	hagar	-0.262 ***	-0.544 ***	1	⇐
el barde	jowhar	-0.354 ***	-0.521 ***	1	⇐
el barde	merka	-0.315 ***	-0.365 ***	1	⇐
el barde	mogadishu bakara	-0.257 ***	-0.338 ***	1	⇒
el barde	qansahdere	-0.319 ***	-0.184 **	1	⇐
el barde	qorioley	-0.288 ***	-0.263 **	1	⇐
el barde	wanle weyne	-0.284 ***	-0.349 ***	1	⇐
elder	abudwaq		-2.328 ***	2	⇔
elder	afgoi	-0.083 **	-1.110 ***	1	⇒
elder	belet wein	-0.099 **	-1.384 ***	1	⇐
elder	bosasso		-2.519 ***	1	⇒
elder	galkayo		-1.278 ***	1	⇒
elder	harahdere	-0.221 **	-0.797 ***	1	⇐
elder	jowhar		-1.725 ***	2	⇐
elder	merka	-0.172 ***	-1.022 ***	1	⇐
elder	qorioley	-0.114 **	-0.892 ***	1	⇐
elder	wanle weyne	-0.097 *	-1.042 ***	2	⇔
el wak	abudwaq	-0.220 ***	-0.825 **	1	⇒
el wak	adanyabal	-0.275 ***	-0.496 **	1	⇒
el wak	bardera	0.180 **	-0.532 ***	2	⇔
el wak	belethawa	-0.351 ***	-0.686 ***	1	⇔
el wak	buale	-0.378 ***	-0.821 ***	1	⇐
el wak	dolo	-0.323 ***	-0.541 ***	1	⇐
el wak	el barde		-1.723 ***	1	⇒
el wak	galkayo	-0.184 ***	0.751 **	3	⇒
el wak	garowe	-0.255 ***	0.843 ***	1	⇐
el wak	jamaame	-0.304 ***	-0.433 ***	1	⇔
el wak	jilib	-0.384 ***	-0.609 ***	1	⇐
el wak	jowhar	-0.090 **	1.339 **	3	⇐
el wak	lugh	-0.309 ***	-0.727 ***	1	⇔
erigavo	boroma	-0.301 ***	-0.710 ***	1	⇔
erigavo	dusamared		-2.455 ***	1	⇐
erigavo	garowe	-0.049 **	2.490 ***	2	⇐
erigavo	hargeisa	-0.130 **	-0.649 ***	1	⇒
erigavo	lasanod	-0.135 **	-0.755 ***	1	⇒
erigavo	zeilac lawayacado	-0.074 *	-1.214 ***	2	⇒
galkayo	adanyabal	-0.148 ***	0.684 **	2	⇐
galkayo	baidoa		4.785 ***	2	⇐
galkayo	beletwein	-0.166 ***	-0.892 ***	1	⇐
galkayo	dusamared	-0.091 **	1.823 **	2	⇐
galkayo	el der	-0.221 ***	-0.782 ***	1	⇐
galkayo	garowe	-0.127 **	-1.360 ***	1	⇒
galkayo	hagar	-0.062 *	-1.588 ***	1	⇒
galkayo	haradhere	-0.201 **	-0.595 ***	2	⇒
galkayo	hargeisa	-0.154 ***	0.449 **	2	⇔
galkayo	hudur		2.757 ***	2	⇐
galkayo	jowhar	-0.153 ***	-2.963 ***	2	⇐
galkayo	merka		-6.071 **	2	⇔
galkayo	mogadishu bakara	-0.045 *	1.202 **	2	⇐
galkayo	qansahdere		1.035 **	2	⇐
garowe	adanyabal	-0.165 ***	0.425 ***	1	⇐
garowe	baidoa	-0.060 *	0.431 **	1	⇐
garowe	bardera		0.530 ***	1	⇒
garowe	dinsor	-0.100 **		1	⇐
garowe	dusamared	-0.108 ***	0.944 ***	1	⇐
garowe	galkayo	-0.207 ***	-0.735 ***	1	⇐
garowe	hargeisa	-0.158 ***	0.287 ***	1	⇐
garowe	hudur	-0.078 **	0.840 ***	2	⇒
garowe	jilib	-0.153 **		1	⇒
garowe	lasanod	-0.140 ***	0.319 **	1	⇐
garowe	lugh		0.671 ***	1	⇒
garowe	qansadhere	-0.095 **	0.300 **	1	⇐
hagar	dinsor	-0.226 ***		1	⇐
hagar	dusamared	-0.225 ***		1	⇒
hagar	el barde	-0.073 *	-1.837 ***	1	⇒
hagar	el der	-0.265 ***	-0.476 ***	1	⇐
hagar	galkayo	-0.245 ***	-0.630 ***	1	⇐
hagar	garowe	-0.304 ***	-0.695 ***	2	⇒
hagar	merka	-0.223 ***		1	⇒
haradhere	el der		-1.254 ***	1	⇒

cont.

Table A.6: Coefficients of bivariate cointegration and direction of causality – Red sorghum *Continued*

cont.

Independent variable (J)	Dependent variable (I)	α_3	θ_2	λ	direction of causality
haradhere	galkayo		-1.679 ***	2	⇐
haradhere	merka	-0.069 **	-1.497 ***	1	⇐
hargeisa	boroma	-0.225 ***	-1.059 ***	1	⇐
hargeisa	dusamared		-3.807 ***	1	⇒
hargeisa	erigavo	-0.159 ***	-1.540 ***	1	⇐
hargeisa	lasanod	-0.155 ***	-1.165 ***	1	⇐
hudur	abudwaq		-1.625 ***	1	⇒
hudur	adanyabal	-0.112 **	-0.345 *	2	⇒
hudur	afgoi		-0.913 ***	1	⇒
hudur	bardera	-0.243 ***	-0.552 ***	2	⇔
hudur	beletwein		-1.105 ***	1	⇒
hudur	dinsor	-0.215 ***	-0.411 ***	2	⇐
hudur	dolo	-0.103 **	-0.621 ***	1	⇒
hudur	dusamared		-1.454 ***	1	⇒
hudur	galkayo	-0.132 ***		2	⇒
hudur	garowe	-0.138 ***	1.190 ***	2	⇐
hudur	jowhar	-0.115 **	-1.035 ***	1	⇔
hudur	merka	-0.215 ***	-0.644 ***	2	⇔
hudur	mogadishu bakara		-0.839 ***	1	⇒
hudur	qansahdere	-0.264 ***	-0.493 ***	2	⇐
hudur	qorioley		-0.727 ***	1	⇒
hudur	wanle weyne	-0.165 **	-0.643 ***	2	⇔
jamaame	dolo	-0.220 ***	-1.003 ***	1	⇐
jamaame	kismayo	-0.097 **	-2.033 ***	2	⇒
jilib	belethawa	-0.081 **	-0.975 ***	1	⇒
jilib	el wak		-1.641 ***	1	⇒
jilib	kismayo		-3.970 ***	1	⇒
jowhar	abudwaq		-1.361 ***	2	⇒
jowhar	afgoi		-0.889 ***	1	⇒
jowhar	bardera	-0.090 **	-0.680 ***	1	⇐
jowhar	belet wein		-1.045 ***	1	⇒
jowhar	dinsor	-0.132 **	-0.480 ***	1	⇐
jowhar	el barde	-0.059 *	-1.918 ***	1	⇒
jowhar	el der	-0.167 ***	-0.580 ***	2	⇒
jowhar	el wak	-0.073 **	0.747 *	3	⇒
jowhar	galkayo	-0.137 ***		2	⇒
jowhar	hudur	-0.135 **	-0.966 ***	1	⇔
jowhar	merka	-0.133 **	-0.812 ***	1	⇔
jowhar	mogadishu bakara	-0.038	-0.833 ***	1	⇒
jowhar	qansahdere	-0.144 **	-0.412 ***	1	⇐
jowhar	qorioley	-0.092 *	-0.714 ***	1	⇒
jowhar	wanle weyne		-0.774 ***	1	⇒
kismayo	abudwaq	-0.273 ***	-0.035 ***	1	⇔
kismayo	afgoi	-0.350 ***	-0.667 ***	1	⇔
kismayo	afmadow	-0.432 ***	-0.488 ***	1	⇐
kismayo	bardera	-0.287 ***	-0.469 ***	1	⇐
kismayo	belet hawa	-0.238 ***	-0.431 ***	1	⇐
kismayo	dinsor	-0.349 ***	-0.368 ***	1	⇐
kismayo	doblei	-0.134 ***	-1.341 ***	1	⇒
kismayo	el der	-0.289 ***	-0.516 ***	1	⇐
kismayo	jowhar	-0.282 ***	-0.685 ***	1	⇐
kismayo	merka	-0.449 ***	-0.613 ***	1	⇐
kismayo	qansahdere	-0.246 ***	-0.384 ***	2	⇐
kismayo	qorioley	-0.370 ***	-0.540 ***	1	⇐
lasanod	galkayo		1.848 ***	2	⇒
lasanod	garowe	-0.027 *	3.137 ***	1	⇒
lasanod	hargeisa		-0.858 ***	1	⇒
lugh	afgoi	-0.085 *	-1.140 ***	1	⇒
lugh	afmadow	-0.054 *	-2.728 ***	2	⇐
lugh	baidoa	-0.205 ***	-0.885 ***	1	⇐
lugh	bardera	-0.167 **	-0.950 ***	1	⇒
lugh	belet hawa	-0.212 ***	-0.905 ***	1	⇒
lugh	dusamared	-0.092 *	-1.950 ***	1	⇒
lugh	el wak	-0.181 **	-1.374 ***	1	⇔
lugh	garowe	-0.142 ***	1.489 ***	1	⇐
lugh	merka	-0.106 **	-0.895 ***	1	⇒
lugh	mogadishu bakara		-1.139 ***	1	⇒
lugh	qorioley	-0.092 *	-0.863 ***	1	⇒
lugh	wanle weyne		-1.177 ***	2	⇔
merka	abudwak		-1.967 ***	3	⇔
merka	afgoi		-1.056 ***	2	⇔
merka	baidoa	-0.133 **	-0.830 ***	1	⇐
merka	bardera	-0.111 **	-0.847 ***	1	⇐

cont.

Table A.6: Coefficients of bivariate cointegration and direction of causality – Red sorghum *Continued*

cont.

Independent variable (J)	Dependent variable (I)	α_3	θ_2	λ	direction of causality
merka	dinsor	-0.162 ***	-0.619 ***	1	←
merka	el barde		-2.738 ***	1	→
merka	el der	-0.075 *	-0.978 ***	1	→
merka	hagar		-3.547 ***	1	←
merka	hudur		-1.552 ***	2	↔
merka	jowhar	-0.117 **	-0.231 ***	1	↔
merka	lugh	-0.075 **	-1.117 ***	1	←
merka	mogadishu bakara	-0.070 *	-0.928 ***	2	→
merka	qansahdere	-0.140 ***	-0.595 ***	1	←
merka	qorioley	-0.131 *	-0.857 ***	1	↔
merka	wanle weyne		-1.213 ***	2	→
mogadishu bakara	abudwaq	-0.124 ***		1	→
mogadishu bakara	afgoi	-0.227 ***	-1.087 ***	1	←
mogadishu bakara	baidoa	-0.330 ***	-0.915 ***	2	↔
mogadishu bakara	bardera	-0.257 ***	-0.854 ***	1	↔
mogadishu bakara	dinsor	-0.330 ***	-0.673 ***	1	↔
mogadishu bakara	dolo	-0.281 ***	-0.807 ***	1	←
mogadishu bakara	dusamared	-0.105 **	-1.649 ***	1	→
mogadishu bakara	el barde	-0.090 ***	-2.955 ***	1	←
mogadishu bakara	galkayo	-0.096 **	0.832 **	2	→
mogadishu bakara	hudur	-0.272 ***	-1.191 ***	1	←
mogadishu bakara	jowhar	-0.210 ***	-1.200 ***	1	←
mogadishu bakara	lugh	-0.227 ***	-0.878 ***	1	←
mogadishu bakara	merka	-0.177 ***	-1.077 ***	2	←
mogadishu bakara	qansahdere	-0.400 ***	-0.669 ***	1	↔
mogadishu bakara	qorioley	-0.157 ***	-0.891 ***	1	→
mogadishu bakara	wanle weyne	-0.175 **	-1.133 ***	2	↔
qansahdere	afgoi		-1.763 ***	2	→
qansahdere	baidoa		-1.361 ***	2	↔
qansahdere	bardera		-1.291 ***	1	→
qansahdere	belet hawa		-2.451 ***	2	→
qansahdere	dinsor		-0.019 ***	1	→
qansahdere	dolo	-0.093 **	-1.278 ***	1	←
qansahdere	dusamared	0.051 *	-3.346 ***	1	→
qansahdere	el barde		-5.422 ***	1	→
qansahdere	hudur		-2.029 ***	2	→
qansahdere	merka		-1.679 ***	1	→
qansahdere	mogadishu bakara		-1.493 ***	1	↔
qansahdere	qorioley	-0.077 *	-1.052 ***	2	→
qansahdere	wanle weyne		-1.426 ***	1	→
qorioley	abudwaq		-0.272 ***	1	→
qorioley	afgoi	-0.250 ***	-1.193 ***	1	←
qorioley	baidoa	-0.241 ***	-0.898 ***	1	←
qorioley	bardera	-0.163 ***	-0.930 ***	1	←
qorioley	dinsor	-0.275 ***	-0.716 ***	1	↔
qorioley	el barde	-0.036 *	-3.798 ***	1	→
qorioley	el der	-0.095 **	-1.120 ***	1	←
qorioley	hudur	-0.142 **	-1.375 ***	1	←
qorioley	jowhar	-0.153 **	-1.400 ***	1	←
qorioley	kismayo	-0.073 *	-1.851 ***	1	→
qorioley	merka	-0.318 ***	-1.166 ***	1	↔
qorioley	mogadishu bakara	-0.137 ***	-1.122 ***	1	←
qorioley	qansahdere	-0.085 *	-0.950 ***	2	←
qorioley	wanle weyne	-0.165 **	-1.155 ***	1	→
togwajiale	erigavo	-0.116 ***	-1.329 ***	2	←
togwajiale	garowe	-0.038 **	3.345 ***	1	↔
wanle weyne	afgoi	-0.394 ***	-1.039 ***	1	←
wanle weyne	baidoa	-0.319 ***	-0.850 ***	1	↔
wanle weyne	bardera	-0.218 ***	-0.623 ***	2	↔
wanle weyne	belet wein	-0.077 **	-1.528 ***	1	←
wanle weyne	dinsor	-0.270 ***	-0.599 ***	2	←
wanle weyne	dolo	-0.085 **	-0.917 **	1	→
wanle weyne	el barde	-0.072 **	-2.862 ***	1	→
wanle weyne	el der	-0.188 ***	-0.959 ***	2	↔
wanle weyne	galkayo	-0.115 **		2	→
wanle weyne	hudur	-0.081 *	-1.553 ***	2	↔
wanle weyne	jowhar	-0.236 ***	-1.291 ***	1	←
wanle weyne	lugh	-0.157 ***	-0.849 ***	2	↔
wanle weyne	merka	-0.270 ***	-0.824 ***	2	←
wanle weyne	mogadishu bakara	-0.168 ***	-0.882 ***	2	↔
wanle weyne	qansahdere	-0.305 ***	-0.701 ***	1	←
wanle weyne	qorioley	-0.190 **	-0.865 ***	1	←
zeilac lawayacado	abudwaq	-0.149 ***	-1.153 **	1	→
zeilac lawayacado	erigavo	-0.271 ***	-0.823 ***	2	←

Note: ↔ identifies bidirectional causality; ← identifies unidirectional causality from I to J; → identifies undirectional causality from J to I.
Significance: *** = 0.01, ** = 0.05, * = 0.1. Only significant coefficient values are reported.
Data source: FSNAU

Table A.7: Coefficients of bivariate cointegration and direction of causality – Red rice

Independent variable (J)	Dependent variable (I)	α_3	θ_2	λ	direction of causality
abudwaq	adanyabal	-0.155 ***	-0.701 ***	2	⇐
abudwaq	afgoi	-0.280 ***	-0.605 ***	2	⇐
abudwaq	afmadow	-0.225 ***	-0.700 ***	2	⇐
abudwaq	baidoa	-0.303 ***	-0.599 ***	2	⇔
abudwaq	bardera	-0.303 ***	-0.847 ***	1	⇐
abudwaq	belet hawa	-0.152 ***	-0.415 ***	2	⇒
abudwaq	beletwein	-0.289 ***	-0.815 ***	1	⇐
abudwaq	bosasso	-0.344 ***	-0.761 ***	1	⇐
abudwaq	buale	-0.234 ***	-0.639 ***	2	⇐
abudwaq	dinsor	-0.336 ***	-0.667 ***	2	⇔
abudwaq	doblei	-0.095 *	-0.901 ***	1	⇔
abudwaq	dolo	-0.161 ***	-0.863 ***	1	⇐
abudwaq	dusamared	-0.111 *	-0.880 ***	1	⇒
abudwaq	elbarde	-0.179 *	-0.999 ***	2	⇒
abudwaq	elder	-0.294 ***	-0.717 ***	2	⇔
abudwaq	elwak	-0.147 **	-1.026 ***	2	⇔
abudwaq	galkayo	-0.293 ***	-0.745 ***	1	⇐
abudwaq	garowe		-0.742 ***	3	⇐
abudwaq	hagar	-0.125 **	-0.871 ***	1	⇐
abudwaq	haradhere	-0.191 ***	-0.552 ***	1	⇐
abudwaq	hudur	-0.280 ***	-0.820 ***	2	⇔
abudwaq	jamaame	-0.273 ***	-0.664 ***	1	⇐
abudwaq	jilib	-0.232 ***	-0.712 ***	1	⇐
abudwaq	jowhar	-0.343 ***	-0.645 ***	2	⇐
abudwaq	kismayo	-0.218 ***	-0.756 ***	1	⇔
abudwaq	lugh	-0.281 ***	-0.866 ***	1	⇔
abudwaq	merka	-0.370 ***	-0.665 ***	1	⇐
abudwaq	mogadishu bakara	-0.151 ***	-0.230 **	2	⇐
abudwaq	qansahdere	-0.323 ***	-0.703 ***	2	⇔
abudwaq	qorioley	-0.330 ***	-0.668 ***	1	⇐
abudwaq	wanle weyne	-0.331 ***	-0.607 ***	2	⇔
adanyabal	abudwaq		-1.427 ***	2	⇒
adanyabal	afmadow	-0.077 *	-0.941 ***	2	⇒
adanyabal	baidoa	-0.179 ***	-0.437 **	1	⇐
adanyabal	beletwein	-0.193 ***	-0.792 ***	2	⇐
adanyabal	dinsor	-0.123 **	-0.563 **	2	⇐
adanyabal	doblei		-1.204 ***	2	⇒
adanyabal	dusamared	-0.175 ***	-1.066 ***	2	⇐
adanyabal	elbarde	-0.321 ***	-1.124 ***	1	⇐
adanyabal	elder	-0.248 ***	-0.705 ***	1	⇐
adanyabal	galkayo	-0.147 **	-0.657 ***	2	⇔
adanyabal	jamaame	-0.202 ***	-0.530 ***	1	⇐
adanyabal	jilib	-0.134 **	-0.743 ***	2	⇐
adanyabal	kismayo	-0.180 ***	-0.768 ***	2	⇐
adanyabal	merka	-0.175 ***	-0.675 ***	2	⇐
adanyabal	qansahdere	-0.092 **	-0.810 ***	2	⇐
adanyabal	qorioley	-0.150 **	-0.547 **	2	⇐
adanyabal	wanle weyne	-0.197 ***	-0.503 **	2	⇐
afgoi	afmadow	-0.114 **	-1.134 ***	2	⇒
afgoi	bardera	-0.162 ***	-1.221 ***	1	⇐
afgoi	belet wein	-0.300 ***	-1.219 ***	1	⇐
afgoi	buale	-0.114 **	-1.098 ***	1	⇐
afgoi	dinsor	-0.194 ***	-1.032 ***	1	⇔
afgoi	dolo		-1.340 ***	1	⇒
afgoi	elder	-0.123 *	-1.169 ***	1	⇒
afgoi	jilib	-0.255 ***	-1.042 ***	1	⇐
afgoi	kismayo	-0.157 **	-1.095 ***	1	⇔
afgoi	mogadishu bakara		-0.630 ***	1	⇒
afgoi	qansahdere		-1.149 ***	2	⇔
afgoi	wanle weyne	-0.362 ***	-1.014 ***	1	⇐
afmadow	abudwak	-0.113 **	-1.429 ***	2	⇒
afmadow	adanyabal	-0.072 *	-1.062 **	2	⇐
afmadow	afgoi	-0.228 ***	-0.882 ***	2	⇐
afmadow	baidoa	-0.513 ***	-0.888 ***	2	⇔
afmadow	bardera	-0.540 ***	-1.095 ***	2	⇔
afmadow	belet hawa	-0.250 ***	-0.792 ***	2	⇔
afmadow	belet wein	-0.248 ***	-1.056 ***	2	⇐
afmadow	buale	-0.350 ***	-0.951 ***	1	⇐
afmadow	dinsor	-0.414 ***	-0.930 ***	1	⇐
afmadow	doblei		-1.142 ***	2	⇔
afmadow	dolo	-0.283 ***	-1.127 ***	1	⇐
afmadow	dusamared		-1.217 ***	2	⇒
afmadow	elbarde		-1.487 ***	2	⇒
afmadow	el der	-0.284 ***	-1.039 ***	2	⇔
afmadow	elwak	-0.205 ***	-1.369 ***	2	⇔
afmadow	galkayo	-0.315 ***	-0.982 ***	2	⇐
afmadow	garowe	-0.269 ***	-1.112 ***	2	⇔
afmadow	hagar	-0.190 **	-1.095 ***	2	⇐
afmadow	harahdere	-0.222 ***	-0.766 ***	1	⇔

cont.

Table A.7: Coefficients of bivariate cointegration and direction of causality – Red rice *Continued*

cont.

Independent variable (J)	Dependent variable (I)	α_3	θ_2	λ	direction of causality
afmadow	hudur	-0.414 ***	-1.233 ***	2	⟺
afmadow	jamaame	-0.408 ***	-0.904 ***	1	⟸
afmadow	jilib	-0.306 ***	-0.950 ***	1	⟸
afmadow	jowhar	-0.302 ***	-0.929 ***	1	⟸
afmadow	kismayo	-0.225 ***	-0.992 ***	1	⟸
afmadow	lugh	-0.267 ***	-1.081 ***	2	⟺
afmadow	merka	-0.289 ***	-0.858 ***	2	⟸
afmadow	qansahdere	-0.355 ***	-0.976 ***	2	⟺
afmadow	qorioley	-0.357 ***	-0.888 ***	2	⟺
afmadow	wanle weyne	-0.377 ***	-0.906 ***	1	⟺
baidoa	abudwaq		-1.668 ***	2	⟺
baidoa	afgoi		-0.983 ***	1	⟺
baidoa	bardera	-0.271 ***	-1.213 ***	1	⟺
baidoa	belethawa		-0.915 ***	2	⟹
baidoa	beletwein	-0.159 ***	-1.243 ***	1	⟸
baidoa	buale	-0.183 ***	-1.031 ***	1	⟹
baidoa	dinsor	-0.224 **	-1.030 ***	1	⟺
baidoa	dolo		-1.260 ***	1	⟹
baidoa	el der		-1.173 ***	1	⟹
baidoa	el wak		-1.672 ***	1	⟹
baidoa	galkayo	-0.159 **	-1.099 ***	1	⟹
baidoa	haradhere	-0.170 ***	-0.876 ***	1	⟺
baidoa	jamaame	-0.214 ***	-0.999 ***	1	⟺
baidoa	jilib	-0.172 ***	-1.042 ***	1	⟺
baidoa	jowhar	0.173 **	-1.035 ***	1	⟺
baidoa	kismayo	-0.081 *	-1.144 ***	1	⟹
baidoa	lugh	-0.167 ***	-1.244 ***	1	⟺
baidoa	merka		-1.155 ***	3	⟺
baidoa	qansahdere	-0.167 **	-1.108 ***	1	⟹
baidoa	qorioley	-0.194 ***	-0.988 ***	1	⟺
baidoa	wanle weyne	-0.260 **	-0.997 ***	1	⟺
bardera	abudwaq		-1.180 ***	1	⟹
bardera	afgoi	-0.139 **	-0.818 ***	1	⟹
bardera	baidoa	-0.371 ***	-0.824 ***	1	⟺
bardera	belet hawa	-0.114 **	-0.801 ***	1	⟹
bardera	beletwein	-0.188 ***	-1.018 ***	1	⟸
bardera	buale	-0.318 ***	-0.849 ***	1	⟺
bardera	dinsor	-0.318 ***	-0.849 ***	2	⟺
bardera	doblei		-1.036 ***	1	⟹
bardera	dolo		-1.052 ***	1	⟹
bardera	dusamared		-1.156 ***	2	⟹
bardera	el barde		-1.525 ***	1	⟹
bardera	el der	-0.123 *	-0.968 ***	1	⟹
bardera	el wak		-1.362 ***	1	⟹
bardera	galkayo	-0.222 ***	-0.901 ***	1	⟺
bardera	garowe	-0.237 ***	-1.037 ***	3	⟺
bardera	hagar		-1.013 ***	1	⟹
bardera	haradhere	-0.185 ***	-0.747 ***	2	⟸
bardera	hudur	-0.160 **	-1.104 ***	1	⟹
bardera	jamaame	-0.296 ***	-0.826 ***	1	⟺
bardera	jowhar	-0.273 ***	-0.874 ***	1	⟺
bardera	jilib	-0.184 **	-0.851 ***	1	⟺
bardera	kismayo	-0.183 **	-0.903 ***	2	⟺
bardera	lugh	-0.115 *	-1.014 ***	1	⟹
bardera	merka	-0.216 ***	-0.821 ***	2	⟺
bardera	mogadishu bakara		-0.363 ***	2	⟹
bardera	qansahdere		-0.913 ***	1	⟹
bardera	qorioley	-0.261 ***	-0.825 ***	2	⟺
bardera	wanle weyne	-0.380 ***	-0.832 ***	1	⟺
belet hawa	afmadow	-0.168 ***	-1.262 ***	2	⟺
belet hawa	bardera	-0.223 ***	-1.247 ***	1	⟸
belet hawa	belet wein	-0.105 **	-1.545 ***	2	⟸
belet hawa	buale	-0.219 ***	-1.115 ***	2	⟸
belet hawa	dinsor	-0.161 ***	-1.203 ***	2	⟸
belet hawa	dolo		-1.253 ***	1	⟹
belet hawa	el wak		-1.707 ***	2	⟹
belet hawa	galkayo	-0.084 *	-1.378 ***	3	⟸
belet hawa	hagar	-0.140 **	-1.473 ***	2	⟸
belet hawa	qansahdere	-0.156 **	-1.297 ***	2	⟸
beletwein	abudwaq		-1.226 ***	1	⟹
beletwein	afgoi		-0.820 ***	1	⟹
beletwein	afmadow		-0.947 ***	2	⟹
beletwein	baidoa	-0.101 *	-0.804 ***	1	⟹
beletwein	bardera	-0.111 **	-0.981 ***	1	⟹
beletwein	belet hawa		-0.647 ***	2	⟹
beletwein	buale	-0.089 *	-0.888 ***	1	⟹
beletwein	dinsor	-0.138 **	-0.843 ***	1	⟺
beletwein	doblei		-1.103 ***	1	⟹

cont.

Table A.7: Coefficients of bivariate cointegration and direction of causality – Red rice *Continued*

cont.

Independent variable (J)	Dependent variable (I)	α_3	θ_2	λ	direction of causality
beletwein	dolo	-0.085 *	-1.059 ***	1	⇒
beletwein	dusamared		-1.244 ***	2	⇒
beletwein	el barde	0.060 *	-2.013 ***	3	⇔
beletwein	el der		-0.965 ***	1	⇒
beletwein	el wak		-1.450 ***	1	⇒
beletwein	galkayo	-0.160 *	-0.897 ***	1	⇔
beletwein	hagar		-1.100 ***	1	⇒
beletwein	haradhere	-0.100 **	-0.676 ***	1	⇒
beletwein	hudur		-1.052 ***	2	⇒
beletwein	jamaame	-0.124 **	-0.815 ***	1	⇒
beletwein	jilib	-0.160 ***	-0.855 ***	1	⇔
beletwein	jowhar	-0.173 **	-0.850 ***	1	⇔
beletwein	kismayo	-0.145 **	-0.908 ***	1	⇔
beletwein	lugh		-1.024 ***	1	⇒
beletwein	merka	-0.217 ***	-0.802 ***	1	⇔
beletwein	mogadishu bakara		-0.486 ***	1	⇒
beletwein	qansahdere		-0.925 ***	1	⇒
beletwein	qorioley	-0.152 *	-0.812 ***	1	⇒
beletwein	wanle weyne	-0.226 **	-0.821 ***	2	⇔
boroma	bosasso		-4.040 ***	2	⇐
boroma	hargeisa	-0.261 **	-1.004 ***	1	⇐
boroma	togwajiale	-0.297 ***	-0.897 ***	1	⇐
boroma	zeilac lawayacado	-0.187 **	-1.050 ***	1	⇐
bosasso	elder		-1.059 ***	1	⇔
bosasso	erigavo		-0.291 *	1	⇒
bosasso	galkayo	-0.199 **	-0.904 ***	2	⇔
bosasso	togwajiale		-0.229 *	1	⇒
bosasso	zeilac lawayacado	-0.080 **	-0.242 *	2	⇒
buale	abudwak		-1.564 ***	2	⇒
buale	afgoi	-0.264 ***	-0.910 ***	1	⇒
buale	afmadow	-0.284 **	-1.051 ***	1	⇒
buale	baidoa	-0.615 ***	-0.969 ***	1	⇐
buale	bardera	-0.442 ***	-1.160 ***	1	⇔
buale	belethawa	-0.170 *	-0.896 ***	2	⇒
buale	belet wein	-0.317 ***	-1.125 ***	1	⇐
buale	dinsor	-0.508 ***	-0.982 ***	1	⇔
buale	dolo	-0.249 ***	-1.180 ***	1	⇒
buale	dusamared		-1.281 **	3	⇒
buale	el der	-0.255 ***	-1.090 ***	1	⇒
buale	el wak	-0.167 ***	-1.512 ***	1	⇒
buale	galkayo	-0.292 ***	-1.012 ***	2	⇐
buale	hagar	-0.236 **	-1.154 ***	1	⇒
buale	haradhere	-0.246 **	-0.888 ***	2	⇔
buale	jamaame	-0.475 ***	-0.933 ***	1	⇐
buale	jilib	-0.362 ***	-0.972 ***	1	⇐
buale	jowhar	-0.386 ***	-0.957 ***	1	⇐
buale	lugh	-0.285 ***	-1.163 ***	1	⇔
buale	merka	-0.269 **	-0.953 ***	2	⇐
buale	qansahdere	-0.370 ***	-1.053 ***	1	⇔
buale	qoriley	-0.414 ***	-0.931 ***	1	⇐
buale	wanle weyne	-0.500 ***	-0.968 ***	1	⇐
dinsor	abudwaq	-0.086 *	-1.497 ***	2	⇔
dinsor	afgoi	-0.142 **	-0.968 ***	1	⇔
dinsor	baidoa	-0.305 ***	-0.970 ***	1	⇔
dinsor	bardera	-0.273 ***	-1.178 ***	1	⇔
dinsor	belet hawa	-0.120 **	-0.831 ***	2	⇒
dinsor	belet wein	-0.220 ***	-1.186 ***	1	⇔
dinsor	buale	-0.218 **	-1.017 ***	1	⇔
dinsor	dolo		-1.250 ***	1	⇒
dinsor	el der		-1.147 ***	1	⇒
dinsor	galkayo	-0.256 ***	-1.068 ***	1	⇔
dinsor	hagar		-1.209 ***	1	⇒
dinsor	haradhere	-0.184 ***	-0.845 ***	1	⇔
dinsor	jamaame	-0.303 ***	-0.970 ***	1	⇔
dinsor	jilib	-0.269 ***	-1.012 ***	1	⇔
dinsor	jowhar	-0.204 **	-1.005 ***	1	⇔
dinsor	kismayo	-0.158 **	-1.079 ***	1	⇔
dinsor	lugh	-0.149 **	-1.203 ***	1	⇔
dinsor	merka	-0.290 ***	-0.950 ***	1	⇔
dinsor	mogadishu bakara		-0.541 **	1	⇒
dinsor	qansahdere	-0.148 **	-1.073 ***	1	⇒
dinsor	qorioley	-0.360 ***	-0.962 ***	2	⇔
dinsor	wanle weyne	-0.414 ***	-0.994 ***	1	⇐
doblei	adanyabal	-0.175 ***	-0.830 **	2	⇐
doblei	afgoi	-0.329 ***	-0.768 ***	1	⇐
doblei	baidoa	-0.364 ***	-0.781 ***	1	⇐
doblei	bardera	-0.440 ***	-0.965 ***	1	⇐

cont.

Table A.7: Coefficients of bivariate cointegration and direction of causality – Red rice *Continued*

cont.

Independent variable (J)	Dependent variable (I)	α_3	θ_2	λ	direction of causality
doblei	belethawa	-0.322 ***	-0.695 ***	2	⇐
doblei	beletwein	-0.300 ***	-0.906 ***	1	⇐
doblei	buale	-0.295 ***	-0.844 ***	1	⇐
doblei	dinsor	-0.395 ***	-0.793 ***	1	⇐
doblei	dolo	-0.321 ***	-0.975 ***	1	⇐
doblei	el barde	-0.230 ***	-1.300 ***	1	⇐
doblei	el der	-0.357 ***	-0.910 ***	1	⇐
doblei	el wak	-0.157 **	-1.293 ***	1	⇒
doblei	galkayo	-0.361 ***	-0.830 ***	1	⇐
doblei	garowe	-0.295 ***	-0.889 ***	1	⇐
doblei	hagar	-0.299 ***	-0.962 ***	1	⇐
doblei	haradhere	-0.293 ***	-0.656 ***	1	⇐
doblei	hudur	-0.477 ***	-1.105 ***	1	⇐
doblei	lugh	-0.328 ***	-0.972 ***	1	⇐
doblei	qorioley	-0.385 ***	-0.770 ***	1	⇐
doblei	wanle weyne	-0.397 ***	-0.767 ***	1	⇐
dolo	abudwak	-0.093 *	-1.159 ***	1	⇒
dolo	afgoi	-0.187 **	-0.746 ***	1	⇐
dolo	bardera	-0.259 ***	-0.950 ***	1	⇐
dolo	belet hawa	-0.246 ***	-0.798 ***	1	⇐
dolo	belet wein	-0.190 **	-0.944 ***	1	⇐
dolo	buale	-0.186 ***	-0.847 ***	1	⇐
dolo	dinsor	-0.256 ***	-0.799 ***	1	⇐
	doblei		-1.025 ***	1	⇒
dolo	el der	-0.202 **	-0.908 ***	1	⇐
dolo	el wak		-1.406 ***	1	⇒
dolo	galkayo	-0.158 **	-0.855 ***	2	⇔
dolo	jilib	-0.217 **	-0.802 ***	2	⇔
dolo	jowhar	-0.214 ***	-0.774 ***	1	⇐
dolo	kismayo	-0.157 **	-0.866 ***	1	⇒
dolo	merka	-0.216 ***	-0.730 ***	1	⇐
dolo	qansahdere	-0.250 ***	-0.881 ***	1	⇐
dolo	qorioley	-0.219 ***	-0.744 ***	1	⇐
dolo	wanle weyne	-0.248 ***	-0.775 ***	1	⇐
dusamared	el barde	-0.092 **	-1.212 ***	1	⇔
dusamared	erigavo	-0.108 **	-0.328 ***	1	⇐
dusamared	lasanod	-0.173 ***	-0.355 ***	2	⇔
el barde	abudwak	-0.139 **	-1.000 ***	2	⇐
el barde	adanyabal	-0.138 **	-0.889 ***	1	⇒
el barde	afgoi	-0.198 ***	-0.555 ***	1	⇐
el barde	bardera	-0.164 ***	-0.655 ***	1	⇐
el barde	belet wein	-0.174 **	-0.496 ***	3	⇔
el barde	dinsor	-0.178 ***	-0.550 ***	1	⇐
el barde	doblei	-0.111 **	-0.769 ***	1	⇒
el barde	dusamared	-0.240 ***	-0.825 ***	1	⇔
el barde	el der	-0.225 ***	-0.670 ***	1	⇔
el barde	el wak	-0.089 **	-1.064 ***	1	⇒
el barde	galkayo	-0.235 ***	-0.621 ***	2	⇔
el barde	garowe	-0.117 **	-0.881 ***	3	⇐
el barde	hargeisa	-0.208 ***	-0.283 ***	1	⇐
el barde	hudur	-0.211 ***	-0.712 ***	1	⇐
el barde	jamaame	-0.184 ***	-0.536 ***	1	⇐
el barde	jilib	-0.170 **	-0.601 ***	1	⇐
el barde	jowhar	-0.226 ***	-0.559 ***	1	⇐
el barde	kismayo	-0.246 ***	-0.642 ***	1	⇐
el barde	lugh	-0.167 ***	-0.740 ***	1	⇐
el barde	merka	-0.281 ***	-0.548 ***	1	⇐
el barde	qorioley	-0.245 ***	-0.543 ***	1	⇔
el barde	wanle weyne	-0.246 ***	-0.498 ***	2	⇔
el barde	zeilac lawayacado	-0.216 ***	-0.302 ***	1	⇐
elder	abudwaq	-0.054 ***	-1.393 ***	2	⇔
elder	afgoi	-0.295 ***	-0.855 ***	1	⇐
elder	baidoa	-0.182 ***	-0.852 ***	1	⇐
elder	bardera	-0.239 ***	-1.033 ***	1	⇐
elder	belet wein	-0.296 ***	-1.035 ***	1	⇐
elder	buale	-0.175 ***	-0.917 ***	1	⇐
elder	bosasso	-0.138 **	-1.064 ***	2	⇔
elder	dinsor	-0.271 ***	-0.871 ***	1	⇐
elder	doblei		-1.098 ***	1	⇒
elder	dolo	-0.101 *	-1.101 ***	1	⇒
elder	el wak		-1.438 ***	1	⇒
elder	erigavo		-0.338 **	1	⇒
elder	galkayo	-0.223 **	-0.972 ***	3	⇔
elder	garowe	-0.080 **	-1.036 ***	1	⇒
elder	hagar	-0.103 **	-1.062 ***	1	⇒
elder	harahdere	-0.141 **	-0.729 ***	1	⇐
elder	hargeisa		-0.297 **	2	⇐
elder	jamaame	-0.202 ***	-0.846 ***	1	⇐

cont.

Table A.7: Coefficients of bivariate cointegration and direction of causality – Red rice *Continued*

cont.

Independent variable (J)	Dependent variable (I)	α_3	θ_2	λ	direction of causality
elder	jilib	-0.206 ***	-0.880 ***	1	⟺
elder	jowhar	-0.358 ***	-0.877 ***	1	⟸
elder	kismayo	-0.192 **	-0.936 ***	1	⟺
elder	lasanod		-0.380 **	1	⟹
elder	lugh	-0.132 **	-1.067 ***	1	⟸
elder	merka	-0.430 ***	-0.820 ***	1	⟸
elder	qansahdere	-0.235 ***	-0.941 ***	1	⟸
elder	qorioley	-0.331 ***	-0.855 ***	2	⟸
elder	togwajiale		-0.287 ***	1	⟹
elder	wanle weyne	-0.462 ***	-0.861 ***	1	⟸
el wak	abudwaq	-0.306 ***	-0.974 ***	2	⟺
el wak	afgoi	-0.441 ***	-0.588 ***	1	⟸
el wak	bardera	-0.514 ***	-0.734 ***	1	⟸
el wak	belethawa	-0.374 ***	-0.585 ***	2	⟸
el wak	belet wein	-0.394 ***	-0.689 ***	1	⟸
el wak	buale	-0.474 ***	-0.661 ***	1	⟸
el wak	dinsor	-0.521 ***	-0.621 ***	1	⟸
el wak	doblei	-0.469 ***	-0.773 ***	1	⟸
el wak	dolo	-0.423 ***	-0.711 ***	1	⟸
el wak	el barde	-0.317 ***	-0.939 ***	1	⟸
el wak	el der	-0.478 ***	-0.695 ***	1	⟸
el wak	galkayo	-0.400 ***	-0.685 ***	2	⟸
el wak	garowe	-0.407 ***	-0.680 ***	1	⟸
el wak	hagar	-0.393 ***	-0.744 ***	1	⟺
el wak	haradhere	-0.356 ***	-0.562 ***	2	⟸
el wak	hudur	-0.545 ***	-0.850 ***	1	⟸
el wak	jamaame	-0.549 ***	-0.604 ***	1	⟸
el wak	jilib	-0.606 ***	-0.644 ***	1	⟸
el wak	jowhar	-0.486 ***	-0.614 ***	1	⟸
el wak	kismayo	-0.429 ***	-0.646 ***	1	⟸
el wak	lugh	-0.469 ***	-0.746 ***	1	⟸
el wak	merka	-0.503 ***	-0.574 ***	1	⟸
el wak	qansahdere	-0.514 ***	-0.675 ***	1	⟸
el wak	qorioley	-0.449 ***	-0.623 ***	2	⟸
el wak	wanle weyne	-0.535 ***	-0.626 ***	1	⟸
erigavo	bosasso	-0.031 *	-3.432 **	1	⟸
erigavo	dusamared	-0.080 **	-3.040 ***	1	⟹
erigavo	el der	-0.061 **	-2.953 ***	1	⟸
erigavo	togwajiale	-0.351 ***	-0.935 ***	1	⟸
erigavo	zeilac lawayacado	-0.137 **	-1.088 ***	1	⟺
galkayo	abudwak		-1.341 ***	1	⟹
galkayo	afgoi	-0.139 **	-0.910 ***	1	⟹
galkayo	baidoa	-0.173 ***	-0.909 ***	1	⟸
galkayo	bardera		-1.109 ***	1	⟺
galkayo	belet hawa	-0.150 **	-0.725 ***	3	⟹
galkayo	beletwein	-0.205 **	-1.114 ***	1	⟺
galkayo	buale	-0.119 **	-0.987 ***	1	⟹
galkayo	dinsor	-0.159 **	0.936 ***	1	⟺
galkayo	doblei		-1.204 ***	1	⟹
galkayo	dolo	0.142 **	-1.169 ***	2	⟺
galkayo	el barde		-1.609 ***	2	⟺
galkayo	el der	-0.261 ***	-1.028 ***	3	⟺
galkayo	el wak		-1.458 ***	2	⟹
galkayo	hagar	-0.067 *	-1.194 ***	1	⟹
galkayo	haradhere	-0.206 ***	-0.803 ***	1	⟺
galkayo	hudur	-0.153 **	-1.195 ***	2	⟺
galkayo	jamaame	-0.166 **	-0.892 ***	2	⟺
galkayo	jilib	-0.187 ***	-0.940 ***	1	⟺
galkayo	jowhar	-0.195 ***	-0.946 ***	1	⟺
galkayo	kismayo	-0.233 ***	-0.917 ***	3	⟺
galkayo	lugh	-0.149 **	-1.130 ***	1	⟺
galkayo	merka	-0.247 ***	-0.896 ***	2	⟺
galkayo	qorioley	-0.341 ***	-0.873 ***	3	⟺
galkayo	togwajiale	-0.056	-0.263 **	1	⟹
galkayo	wanle weyne	-0.299 ***	-0.917 ***	2	⟺
garowe	bardera	-0.336 ***	-0.964 ***	3	⟺
garowe	doblei		-1.124 ***	1	⟹
garowe	el wak		-1.468 ***	1	⟹
garowe	galkayo	-0.231 ***	-0.792 ***	2	⟸
garowe	hudur	-0.230 ***	-1.126 ***	1	⟺
garowe	lasanod	-0.120 ***	-0.120	2	⟸
hagar	abudwak	-0.168 ***	-1.147 ***	1	⟹
hagar	afgoi	-0.232 ***	-0.755 ***	1	⟸
hagar	bardera	-0.422 ***	-0.986 ***	1	⟸
hagar	belet hawa	-0.207 **	-0.678 ***	2	⟹
hagar	belet wein	-0.225 ***	-0.909 ***	1	⟸
hagar	buale	-0.348 ***	-0.866 ***	1	⟸

cont.

Table A.7: Coefficients of bivariate cointegration and direction of causality – Red rice *Continued*

cont.

Independent variable (J)	Dependent variable (I)	α_3	θ_2	λ	direction of causality
hagar	dinsor	-0.371 ***	-0.826 ***	1	⇐
hagar	doblei	-0.140 **	-1.039 ***	1	⇒
hagar	dusamared	-0.113 **	-0.943 **	3	⇒
hagar	el der	-0.277 ***	-0.941 ***	1	⇐
hagar	el wak	-0.204 ***	-1.344 ***	1	⇔
hagar	galkayo	-0.243 ***	-0.836 ***	1	⇐
hagar	garowe	-0.243 ***	-0.942 ***	1	⇔
hagar	harahdere	-0.207 ***	-0.637 ***	1	⇐
hagar	hudur	-0.383 ***	-1.106 ***	1	⇐
hagar	jamaame	-0.328 ***	-0.795 ***	1	⇐
hagar	jilib	-0.277 ***	-0.841 ***	1	⇐
hagar	jowhar	-0.300 ***	-0.797 ***	1	⇐
hagar	kismayo	-0.219 ***	-0.845 ***	1	⇐
hagar	lugh	-0.272 ***	-1.011 ***	1	⇔
hagar	merka	-0.308 ***	-0.747 ***	1	⇐
hagar	qansahdere	-0.352 ***	-0.910 ***	1	⇔
hagar	qoriley	-0.322 ***	-0.780 ***	1	⇐
hagar	wanle weyne	-0.348 ***	-0.798 ***	1	⇐
haradhere	abudwaq		-1.810 ***	1	⇒
haradhere	baidoa	-0.114 **	-1.140 ***	1	⇔
haradhere	bardera	-0.098 **	-1.337 ***	2	⇒
haradhere	beletwein	-0.075 **	-1.478 ***	1	⇐
haradhere	buale	-0.100 **	-1.125 ***	2	⇔
haradhere	dinsor	-0.099 **	-1.183 ***	1	⇔
haradhere	el der	-0.075 *	-1.370 ***	1	⇒
haradhere	galkayo	-0.085 *	-1.245 ***	1	⇔
haradhere	jamaame		-1.116 ***	1	⇒
haradhere	jilib		-1.165 ***	1	⇒
haradhere	kismayo		-1.263 ***	1	⇒
haradhere	lugh		-1.430 ***	1	⇒
haradhere	merka	-0.086 **	-1.150 ***	2	⇐
haradhere	qansahdere	-0.073 **	-1.337 ***	1	⇒
haradhere	qorioley	-0.088 *	-1.118 ***	1	⇒
haradhere	wanle weyne	-0.157 **	-1.115 ***	3	⇔
hargeisa	boroma	-0.233 **	-0.995 ***	1	⇒
hargeisa	el der	-0.041 *	-3.361 ***	2	⇒
hargeisa	galkayo	-0.055 **	-2.902 ***	2	⇐
hargeisa	haradhere	-0.065 ***	-1.896 ***	1	⇐
hargeisa	lasanod	-0.140 **	-1.165 ***	2	⇒
hargeisa	togwajiale	-0.455 ***	-0.901 ***	1	⇐
hargeisa	zeilac lawayacado	-0.128 **	-1.044 ***	1	⇒
hudur	bardera	-0.280 ***	-0.905 ***	1	⇐
hudur	doblei	-0.083 *	-0.904 ***	1	⇒
hudur	el wak		-1.175 ***	1	⇒
hudur	galkayo	-0.198 ***	-0.836 ***	2	⇔
hudur	garowe	-0.157 ***	-0.887 ***	1	⇔
hudur	hagar	-0.072	-0.903 ***	1	⇒
jamaame	abudwaq		-1.505 ***	1	⇒
jamaame	belet wein	-0.236 ***	-1.225 ***	1	⇐
jamaame	buale		-1.071 ***	1	⇒
jamaame	el der	-0.132 **	-1.181 ***	1	⇒
jamaame	galkayo	-0.295 ***	-1.120 ***	2	⇔
jamaame	haradhere	-0.225 ***	-0.895 ***	1	⇐
jamaame	jilib	-0.351 ***	-1.049 ***	1	⇐
jamaame	jowhar	-0.238 ***	-1.042 ***	1	⇔
jamaame	kismayo		-1.121 ***	1	⇒
jamaame	merka	-0.362 ***	-0.983 ***	2	⇔
jamaame	mogadishu bakara	-0.037	-0.577 ***	1	⇒
jamaame	qorioley	-0.329 ***	-1.005 ***	1	⇔
jamaame	wanle weyne	-0.292 **	-1.029 ***	1	⇔
jilib	abudwaq	-0.112 **	-1.405 ***	1	⇒
jilib	afgoi	-0.200 **	-0.959 ***	1	⇒
jilib	bardera	-0.200 ***	-1.143 ***	1	⇔
jilib	belet wein	-0.316 ***	-1.169 ***	1	⇔
jilib	buale	-0.148 **	-1.028 ***	1	⇒
jilib	dolo	-0.183 **	-1.247 ***	2	⇔
jilib	el der	-0.227 ***	-1.135 ***	1	⇒
jilib	el wak		-1.551 ***	1	⇒
jilib	galkayo	-0.355 ***	-1.062 ***	1	⇔
jilib	haradhere	-0.302 ***	-0.858 ***	1	⇐
jilib	jamaame	-0.205 **	-0.952 ***	1	⇒
jilib	jowhar	-0.297 ***	-1.001 ***	1	⇔
jilib	kismayo	-0.184 **	-1.063 ***	1	⇒
jilib	lugh	-0.231 ***	-1.190 ***	1	⇔
jilib	merka	-0.380 ***	-0.940 ***	1	⇔
jilib	mogadishu bakara		-0.534 ***	1	⇒
jilib	qansahdere	-0.209 ***	-1.065 ***	1	⇔

cont.

Table A.7: Coefficients of bivariate cointegration and direction of causality – Red rice *Continued*

cont.

Independent variable (J)	Dependent variable (I)	α_3	θ_2	λ	direction of causality
jilib	qorioley	-0.370 ***	-0.965 ***	1	⟺
jilib	wanle weyne	-0.388 ***	-0.994 ***	1	⟺
jowhar	abudwaq		-1.550 **	2	⟹
jowhar	bardera	-0.155 ***	-1.174 ***	1	⟺
jowhar	belet wein	-0.201 ***	-1.176 ***	1	⟺
jowhar	buale		-1.044 ***	1	⟹
jowhar	dinsor	-0.194 ***	-0.994 ***	1	⟺
jowhar	dolo		-1.292 ***	1	⟹
jowhar	el der		-1.139 ***	1	⟹
jowhar	jamaame	-0.180 **	-0.958 ***	1	⟺
jowhar	jilib	-0.237 ***	-0.998 ***	1	⟺
jowhar	kismayo	-0.099 *	-1.075 ***	1	⟹
jowhar	lugh	-0.123 **	-1.205 ***	1	⟹
jowhar	merka	-0.364 ***	-0.936 ***	1	⟺
jowhar	qansahdere	-0.132 **	-1.068 ***	1	⟹
jowhar	qorioley	-0.385 ***	-0.961 ***	1	⟺
jowhar	wanle weyne	-0.377 ***	-0.987 ***	1	⟺
kismayo	abudwaq	-0.108 *	-1.322 ***	1	⟺
kismayo	afgoi	-0.263 ***	-0.912 ***	1	⟺
kismayo	afmadow	-0.140 *	-1.008 ***	1	⟹
kismayo	baidoa	-0.178 ***	-0.873 ***	1	⟸
kismayo	bardera	-0.228 ***	-1.106 ***	2	⟺
kismayo	belet wein	-0.350 ***	-1.101 ***	1	⟺
kismayo	dinsor	-0.235 ***	-0.926 ***	1	⟺
kismayo	dolo	-0.230 ***	-1.154 ***	1	⟸
kismayo	galkayo	-0.259 **	-1.089 ***	3	⟺
kismayo	haradhere	-0.230 ***	-0.791 ***	1	⟸
kismayo	jamaame	-0.300 ***	-0.891 ***	1	⟸
kismayo	jilib	-0.273 ***	-0.939 ***	1	⟸
kismayo	jowhar	-0.312 ***	-0.929 ***	1	⟸
kismayo	lugh	-0.206 ***	-1.131 ***	1	⟸
kismayo	merka	-0.441 ***	-0.881 ***	1	⟸
kismayo	mogadishu bakara	-0.079 *	-0.555 ***	1	⟹
kismayo	qansahdere	-0.166 **	-1.005 ***	1	⟹
kismayo	qorioley	-0.377 ***	-0.902 ***	1	⟺
kismayo	wanle weyne	-0.448 ***	-0.909 ***	2	⟺
lasanod	dusamared		-2.814 ***	2	⟺
lasanod	garowe		-8.272 ***	2	⟹
lasanod	zeilac lawayacado		-0.902 ***	1	⟹
lugh	abudwak	-0.201 ***	-1.154 ***	1	⟺
lugh	afgoi	-0.225 ***	-0.783 ***	1	⟸
lugh	afmadow	-0.199 **	-0.924 ***	2	⟺
lugh	baidoa	-0.359 ***	-0.803 ***	1	⟺
lugh	bardera	-0.421 ***	-0.986 ***	1	⟸
lugh	belet wein	-0.354 ***	-0.976 ***	1	⟸
lugh	buale	-0.238 ***	-0.859 ***	1	⟺
lugh	dinsor	-0.377 ***	-0.831 ***	1	⟺
lugh	doblei		-1.028 ***	1	⟹
lugh	el barde		-1.350 ***	1	⟹
lugh	el der	-0.241 ***	-0.937 ***	1	⟹
lugh	el wak		-1.339 ***	1	⟹
lugh	galkayo	-0.368 ***	-0.884 ***	1	⟺
lugh	hagar	-0.182 ***	-0.988 ***	1	⟺
lugh	haradhere	-0.276 ***	-0.699 ***	1	⟸
lugh	hudur	-0.260 ***	-1.071 ***	1	⟹
lugh	jamaame	-0.308 ***	-0.796 ***	1	⟺
lugh	jilib	-0.328 ***	-0.839 ***	1	⟺
lugh	jowhar	-0.313 ***	-0.829 ***	1	⟸
lugh	kismayo	-0.199 ***	-0.883 ***	1	⟹
lugh	merka	-0.377 ***	-0.784 ***	1	⟺
lugh	qansahdere	-0.408 ***	-0.895 ***	1	⟸
lugh	qorioley	-0.374 ***	-0.797 ***	1	⟸
lugh	wanle weyne	-0.381 ***	-0.817 ***	1	⟸
merka	abudwak		-1.502 ***	1	⟹
merka	afgoi		-1.031 ***	1	⟺
merka	afmadow		-1.165 ***	2	⟹
merka	baidoa	-0.133 **	-0.865 ***	3	⟺
merka	bardera	-0.119 *	-1.217 ***	2	⟺
merka	belet wein	-0.237 ***	-1.246 ***	1	⟺
merka	buale		-1.048 ***	2	⟹
merka	dinsor	-0.119 *	-1.052 ***	1	⟺
merka	dolo		-1.369 ***	1	⟹
merka	el der		-1.219 ***	1	⟹
merka	el wak		-1.740 ***	1	⟹
merka	galkayo	-0.251 ***	-1.114 ***	2	⟺
merka	haradhere	-0.139 **	-0.869 ***	2	⟹
merka	jamaame		-1.003 ***	2	⟺

cont.

Table A.7: Coefficients of bivariate cointegration and direction of causality – Red rice *Continued*

cont.

Independent variable (J)	Dependent variable (I)	α_3	θ_2	λ	direction of causality
merka	jilib	-0.167 ***	-1.062 ***	1	⟺
merka	jowhar	-0.175 *	-1.067 ***	1	⟺
merka	kismayo		-1.134 ***	1	⟹
merka	lugh	-0.119 **	-1.274 ***	1	⟺
merka	mogadishu bakara		-0.620 ***	1	⟹
merka	qansahdere		-1.143 ***	1	⟹
merka	qorioley		-1.032 ***	1	⟺
merka	wanle weyne		-1.052 ***	1	⟹
mogadishu bakara	abudwaq		-4.342 ***	2	⟹
mogadishu bakara	afgoi	-1.105 **	-1.585 ***	1	⟹
mogadishu bakara	bardera	-0.039 **	-2.755 ***	2	⟸
mogadishu bakara	belet wein	-0.103 ***	-2.055 ***	1	⟸
mogadishu bakara	dinsor	-0.057 **	-1.846 ***	2	⟸
mogadishu bakara	jamaame	-0.074 **	-1.731 ***	1	⟸
mogadishu bakara	jilib	-0.088 ***	-1.869 ***	1	⟸
mogadishu bakara	kismayo	-0.099 ***	-1.800 ***	1	⟸
mogadishu bakara	merka	-0.108 ***	-1.611 ***	1	⟸
mogadishu bakara	wanle weyne	-0.142 ***	-1.402 ***	1	⟸
qansahdere	abudwaq	-0.115 **	-1.422 ***	2	⟺
qansahdere	afgoi	-0.206 **	-0.870 ***	2	⟺
qansahdere	afmadow	-0.214 ***	-1.024 ***	2	⟺
qansahdere	baidoa	-0.406 ***	-0.902 ***	1	⟸
qansahdere	bardera	-0.418 ***	-1.094 ***	1	⟸
qansahdere	belet hawa	-0.140 **	-0.771 ***	2	⟹
qansahdere	belet wein	-0.279 ***	-1.080 ***	1	⟸
qansahdere	buale	-0.307 ***	-0.949 ***	1	⟺
qansahdere	dinsor	-0.431 ***	-0.931 ***	1	⟸
qansahdere	dolo		-1.135 ***	1	⟹
qansahdere	el der	-0.181 **	-1.062 ***	1	⟹
qansahdere	el wak	-0.083 **	-1.481 ***	1	⟹
qansahdere	galkayo	-0.289 ***	-0.981 ***	1	⟺
qansahdere	hagar	-0.167 ***	-1.097 ***	1	⟺
qansahdere	haradhere	-0.183 ***	-0.747 ***	1	⟸
qansahdere	jamaame	0.334 ***	-0.895 ***	1	⟸
qansahdere	jilib	-0.310 ***	-0.938 ***	1	⟺
qansahdere	jowhar	-0.333 ***	-0.935 ***	1	⟸
qansahdere	kismayo	-0.248 ***	-0.994 ***	1	⟸
qansahdere	lugh	-0.181 **	-1.117 ***	1	⟹
qansahdere	merka	-0.406 ***	-0.874 ***	1	⟸
qansahdere	qorioley	-0.392 ***	-0.885 ***	1	⟸
qansahdere	wanle weyne	-0.430 ***	-0.899 ***	1	⟸
qorioley	abudwaq		-1.496 ***	1	⟸
qorioley	afmadow	-0.081 *	-1.125 ***	2	⟺
qorioley	baidoa	-0.119 **	-1.011 ***	1	⟺
qorioley	bardera		-1.210 ***	2	⟺
qorioley	belet hawa		-0.858 ***	2	⟹
qorioley	belet wein	-0.254 ***	-1.231 ***	1	⟸
qorioley	buale		-1.074 ***	1	⟹
qorioley	dinsor		-1.039 ***	2	⟺
qorioley	dolo		-1.343 ***	1	⟹
qorioley	el der		-1.168 ***	2	⟹
qorioley	galkayo	-0.181 **	-1.145 ***	3	⟺
qorioley	haradhere	-0.105 **	-0.894 ***	1	⟸
qorioley	jamaame	-0.179 **	-0.994 ***	1	⟺
qorioley	jilib	-0.209 ***	-1.036 ***	1	⟺
qorioley	jowhar	-0.186 *	-1.039 ***	1	⟺
qorioley	kismayo	-0.097 *	-1.108 ***	1	⟺
qorioley	lugh		-1.254 ***	1	⟹
qorioley	merka	-0.584 ***	-0.968 ***	1	⟺
qorioley	wanle weyne	-0.318 **	-1.020 ***	1	⟺
togwajiale	boroma		-1.114 ***	1	⟹
togwajiale	bosasso	-0.020 *	-4.369 ***	1	⟸
togwajiale	el der	-0.042 **	-3.476 ***	1	⟸
togwajiale	erigavo		-1.068 ***	1	⟹
togwajiale	galkayo	-0.028 **	-3.789 ***	1	⟸
togwajiale	hargeisa		-1.109 ***	1	⟹
togwajiale	zeilac lawayacado	-0.094 **	-1.175 ***	1	⟹
wanle weyne	abudwaq		-1.646 ***	2	⟺
wanle weyne	afgoi	-0.056 ***	-0.985 ***	1	⟹
wanle weyne	afmadow	-0.094 *	-1.102 ***	1	⟺
wanle weyne	baidoa	-0.195 **	-1.002 ***	1	⟺
wanle weyne	bardera	-0.147 **	-1.201 ***	1	⟺
wanle weyne	belet wein	-0.253 ***	-1.217 ***	2	⟺
wanle weyne	buale		-1.032 ***	1	⟹
wanle weyne	dinsor		-1.005 ***	1	⟹
wanle weyne	dolo	-0.079 *	-1.289 ***	1	⟹
wanle weyne	el der		-1.160 ***	1	⟹

cont.

Table A.7: Coefficients of bivariate cointegration and direction of causality – Red rice *Continued*

cont.

Independent variable (J)	Dependent variable (I)	α_3	θ_2	λ	direction of causality
wanle weyne	galkayo	-0.264 ***	-1.089 ***	2	⟺
wanle weyne	haradhere	-0.173 **	-0.897 ***	3	⟺
wanle weyne	jamaame	-0.191 **	-0.971 ***	1	⟺
wanle weyne	jilib	-0.246 ***	-1.005 ***	1	⟺
wanle weyne	jowhar	-0.224 **	-1.012 ***	1	⟺
wanle weyne	kismayo		-1.083 ***	1	⟺
wanle weyne	lugh		-1.222 ***	1	→
wanle weyne	merka	-0.454 ***	-0.950 ***	1	←
wanle weyne	mogadishu bakara		-0.713 ***	1	→
wanle weyne	qorioley	-0.370 **	-0.979 ***	1	⟺
zeilac lawayacado	boroma	-0.174 **	-0.952 ***	1	→
zeilac lawayacado	bosasso		-4.118 ***	2	←
zeilac lawayacado	erigavo	-0.218 ***	-0.918 ***	1	⟺
zeilac lawayacado	hargeisa	-0.169 **	-0.957 ***	1	←
zeilac lawayacado	lasanod	-0.231 ***	-1.108 ***	1	←

Note: ↔ identifies bidirectional causality; ← identifies unidirectional causality from I to J; → identifies undirectional causality from J to I.
Significance: *** = 0.01, ** = 0.05, * = 0.1. Only significant coefficient values are reported.
Data source: FSNAU

Table A.8: Granger causality – Red sorghum

Equation (Ref. market)	Excluded	χ^2	d.f.	Prob > χ^2
All zones				
Baidoa	Beletwein	7.1954	1	0.007
Baidoa	Jowhar	9.5854	1	0.002
Merka	Baidoa	4.6968	1	0.030
Merka	Beletwein	2.8175	1	0.093
Merka	Jowhar	10.9470	1	0.001
Merka	Wanle Weyne	2.9319	1	0.087
Merka	Galkayo	5.6245	1	0.018
Merka	Hargeisa	3.4506	1	0.063
Belet Wein	Jowhar	9.0580	1	0.003
Belet Wein	Kismayo	2.7328	1	0.098
Belet Wein	Wanle Weyne	6.7143	1	0.010
Jowhar	Baidoa	2.9906	1	0.084
Jowhar	Merka	7.6370	1	0.006
Jowhar	Wanle Weyne	5.9767	1	0.014
Jowhar	Hargeisa	4.5821	1	0.032
Kismayo	Merka	13.0280	1	0.000
Lugh	Baidoa	3.4581	1	0.063
Lugh	Beletwein	3.9575	1	0.047
Wanle Weyne	Baidoa	5.7338	1	0.017
Wanle Weyne	Merka	3.0594	1	0.080
Wanle Weyne	Beletwein	4.0344	1	0.045
Wanle Weyne	Jowhar	17.3110	1	0.000
Wanle Weyne	Galkayo	4.1701	1	0.041
Wanle Weyne	Haradhere	3.2102	1	0.073
Galkayo	Jowhar	4.3052	1	0.038
Galkayo	Haradhere	2.8084	1	0.094
Galkayo	Hargeisa	6.0581	1	0.014
Hara Dhere	Merka	6.4393	1	0.011
Bosasso	Merka	4.1610	1	0.041
Hargeisa	Baidoa	4.8538	1	0.028
Hargeisa	Beletwein	5.1199	1	0.024
Hargeisa	Jowhar	4.5029	1	0.034
Hargeisa	Wanle Weyne	5.8387	1	0.016
Southern zone				
Merka	Beletwein	10.3620	1	0.001
Merka	Adanyabal	3.4958	1	0.062
Merka	Hudur	4.1268	1	0.042
Merka	Jowhar	13.3450	1	0.000
Merka	Qansah Dere	3.0208	1	0.082
Merka	Qorioley	3.7174	1	0.054
Merka	Wanle Weyne	13.4840	1	0.000
Baidoa	Kismayo	3.1264	1	0.077
Baidoa	Beletwein	12.1750	1	0.000
Baidoa	Adanyabal	12.4970	1	0.000
Baidoa	Hudur	5.9381	1	0.015
Baidoa	Jowhar	3.6966	1	0.055
Baidoa	Mogadishu	3.3469	1	0.067
Baidoa	Qorioley	3.0676	1	0.080
Baidoa	Wanle Weyne	2.8323	1	0.092
Kismayo	Merka	6.1570	1	0.013
Belet Wein	Kismayo	3.0896	1	0.079
Belet Wein	Adanyabal	8.6739	1	0.003
Belet Wein	Hudur	18.3610	1	0.000
Belet Wein	Jowhar	8.3389	1	0.004
Belet Wein	Wanle Weyne	9.2317	1	0.002
Adanyabal	Hudur	2.9210	1	0.087
Hudur	Baidoa	6.1433	1	0.013
Hudur	Wanle Weyne	7.6997	1	0.006
Jowhar	Merka	10.3210	1	0.001
Jowhar	Adanyabal	18.4460	1	0.000
Jowhar	Hudur	5.2441	1	0.022
Jowhar	Wanle Weyne	6.4961	1	0.011
Mogadishu	Baidoa	3.6077	1	0.058
Mogadishu	Beletwein	3.8815	1	0.049
Qansahdere	Baidoa	4.8259	1	0.028
Qansahdere	Beletwein	5.4731	1	0.019
Qansahdere	Adanyabal	5.7180	1	0.017
Qansahdere	Hudur	4.5775	1	0.032
Qansahdere	Wanle Weyne	7.5205	1	0.006
Qorioley	Merka	6.1941	1	0.013
Qorioley	Adanyabal	7.8034	1	0.005
Qorioley	Jowhar	3.4391	1	0.064
Wanle Weyne	Baidoa	3.1099	1	0.078
Wanle Weyne	Beletwein	3.5475	1	0.060
Wanle Weyne	Jowhar	20.2510	1	0.000
Wanle Weyne	Qansah Dere	7.1725	1	0.007

cont.

Table A.8: Granger causality – Red sorghum *continued*

Equation (Ref. market)	Excluded	χ^2	d.f.	Prob > χ^2
Central zone				
Galkayo	Dusamared	2.8322	1	0.092
Galkayo	El Der	6.1057	1	0.013
Hara Dhere	Dusamared	5.3270	1	0.021
Abudwak	El Der	11.0420	1	0.001
Dusamared	Abudwak	7.4658	1	0.006
El Der	Hara Dhere	4.7555	1	0.029
Garowe	Galkayo	11.3960	1	0.001
Northern zone				
Bosasso	Hargeisa	27.5410	2	0.000
Bosasso	Erigavo	13.0570	2	0.001
Bosasso	Togwajiale	13.1230	2	0.001
Hargeisa	Boroma	11.6760	2	0.003
Erigavo	Boroma	7.8363	2	0.020
Boroma	Erigavo	16.1870	2	0.000
Boroma	Togwajiale	10.8840	2	0.004
Togwajiale	Hargeisa	4.6426	2	0.098
Togwajiale	Boroma	5.8176	2	0.055
Zeilac L.	Boroma	7.7039	2	0.021

Data source: FSNAU

Table A.9: Granger causality – Red rice

Equation (Ref. market)	Excluded	χ^2	d.f.	Prob > χ^2
All zones				
Merka	Beletwein	3.7639	1	0.052
Merka	Hargeisa	3.8678	1	0.049
Baidoa	Hara Dhere	4.1541	1	0.042
Baidoa	Hargeisa	13.0430	1	0.000
Belet Wein	Hargeisa	2.9734	1	0.085
Galkayo	Bosasso	7.3957	1	0.007
Galkayo	Hara Dhere	8.3415	1	0.004
Bosasso	Jowhar	2.7098	1	0.100
Jowhar	Merka	5.8770	1	0.015
Kismayo	Merka	5.8268	1	0.016
Lugh	Beletwein	3.6784	1	0.055
Lugh	Bosasso	5.2716	1	0.022
Lugh	Hara Dhere	2.7681	1	0.096
Wanle Weyne	Merka	11.4370	1	0.001
Wanle Weyne	Baidoa	2.9338	1	0.087
Wanle Weyne	Beletwein	4.5105	1	0.034
Wanle Weyne	Hara Dhere	9.9953	1	0.002
Hargeisa	Baidoa	6.2761	1	0.012
Hargeisa	Beletwein	5.5471	1	0.019
Hargeisa	Hara Dhere	4.9699	1	0.026
Southern zone				
Merka	Beletwein	7.7677	1	0.005
Baidoa	Merka	8.0428	1	0.005
Baidoa	Adanyabal	4.5089	1	0.034
Baidoa	Mogadishu	9.5955	1	0.002
Baidoa	Qorioley	3.3220	1	0.068
Baidoa	Wanle Weyne	3.8043	1	0.051
Kismayo	Merka	5.5448	1	0.019
Kismayo	Beletwein	4.8376	1	0.028
Beletwein	Merka	5.2444	1	0.022
Beletwein	Qorioley	3.9875	1	0.046
Adanyabal	Merka	6.0251	1	0.014
Adanyabal	Kismayo	2.8852	1	0.089
Hudur	Kismayo	3.8252	1	0.050
Hudur	Beletwein	3.3529	1	0.067
Hudur	Adanyabal	5.0474	1	0.025
Jowhar	Merka	4.5729	1	0.032
Jowhar	Adanyabal	2.7716	1	0.096
Jowhar	Wanle Weyne	3.7944	1	0.051
Qansah Dere	Merka	8.1380	1	0.004
Qansah Dere	Adanyabal	4.7655	1	0.029
Qorioley	Merka	29.2410	1	0.000
Qorioley	Beletwein	11.3630	1	0.001
Qorioley	Qansah Dere	3.0953	1	0.079
Qorioley	Wanle Weyne	3.6242	1	0.057
Wanle Weyne	Merka	14.4790	1	0.000
Wanle Weyne	Baidoa	7.8703	1	0.005
Wanle Weyne	Beletwein	5.4422	1	0.020
Wanle Weyne	Adanyabal	2.8974	1	0.089
Wanle Weyne	Qansah Dere	3.6813	1	0.055

cont.

Table A.9: Granger causality – Red rice continued

Equation (Ref. market)	Excluded	χ^2	d.f.	Prob > χ^2
Central zone				
Galkayo	Hara Dhere	7.3093	1	0.007
Galkayo	Abudwak	5.9975	1	0.014
Hara Dhere	Galkayo	3.2401	1	0.072
Hara Dhere	El Der	3.1758	1	0.075
Abudwak	Galkayo	7.4867	1	0.006
Dusamared	Galkayo	16.1120	1	0.000
Dusamared	Hara Dhere	3.6812	1	0.055
Dusamared	Abudwak	4.2109	1	0.040
Dusamared	Garowe	10.1660	1	0.001
El Der	Galkayo	3.6805	1	0.055
Northern zone				
Bosasso	Boroma	4.6336	2	0.099
Hargeisa	Bosasso	6.6038	2	0.037
Hargeisa	Lasanod	4.8411	2	0.089
Hargeisa	Togwajiale	12.4580	2	0.002
Erigavo	Bosasso	15.7000	2	0.000
Erigavo	Togwajiale	9.4463	2	0.009
Boroma	Bosasso	24.8700	2	0.000
Boroma	Hargeisa	6.7119	2	0.035
Boroma	Erigavo	5.6876	2	0.058
Lasanod	Bosasso	20.7150	2	0.000
Lasanod	Hargeisa	6.0490	2	0.049
Togwajiale	Bosasso	6.9392	2	0.031
Zeilac L.	Bosasso	10.3760	2	0.006
Zeilac L.	Hargeisa	6.7891	2	0.034
Zeilac L.	Lasanod	4.7376	2	0.094

Data source: FSNAU

Table A.10: T-test of equality of estimates of θ_2 and α_3

H_a			Pr(|T| > |t|)	H_a			Pr(|T| > |t|)
$\theta_{2\ sorghum\ North}$	≠	$\theta_{2\ sorghum\ Center}$	0.015	$\alpha_{3\ sorghum\ North}$	≠	$\alpha_{3\ sorghum\ Center}$	0.967
$\theta_{2\ sorghum\ North}$	≠	$\theta_{2\ sorghum\ South}$	0.000	$\alpha_{3\ sorghum\ North}$	≠	$\alpha_{3\ sorghum\ South}$	0.074
$\theta_{2\ sorghum\ North}$	≠	$\theta_{2\ sorghum\ All}$	0.006	$\alpha_{3\ sorghum\ North}$	≠	$\alpha_{3\ sorghum\ All}$	0.781
$\theta_{2\ sorghum\ Center}$	≠	$\theta_{2\ sorghum\ South}$	0.989	$\alpha_{3\ sorghum\ Center}$	≠	$\alpha_{3\ sorghum\ South}$	0.070
$\theta_{2\ sorghum\ Center}$	≠	$\theta_{2\ sorghum\ All}$	0.424	$\alpha_{3\ sorghum\ Center}$	≠	$\alpha_{3\ sorghum\ All}$	0.715
$\theta_{2\ sorghum\ South}$	≠	$\theta_{2\ sorghum\ All}$	0.284	$\alpha_{3\ sorghum\ South}$	≠	$\alpha_{3\ sorghum\ All}$	0.037
$\theta_{2\ rice\ North}$	≠	$\theta_{2\ rice\ Center}$	0.903	$\alpha_{3\ rice\ North}$	≠	$\alpha_{3\ rice\ Center}$	0.092
$\theta_{2\ rice\ North}$	≠	$\theta_{2\ rice\ South}$	0.809	$\alpha_{3\ rice\ North}$	≠	$\alpha_{3\ rice\ South}$	0.815
$\theta_{2\ rice\ North}$	≠	$\theta_{2\ rice\ All}$	0.515	$\alpha_{3\ rice\ North}$	≠	$\alpha_{3\ rice\ All}$	0.695
$\theta_{2\ rice\ Center}$	≠	$\theta_{2\ rice\ South}$	0.742	$\alpha_{3\ rice\ Center}$	≠	$\alpha_{3\ rice\ South}$	0.114
$\theta_{2\ rice\ Center}$	≠	$\theta_{2\ rice\ All}$	0.465	$\alpha_{3\ rice\ Center}$	≠	$\alpha_{3\ rice\ All}$	0.002
$\theta_{2\ rice\ South}$	≠	$\theta_{2\ rice\ All}$	0.656	$\alpha_{3\ rice\ South}$	≠	$\alpha_{3\ rice\ All}$	0.869
$\theta_{2\ sorghum\ North}$	≠	$\theta_{2\ rice\ North}$	0.007	$\alpha_{3\ sorghum\ North}$	≠	$\alpha_{3\ rice\ North}$	0.061
$\theta_{2\ sorghum\ Center}$	≠	$\theta_{2\ rice\ Center}$	0.548	$\alpha_{3\ sorghum\ Center}$	≠	$\alpha_{3\ rice\ Center}$	0.362
$\theta_{2\ sorghum\ South}$	≠	$\theta_{2\ rice\ South}$	0.195	$\alpha_{3\ sorghum\ South}$	≠	$\alpha_{3\ rice\ South}$	0.160
$\theta_{2\ sorghum\ All}$	≠	$\theta_{2\ rice\ All}$	0.348	$\alpha_{3\ sorghum\ All}$	≠	$\alpha_{3\ rice\ All}$	0.000

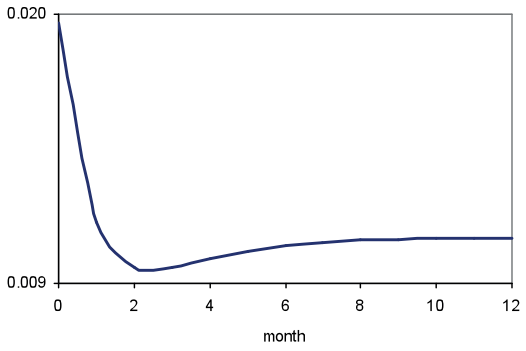
Data source: Tables 9 - 11

Table A.11: Impulse response functions – Red sorghum in the Northern zone

Response to changes of red sorghum price in Bosasso

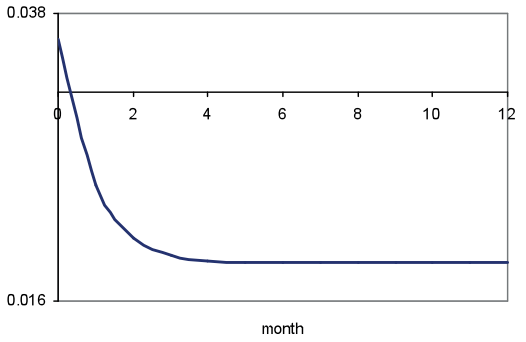
Response in Hargeisa

month	response
0	0.01963
1	0.01147
2	0.00965
3	0.00964
4	0.01000
5	0.01032
6	0.01055
7	0.01068
8	0.01076
9	0.01080
10	0.01082
11	0.01083
12	0.01084



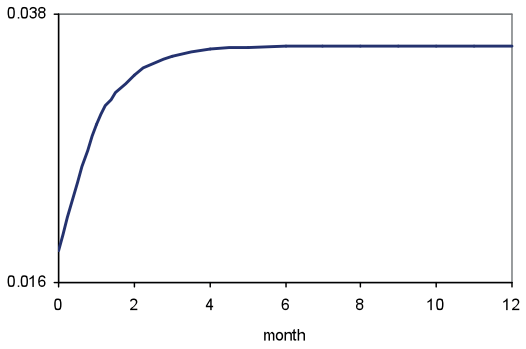
Response in Erigavo

month	response
0	0.03601
1	0.02484
2	0.02085
3	0.01949
4	0.01907
5	0.01896
6	0.01895
7	0.01896
8	0.01897
9	0.01898
10	0.01898
11	0.01899
12	0.01899



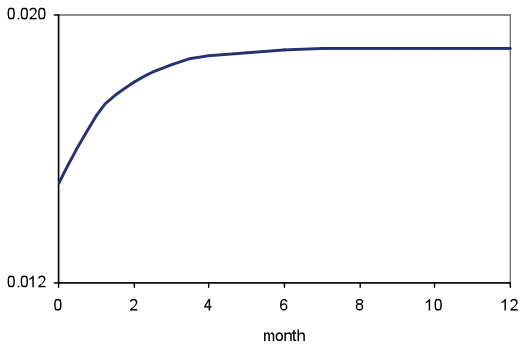
Response in Boroma

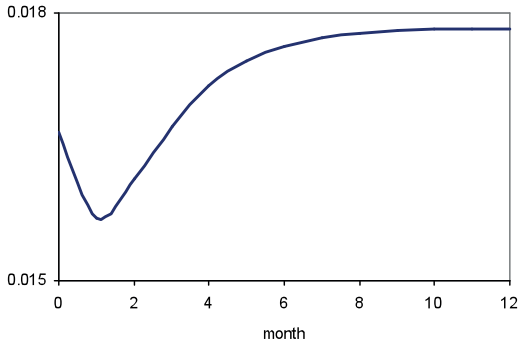
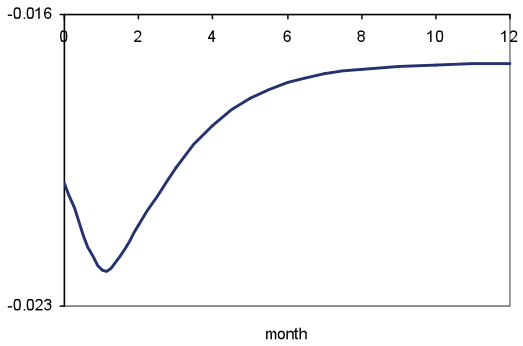
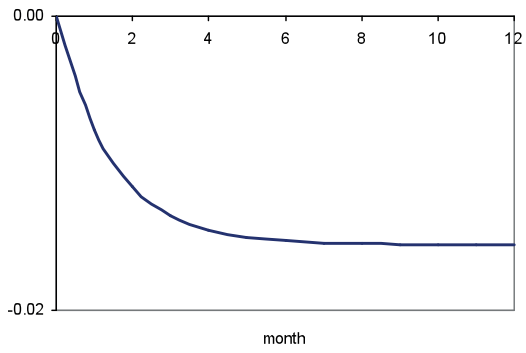
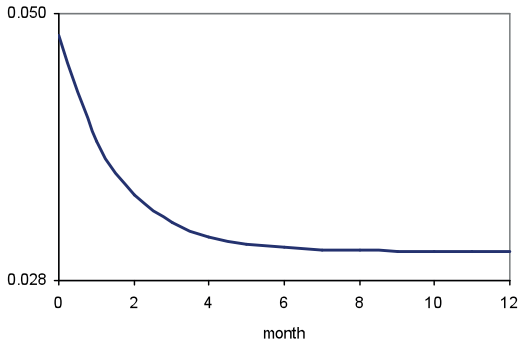
month	response
0	0.01866
1	0.02899
2	0.03299
3	0.03452
4	0.03510
5	0.03531
6	0.03539
7	0.03541
8	0.03542
9	0.03542
10	0.03542
11	0.03542
12	0.03542



Response in Lasanod

month	response
0	0.01497
1	0.01700
2	0.01801
3	0.01851
4	0.01877
5	0.01889
6	0.01895
7	0.01899
8	0.01900
9	0.01901
10	0.01901
11	0.01901
12	0.01902



Response in Togwajiale	month response 0 0.01666 1 0.01569 2 0.01614 3 0.01673 4 0.01718 5 0.01746 6 0.01763 7 0.01772 8 0.01777 9 0.01780 10 0.01781 11 0.01782 12 0.01782	
Response in Zeilac Lawayacado	month response 0 -0.02007 1 -0.02212 2 -0.02105 3 -0.01968 4 -0.01865 5 -0.01800 6 -0.01763 7 -0.01741 8 -0.01730 9 -0.01724 10 -0.01721 11 -0.01719 12 -0.01718	
Response to changes of red sorghum price in Hargeisa		
Response in Bosasso	month response 0 0.00000 1 -0.00770 2 -0.01159 3 -0.01355 4 -0.01454 5 -0.01504 6 -0.01528 7 -0.01541 8 -0.01547 9 -0.01550 10 -0.01552 11 -0.01553 12 -0.01553	
Response in Erigavo	month response 0 0.04822 1 0.03946 2 0.03500 3 0.03272 4 0.03157 5 0.03099 6 0.03070 7 0.03055 8 0.03048 9 0.03044 10 0.03042 11 0.03041 12 0.03041	

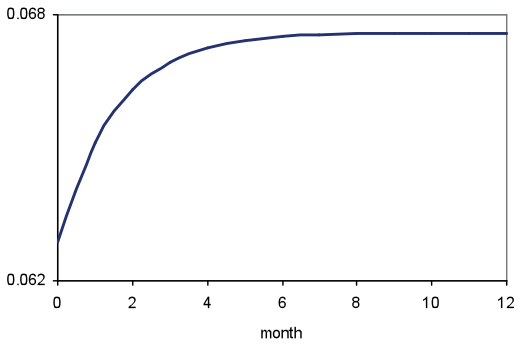
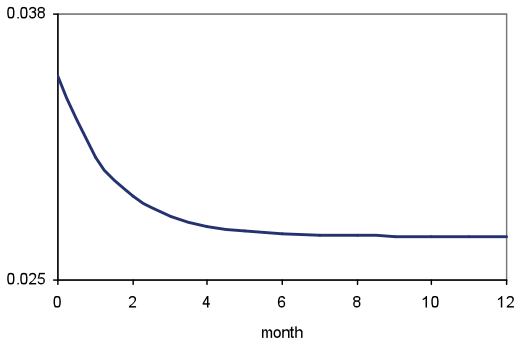
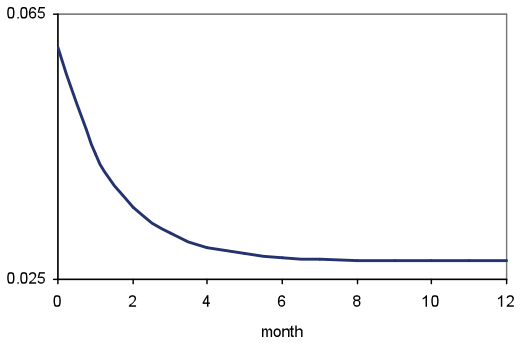
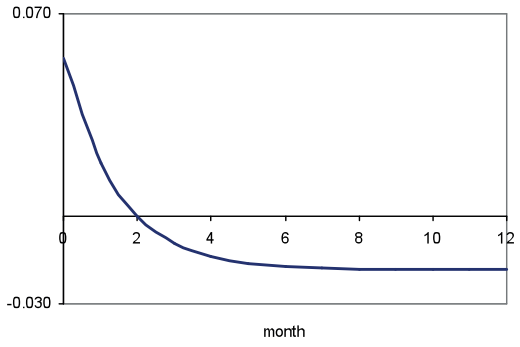
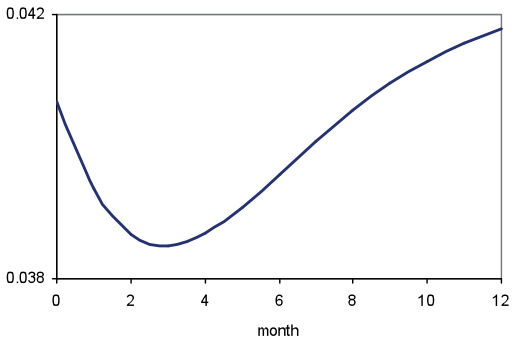
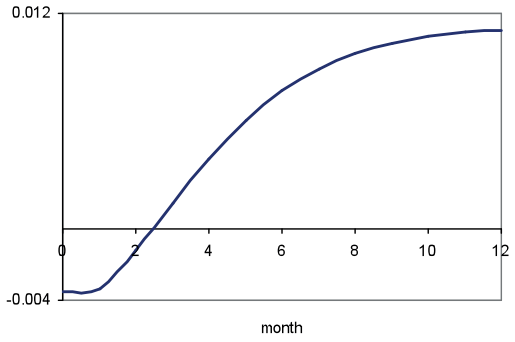
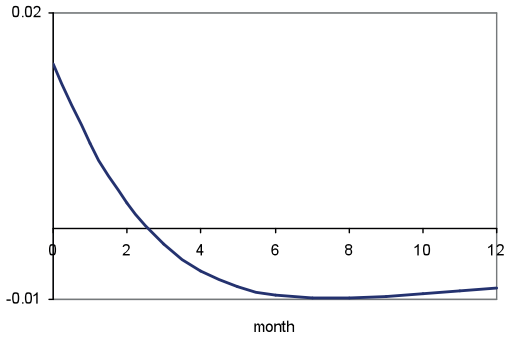
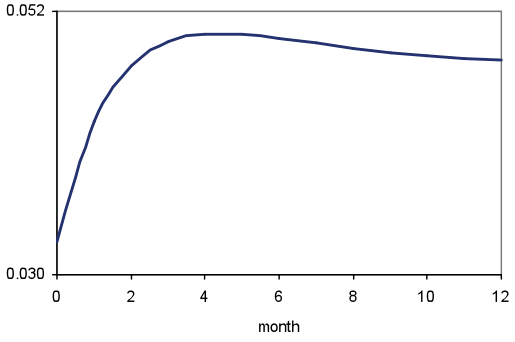
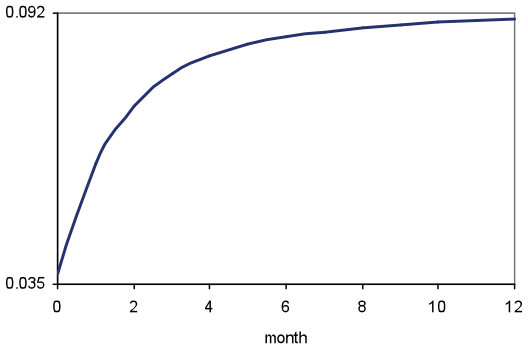
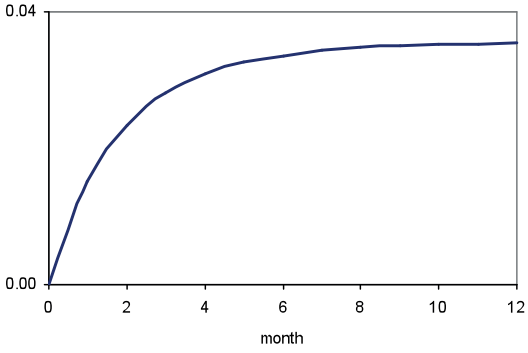
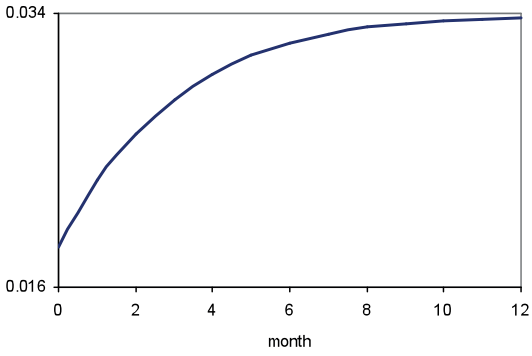
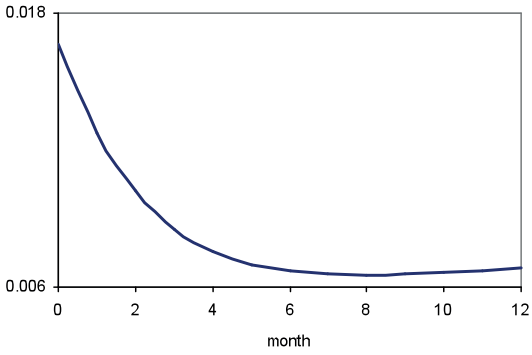
Response in Boroma	month response 0 0.06286 1 0.06511 2 0.06631 3 0.06693 4 0.06726 5 0.06742 6 0.06751 7 0.06755 8 0.06757 9 0.06758 10 0.06759 11 0.06759 12 0.06759	
Response in Lasanod	month response 0 0.03495 1 0.03104 2 0.02908 3 0.02811 4 0.02762 5 0.02738 6 0.02726 7 0.02719 8 0.02716 9 0.02715 10 0.02714 11 0.02714 12 0.02714	
Response in Togwajiale	month response 0 0.05993 1 0.04394 2 0.03590 3 0.03186 4 0.02983 5 0.02882 6 0.02831 7 0.02805 8 0.02792 9 0.02786 10 0.02783 11 0.02781 12 0.02781	
Response in Zeilac Lawayacado	month response 0 0.05474 1 0.01838 2 0.00010 3 -0.00909 4 -0.01370 5 -0.01601 6 -0.01717 7 -0.01775 8 -0.01804 9 -0.01818 10 -0.01825 11 -0.01829 12 -0.01831	

Table A.12: Impulse response functions – Red sorghum in the Central zone

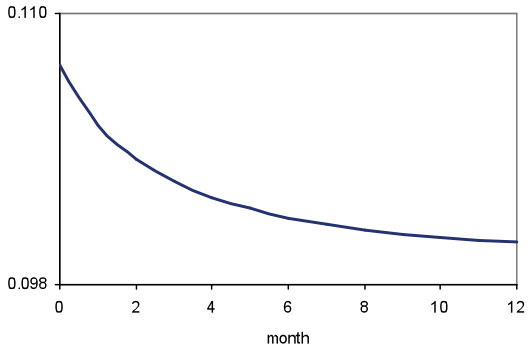
Response to changes of red sorghum price in Galkayo

Response in Haradhere	month response 0 0.04068 1 0.03936 2 0.03867 3 0.03850 4 0.03868 5 0.03908 6 0.03957 7 0.04007 8 0.04054 9 0.04095 10 0.04129 11 0.04157 12 0.04178	
Response in Abudwak	month response 0 -0.00352 1 -0.00336 2 -0.00124 3 0.00141 4 0.00392 5 0.00603 6 0.00768 7 0.00891 8 0.00977 9 0.01036 10 0.01073 11 0.01095 12 0.01107	
Response in Dusamared	month response 0 0.01147 1 0.00593 2 0.00177 3 -0.00113 4 -0.00300 5 -0.00411 6 -0.00469 7 -0.00491 8 -0.00491 9 -0.00480 10 -0.00462 11 -0.00443 12 -0.00425	
Response in El Der	month response 0 0.03272 1 0.04274 2 0.04751 3 0.04952 4 0.05014 5 0.05008 6 0.04974 7 0.04932 8 0.04891 9 0.04856 10 0.04827 11 0.04806 12 0.04790	

Response in Garowe	month response 0 0.03715 1 0.06045 2 0.07259 3 0.07918 4 0.08298 5 0.08535 6 0.08694 7 0.08808 8 0.08893 9 0.08958 10 0.09007 11 0.09044 12 0.09071	
Response to changes of red sorghum price in Haradhere		
Response in Galkayo	month response 0 0.00000 1 0.01505 2 0.02335 3 0.02808 4 0.03085 5 0.03255 6 0.03360 7 0.03428 8 0.03472 9 0.03501 10 0.03519 11 0.03531 12 0.03537	
Response in Abudwak	month response 0 0.01867 1 0.02301 2 0.02611 3 0.02837 4 0.03002 5 0.03122 6 0.03207 7 0.03267 8 0.03308 9 0.03335 10 0.03352 11 0.03362 12 0.03367	
Response in Dusamared	month response 0 0.01663 1 0.01274 2 0.01019 3 0.00856 4 0.00756 5 0.00698 6 0.00668 7 0.00656 8 0.00655 9 0.00659 10 0.00667 11 0.00675 12 0.00682	

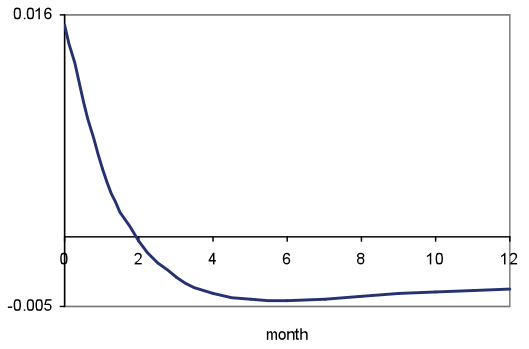
Response in El Der

month	response
0	0.10770
1	0.10508
2	0.10354
3	0.10256
4	0.10188
5	0.10136
6	0.10097
7	0.10066
8	0.10041
9	0.10023
10	0.10009
11	0.09999
12	0.09992



Response in Garowe

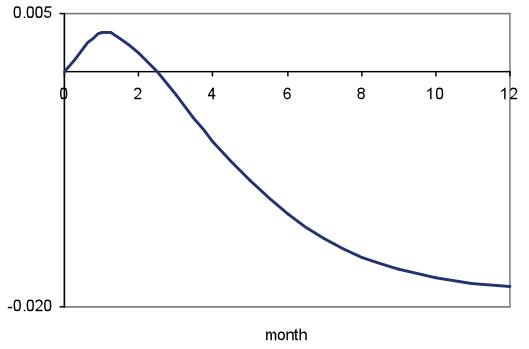
month	response
0	0.01528
1	0.00496
2	-0.00031
3	-0.00289
4	-0.00406
5	-0.00448
6	-0.00454
7	-0.00444
8	-0.00427
9	-0.00410
10	-0.00394
11	-0.00381
12	-0.00371



Response to changes of red sorghum price in Abudwak

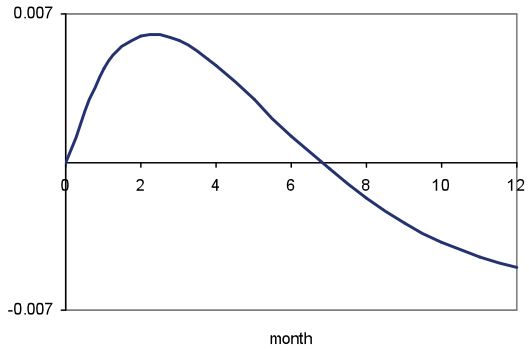
Response in Galkayo

month	response
0	0.00000
1	0.00337
2	0.00162
3	-0.00197
4	-0.00583
5	-0.00929
6	-0.01209
7	-0.01423
8	-0.01577
9	-0.01684
10	-0.01754
11	-0.01797
12	-0.01822



Response in Haradhere

month	response
0	0.00000
1	0.00443
2	0.00595
3	0.00572
4	0.00454
5	0.00293
6	0.00124
7	-0.00035
8	-0.00173
9	-0.00288
10	-0.00379
11	-0.00448
12	-0.00500



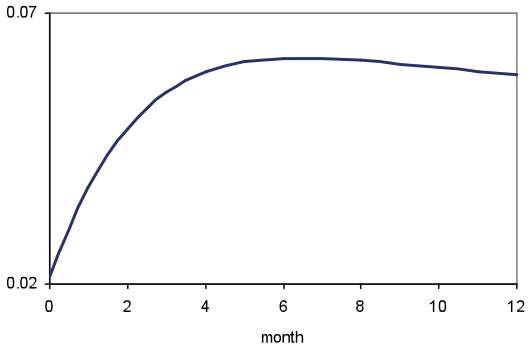
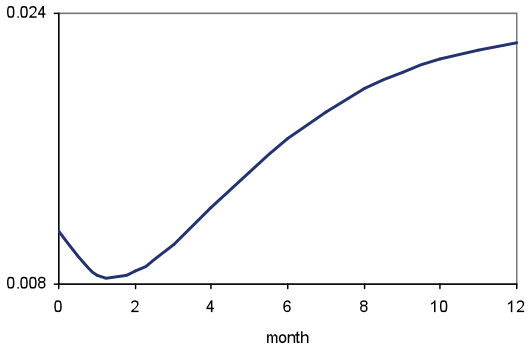
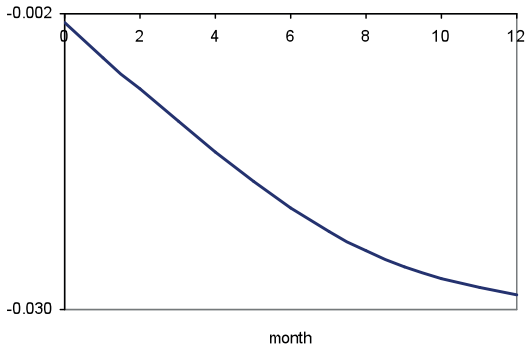
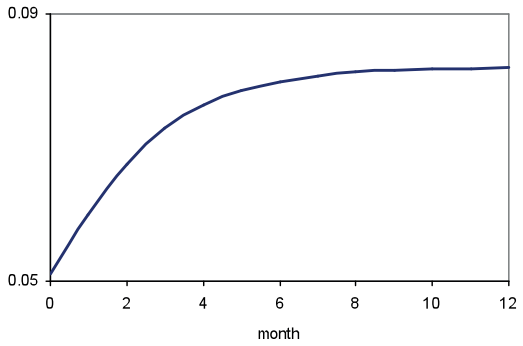
Response in Dusamared	month response 0 0.02147 1 0.03785 2 0.04863 3 0.05532 4 0.05915 5 0.06106 6 0.06174 7 0.06168 8 0.06122 9 0.06059 10 0.05992 11 0.05929 12 0.05874	
Response in El Der	month response 0 0.01109 1 0.00852 2 0.00877 3 0.01038 4 0.01248 5 0.01463 6 0.01657 7 0.01821 8 0.01952 9 0.02054 10 0.02130 11 0.02185 12 0.02223	
Response in Garowe	month response 0 -0.00289 1 -0.00620 2 -0.00915 3 -0.01211 4 -0.01507 5 -0.01788 6 -0.02043 7 -0.02263 8 -0.02446 9 -0.02592 10 -0.02706 11 -0.02791 12 -0.02854	

Table A.13: Impulse response functions – Red sorghum in the Southern zone

Response to changes of red sorghum price in Merka

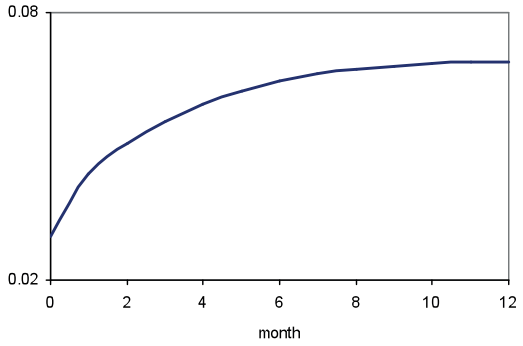
Response in Baidoa

month	response
0	0.05102
1	0.06004
2	0.06759
3	0.07287
4	0.07633
5	0.07852
6	0.07989
7	0.08074
8	0.08126
9	0.08157
10	0.08177
11	0.08188
12	0.08195



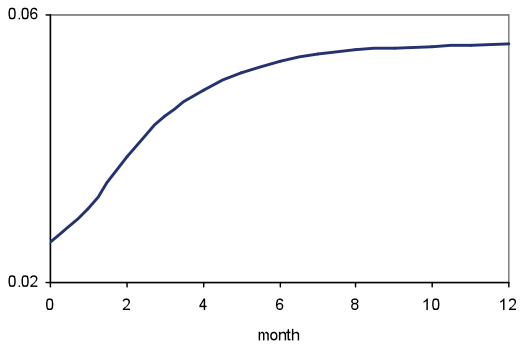
Response in Kismayo

month	response
0	0.02984
1	0.04376
2	0.05064
3	0.05559
4	0.05947
5	0.06244
6	0.06462
7	0.06618
8	0.06726
9	0.06800
10	0.06849
11	0.06881
12	0.06902



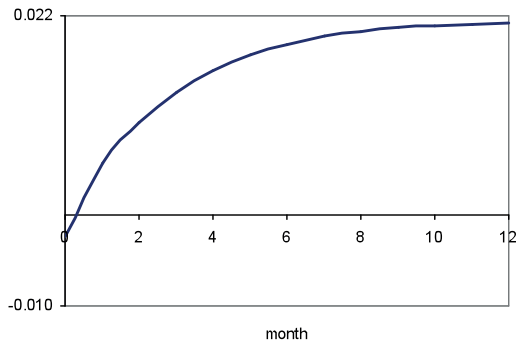
Response in Beletwein

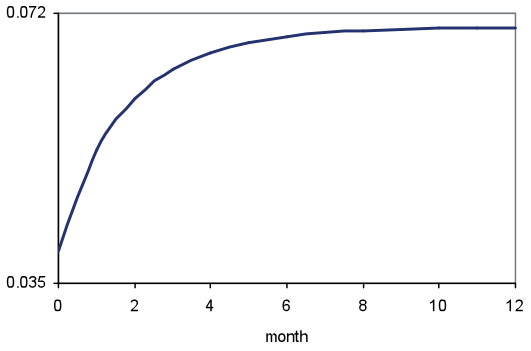
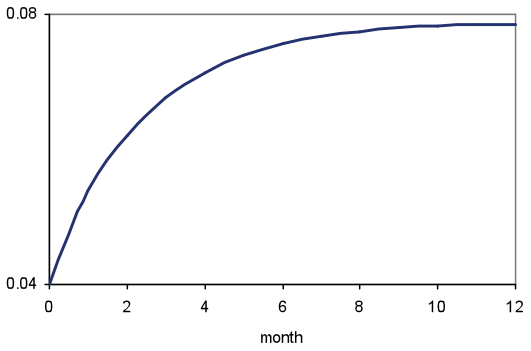
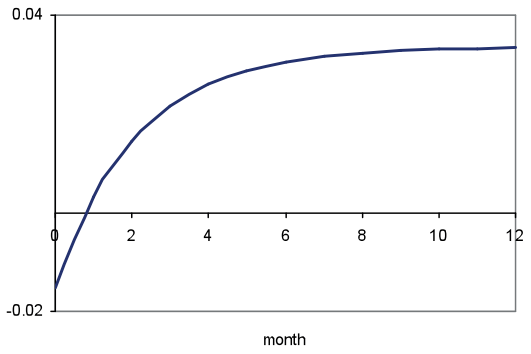
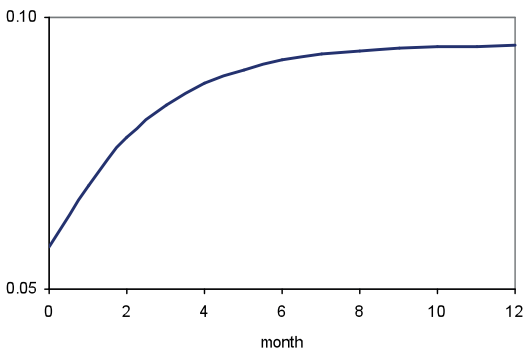
month	response
0	0.02598
1	0.03104
2	0.03880
3	0.04481
4	0.04886
5	0.05146
6	0.05309
7	0.05411
8	0.05473
9	0.05512
10	0.05535
11	0.05549
12	0.05557

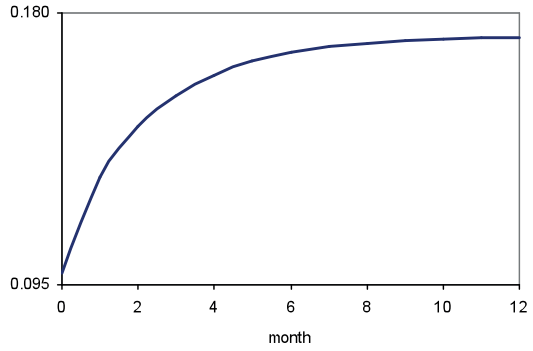
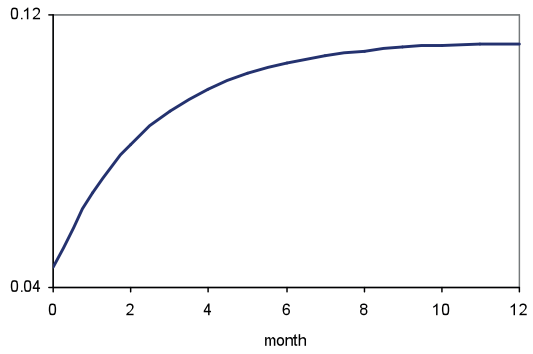
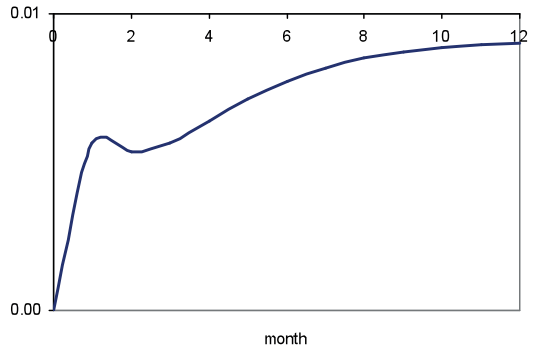
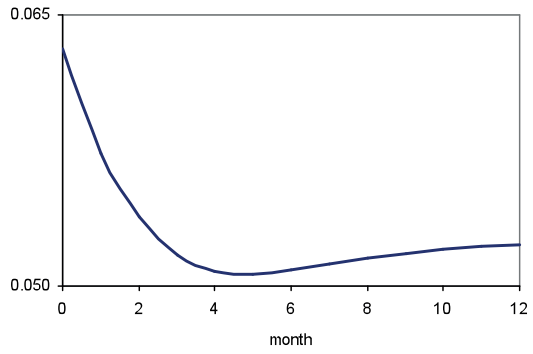


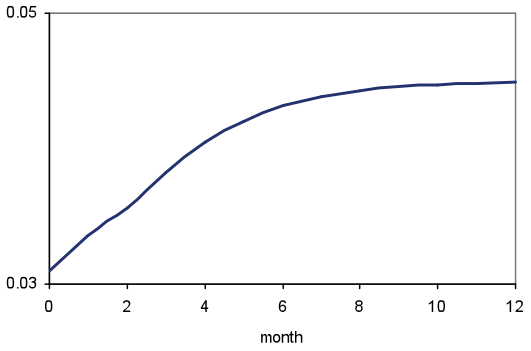
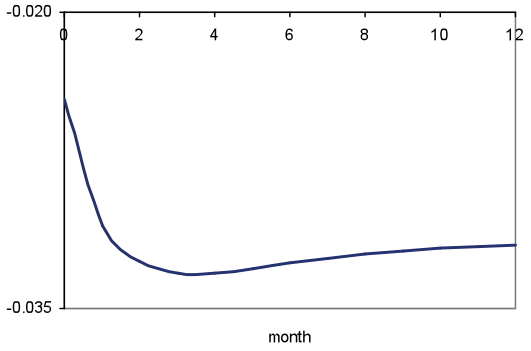
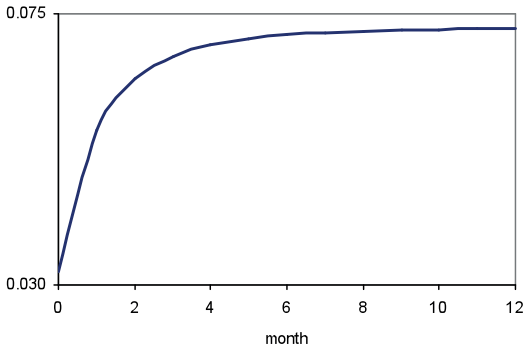
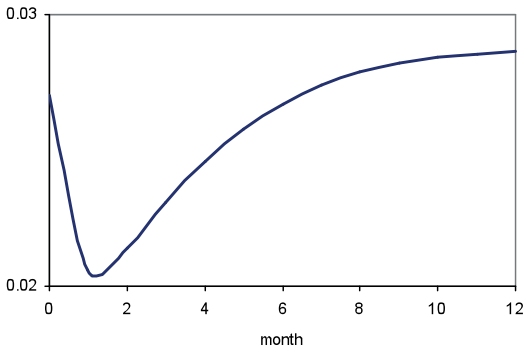
Response in Adanyabal

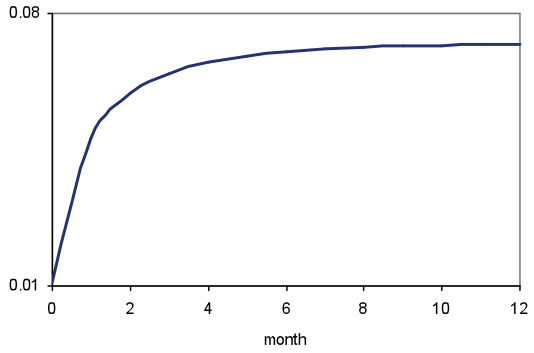
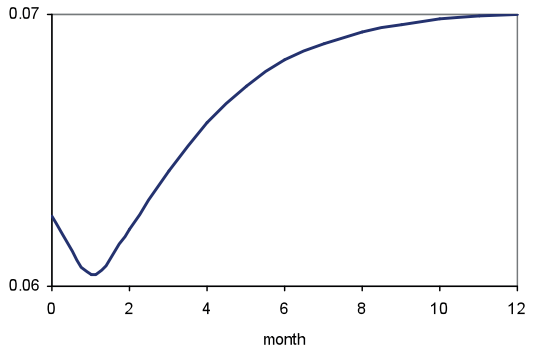
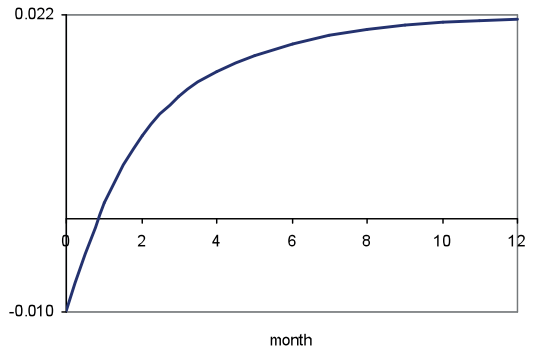
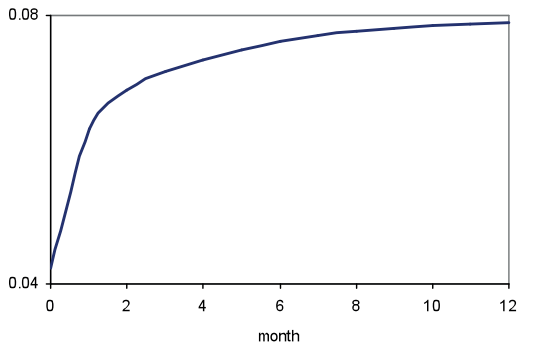
month	response
0	-0.00230
1	0.00575
2	0.01030
3	0.01352
4	0.01591
5	0.01764
6	0.01887
7	0.01972
8	0.02030
9	0.02068
10	0.02093
11	0.02109
12	0.02120



Response in Hudur	month response 0 0.03933 1 0.05328 2 0.06038 3 0.06432 4 0.06663 5 0.06801 6 0.06885 7 0.06936 8 0.06967 9 0.06985 10 0.06996 11 0.07003 12 0.07007	
Response in Jowhar	month response 0 0.04006 1 0.05379 2 0.06212 3 0.06767 4 0.07143 5 0.07397 6 0.07566 7 0.07676 8 0.07748 9 0.07795 10 0.07824 11 0.07843 12 0.07855	
Response in Mogadishu Bakara	month response 0 -0.01519 1 0.00308 2 0.01439 3 0.02145 4 0.02591 5 0.02873 6 0.03052 7 0.03164 8 0.03235 9 0.03279 10 0.03306 11 0.03323 12 0.03333	
Response in Qansah Dere	month response 0 0.05781 1 0.06921 2 0.07783 3 0.08382 4 0.08782 5 0.09044 6 0.09213 7 0.09321 8 0.09389 9 0.09432 10 0.09459 11 0.09476 12 0.09486	

Response in Qorioley	month response 0 0.09841 1 0.12857 2 0.14446 3 0.15423 4 0.16060 5 0.16481 6 0.16758 7 0.16938 8 0.17056 9 0.17131 10 0.17178 11 0.17209 12 0.17228	
Response in Wanle Weyne	month response 0 0.04613 1 0.06783 2 0.08194 3 0.09164 4 0.09835 5 0.10295 6 0.10607 7 0.10815 8 0.10951 9 0.11040 10 0.11097 11 0.11134 12 0.11157	
Response to changes of red sorghum price in Baidoa		
Response in Merka	month step 0 0.00000 1 0.00566 2 0.00536 3 0.00566 4 0.00638 5 0.00712 6 0.00773 7 0.00818 8 0.00850 9 0.00872 10 0.00887 11 0.00897 12 0.00903	
Response in Kismayo	month step 0 0.06310 1 0.05731 2 0.05385 3 0.05172 4 0.05080 5 0.05065 6 0.05087 7 0.05120 8 0.05153 9 0.05181 10 0.05202 11 0.05218 12 0.05229	

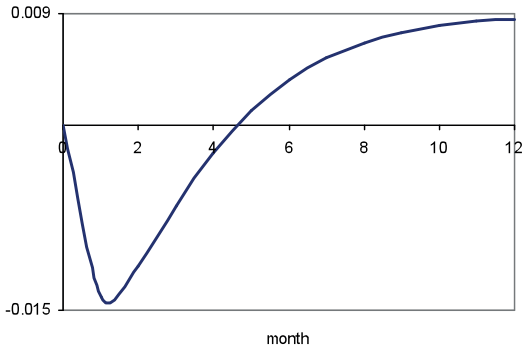
Response in Beletwein	month step 0 0.03097 1 0.03357 2 0.03565 3 0.03823 4 0.04045 5 0.04205 6 0.04314 7 0.04384 8 0.04429 9 0.04457 10 0.04475 11 0.04486 12 0.04493	
Response in Adanyabal	month step 0 -0.02439 1 -0.03084 2 -0.03263 3 -0.03319 4 -0.03321 5 -0.03299 6 -0.03271 7 -0.03244 8 -0.03222 9 -0.03205 10 -0.03193 11 -0.03185 12 -0.03179	
Response in Hudur	month step 0 0.03226 1 0.05557 2 0.06416 3 0.06791 4 0.06982 5 0.07089 6 0.07153 7 0.07192 8 0.07215 9 0.07230 10 0.07239 11 0.07244 12 0.07248	
Response in Jowhar	month step 0 0.02964 1 0.02450 2 0.02512 3 0.02644 4 0.02766 5 0.02864 6 0.02938 7 0.02992 8 0.03029 9 0.03055 10 0.03073 11 0.03084 12 0.03092	

Response in Mogadishu Bakara	month step 0 0.01114 1 0.04780 2 0.05954 3 0.06463 4 0.06741 5 0.06912 6 0.07021 7 0.07092 8 0.07138 9 0.07167 10 0.07186 11 0.07198 12 0.07205	
Response in Qansah Dere	month step 0 0.06258 1 0.06044 2 0.06208 3 0.06424 4 0.06605 5 0.06738 6 0.06832 7 0.06895 8 0.06937 9 0.06965 10 0.06982 11 0.06994 12 0.07001	
Response in Qorioley	month step 0 -0.00990 1 0.00177 2 0.00905 3 0.01318 4 0.01581 5 0.01763 6 0.01892 7 0.01983 8 0.02046 9 0.02088 10 0.02117 11 0.02136 12 0.02148	
Response in Wanle Weyne	month step 0 0.04244 1 0.06316 2 0.06893 3 0.07156 4 0.07343 5 0.07494 6 0.07613 7 0.07704 8 0.07769 9 0.07816 10 0.07847 11 0.07869 12 0.07883	

Response to changes of red sorghum price in Kismayo

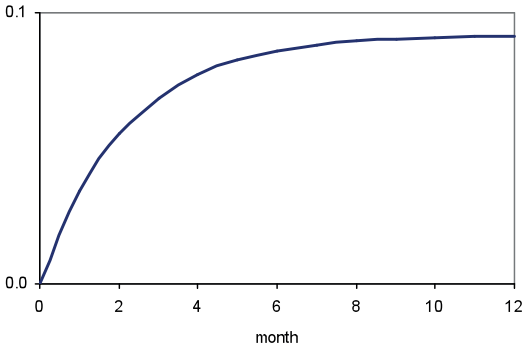
Response in Merka

month	response
0	0.00000
1	-0.01395
2	-0.01142
3	-0.00662
4	-0.00228
5	0.00112
6	0.00363
7	0.00540
8	0.00662
9	0.00744
10	0.00799
11	0.00835
12	0.00858



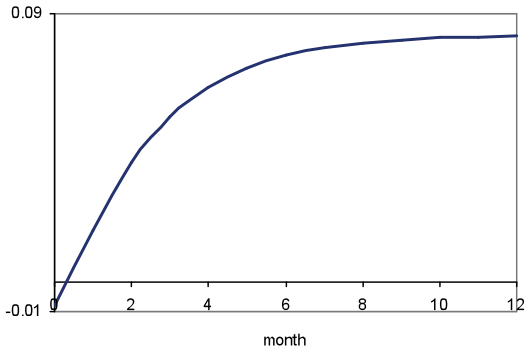
Response in Baidoa

month	response
0	0.00000
1	0.03416
2	0.05529
3	0.06868
4	0.07722
5	0.08266
6	0.08610
7	0.08827
8	0.08963
9	0.09048
10	0.09100
11	0.09133
12	0.09152



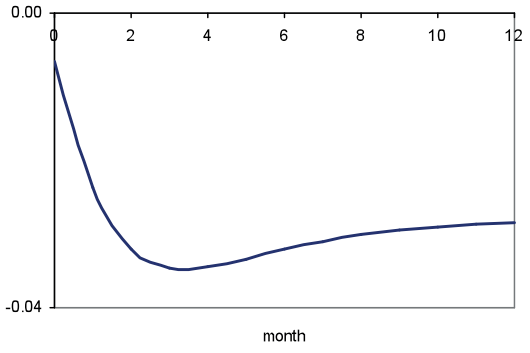
Response in Beletwein

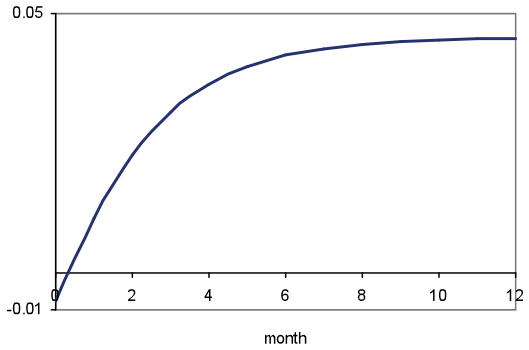
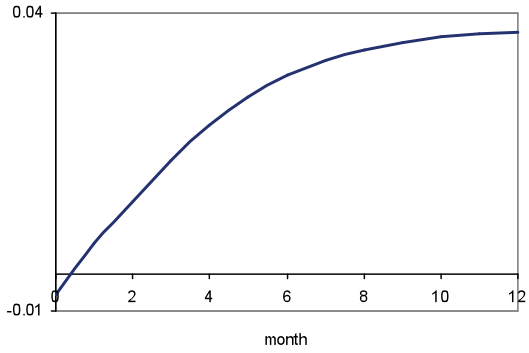
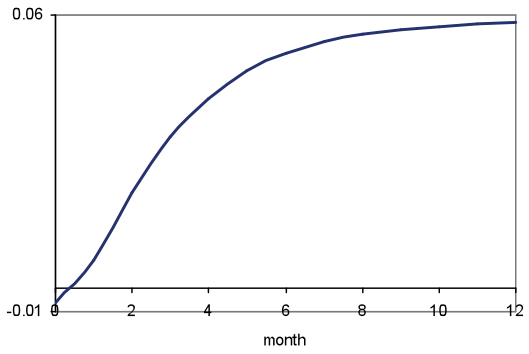
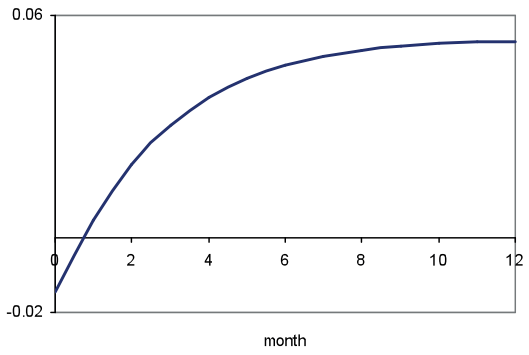
month	response
0	-0.00826
1	0.01734
2	0.03995
3	0.05541
4	0.06548
5	0.07192
6	0.07602
7	0.07860
8	0.08023
9	0.08124
10	0.08187
11	0.08225
12	0.08249

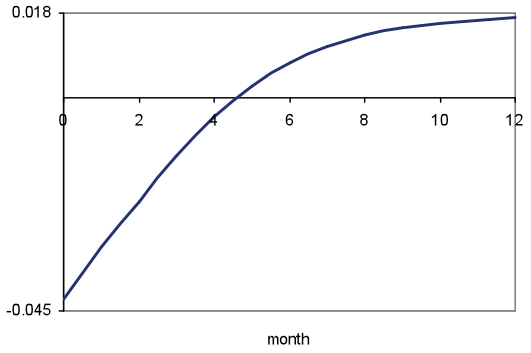
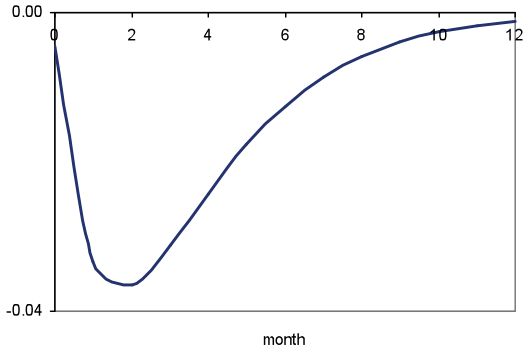
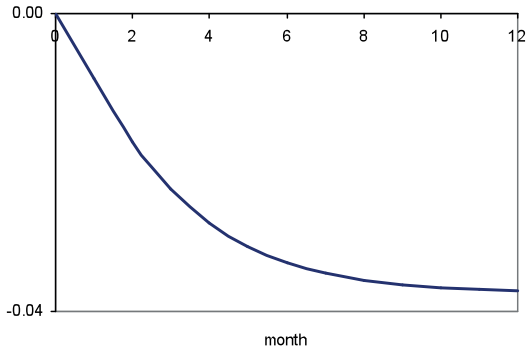
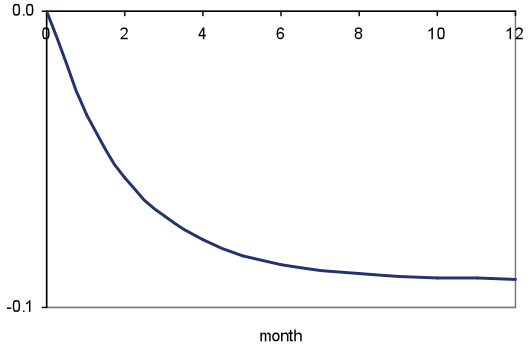


Response in Adanyabal

month	response
0	-0.00662
1	-0.02370
2	-0.03205
3	-0.03461
4	-0.03449
5	-0.03339
6	-0.03213
7	-0.03101
8	-0.03012
9	-0.02946
10	-0.02899
11	-0.02866
12	-0.02844

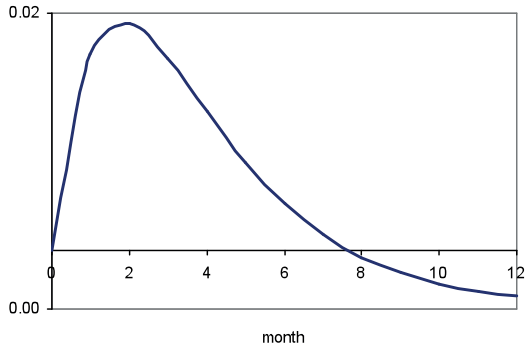


Response in Hudur	month response 0 -0.00524 1 0.01054 2 0.02270 3 0.03098 4 0.03637 5 0.03980 6 0.04196 7 0.04331 8 0.04414 9 0.04465 10 0.04497 11 0.04516 12 0.04527	
Response in Jowhar	month response 0 -0.00278 1 0.00412 2 0.00960 3 0.01511 4 0.01995 5 0.02380 6 0.02667 7 0.02873 8 0.03015 9 0.03111 10 0.03176 11 0.03218 12 0.03246	
Response in Mogadishu Bakara	month response 0 -0.00293 1 0.00615 2 0.02108 3 0.03318 4 0.04180 5 0.04767 6 0.05158 7 0.05414 8 0.05580 9 0.05687 10 0.05754 11 0.05797 12 0.05824	
Response in Qansah Dere	month response 0 -0.01446 1 0.00493 2 0.01965 3 0.03039 4 0.03798 5 0.04322 6 0.04676 7 0.04912 8 0.05067 9 0.05168 10 0.05232 11 0.05273 12 0.05299	

Response in Qorioley	month response 0 -0.04250 1 -0.03133 2 -0.02174 3 -0.01214 4 -0.00383 5 0.00269 6 0.00750 7 0.01090 8 0.01325 9 0.01483 10 0.01589 11 0.01657 12 0.01702	
Response in Wanle Weyne	month response 0 -0.00810 1 -0.03396 2 -0.03680 3 -0.03213 4 -0.02580 5 -0.01996 6 -0.01526 7 -0.01175 8 -0.00923 9 -0.00748 10 -0.00630 11 -0.00550 12 -0.00498	
Response to changes of red sorghum price in Beletwein		
Response in Merka	month response 0 0.00000 1 -0.00875 2 -0.01724 3 -0.02365 4 -0.02822 5 -0.03136 6 -0.03349 7 -0.03491 8 -0.03584 9 -0.03645 10 -0.03684 11 -0.03708 12 -0.03724	
Response in Baidoa	month response 0 0.00000 1 -0.02442 2 -0.03921 3 -0.04838 4 -0.05410 5 -0.05768 6 -0.05990 7 -0.06127 8 -0.06212 9 -0.06264 10 -0.06296 11 -0.06315 12 -0.06327	

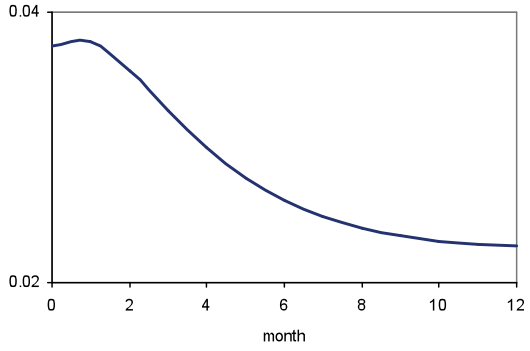
Response in Kismayo

month	response
0	0.00000
1	0.01323
2	0.01534
3	0.01295
4	0.00935
5	0.00593
6	0.00314
7	0.00103
8	-0.00050
9	-0.00156
10	-0.00228
11	-0.00276
12	-0.00308



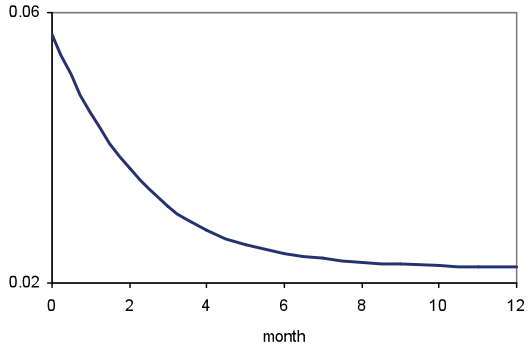
Response in Adanyabal

month	response
0	0.03748
1	0.03780
2	0.03561
3	0.03268
4	0.02995
5	0.02773
6	0.02607
7	0.02487
8	0.02404
9	0.02347
10	0.02309
11	0.02284
12	0.02268



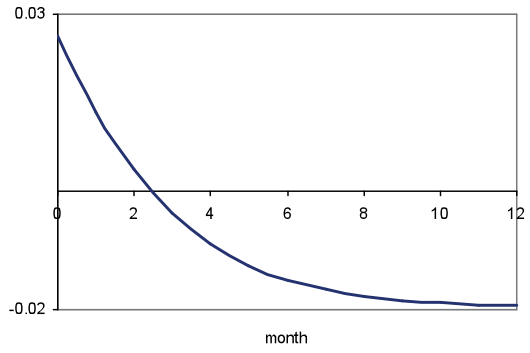
Response in Hudur

month	response
0	0.05173
1	0.04014
2	0.03186
3	0.02640
4	0.02293
5	0.02076
6	0.01942
7	0.01859
8	0.01809
9	0.01778
10	0.01760
11	0.01748
12	0.01742



Response in Jowhar

month	response
0	0.02625
1	0.01335
2	0.00365
3	-0.00360
4	-0.00882
5	-0.01246
6	-0.01494
7	-0.01661
8	-0.01770
9	-0.01842
10	-0.01888
11	-0.01917
12	-0.01936



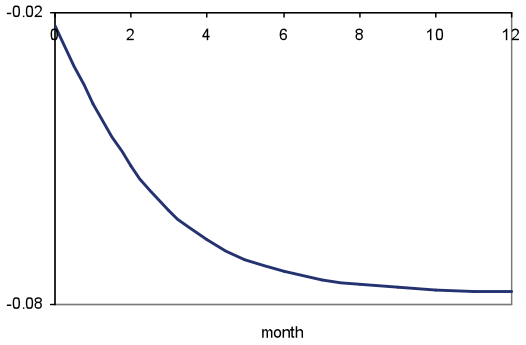
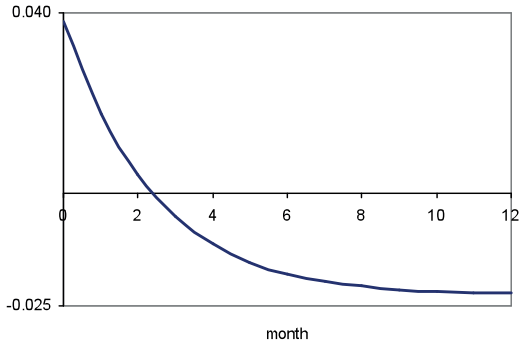
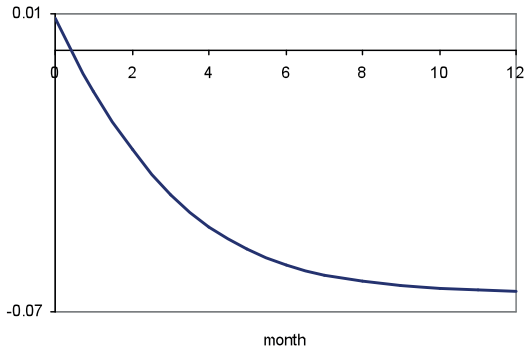
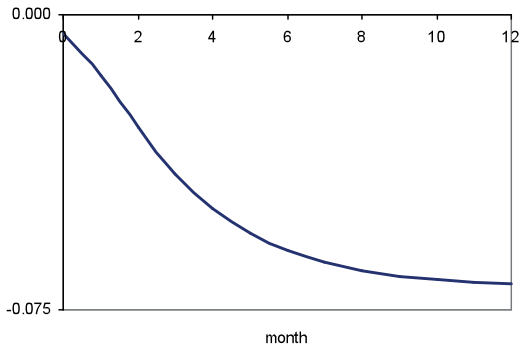
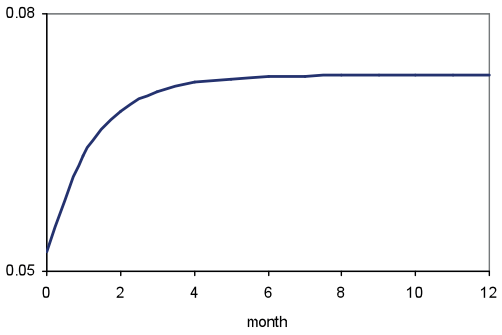
Response in Mogadishu Bakara	month response 0 -0.01784 1 -0.03516 2 -0.04922 3 -0.05908 4 -0.06565 5 -0.06995 6 -0.07271 7 -0.07448 8 -0.07559 9 -0.07629 10 -0.07673 11 -0.07700 12 -0.07717	
Response in Qansah Dere	month response 0 0.03797 1 0.01775 2 0.00405 3 -0.00515 4 -0.01127 5 -0.01528 6 -0.01790 7 -0.01958 8 -0.02065 9 -0.02133 10 -0.02176 11 -0.02203 12 -0.02219	
Response in Qorioley	month response 0 0.00871 1 -0.01095 2 -0.02666 3 -0.03860 4 -0.04722 5 -0.05322 6 -0.05729 7 -0.06001 8 -0.06180 9 -0.06296 10 -0.06370 11 -0.06418 12 -0.06448	
Response in Wanle Weyne	month response 0 -0.00475 1 -0.01559 2 -0.02883 3 -0.04028 4 -0.04909 5 -0.05548 6 -0.05996 7 -0.06302 8 -0.06506 9 -0.06641 10 -0.06729 11 -0.06786 12 -0.06822	

Table A.14: Impulse response functions – Red sorghum in all zones

Response to changes of red sorghum price in Baidoa

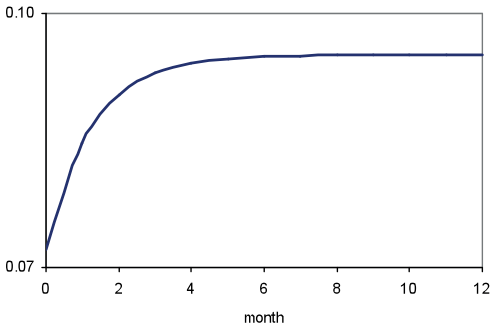
Response in Merka

month	response
0	0.05222
1	0.06351
2	0.06862
3	0.07093
4	0.07198
5	0.07245
6	0.07267
7	0.07277
8	0.07281
9	0.07283
10	0.07284
11	0.07284
12	0.07284



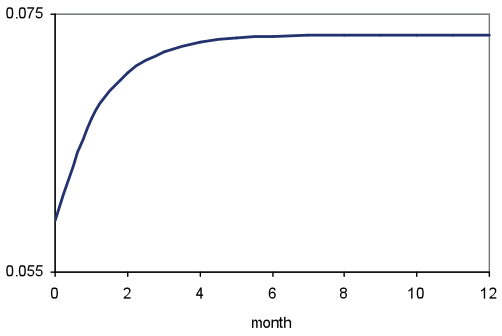
Response in Beletwein

month	response
0	0.07211
1	0.08469
2	0.09039
3	0.09297
4	0.09414
5	0.09467
6	0.09491
7	0.09501
8	0.09506
9	0.09509
10	0.09510
11	0.09510
12	0.09510



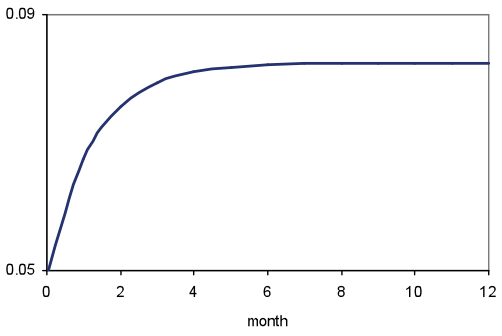
Response in Jowhar

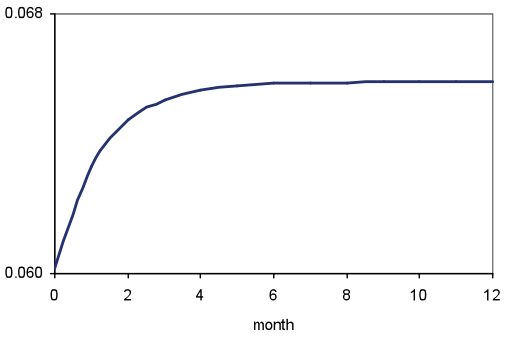
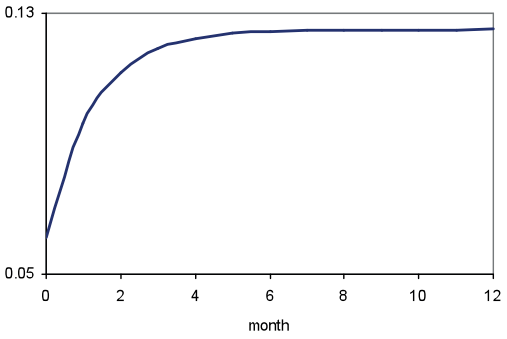
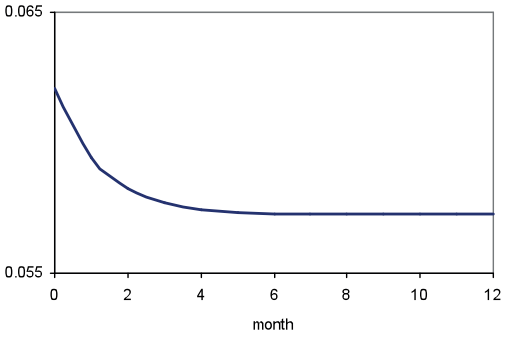
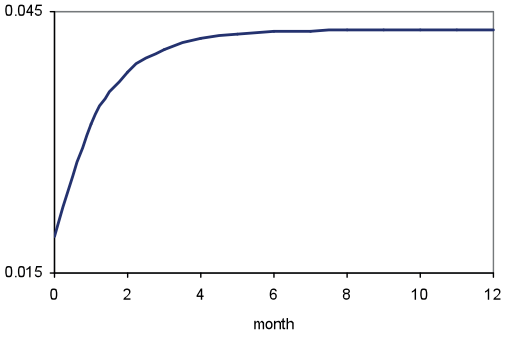
month	response
0	0.05900
1	0.06689
2	0.07047
3	0.07209
4	0.07282
5	0.07315
6	0.07330
7	0.07337
8	0.07340
9	0.07342
10	0.07342
11	0.07343
12	0.07343



Response in Kismayo

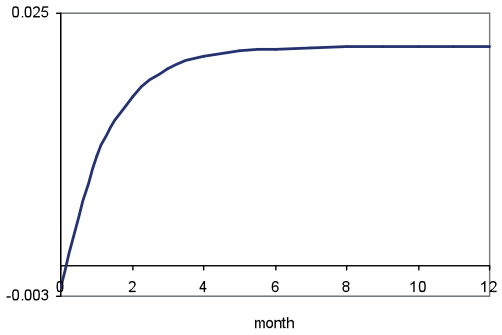
month	response
0	0.04911
1	0.06734
2	0.07560
3	0.07933
4	0.08103
5	0.08179
6	0.08214
7	0.08230
8	0.08237
9	0.08240
10	0.08242
11	0.08242
12	0.08243



Response in Lugh	month response 0 0.06016 1 0.06330 2 0.06472 3 0.06537 4 0.06566 5 0.06579 6 0.06585 7 0.06588 8 0.06589 9 0.06589 10 0.06590 11 0.06590 12 0.06590	
Response in Wanle Weyne	month response 0 0.06141 1 0.09623 2 0.11199 3 0.11913 4 0.12236 5 0.12383 6 0.12449 7 0.12479 8 0.12492 9 0.12499 10 0.12501 11 0.12503 12 0.12503	
Response in Galkayo	month response 0 0.06209 1 0.05944 2 0.05824 3 0.05770 4 0.05745 5 0.05734 6 0.05729 7 0.05727 8 0.05725 9 0.05725 10 0.05725 11 0.05725 12 0.05725	
Response in Haradhere	month response 0 0.01921 1 0.03217 2 0.03803 3 0.04069 4 0.04189 5 0.04244 6 0.04269 7 0.04280 8 0.04285 9 0.04287 10 0.04288 11 0.04289 12 0.04289	

Response in Bosasso

month	response
0	-0.00213
1	0.01091
2	0.01682
3	0.01949
4	0.02070
5	0.02125
6	0.02150
7	0.02161
8	0.02166
9	0.02168
10	0.02169
11	0.02170
12	0.02170



Response in Hargeisa

month	response
0	0.01786
1	0.04122
2	0.05179
3	0.05658
4	0.05875
5	0.05973
6	0.06017
7	0.06038
8	0.06047
9	0.06051
10	0.06053
11	0.06054
12	0.06054

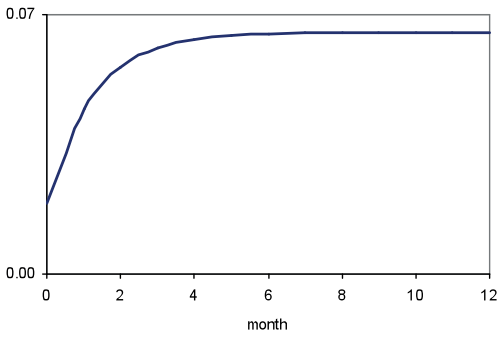
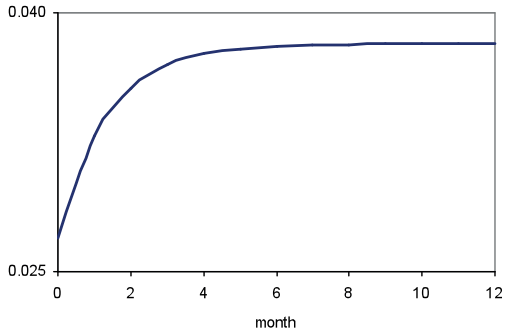


Table A.15: Impulse response functions – Red rice in the Northern zone

Response to changes of red rice price in Bosasso

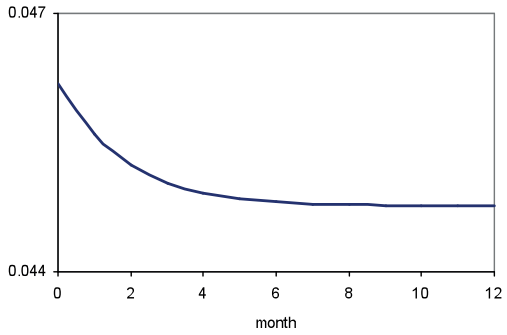
Response in Hargeisa

month	response
0	0.02697
1	0.03286
2	0.03565
3	0.03698
4	0.03761
5	0.03792
6	0.03807
7	0.03814
8	0.03817
9	0.03819
10	0.03820
11	0.03820
12	0.03821



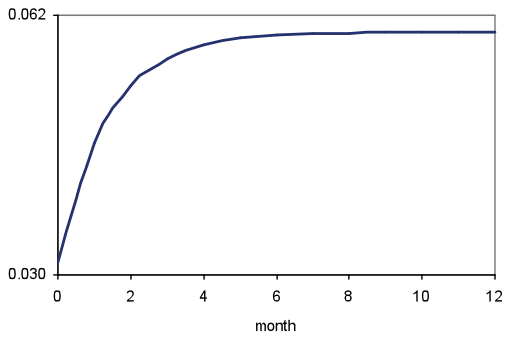
Response in Erigavo

month	response
0	0.04618
1	0.04560
2	0.04524
3	0.04503
4	0.04491
5	0.04485
6	0.04481
7	0.04479
8	0.04478
9	0.04477
10	0.04477
11	0.04477
12	0.04477



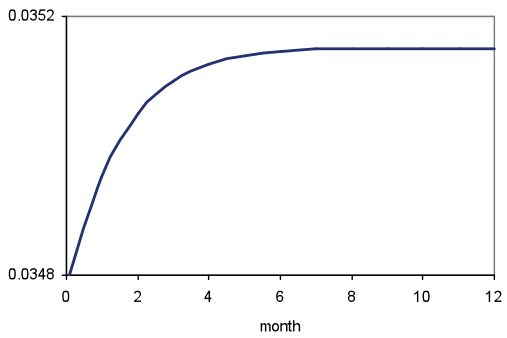
Response in Boroma

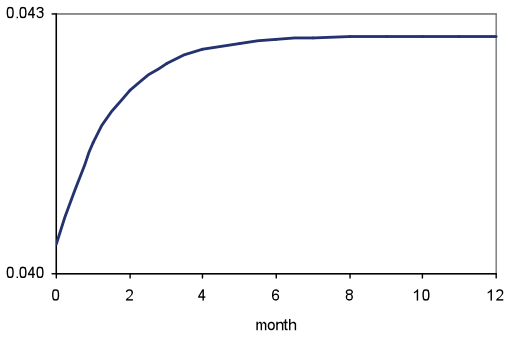
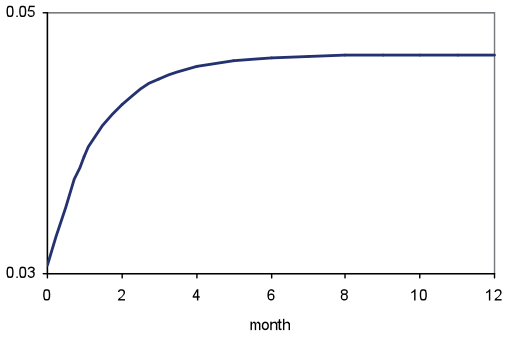
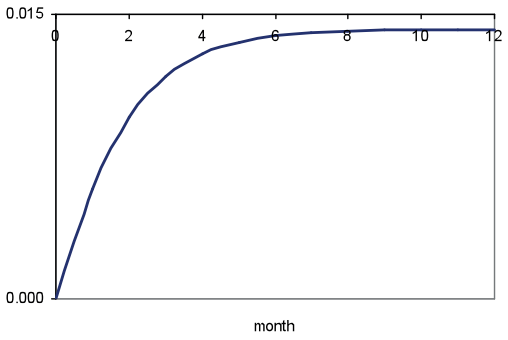
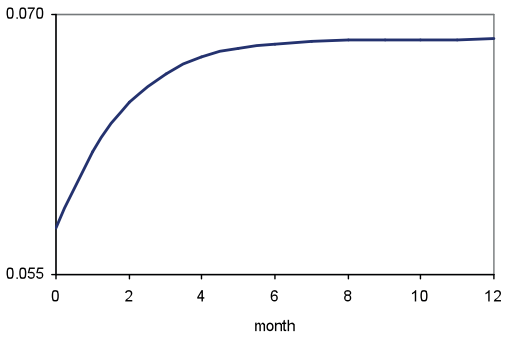
month	response
0	0.03160
1	0.04619
2	0.05327
3	0.05670
4	0.05836
5	0.05916
6	0.05955
7	0.05974
8	0.05983
9	0.05988
10	0.05990
11	0.05991
12	0.05992

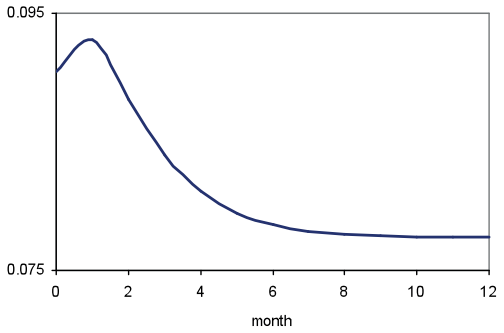
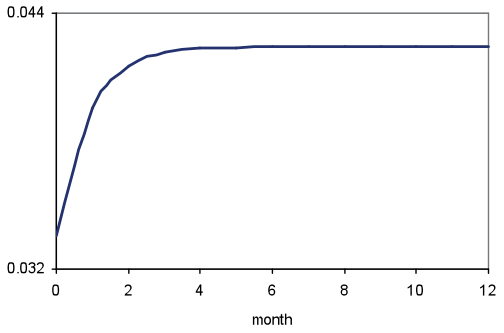
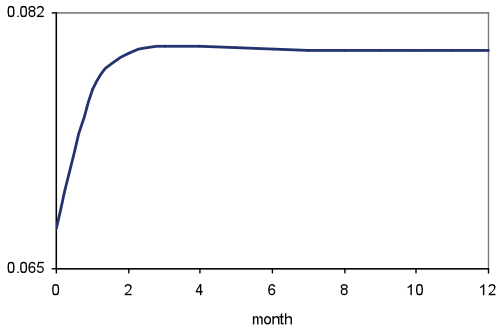
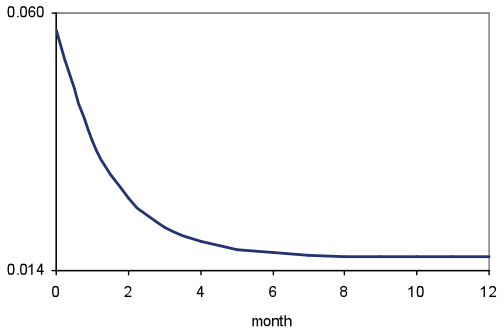


Response in Lasanod

month	response
0	0.03479
1	0.03495
2	0.03505
3	0.03510
4	0.03513
5	0.03514
6	0.03515
7	0.03515
8	0.03515
9	0.03515
10	0.03515
11	0.03515
12	0.03515



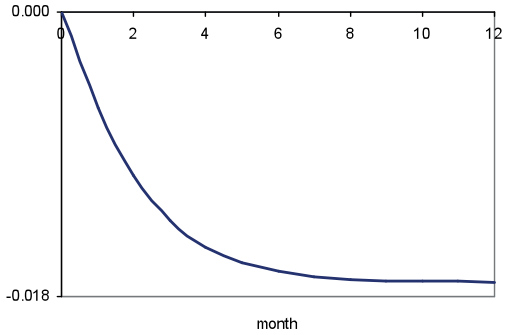
Response in Togwajiale	month response 0 0.04035 1 0.04152 2 0.04212 3 0.04243 4 0.04259 5 0.04267 6 0.04270 7 0.04272 8 0.04273 9 0.04274 10 0.04274 11 0.04274 12 0.04274	
Response in Zeilac Lawayacado	month response 0 0.03068 1 0.03900 2 0.04301 3 0.04494 4 0.04588 5 0.04633 6 0.04655 7 0.04666 8 0.04671 9 0.04674 10 0.04675 11 0.04676 12 0.04676	
Response to changes of red sorghum price in Hargeisa		
Response in Bosasso	month response 0 0.00000 1 0.00582 2 0.00955 3 0.01171 4 0.01290 5 0.01352 6 0.01385 7 0.01402 8 0.01411 9 0.01416 10 0.01418 11 0.01419 12 0.01420	
Response in Erigavo	month response 0 0.05766 1 0.06206 2 0.06491 3 0.06658 4 0.06751 5 0.06802 6 0.06829 7 0.06843 8 0.06850 9 0.06854 10 0.06856 11 0.06857 12 0.06858	

Response in Boroma	month response 0 0.09045 1 0.09298 2 0.08830 3 0.08396 4 0.08111 5 0.07945 6 0.07854 7 0.07805 8 0.07780 9 0.07767 10 0.07760 11 0.07757 12 0.07755	
Response in Lasanod	month response 0 0.03359 1 0.03959 2 0.04153 3 0.04215 4 0.04234 5 0.04239 6 0.04241 7 0.04241 8 0.04241 9 0.04241 10 0.04241 11 0.04241 12 0.04241	
Response in Togwajiale	month response 0 0.06769 1 0.07690 2 0.07931 3 0.07977 4 0.07976 5 0.07967 6 0.07959 7 0.07954 8 0.07952 9 0.07950 10 0.07949 11 0.07949 12 0.07949	
Response in Zeilac Lawayacado	month response 0 0.05706 1 0.03701 2 0.02685 3 0.02171 4 0.01911 5 0.01779 6 0.01712 7 0.01678 8 0.01661 9 0.01652 10 0.01648 11 0.01645 12 0.01644	

Response to changes of red rice price in Erigavo

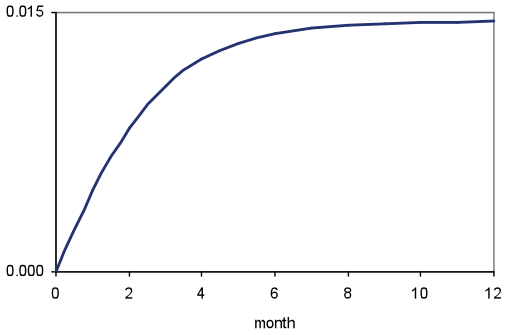
Response in Bosasso

month	response
0	0.00000
1	-0.00603
2	-0.01037
3	-0.01317
4	-0.01486
5	-0.01584
6	-0.01640
7	-0.01672
8	-0.01689
9	-0.01698
10	-0.01704
11	-0.01706
12	-0.01708



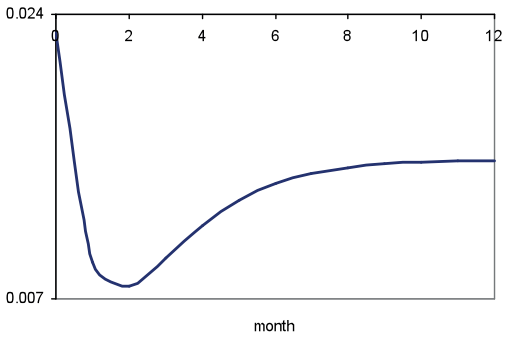
Response in Hargeisa

month	response
0	0.00000
1	0.00473
2	0.00832
3	0.01075
4	0.01229
5	0.01323
6	0.01378
7	0.01410
8	0.01427
9	0.01437
10	0.01443
11	0.01446
12	0.01447



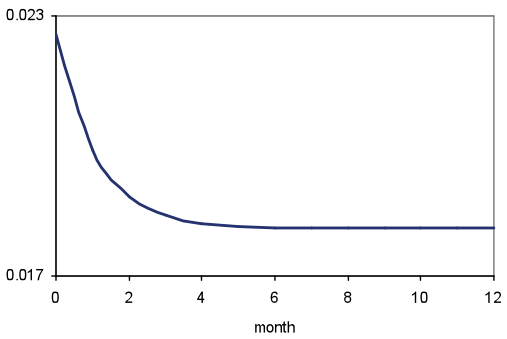
Response in Boroma

month	response
0	0.02294
1	0.00920
2	0.00772
3	0.00941
4	0.01137
5	0.01287
6	0.01387
7	0.01448
8	0.01485
9	0.01505
10	0.01517
11	0.01524
12	0.01527



Response in Lasanod

month	response
0	0.02256
1	0.01989
2	0.01882
3	0.01839
4	0.01822
5	0.01815
6	0.01812
7	0.01810
8	0.01810
9	0.01810
10	0.01810
11	0.01810
12	0.01810



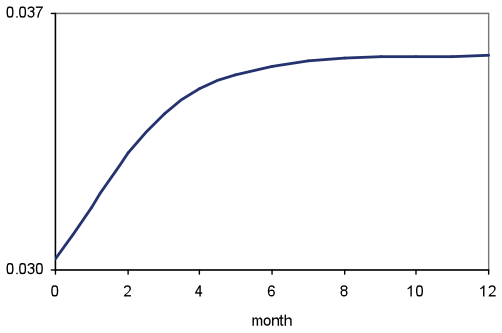
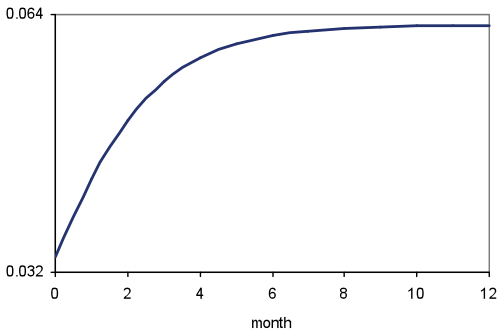
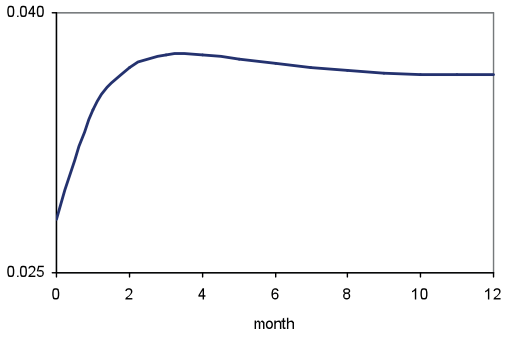
Response in Togwajiale	month response 0 0.03031 1 0.03170 2 0.03319 3 0.03427 4 0.03494 5 0.03534 6 0.03557 7 0.03570 8 0.03577 9 0.03580 10 0.03582 11 0.03583 12 0.03584	
Response in Zeilac Lawayacado	month response 0 0.03385 1 0.04365 2 0.05093 3 0.05571 4 0.05866 5 0.06040 6 0.06140 7 0.06197 8 0.06228 9 0.06245 10 0.06255 11 0.06260 12 0.06263	

Table A.16: Impulse response functions – Red rice in Central zone

Response to changes of red rice price in Galkayo

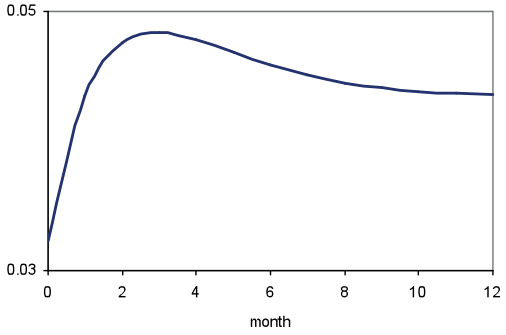
Response in Haradhere

month	response
0	0.02808
1	0.03439
2	0.03688
3	0.03760
4	0.03760
5	0.03735
6	0.03706
7	0.03682
8	0.03665
9	0.03653
10	0.03646
11	0.03642
12	0.03640



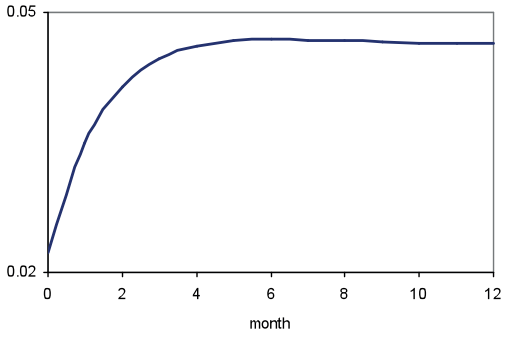
Response in Abudwak

month	response
0	0.03231
1	0.04347
2	0.04760
3	0.04841
4	0.04784
5	0.04686
6	0.04589
7	0.04509
8	0.04449
9	0.04408
10	0.04382
11	0.04365
12	0.04355



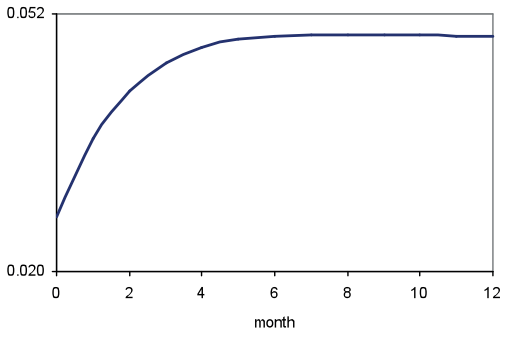
Response in Dusamared

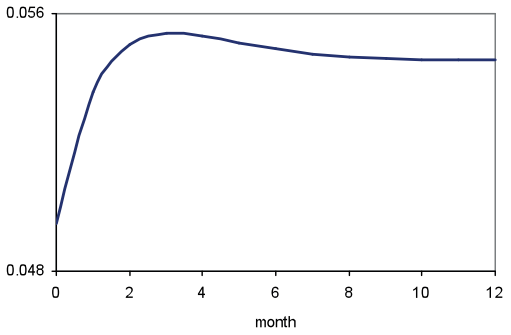
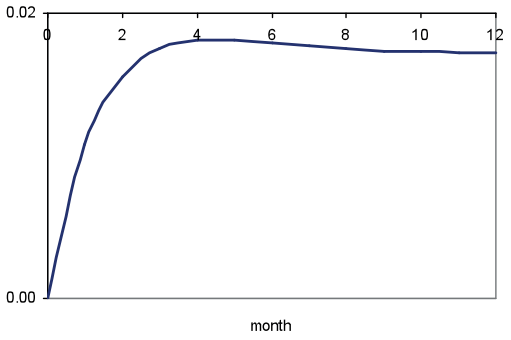
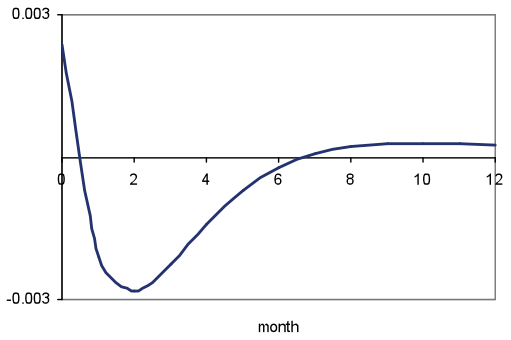
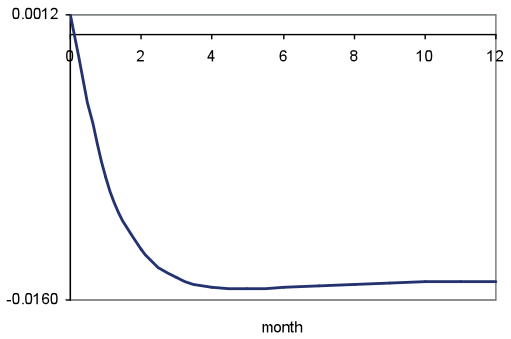
month	response
0	0.02231
1	0.03491
2	0.04146
3	0.04470
4	0.04617
5	0.04674
6	0.04687
7	0.04682
8	0.04671
9	0.04659
10	0.04649
11	0.04642
12	0.04637

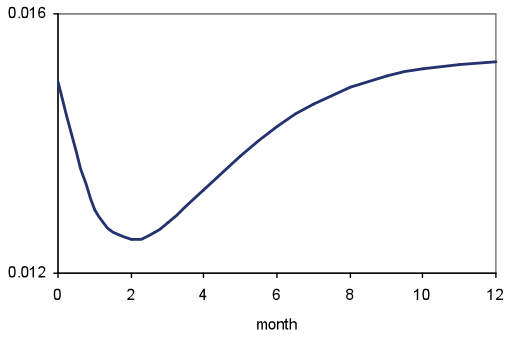
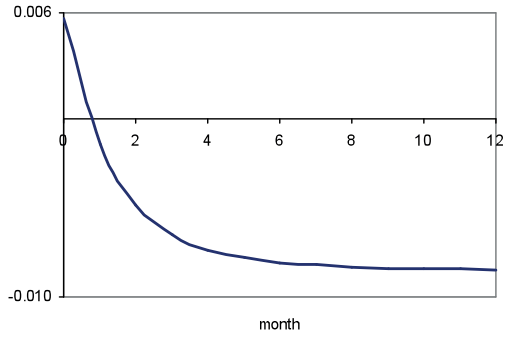
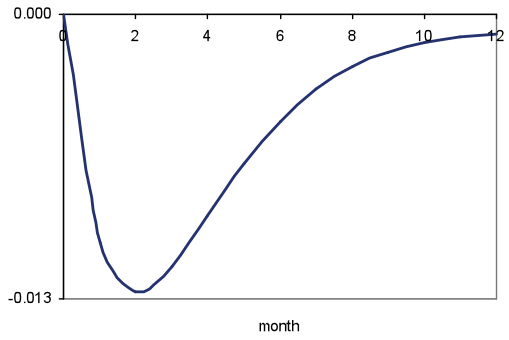
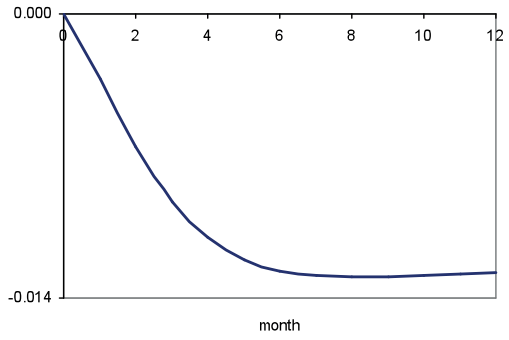


Response in El Der

month	response
0	0.02677
1	0.03644
2	0.04240
3	0.04591
4	0.04785
5	0.04885
6	0.04930
7	0.04945
8	0.04945
9	0.04940
10	0.04932
11	0.04925
12	0.04920



Response in Garowe	month response 0 0.04947 1 0.05356 2 0.05504 3 0.05538 4 0.05530 5 0.05510 6 0.05490 7 0.05476 8 0.05466 9 0.05460 10 0.05457 11 0.05455 12 0.05455	
Response to changes of red rice price in Hardhere		
Response in Galkayo	month response 0 0.00000 1 0.01075 2 0.01558 3 0.01751 4 0.01809 5 0.01810 6 0.01791 7 0.01769 8 0.01751 9 0.01738 10 0.01728 11 0.01723 12 0.01719	
Response in Abudwak	month response 0 0.00237 1 -0.00212 2 -0.00283 3 -0.00224 4 -0.00141 5 -0.00071 6 -0.00023 7 0.00006 8 0.00022 9 0.00028 10 0.00029 11 0.00028 12 0.00025	
Response in Dusamared	month response 0 0.00116 1 -0.00860 2 -0.01292 3 -0.01465 4 -0.01522 5 -0.01531 6 -0.01523 7 -0.01512 8 -0.01503 9 -0.01497 10 -0.01493 11 -0.01491 12 -0.01490	

Response in El Der	month response 0 0.01496 1 0.01297 2 0.01253 3 0.01278 4 0.01329 5 0.01381 6 0.01426 7 0.01461 8 0.01487 9 0.01504 10 0.01515 11 0.01522 12 0.01527	
Response in Garowe	month response 0 0.00569 1 -0.00137 2 -0.00481 3 -0.00650 4 -0.00735 5 -0.00780 6 -0.00805 7 -0.00821 8 -0.00831 9 -0.00837 10 -0.00842 11 -0.00845 12 -0.00847	
Response to changes of red rice price in Abudwak		
Response in Galkayo	month response 0 0.00000 1 -0.01043 2 -0.01270 3 -0.01151 4 -0.00920 5 -0.00685 6 -0.00489 7 -0.00342 8 -0.00239 9 -0.00171 10 -0.00128 11 -0.00102 12 -0.00088	
Response in Haradhere	month response 0 0.00000 1 -0.00318 2 -0.00658 3 -0.00924 4 -0.01103 5 -0.01209 6 -0.01265 7 -0.01290 8 -0.01296 9 -0.01293 10 -0.01286 11 -0.01279 12 -0.01273	

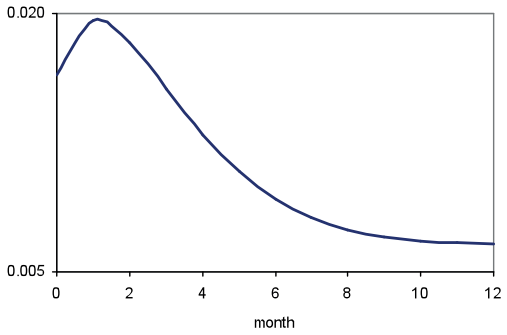
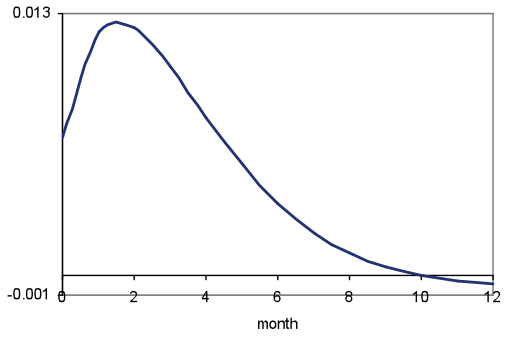
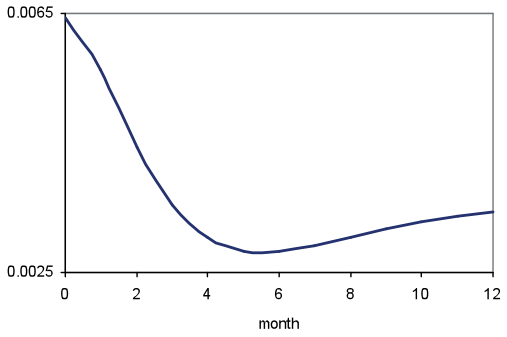
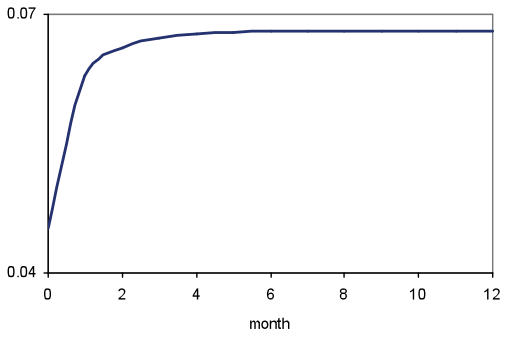
Response in Dusamared	month response 0 0.01644 1 0.01964 2 0.01833 3 0.01565 4 0.01297 5 0.01080 6 0.00921 7 0.00813 8 0.00745 9 0.00704 10 0.00680 11 0.00669 12 0.00663	
Response in El Der	month response 0 0.00683 1 0.01210 2 0.01230 3 0.01036 4 0.00785 5 0.00549 6 0.00356 7 0.00211 8 0.00109 9 0.00040 10 -0.00004 11 -0.00031 12 -0.00047	
Response in Garowe	month response 0 0.00643 1 0.00562 2 0.00444 3 0.00355 4 0.00304 5 0.00283 6 0.00282 7 0.00291 8 0.00304 9 0.00317 10 0.00328 11 0.00337 12 0.00343	

Table A.17: Impulse response functions – Red rice in Southern zone

Response to changes of red rice price in Merka

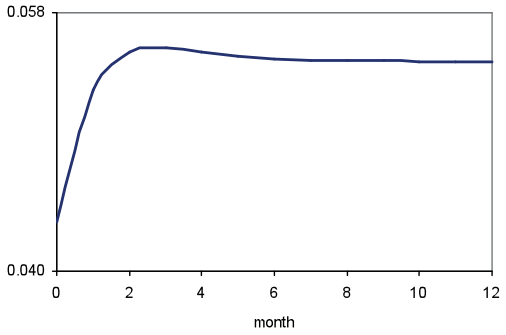
Response in Baidoa

month	response
0	0.04018
1	0.05784
2	0.06117
3	0.06230
4	0.06276
5	0.06294
6	0.06301
7	0.06304
8	0.06305
9	0.06305
10	0.06305
11	0.06305
12	0.06305



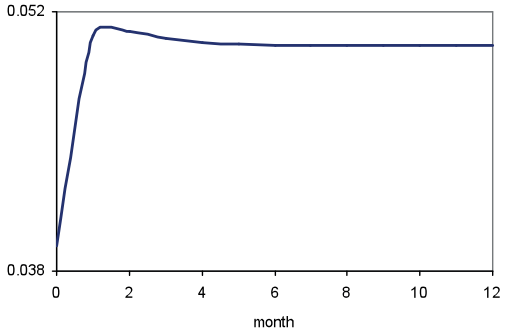
Response in Kismayo

month	response
0	0.04340
1	0.05260
2	0.05529
3	0.05553
4	0.05522
5	0.05494
6	0.05477
7	0.05469
8	0.05464
9	0.05463
10	0.05462
11	0.05462
12	0.05462



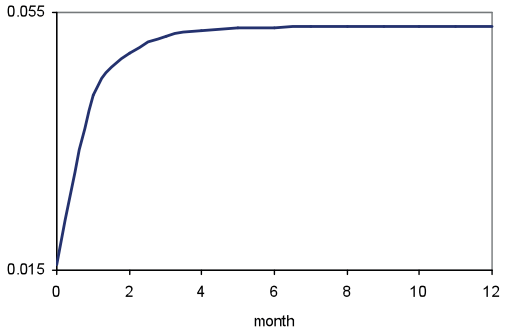
Response in Beletwein

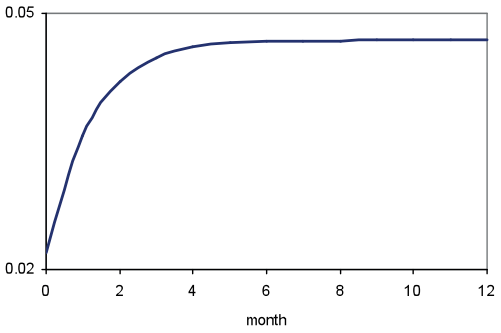
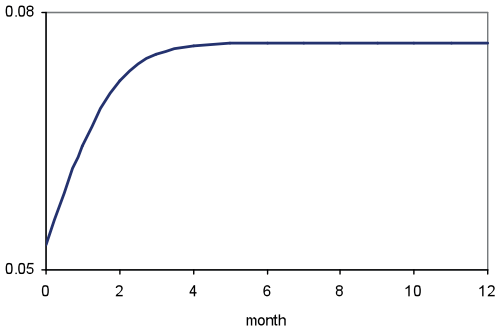
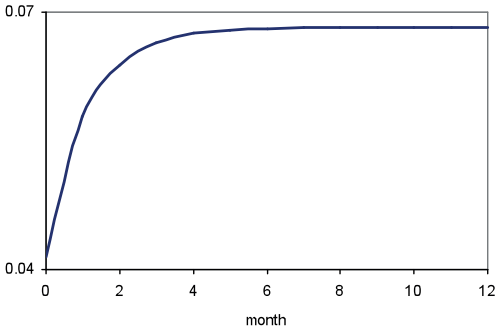
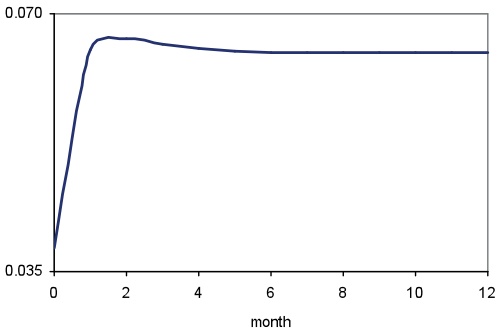
month	response
0	0.03939
1	0.05070
2	0.05092
3	0.05055
4	0.05034
5	0.05025
6	0.05022
7	0.05021
8	0.05020
9	0.05020
10	0.05020
11	0.05020
12	0.05020

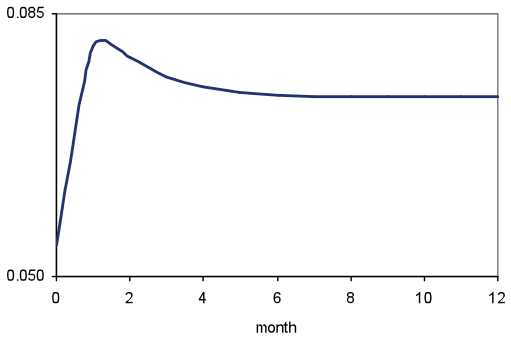
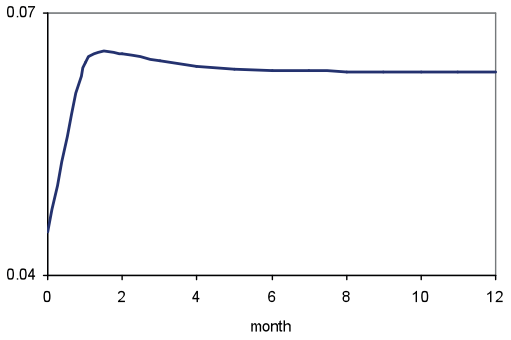
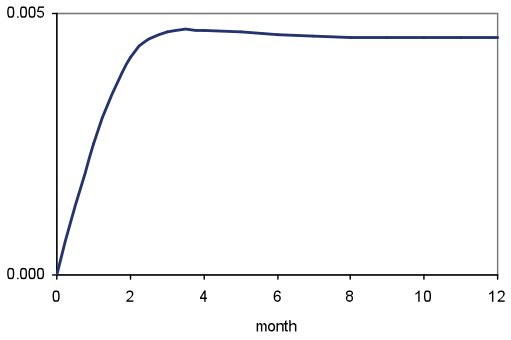
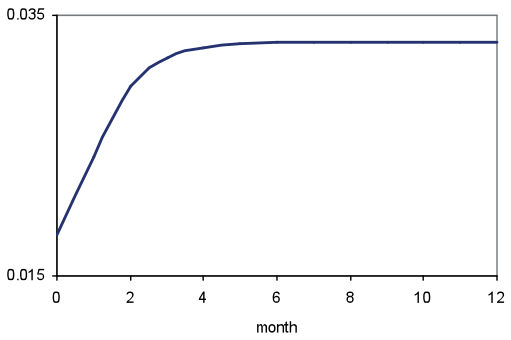


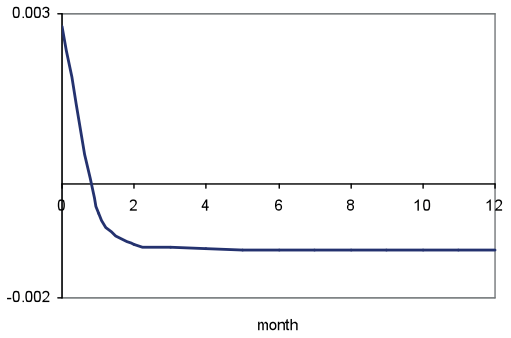
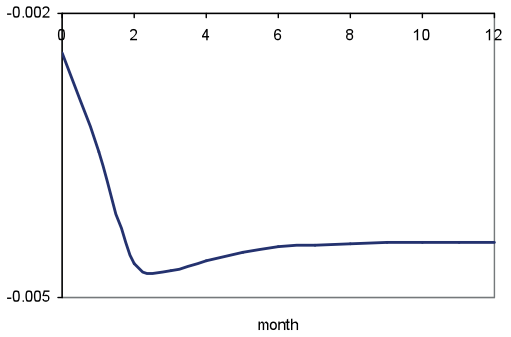
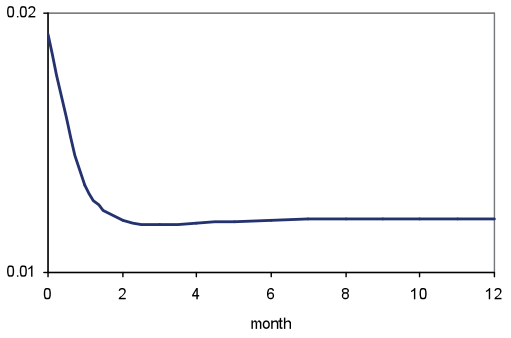
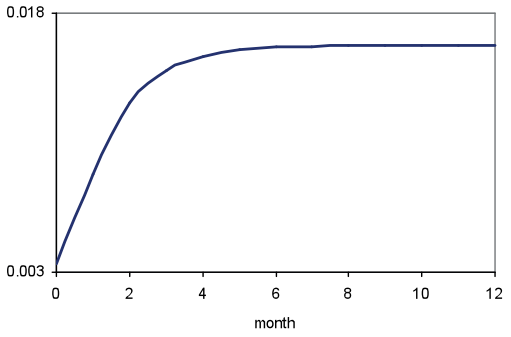
Response in Adanyabal

month	response
0	0.01586
1	0.04209
2	0.04878
3	0.05121
4	0.05217
5	0.05254
6	0.05268
7	0.05273
8	0.05275
9	0.05275
10	0.05275
11	0.05275
12	0.05275



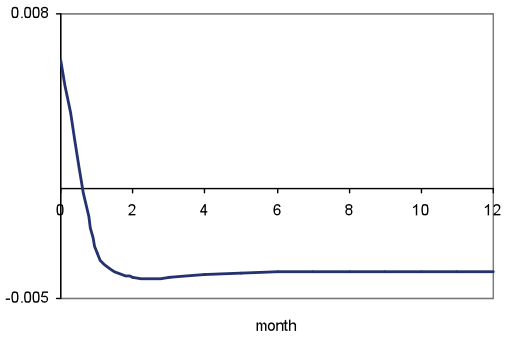
Response in Hudur	month response 0 0.02190 1 0.03571 2 0.04197 3 0.04481 4 0.04603 5 0.04653 6 0.04673 7 0.04680 8 0.04682 9 0.04683 10 0.04683 11 0.04683 12 0.04683	
Response in Jowhar	month response 0 0.04832 1 0.06185 2 0.07080 3 0.07433 4 0.07551 5 0.07585 6 0.07592 7 0.07592 8 0.07591 9 0.07590 10 0.07590 11 0.07590 12 0.07589	
Response in Mogadishu Bakara	month response 0 0.04118 1 0.05489 2 0.05993 3 0.06206 4 0.06294 5 0.06329 6 0.06342 7 0.06346 8 0.06348 9 0.06348 10 0.06348 11 0.06348 12 0.06348	
Response in Qansah Dere	month response 0 0.03816 1 0.06510 2 0.06666 3 0.06590 4 0.06530 5 0.06498 6 0.06482 7 0.06476 8 0.06473 9 0.06472 10 0.06471 11 0.06471 12 0.06471	

Response in Qorioley	month response 0 0.05419 1 0.08062 2 0.07913 3 0.07662 4 0.07518 5 0.07448 6 0.07417 7 0.07404 8 0.07399 9 0.07397 10 0.07397 11 0.07397 12 0.07397	
Response in Wanle Weyne	month response 0 0.04502 1 0.06442 2 0.06531 3 0.06449 4 0.06389 5 0.06358 6 0.06343 7 0.06336 8 0.06334 9 0.06333 10 0.06332 11 0.06332 12 0.06332	
Response to changes of red rice price in Baidoa		
Response in Merka	month response 0 0.00000 1 0.00252 2 0.00417 3 0.00464 4 0.00468 5 0.00464 6 0.00459 7 0.00457 8 0.00455 9 0.00455 10 0.00454 11 0.00454 12 0.00454	
Response in Kismayo	month response 0 0.01813 1 0.02418 2 0.02953 3 0.03172 4 0.03253 5 0.03280 6 0.03289 7 0.03291 8 0.03291 9 0.03291 10 0.03291 11 0.03291 12 0.03291	

Response in Beletwein	month response 0 0.00278 1 -0.00051 2 -0.00106 3 -0.00112 4 -0.00114 5 -0.00115 6 -0.00116 7 -0.00117 8 -0.00117 9 -0.00117 10 -0.00117 11 -0.00117 12 -0.00117	
Response in Adanyabal	month response 0 -0.00242 1 -0.00347 2 -0.00465 3 -0.00472 4 -0.00461 5 -0.00452 6 -0.00447 7 -0.00444 8 -0.00443 9 -0.00442 10 -0.00442 11 -0.00442 12 -0.00442	
Response in Hudur	month response 0 0.01513 1 0.00871 2 0.00721 3 0.00701 4 0.00708 5 0.00717 6 0.00723 7 0.00726 8 0.00727 9 0.00728 10 0.00728 11 0.00728 12 0.00728	
Response in Jowhar	month response 0 0.00348 1 0.00869 2 0.01278 3 0.01467 4 0.01551 5 0.01587 6 0.01602 7 0.01608 8 0.01610 9 0.01611 10 0.01611 11 0.01611 12 0.01611	

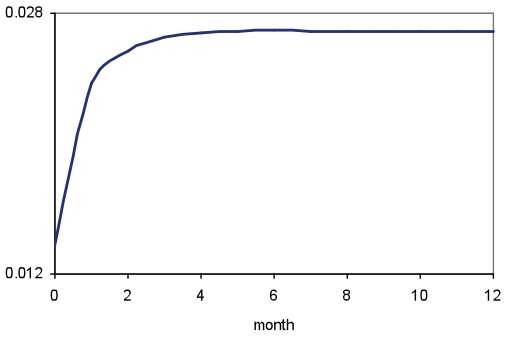
Response in Mogadishu Bakara

month	response
0	0.00588
1	-0.00293
2	-0.00403
3	-0.00405
4	-0.00394
5	-0.00385
6	-0.00380
7	-0.00378
8	-0.00377
9	-0.00376
10	-0.00376
11	-0.00376
12	-0.00376



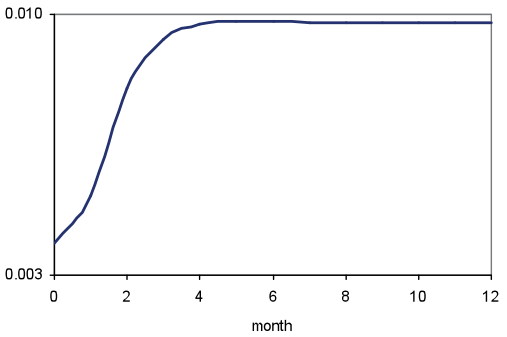
Response in Qansah Dere

month	response
0	0.01383
1	0.02367
2	0.02567
3	0.02653
4	0.02683
5	0.02691
6	0.02693
7	0.02692
8	0.02692
9	0.02692
10	0.02692
11	0.02691
12	0.02691



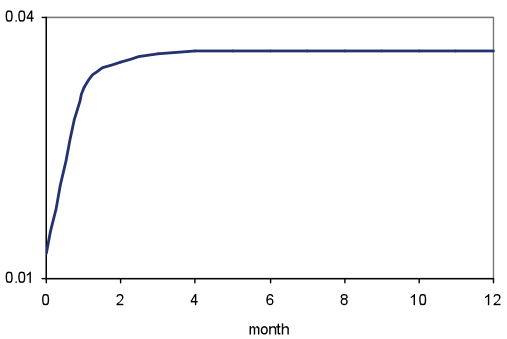
Response in Qorioley

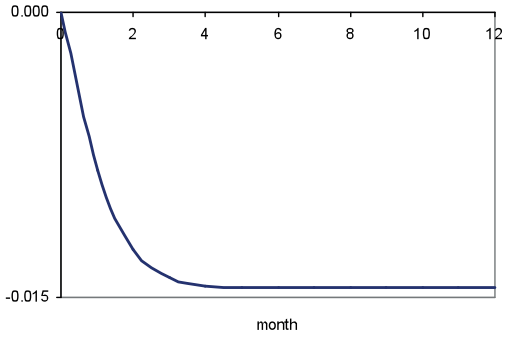
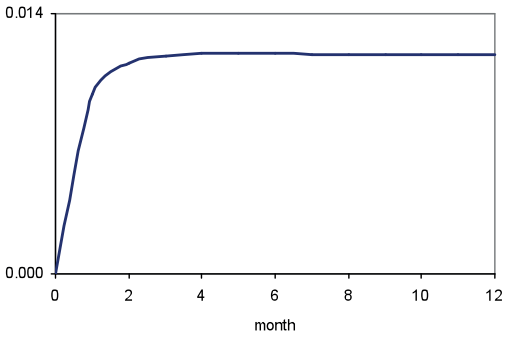
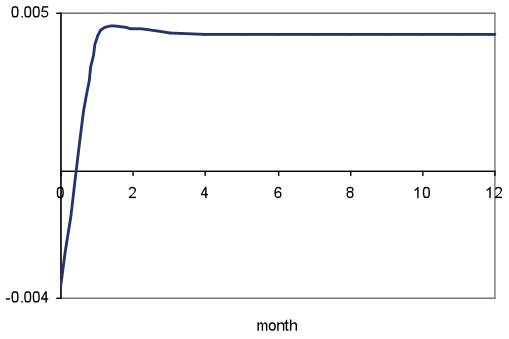
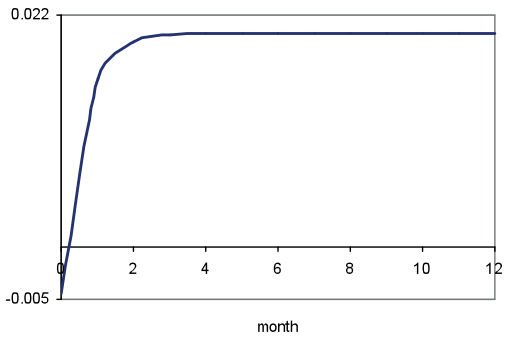
month	response
0	0.00386
1	0.00512
2	0.00802
3	0.00934
4	0.00973
5	0.00981
6	0.00980
7	0.00978
8	0.00977
9	0.00976
10	0.00976
11	0.00976
12	0.00976



Response in Wanle Weyne

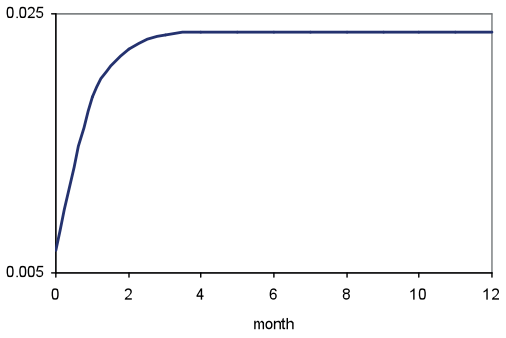
month	response
0	0.01464
1	0.03249
2	0.03520
3	0.03609
4	0.03639
5	0.03647
6	0.03648
7	0.03647
8	0.03647
9	0.03647
10	0.03647
11	0.03647
12	0.03646



Response to changes of red rice price in Kismayo		
Response in Merka	month response 0 0.00000 1 -0.00831 2 -0.01248 3 -0.01394 4 -0.01437 5 -0.01447 6 -0.01448 7 -0.01447 8 -0.01446 9 -0.01446 10 -0.01445 11 -0.01445 12 -0.01445	
Response in Baidoa	month response 0 0.00000 1 0.00966 2 0.01135 3 0.01175 4 0.01184 5 0.01185 6 0.01184 7 0.01183 8 0.01183 9 0.01182 10 0.01182 11 0.01182 12 0.01182	
Response in Beletwein	month response 0 -0.00356 1 0.00430 2 0.00450 3 0.00437 4 0.00432 5 0.00432 6 0.00432 7 0.00432 8 0.00433 9 0.00433 10 0.00433 11 0.00433 12 0.00433	
Response in Adanyabal	month response 0 -0.00446 1 0.01595 2 0.01945 3 0.02018 4 0.02031 5 0.02030 6 0.02028 7 0.02026 8 0.02025 9 0.02024 10 0.02024 11 0.02024 12 0.02024	

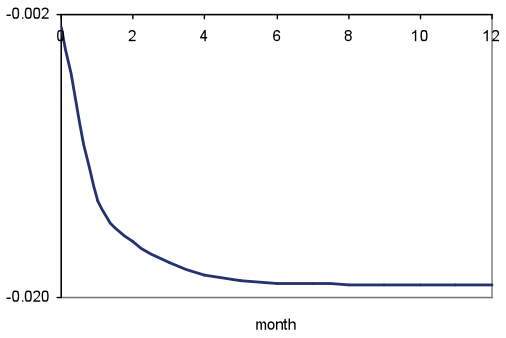
Response in Hudur

month	response
0	0.00672
1	0.01860
2	0.02227
3	0.02335
4	0.02361
5	0.02364
6	0.02362
7	0.02361
8	0.02359
9	0.02359
10	0.02358
11	0.02358
12	0.02358



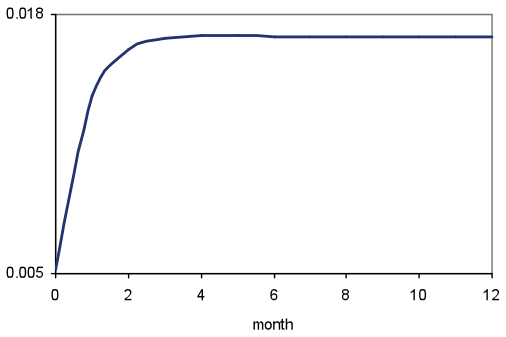
Response in Jowhar

month	response
0	-0.00282
1	-0.01387
2	-0.01644
3	-0.01779
4	-0.01853
5	-0.01890
6	-0.01907
7	-0.01915
8	-0.01918
9	-0.01919
10	-0.01919
11	-0.01919
12	-0.01919



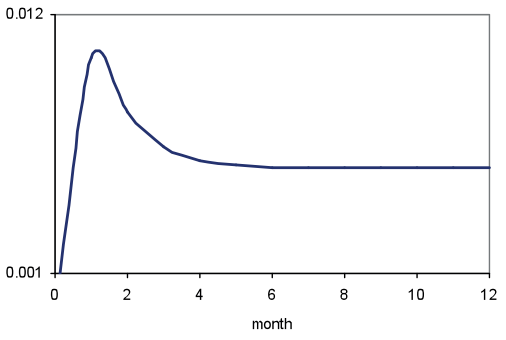
Response in Mogadishu Bakara

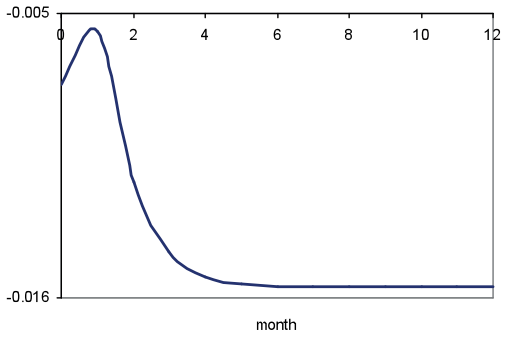
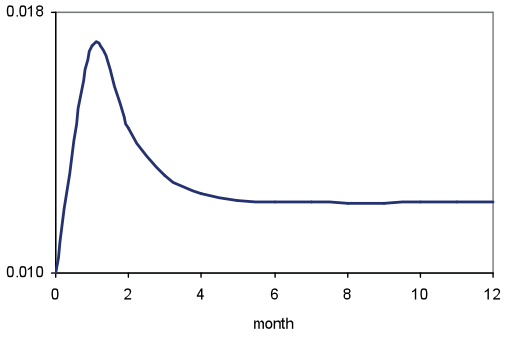
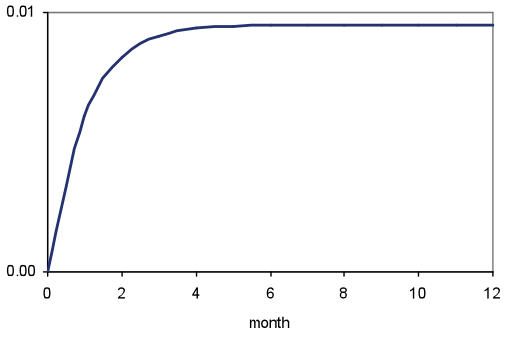
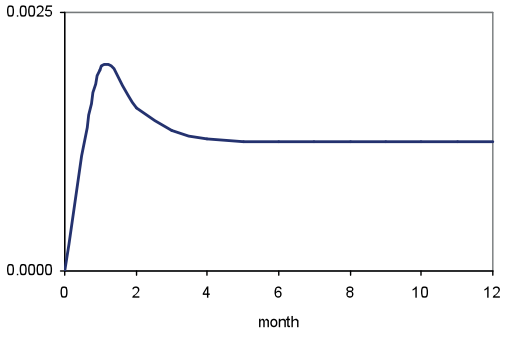
month	response
0	0.00521
1	0.01391
2	0.01622
3	0.01683
4	0.01694
5	0.01693
6	0.01691
7	0.01689
8	0.01688
9	0.01687
10	0.01687
11	0.01687
12	0.01687



Response in Qansah Dere

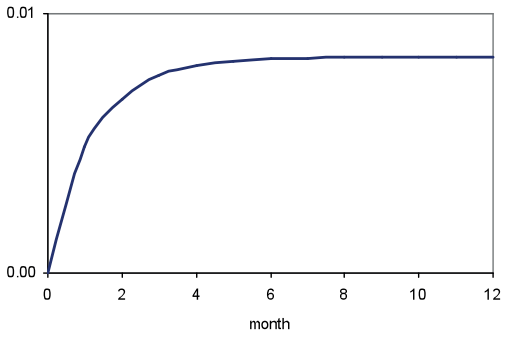
month	response
0	-0.00075
1	0.01014
2	0.00784
3	0.00637
4	0.00579
5	0.00559
6	0.00552
7	0.00551
8	0.00551
9	0.00551
10	0.00551
11	0.00551
12	0.00551



Response in Qorioley	month response 0 -0.00773 1 -0.00573 2 -0.01153 3 -0.01420 4 -0.01517 5 -0.01547 6 -0.01556 7 -0.01557 8 -0.01557 9 -0.01556 10 -0.01556 11 -0.01556 12 -0.01556	
Response in Wanle Weyne	month response 0 0.01001 1 0.01699 2 0.01445 3 0.01300 4 0.01243 5 0.01224 6 0.01218 7 0.01216 8 0.01216 9 0.01216 10 0.01216 11 0.01216 12 0.01216	
Response to changes of red rice price in Beletwein		
Response in Merka	month response 0 0.00000 1 0.00601 2 0.00826 3 0.00909 4 0.00938 5 0.00948 6 0.00951 7 0.00951 8 0.00951 9 0.00951 10 0.00951 11 0.00951 12 0.00951	
Response in Baidoa	month response 0 0.00000 1 0.00195 2 0.00158 3 0.00136 4 0.00128 5 0.00126 6 0.00125 7 0.00125 8 0.00125 9 0.00125 10 0.00125 11 0.00125 12 0.00125	

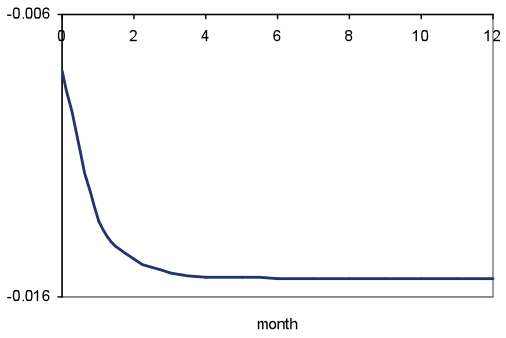
Response in Kismayo

month	response
0	0.00000
1	0.00489
2	0.00671
3	0.00760
4	0.00801
5	0.00819
6	0.00826
7	0.00829
8	0.00830
9	0.00830
10	0.00830
11	0.00830
12	0.00830



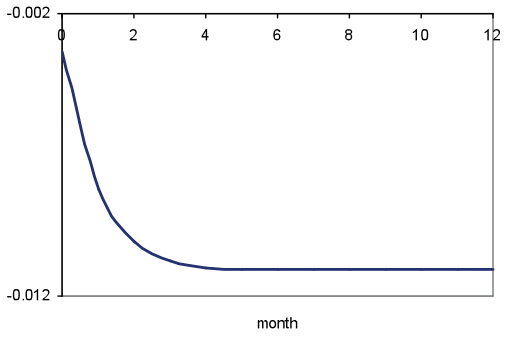
Response in Adanyabal

month	response
0	-0.00799
1	-0.01330
2	-0.01468
3	-0.01514
4	-0.01529
5	-0.01533
6	-0.01534
7	-0.01533
8	-0.01533
9	-0.01533
10	-0.01533
11	-0.01533
12	-0.01533



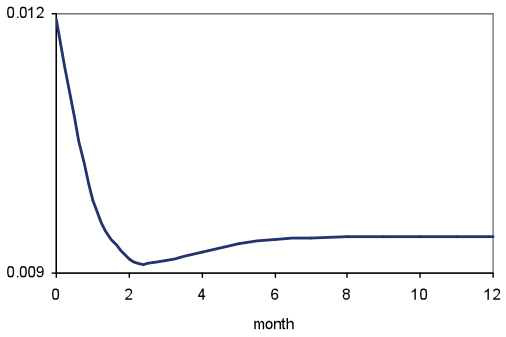
Response in Hudur

month	response
0	-0.00333
1	-0.00820
2	-0.01008
3	-0.01076
4	-0.01099
5	-0.01106
6	-0.01108
7	-0.01108
8	-0.01108
9	-0.01108
10	-0.01108
11	-0.01108
12	-0.01108



Response in Jowhar

month	response
0	0.01193
1	0.00985
2	0.00916
3	0.00914
4	0.00925
5	0.00933
6	0.00938
7	0.00941
8	0.00942
9	0.00942
10	0.00943
11	0.00943
12	0.00943



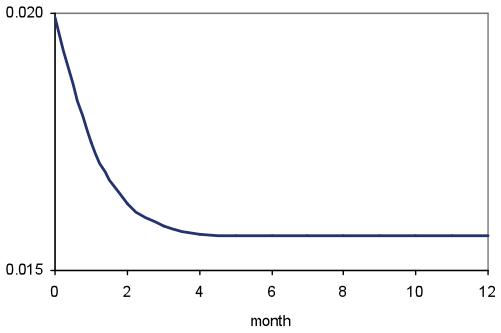
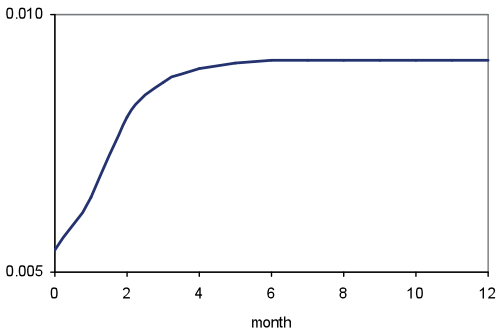
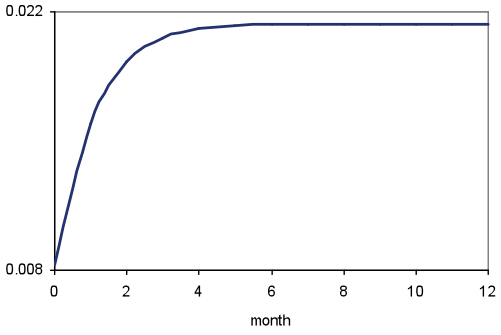
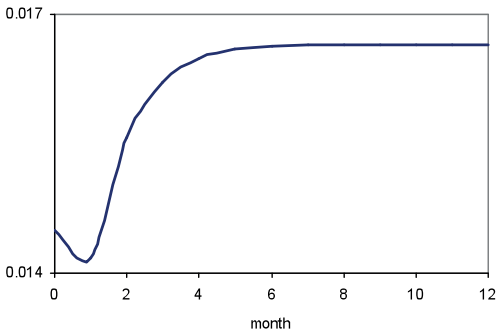
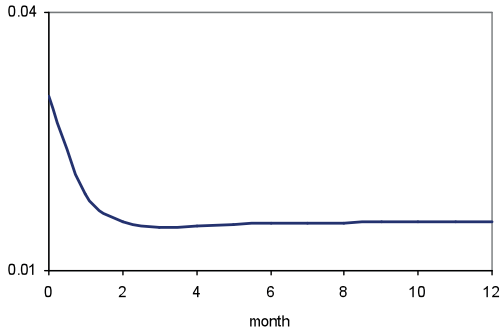
Response in Mogadishu Bakara	month response 0 0.01992 1 0.01748 2 0.01629 3 0.01585 4 0.01572 5 0.01568 6 0.01567 7 0.01567 8 0.01567 9 0.01567 10 0.01568 11 0.01568 12 0.01568	
Response in Qansah Dere	month response 0 0.00543 1 0.00645 2 0.00800 3 0.00868 4 0.00896 5 0.00907 6 0.00910 7 0.00912 8 0.00912 9 0.00912 10 0.00912 11 0.00912 12 0.00912	
Response in Qorioley	month response 0 0.00830 1 0.01597 2 0.01928 3 0.02059 4 0.02109 5 0.02127 6 0.02134 7 0.02135 8 0.02136 9 0.02136 10 0.02136 11 0.02136 12 0.02136	
Response in Wanle Weyne	month response 0 0.01449 1 0.01417 2 0.01557 3 0.01622 4 0.01649 5 0.01659 6 0.01663 7 0.01664 8 0.01665 9 0.01665 10 0.01665 11 0.01665 12 0.01665	

Table A.18: Impulse response functions – Red rice in all zones

Response to changes of red rice price in Baidoa

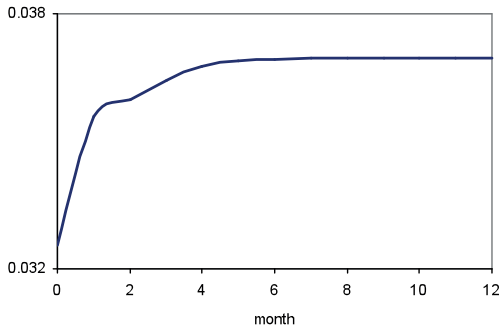
Response in Merka

month	response
0	0.03023
1	0.01898
2	0.01575
3	0.01508
4	0.01517
5	0.01536
6	0.01550
7	0.01557
8	0.01559
9	0.01560
10	0.01560
11	0.01560
12	0.01560



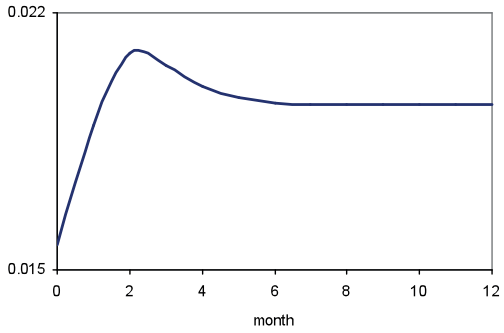
Response in Beletwein

month	response
0	0.03257
1	0.03560
2	0.03596
3	0.03644
4	0.03675
5	0.03689
6	0.03694
7	0.03695
8	0.03695
9	0.03694
10	0.03694
11	0.03694
12	0.03694



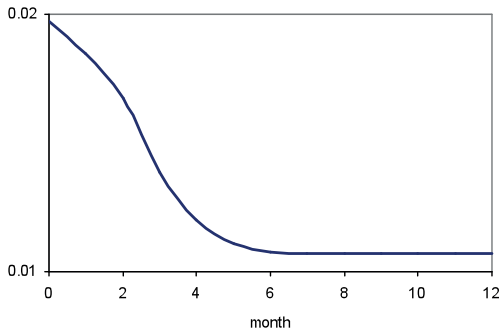
Response in Galkayo

month	response
0	0.01569
1	0.01892
2	0.02089
3	0.02055
4	0.02000
5	0.01968
6	0.01955
7	0.01951
8	0.01950
9	0.01951
10	0.01951
11	0.01951
12	0.01952



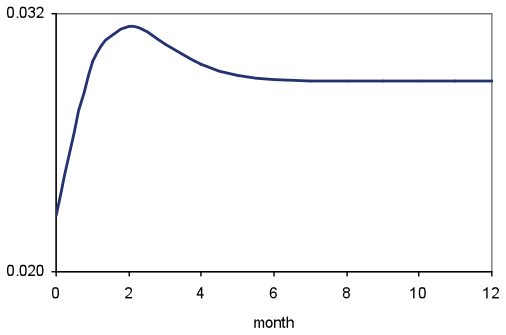
Response in Bosasso

month	response
0	0.01789
1	0.01740
2	0.01670
3	0.01555
4	0.01480
5	0.01444
6	0.01431
7	0.01427
8	0.01427
9	0.01428
10	0.01429
11	0.01429
12	0.01429



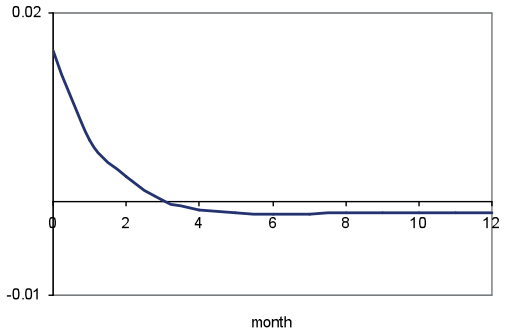
Response in Jowhar

month	response
0	0.02262
1	0.02979
2	0.03143
3	0.03058
4	0.02966
5	0.02914
6	0.02892
7	0.02885
8	0.02884
9	0.02885
10	0.02886
11	0.02886
12	0.02886



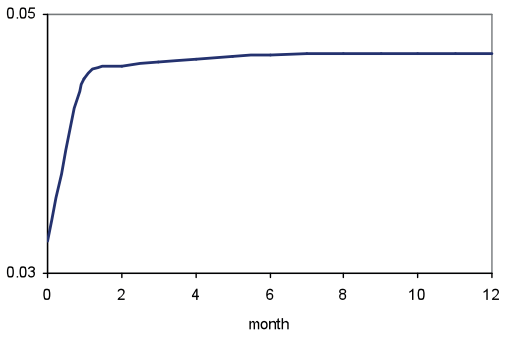
Response in Kismayo

month	response
0	0.01594
1	0.00650
2	0.00258
3	0.00015
4	-0.00094
5	-0.00129
6	-0.00135
7	-0.00132
8	-0.00128
9	-0.00126
10	-0.00125
11	-0.00125
12	-0.00125



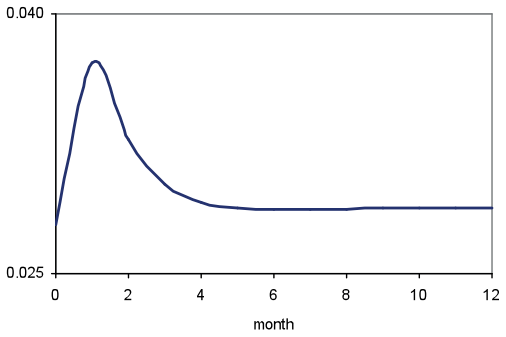
Response in Lugh

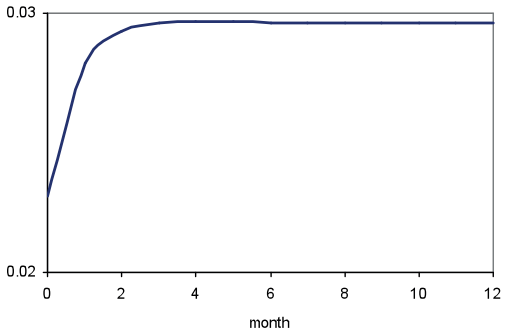
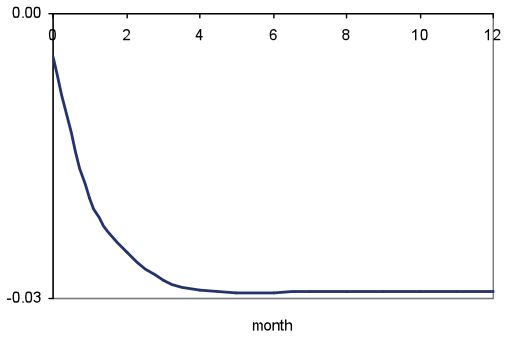
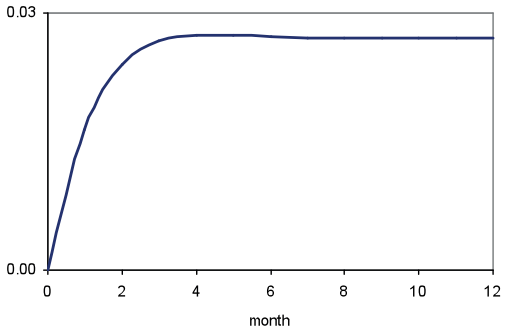
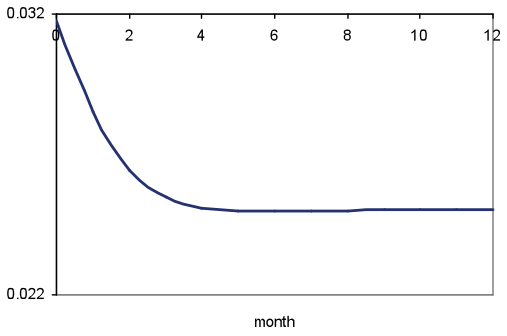
month	response
0	0.03249
1	0.04503
2	0.04600
3	0.04632
4	0.04659
5	0.04679
6	0.04691
7	0.04697
8	0.04699
9	0.04700
10	0.04701
11	0.04701
12	0.04701

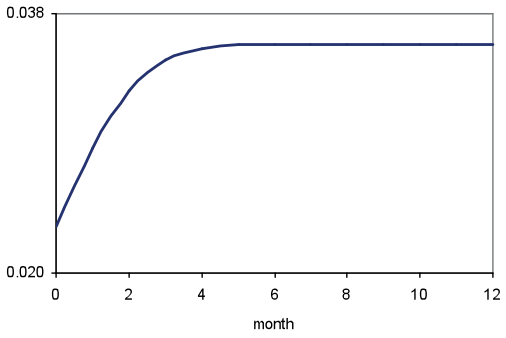
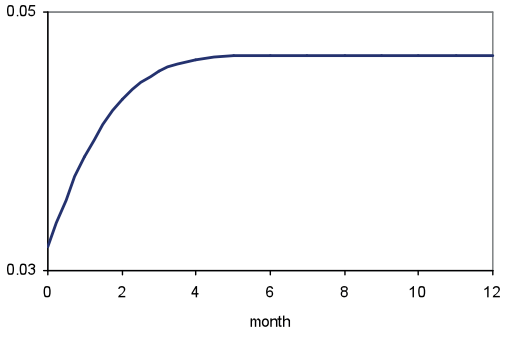
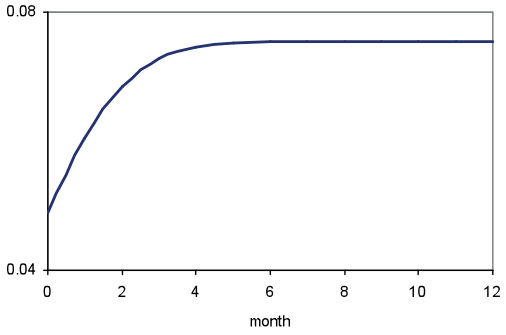
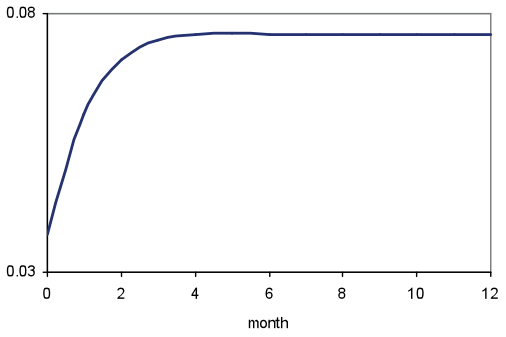


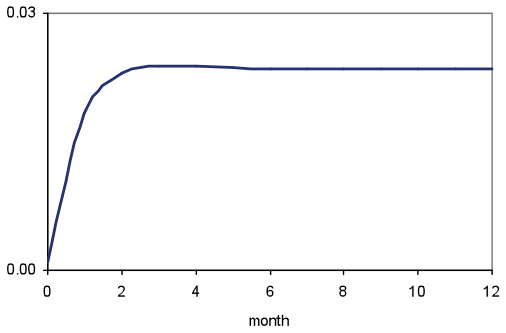
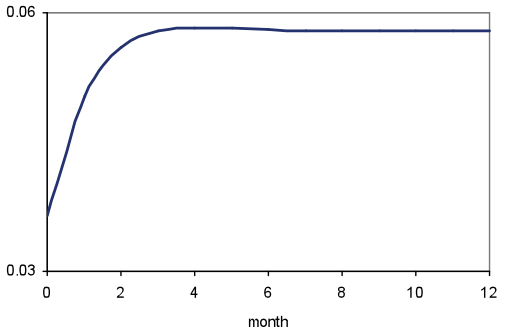
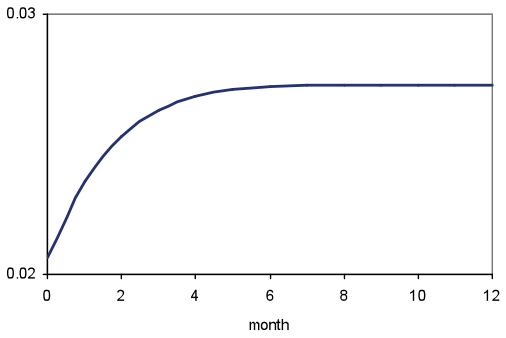
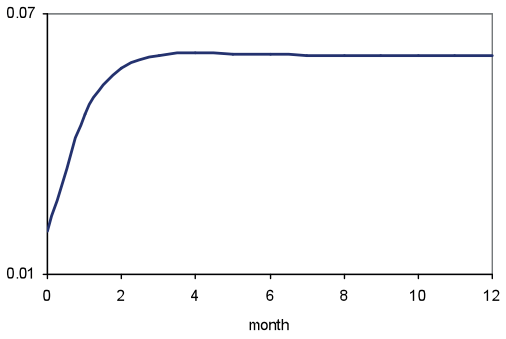
Response in Wanle Weyne

month	response
0	0.02782
1	0.03714
2	0.03277
3	0.03017
4	0.02909
5	0.02875
6	0.02870
7	0.02872
8	0.02874
9	0.02876
10	0.02877
11	0.02877
12	0.02877



Response in Haradhere	month response 0 0.01854 1 0.02467 2 0.02615 3 0.02656 4 0.02662 5 0.02660 6 0.02657 7 0.02656 8 0.02655 9 0.02655 10 0.02655 11 0.02655 12 0.02655	
Response in Hargeisa	month response 0 -0.00459 1 -0.01948 2 -0.02522 3 -0.02811 4 -0.02917 5 -0.02941 6 -0.02937 7 -0.02930 8 -0.02925 9 -0.02922 10 -0.02921 11 -0.02920 12 -0.02920	
Response to changes of red rice price in Merka		
Response in Baidoa	month response 0 0.00000 1 0.01528 2 0.02247 3 0.02497 4 0.02555 5 0.02553 6 0.02540 7 0.02530 8 0.02525 9 0.02523 10 0.02523 11 0.02522 12 0.02522	
Response in Beletwein	month response 0 0.03177 1 0.02854 2 0.02645 3 0.02547 4 0.02510 5 0.02500 6 0.02499 7 0.02500 8 0.02501 9 0.02501 10 0.02502 11 0.02502 12 0.02502	

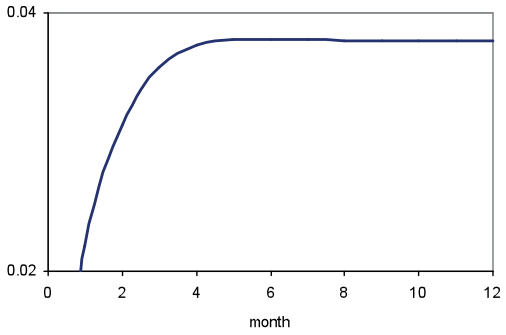
Response in Galkayo	month response 0 0.02325 1 0.02866 2 0.03270 3 0.03476 4 0.03560 5 0.03586 6 0.03590 7 0.03588 8 0.03585 9 0.03584 10 0.03583 11 0.03582 12 0.03582	
Response in Bosasso	month response 0 0.02734 1 0.03600 2 0.04154 3 0.04426 4 0.04537 5 0.04572 6 0.04580 7 0.04579 8 0.04577 9 0.04576 10 0.04575 11 0.04575 12 0.04575	
Response in Jowhar	month response 0 0.04883 1 0.06044 2 0.06850 3 0.07275 4 0.07463 5 0.07532 6 0.07551 7 0.07553 8 0.07552 9 0.07550 10 0.07549 11 0.07549 12 0.07549	
Response in Kismayo	month response 0 0.03732 1 0.06060 2 0.07103 3 0.07486 4 0.07594 5 0.07609 6 0.07601 7 0.07593 8 0.07588 9 0.07586 10 0.07585 11 0.07585 12 0.07585	

Response in Lugh	month response 0 0.00080 1 0.01524 2 0.01913 3 0.01987 4 0.01984 5 0.01971 6 0.01963 7 0.01960 8 0.01959 9 0.01959 10 0.01959 11 0.01959 12 0.01960	
Response in Wanle Weyne	month response 0 0.03644 1 0.05025 2 0.05596 3 0.05788 4 0.05826 5 0.05818 6 0.05803 7 0.05793 8 0.05788 9 0.05785 10 0.05785 11 0.05785 12 0.05785	
Response in Haradhere	month response 0 0.02267 1 0.02559 2 0.02731 3 0.02831 4 0.02884 5 0.02910 6 0.02921 7 0.02925 8 0.02926 9 0.02927 10 0.02927 11 0.02927 12 0.02927	
Response in Hargeisa	month response 0 0.01993 1 0.04685 2 0.05735 3 0.06047 4 0.06096 5 0.06077 6 0.06054 7 0.06039 8 0.06033 9 0.06030 10 0.06029 11 0.06029 12 0.06029	

Response to changes of red rice price in Beletwein

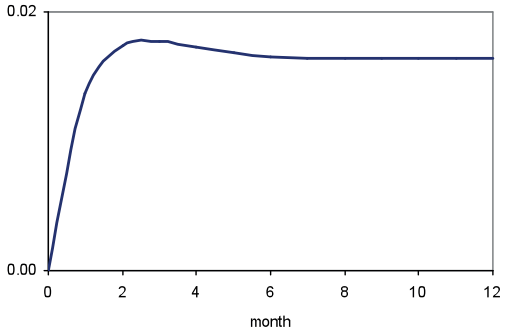
Response in Baidoa

month	response
0	0.00000
1	0.02189
2	0.03135
3	0.03579
4	0.03748
5	0.03795
6	0.03799
7	0.03793
8	0.03788
9	0.03785
10	0.03783
11	0.03783
12	0.03783



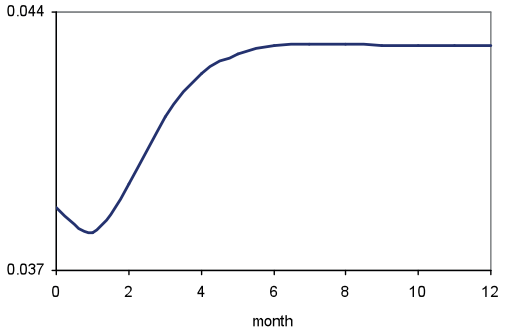
Response in Merka

month	response
0	0.00000
1	0.01367
2	0.01741
3	0.01776
4	0.01729
5	0.01684
6	0.01657
7	0.01645
8	0.01640
9	0.01639
10	0.01639
11	0.01639
12	0.01639



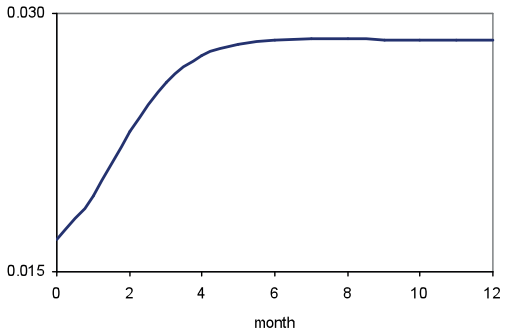
Response in Galkayo

month	response
0	0.03869
1	0.03803
2	0.03933
3	0.04116
4	0.04233
5	0.04288
6	0.04308
7	0.04312
8	0.04312
9	0.04311
10	0.04310
11	0.04309
12	0.04309



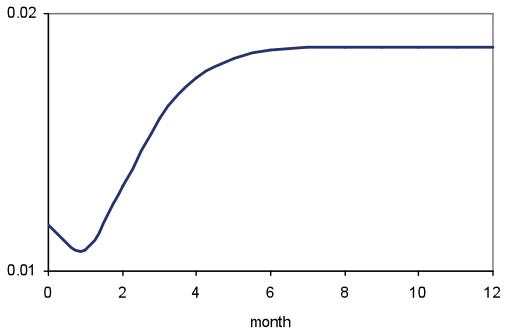
Response in Bosasso

month	response
0	0.01685
1	0.01942
2	0.02315
3	0.02599
4	0.02753
5	0.02820
6	0.02844
7	0.02850
8	0.02850
9	0.02849
10	0.02848
11	0.02847
12	0.02847



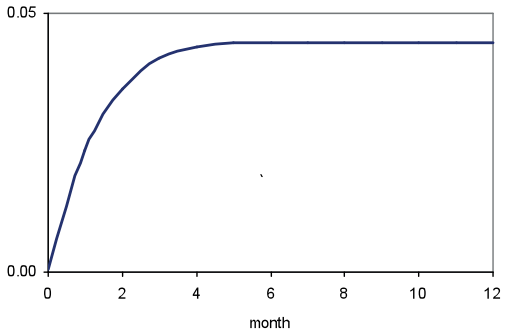
Response in Jowhar

month	response
0	0.01053
1	0.00914
2	0.01265
3	0.01627
4	0.01851
5	0.01959
6	0.02001
7	0.02014
8	0.02016
9	0.02016
10	0.02015
11	0.02014
12	0.02014



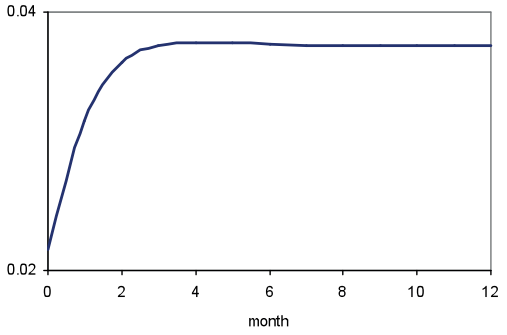
Response in Kismayo

month	response
0	0.00061
1	0.02353
2	0.03553
3	0.04131
4	0.04359
5	0.04430
6	0.04442
7	0.04439
8	0.04434
9	0.04430
10	0.04429
11	0.04428
12	0.04428



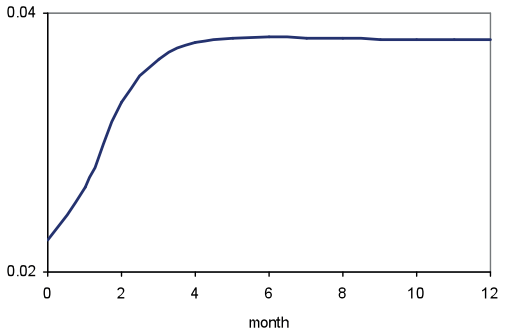
Response in Lugh

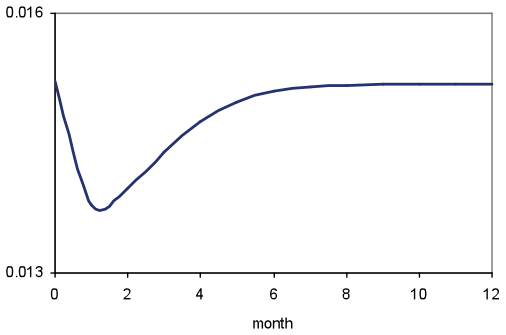
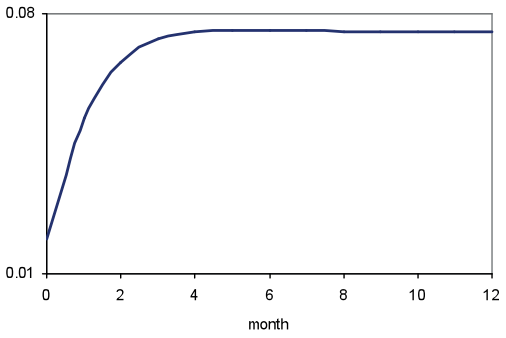
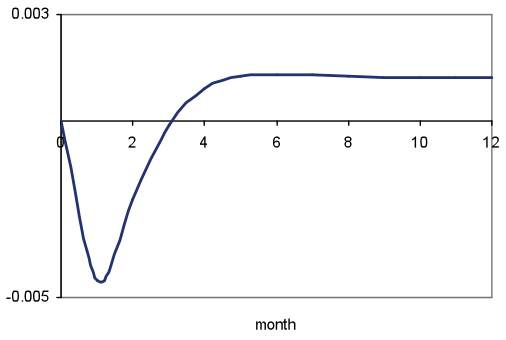
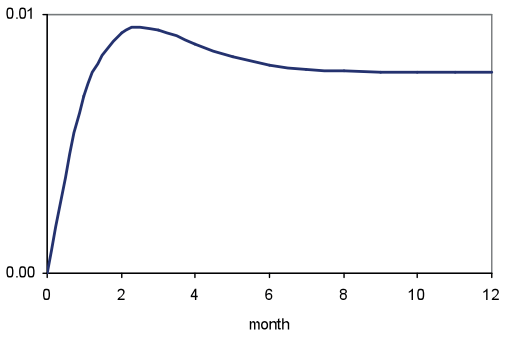
month	response
0	0.01705
1	0.02950
2	0.03518
3	0.03682
4	0.03706
5	0.03697
6	0.03685
7	0.03679
8	0.03676
9	0.03675
10	0.03675
11	0.03675
12	0.03675

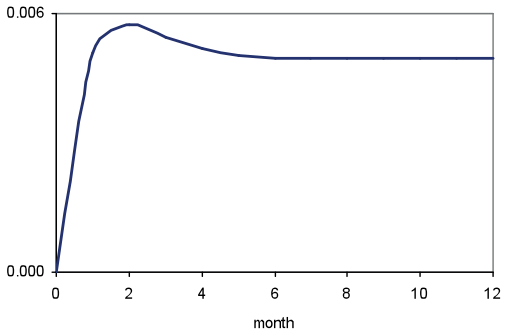
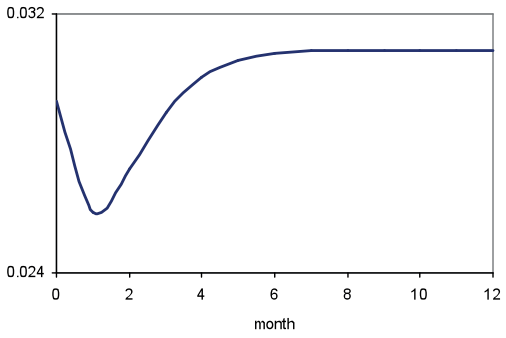
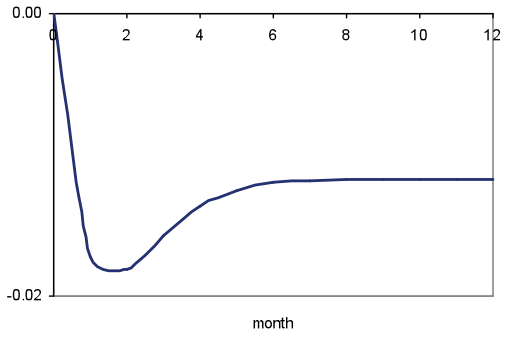
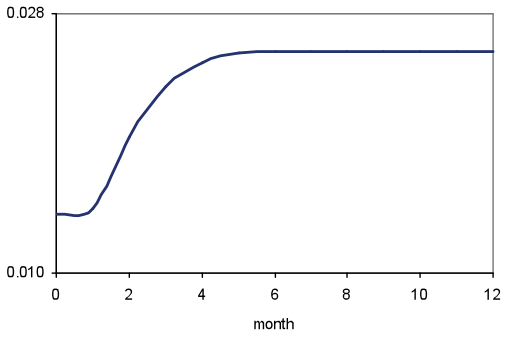


Response in Wanle Weyne

month	response
0	0.01788
1	0.02253
2	0.03011
3	0.03396
4	0.03544
5	0.03583
6	0.03585
7	0.03579
8	0.03573
9	0.03570
10	0.03569
11	0.03568
12	0.03568

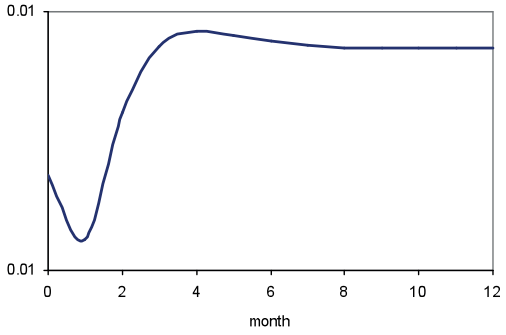


Response in Haradhere	month response 0 0.01522 1 0.01379 2 0.01398 3 0.01440 4 0.01475 5 0.01498 6 0.01509 7 0.01515 8 0.01517 9 0.01518 10 0.01518 11 0.01518 12 0.01518	
Response in Hargeisa	month response 0 0.01953 1 0.05199 2 0.06689 3 0.07312 4 0.07517 5 0.07559 6 0.07553 7 0.07540 8 0.07531 9 0.07527 10 0.07525 11 0.07525 12 0.07525	
Response to changes of red rice price in Galkayo		
Response in Baidoa	month response 0 0.00000 1 -0.00453 2 -0.00222 3 -0.00013 4 0.00090 5 0.00125 6 0.00131 7 0.00129 8 0.00126 9 0.00124 10 0.00122 11 0.00122 12 0.00122	
Response in Merka	month response 0 0.00000 1 0.00445 2 0.00604 3 0.00612 4 0.00576 5 0.00543 6 0.00523 7 0.00512 8 0.00508 9 0.00507 10 0.00506 11 0.00506 12 0.00506	

Response in Beletwein	month response 0 0.00000 1 0.00510 2 0.00573 3 0.00546 4 0.00518 5 0.00503 6 0.00497 7 0.00496 8 0.00496 9 0.00496 10 0.00497 11 0.00497 12 0.00497	
Response in Bosasso	month response 0 0.02929 1 0.02587 2 0.02724 3 0.02895 4 0.03004 5 0.03058 6 0.03079 7 0.03086 8 0.03087 9 0.03087 10 0.03087 11 0.03087 12 0.03087	
Response in Jowhar	month response 0 -0.00091 1 -0.01306 2 -0.01367 3 -0.01198 4 -0.01055 5 -0.00975 6 -0.00939 7 -0.00926 8 -0.00922 9 -0.00922 10 -0.00922 11 -0.00923 12 -0.00923	
Response in Kismayo	month response 0 0.01411 1 0.01444 2 0.01945 3 0.02293 4 0.02460 5 0.02523 6 0.02540 7 0.02541 8 0.02539 9 0.02538 10 0.02537 11 0.02536 12 0.02536	

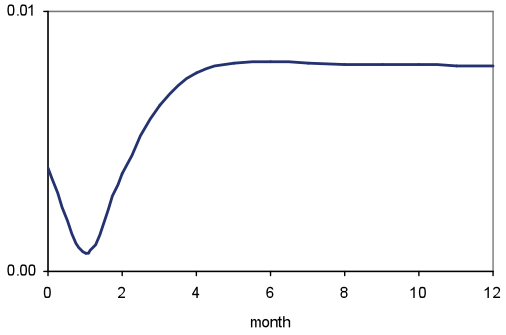
Response in Lugh

month	response
0	0.00691
1	0.00630
2	0.00753
3	0.00817
4	0.00831
5	0.00827
6	0.00821
7	0.00817
8	0.00816
9	0.00815
10	0.00815
11	0.00815
12	0.00815



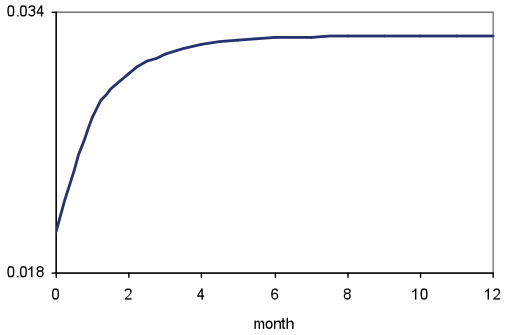
Response in Wanle Weyne

month	response
0	0.00580
1	0.00348
2	0.00565
3	0.00748
4	0.00835
5	0.00863
6	0.00866
7	0.00862
8	0.00859
9	0.00857
10	0.00856
11	0.00855
12	0.00855



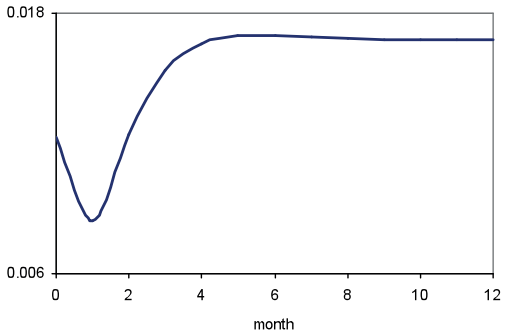
Response in Haradhere

month	response
0	0.02060
1	0.02756
2	0.03023
3	0.03142
4	0.03200
5	0.03229
6	0.03243
7	0.03249
8	0.03252
9	0.03253
10	0.03253
11	0.03253
12	0.03253



Response in Hargeisa

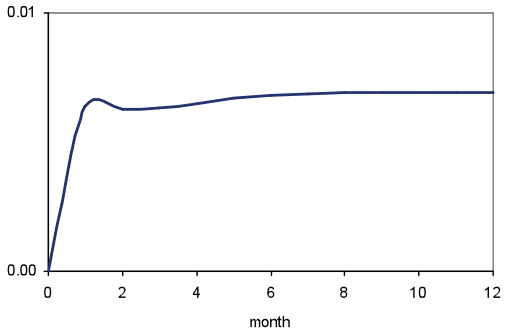
month	response
0	0.01230
1	0.00845
2	0.01244
3	0.01536
4	0.01662
5	0.01696
6	0.01696
7	0.01689
8	0.01683
9	0.01680
10	0.01679
11	0.01678
12	0.01678



Response to changes of red rice price in Bosasso

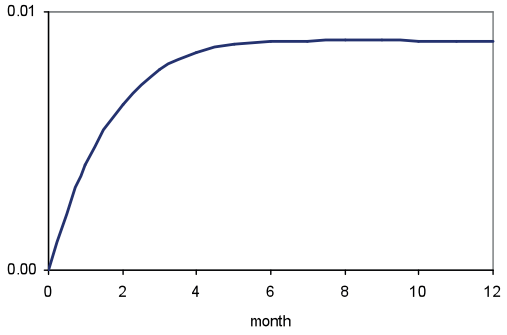
Response in Baidoa

month	response
0	0.00000
1	0.00636
2	0.00628
3	0.00630
4	0.00650
5	0.00670
6	0.00682
7	0.00689
8	0.00692
9	0.00693
10	0.00693
11	0.00693
12	0.00693



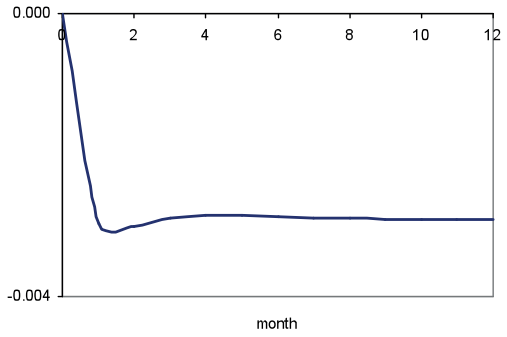
Response in Merka

month	response
0	0.00000
1	0.00409
2	0.00643
3	0.00776
4	0.00844
5	0.00874
6	0.00885
7	0.00888
8	0.00889
9	0.00889
10	0.00889
11	0.00888
12	0.00888



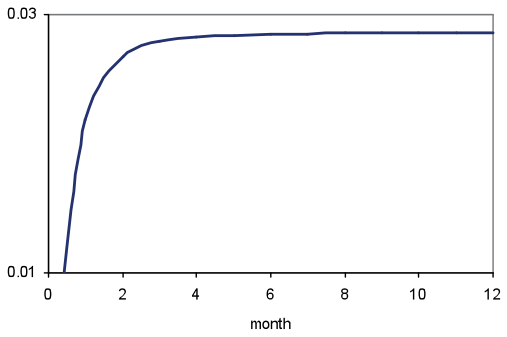
Response in Beletwein

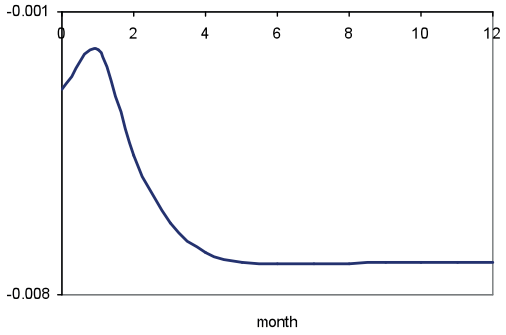
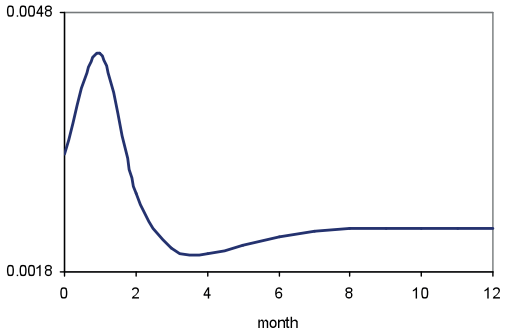
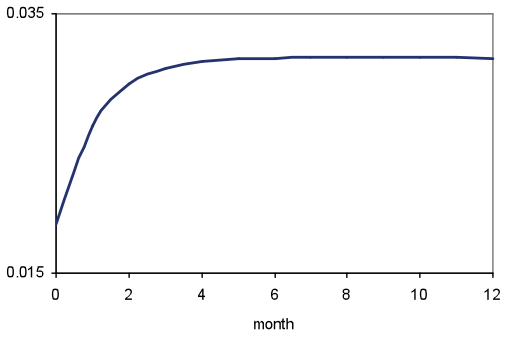
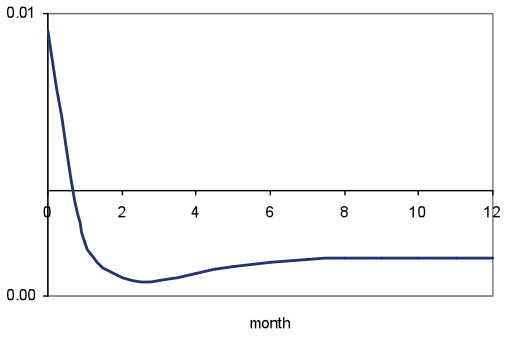
month	response
0	0.00000
1	-0.00297
2	-0.00301
3	-0.00290
4	-0.00285
5	-0.00286
6	-0.00288
7	-0.00289
8	-0.00290
9	-0.00290
10	-0.00290
11	-0.00291
12	-0.00291



Response in Galkayo

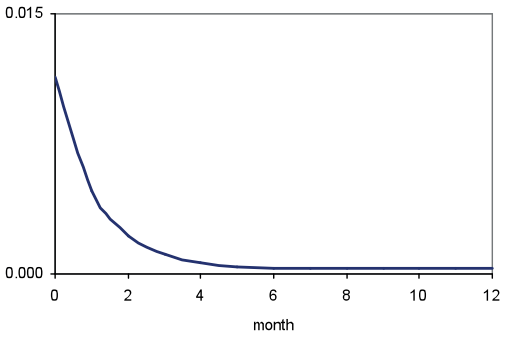
month	response
0	0.00000
1	0.02188
2	0.02675
3	0.02792
4	0.02825
5	0.02839
6	0.02847
7	0.02852
8	0.02855
9	0.02856
10	0.02856
11	0.02856
12	0.02856



Response in Jowhar	month response 0 -0.00293 1 -0.00193 2 -0.00454 3 -0.00622 4 -0.00695 5 -0.00720 6 -0.00725 7 -0.00724 8 -0.00723 9 -0.00722 10 -0.00721 11 -0.00721 12 -0.00721	
Response in Kismayo	month response 0 0.00317 1 0.00432 2 0.00271 3 0.00207 4 0.00201 5 0.00211 6 0.00221 7 0.00227 8 0.00230 9 0.00230 10 0.00231 11 0.00231 12 0.00231	
Response in Lugh	month response 0 0.01875 1 0.02640 2 0.02962 3 0.03084 4 0.03132 5 0.03151 6 0.03158 7 0.03160 8 0.03160 9 0.03160 10 0.03160 11 0.03160 12 0.03159	
Response in Wanle Weyne	month response 0 0.00452 1 -0.00145 2 -0.00247 3 -0.00256 4 -0.00237 5 -0.00217 6 -0.00204 7 -0.00197 8 -0.00195 9 -0.00193 10 -0.00193 11 -0.00193 12 -0.00193	

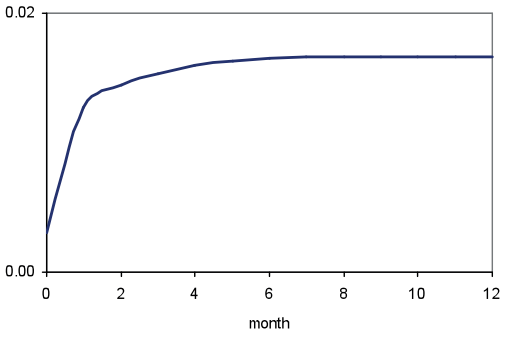
Response in Haradhere

month	response
0	0.01132
1	0.00476
2	0.00222
3	0.00111
4	0.00063
5	0.00043
6	0.00035
7	0.00032
8	0.00031
9	0.00031
10	0.00031
11	0.00031
12	0.00031



Response in Hargeisa

month	response
0	0.00305
1	0.01273
2	0.01448
3	0.01533
4	0.01594
5	0.01633
6	0.01653
7	0.01663
8	0.01666
9	0.01668
10	0.01668
11	0.01668
12	0.01668



The Information Management Process

Gathering & processing

- FSNAU has a unique network of 32 specialists all over Somalia, who assess the nutrition and food security situation regularly and 120 enumerators throughout the country, who provide a rich source of information to ensure a good coverage of data.
- Nutrition data is processed and analyzed using the Statistical Package for Social Sciences (SPSS), EPInfo/ENA and STATA software for meta-analysis.
- FSNAU developed the Integrated Phase Classification (IPC), a set of protocols for consolidating and summarizing situational analysis. The mapping tool provides a common classification system for food security that draws from the strengths of existing classification systems and integrates them with supporting tools for analysis and communication of food insecurity.
- Food security information is gathered through rapid assessments as well as monthly monitoring of market prices, climate, crop and livestock situations.
- Baseline livelihood analysis is conducted using an expanded Household Economy Approach (HEA).
- The Integrated Database System (IDS), an online repository on FSNAU's official website www.fsnau.org, provides a web-based user interface for data query, data import and export facilities from and into MS Excel, graphing, spreadsheet management and edit functions.

Validation of Analysis

- Quality control of nutrition data is done using the automated plausibility checks function in ENA software. The parameters tested include; missing/flagged data, age distribution, kurtosis, digit preference, skewness and overall sex ratio.
- Quality control of food security data is done through exploratory and trend analysis of the different variables including checks for completeness/missing data, market price consistency, seasonal and pattern trends, ground truthing and triangulation of data with staff and other partner agencies, and secondary data such as satelitte imagery, international market prices, FSNAU baseline data, etc.
- Before the launch of the biannual seasonal assessment results (Gu and *Deyr*), two separate day-long vetting meetings are held comprising of major technical organizations and agencies in Somalia's Food Security and Nutrition clusters. The team critically reviews the analysis presented by FSNAU and challenges the overall analysis where necessary. This is an opportunity to share the detailed analysis, which is often not possible during shorter presentations or in the briefs.

Products and Dissemination

- A broad range of FSNAU information products include, monthly, quarterly and biannual reports on food and livelihood insecurity, markets, climate and nutrition, which are distributed both in print and digital formats including PowerPoint presentations and downloadable file available on the FSNAU site.
- Feedback meetings with key audiences enable us to evaluate the effectiveness of our information products. We constantly refine our information to make sure it is easily understandable to our different audiences.
- FSNAU has also developed a three year integrated communication strategy to ensure that its information products are made available in ways appropriate to different audiences including, donors, aid and development agencies, the media, Somalia authorities and the general public.

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