Technical Guidance Note

Calculation and Use of the **Al**ert for **P**rice **S**pikes (ALPS) Indicator

April 2014

WFP
World Food Programme
wfp.org

Technical Guidance Note

Calculation and Use of The Alert for Price Spikes (ALPS) Indicator

© April 2014, World Food Programme

Policy, Programme and Innovation Division (PPI)

Analysis and Nutrition Service (OSZAF)

United Nations World Food Programme
Via Cesare Giulio Viola 68/70
Parco de' Medici
00148 Rome, Italy
http://www.wfp.org/food-security
wfp.vaminfo@wfp.org

For more information, please contact:
Joyce Kanyangwa-Luma
Deputy Director, Policy, Programme and Innovation Division (PPI)
Analysis and Nutrition Service (OSZA)
joyce.luma@wfp.org

Issa Sanogo,
Senior Programme Advisor, Team Leader Economic & Market Analysis Unit (OSZAF)
issa.sanogo@wfp.org

Contents

1. Introduction and background

Food prices on a local market reflect the situation of supply (availability) and demand (access) over time. They also reflect expectations of agents on future supply and demand conditions, including the seasonal patterns of supply.

Local food price crises are often correlated with food security crises. Because rural households in developing countries usually spend a large percentage of their income on food, food price spikes could have devastating effects on food security. Food price increases limit the purchasing power of households, particularly of low-income net-buyers of food, which may reduce food consumption or increase the use of coping strategies to maintain a minimum level of food consumption. Thus, the early detection of high and rising food prices supports decision making and early action of food security programming and policy design.

In 2012, the Food Security Analysis Service (VAM) of the World Food Programming (WFP) and the Centre of Research and Studies on Economic Development (CERDI, France) signed a partnership agreement to integrate a new price indicator within WFP's food price database. This indicator, the Alert for Price Spikes (ALPS), is based on empirical work at CERDI.[1]

The ALPS detects abnormally high levels of local food prices for selected staple commodities and indicates the number of markets experiencing high food prices in a country. The ALPS allows comparison between markets at the same time and over different periods for the same market. A general assumption is that food prices begin to increase abnormally several months before their crisis level. In other words, an abnormal price increase generally leads to price crises. With the early detection of signs of looming food price crises, the ALPS can be used both to monitor market dynamics and to track food security changes.

The objective of this guidance note is to highlight advantages of the indicator for decision making (section 2), to provide an understanding of the methodology behind the construction of the indicator (section 3) and to explain the way to use the indicator (section 4).

2. Why is the ALPS important for decision-making?

The Alert for Price Spikes (ALPS) can serve several operational purposes:

Monitoring: If a price monitoring system exists with adequate subnational and staple food commodity coverage, the ALPS can serve as a price monitoring tool. It enables the user to easily identify which commodities and markets are experiencing abnormal price levels, the severity and the persistence of such price abnormalities.

Early warning: The ALPS provides a sense of the intensity of price fluctuations through an ordered and standardized compilation of the prices that remain in constant fluctuation over time. Therefore,

---

[1] Araujo Bonjean, C., & Brunelin, S. (2010). Prévenir les crises alimentaires au Sahel: des indicateurs basés sur les prix de marchés. *Document de travail, 95*, AFD.
Araujo, C., Araujo Bonjean, C., Brunelin, S. (2012). Alert at Maradi: Preventing food crises by using price signals. *World Development, Vol. 40, No 9, 1882-1894*.

the ALPS can generate timely warning information on food price dynamics that enables the users to prepare and act appropriately and in sufficient time to reduce harm to households that are most likely vulnerable to abnormal food price fluctuations. As such the information from ALPS can serve to trigger further assessment and analysis to evaluate how abnormal price hikes affect market functioning and household food security.

Early response: The early detection of price alerts and price crises and the understanding of the underlying reasons can trigger preparedness measures and contingency planning as well as programme adjustments. For instance, the information from ALPS can help anticipate the adjustment of cash/voucher transfer values in food assistance programmes.

ALPS can also help planning local purchases as regards timing and location. Indeed, ALPS warns about potential food price crises and highlights markets and commodities for which food prices levels are higher than normal at a given time. This is key for local procurement decisions.

3. Calculation of the Alert for Price Spikes

The Alert for Price Spikes (ALPS) is based on a trend analysis of monthly price data. **The idea behind the indicator is to compare the long-term seasonal trend of a commodity's price series at each market with the last observed price on the same market.** The assumption is that the estimated trend reflects the dynamics of the price series beyond the spikes and abnormal levels, something which - in other words - can be defined as the "normal" pattern of the price series.

3.1. The four steps of the calculation of the indicator

The calculation of the indicator follows four steps:

> Step 1: Estimation of the seasonal price trend
>
> Step 2: Calculation of the difference between market price and estimated price
>
> Step 3: Calculation of the ALPS indicator considering price volatility
>
> Step 4: Calculation of the different thresholds of the indicator

3.1.1. Step 1: Estimation of the seasonal price trend[2]

Seasonal price trend values are obtained by regressing market price series on a deterministic trend with monthly dummies with an ordinary least square estimator (1). The price trend is estimated for each market over the entire period. The seasonal monthly dummies ($\sum_{m=1}^{12} \mathbf{D_m}$) catch the monthly price fluctuations related to the production or demand cycle, and the trend T captures long term movement (e.g., related to population growth).[3]

$$\mathbf{Price_t = \alpha * T_t + \sum_{m=1}^{12} \beta_m * D_{mt} + \epsilon_t} \quad (1)$$

With:

Price_t is the market price at time t

ϵ_t is a random variable (the random gap)

---

[2] Calculations were done on STATA software. The basic outline is available in the Appendix.
[3] The constant term is excluded from this regression to avoid the perfect multicollinearity of the dummy variables.

α is the coefficient of the trend, β_m are the m coefficients of the monthly dummies

T is the trend

D_{mt}= monthly dummies (m = {1,… , 12} = {January, …, December})

e.g.: D_1 = January dummy $\Leftrightarrow$ 1 if month = January, 0 if not

The estimated price trend is given by:

$$\widehat{Price}_t = \hat{\alpha} * T_t + \sum_{m=1}^{12} \widehat{\beta_m} * D_{mt} \qquad (2)$$

With:

$\widehat{Price}_t$ is the estimated price at time t

$\hat{\alpha}$ and $\widehat{\beta_m}$ are the estimated parameters of the seasonal trend equation

In this note, we define the price trend at a specific time *t* as the "estimated price" or the "normal price" at that time. In contrast, the market price at a specific time t is called "observed price".

The seasonal trend can be graphically illustrated as below.[4]

Figure 1 : Market price series and seasonal estimated price trend
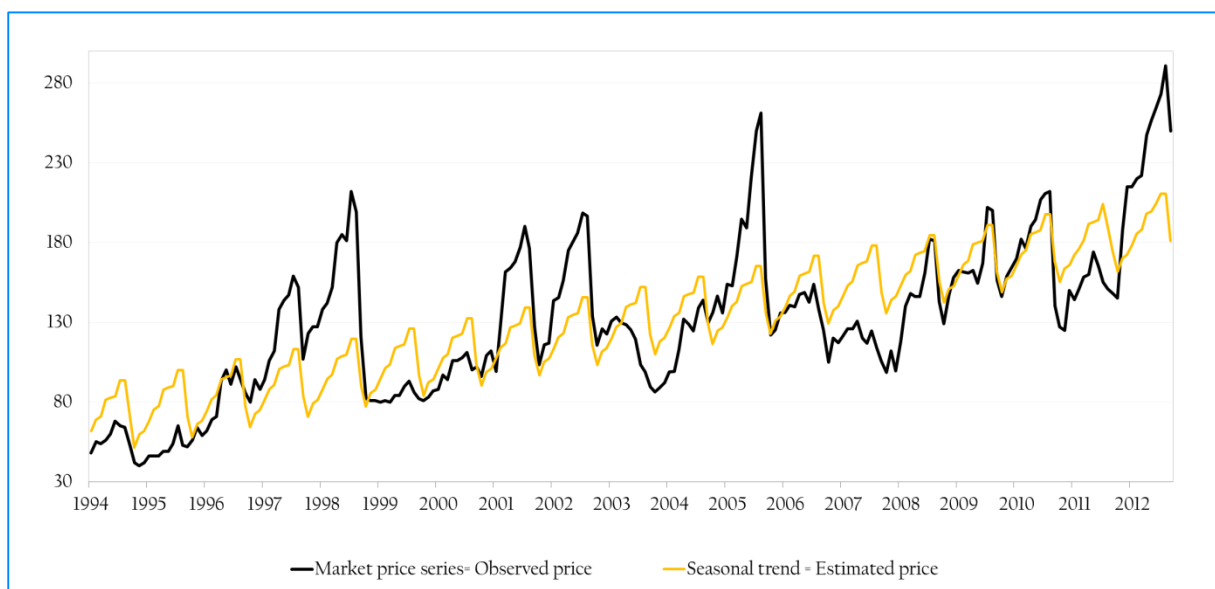
Source: WFP Food price database

3.1.2. Step 2. Calculation of the difference between market price and estimated price

The second step is to calculate for each month the difference between the market price and the estimated price. This represents the estimated error of the model at each period ($\widehat{\varepsilon}_t$):

$$\widehat{\varepsilon}_t = Price_t - \widehat{Price}_t = \text{Difference between market price and estimated price, residuals} \qquad (3)$$

With:

$Price_t$: Market price

$\widehat{Price}_t$: Estimated price

In this technical note we are only interested in **positive differences between market price and estimated price** ($Price_{it} - \widehat{Price}_{it} > 0$). In other words, we focus only on situations in which the

---

[4] Graphs and examples are quoted from a study case on the application of the alert indicator for millet market in Niger.

observed market price is above the long term trend of the price series, and we consider this price difference as "abnormal".

Figure 2 : Positive differences between market prices and estimated trend
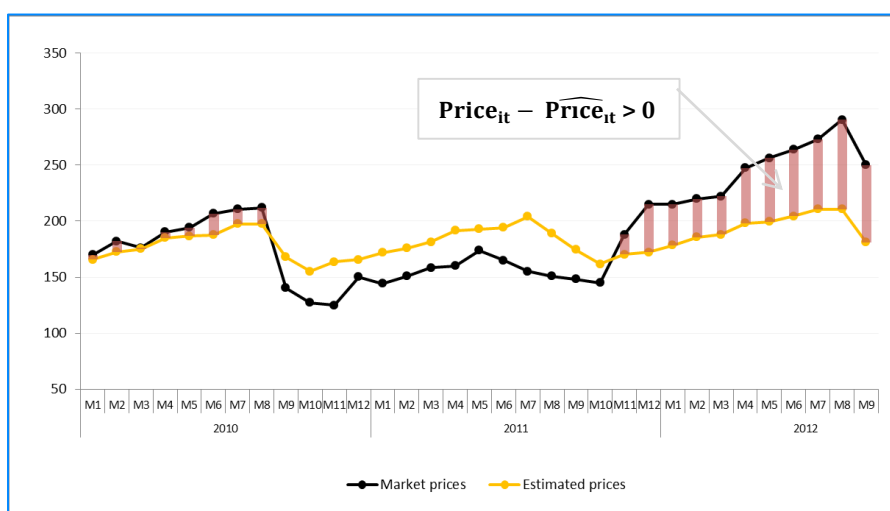
Source: WFP Food price database

3.1.3. Step 3. Calculation of the ALPS indicator considering price volatility

The **Alert for Price Spikes indicator** (4) is calculated for each period (month) by dividing the price difference between the observed and estimated price by the standard deviation (STD) of the error term:

$$\textbf{Alert for Price Spikes (ALPS)} = \frac{Price_{it} - \widehat{Price}_{it}}{\sigma_{\hat{\varepsilon}}} \qquad (4)$$

With:

$Price_t$: Observed market price

$\widehat{Price}_t$: Estimated price

$\hat{\varepsilon}_t = Price_t - \widehat{Price}_t$ = residuals, difference between market price and estimated price

$\sigma_{\hat{\varepsilon}}$: Standard deviation of the residuals

3.1.4. Step 4. Calculation of the different thresholds of the indicator

The ALPS provides a sense of the **intensity of the price difference between the trend and the market price**. The higher the difference, the more severe the alert.

Table 1: ALPS categories and thresholds

Situation on a given market :	ALPS thresholds :	Interpretation in terms of price gap :
Normal	ALPS < 0.25	$(Price_{it} - \widehat{Price}_{it})/\sigma_{\hat{\varepsilon}} < 0.25$
Stress	0.25 ≤ ALPS < 1	$0.25 \leq (Price_{it} - \widehat{Price}_{it})/\sigma_{\hat{\varepsilon}} < 1$
Alert	1 ≤ ALPS < 2	$1 \leq (Price_{it} - \widehat{Price}_{it})/\sigma_{\hat{\varepsilon}} < 2$
Crisis	ALPS ≥ 2	$(Price_{it} - \widehat{Price}_{it})/\sigma_{\hat{\varepsilon}} \geq 2$

A market is considered to be in a crisis phase at a given time t if the gap between the observed price $Price_t$ and the trend value $\widehat{Price_t}$ is greater than two standard deviations of the error terms.

The stress, alert and crisis phases can be illustrated as in the graph below.

Figure 3: Stress, alert and crisis periods on Maradi market (Niger)[5]
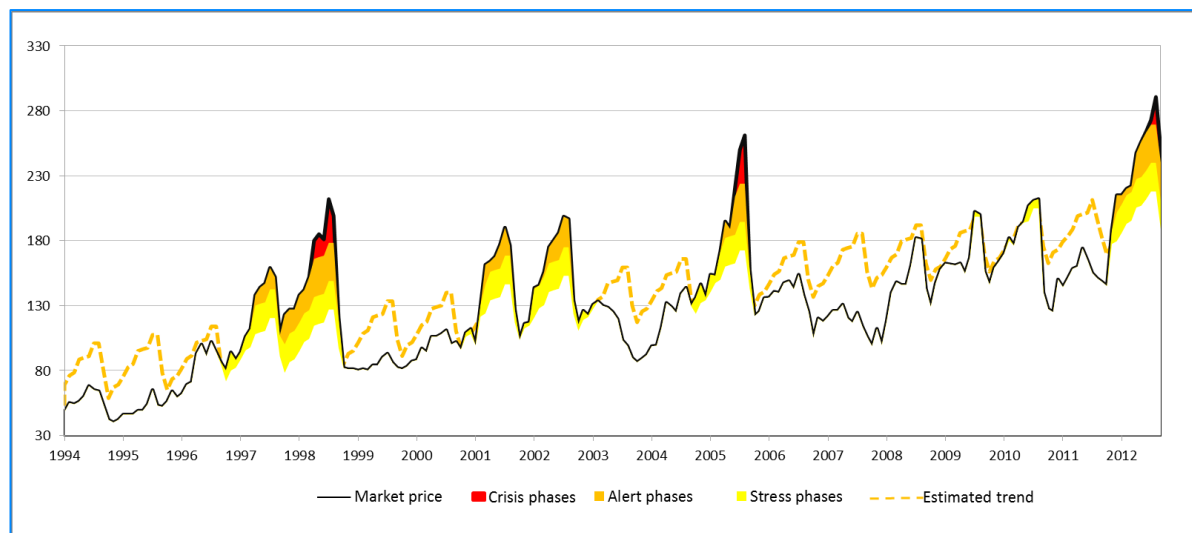
Source: WFP Food price database

3.2. Some statistical considerations when calculating the ALPS
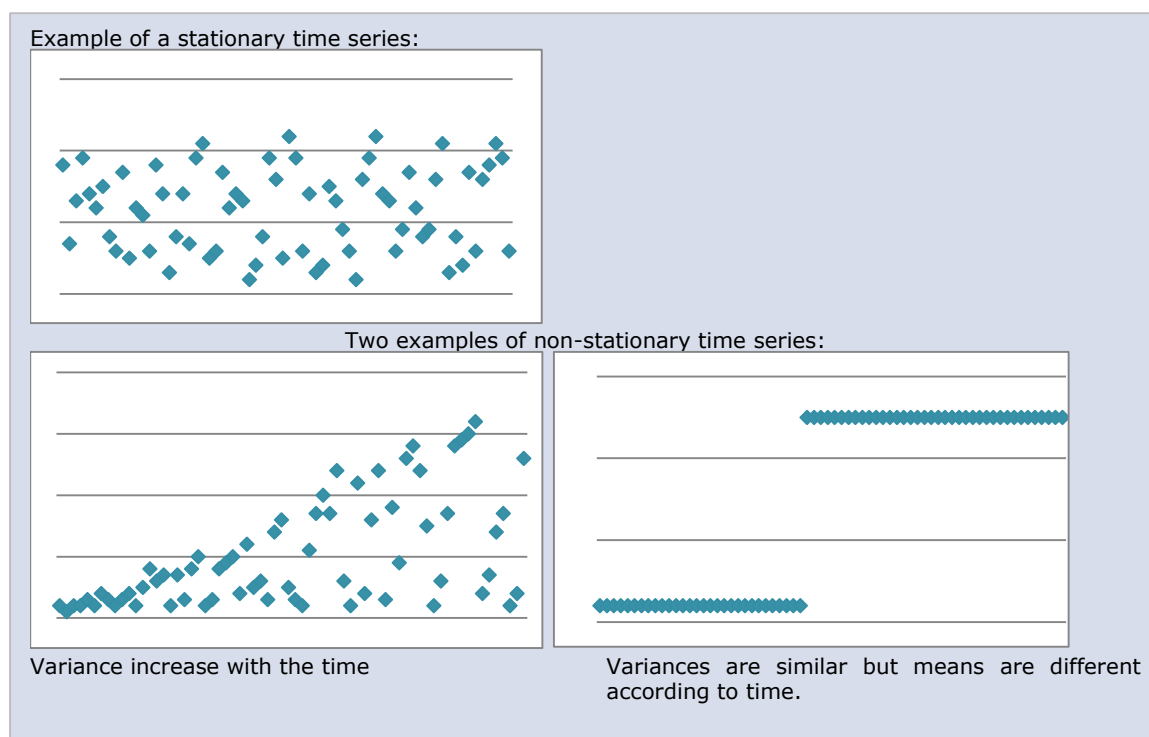
3.2.1. Price series should be stationary

A time series is a stationary process if its mean and variance do not change over time or space. Ideally, unit root tests[6] should be applied to price series before calculating the ALPS to detect if the price series is characterized by a non-stationary process. Indeed, the estimated parameters could be biased if the series is not trend stationary, as ordinary least square regression models with non-stationary variables give spurious results. Thence, the Augmented Dickey Fuller unit root test (ADF) is applied as a pre-requisite to run the ALPS methodology presented here. When the p-value of the null hypothesis is statistically significant, the time series is considered non-stationary. For some series, stationary characteristics can be observed graphically. However, a graphical analysis cannot replace statistical test procedures. The following graph provides an intuitive idea of a stationary or non-stationary process.

---

[5] Millet retail prices, monthly data from 1994 to 2012, in XOF/kg, taken from VAM Food price database.

[6] If a price series presents a unit root it is a non-stationary process.

Figure 4: Stationary vs. non-stationary time series

Example of a stationary time series:

Two examples of non-stationary time series:

Variance increase with the time

Variances are similar but means are different according to time.

In some case, it is necessary to take into account potential breaks in the trend when analysing the stationarity of a series. Some stationary tests allow for some structural instability in the series. Indeed, a weakness of the Dickey–Fuller test is its potential confusion of structural breaks in the series as evidence of non-stationarity. Perron (1992) developed a test in the presence of an already known structural break. On the contrary, Andrews and Zivot (1992) considered determining the structural break endogenously from the data was most efficiently. Their test allows for a single structural break in the intercept and the trend of the series, as determined by a grid search over possible breakpoints. Clemente, Montanes, and Reyes (1998) proposed tests that allow for two breaks within the observed period of a time series, either detecting additive or innovational outliers.

Figure 5 : Structural break in the trend of a time series (fictive)
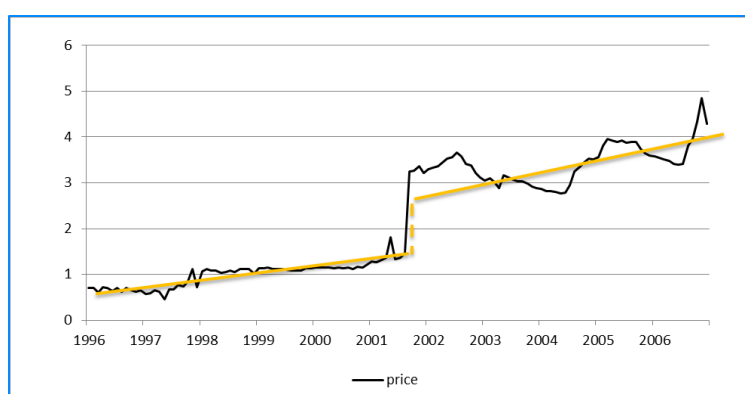
Source: WFP Food price database

Detecting structural breaks is important as the proposed econometric procedure is based upon the hypothesis that the coefficients are stable over time and space. Structural breaks in the coefficient could be interpreted as a wrong specification of the model.

Most of the above tests could theoretically be implemented during the process of calculating the ALPS. But in order to derive a straightforward methodology that is valid for all markets in the WFP

VAM price database, they are not computed on a large scale. However, they could be easily executed for specific local markets, should the data suggest to take structural breaks into account. For instance, when only one structural change appears in a given year, it is advised to add a dummy in the model.[7]

3.2.2. Minimum data requirement

Within WFP's database, the indicator is calculated on monthly prices when the series comprises at least 3 years, i.e., ideally it would include 36 observations. With less than 3 years of monthly data, it is impossible to systematically get a relevant seasonal trend. In such a case singular price movements would influence the trend and hence not reflect the long term pattern and level of prices. However, this minimum requirement could be insufficient if a market experienced unusual prices patterns over the last 3 years. Since there is no methodology to systematically and statistically assess the quality and reliability of the calculated seasonal trend, there exists thus no universal, acceptable threshold for the minimum data requirement for all markets. While the three years of data constitute a bare minimum requirement, the user is encouraged to still assess the relevance of the calculated trend, e.g., by plotting it in a graph.

3.2.3. Updating the computed trend

The seasonal price trend is calculated using the available entire price series. Price trends can be updated every month, as new market prices become available. In so doing, the precision of the seasonal trend estimation increases with the length of the series and thus the precision of the price alert indicator. However, in some cases, this update is not advisable. For instance, if the market is suspected to experience a crisis, the calculated trend could be overestimated due to the last values. This would lead to triggering fewer alerts which again is more accentuated with shorter price series.

In addition, common factors, such as devaluation, exchange rate regime or other covariant shocks (e.g. natural disasters), can lead to structural breaks in the price series. Monitoring of price series patterns and the economic situation in a country will tell if the change is irreversible or if the series is likely to return to the previous trend. In the former case, the price series would be characterised by outliers[8] necessitating to adjust the trend.

3.2.4. Note on the historical analysis of the indicator

An historical analysis of a price crisis could also be done with the ALPS. The identification of periods when ALPS raises alerts permits to identify an increasing price based on past evidence of markets that experienced *alert* and *crisis* periods earlier. A methodological limitation should nevertheless be mentioned here. The seasonal price trend calculation (and thus ALPS values) is based on the complete price time series available *up to now*. The trend includes, therefore, information that was not available at the time of the periods classified now as *stress/alert/crisis*. In other words, it is possible that ex-post one period shows *stress,* whereas it would have been defined as *normal* or *crisis* in the past. Yet, long time series with substantial price information are less prone to this criticism because the trend would not change significantly.

---

[7] For example if a structural break is detected in 2000 for a whole period (1990-2012), a dummy equal to one for years between 2000 (starting from the month of the break) and 2012 is added to the trend equation (Step 1).

[8] Outliers can be '*additive*', when a sudden change affects the series temporarily, or '*innovational*', when the change effect lasts through the dynamic of the model.

4. The ALPS in practise: How to use and interpret it?

4.1. Practical questions to address before using the ALPS

The main objective of the ALPS is to detect abnormal high levels of local food prices for a selected commodity in a specific country and to indicate the number of markets experiencing high food prices, which provides an idea of the severity of the crisis. The ALPS can thus be applied to several markets and food commodities within a country. However, before making such an investment in time and effort, some preliminary issues should be addressed to select markets and commodities in the context of market and food security analysis.

4.1.1. Most consumed food commodities are priority

First, the indicator is more meaningful when applied to the **most consumed food commodities** in the country. Indeed, WFP is interested in the dynamic of price increases which affects food access of households through changes of purchasing power, especially of urban and net-buying households. Thus the prime interest is to study the main consumed commodities.

Secondly, **locally produced staples food commodities** are generally consumed by most households. Such commodities should get priority attention to the ALPS exercise. In general, crises on local markets reflect tensions of supply and demand of locally produced commodities and their interactions with substitutes from other regions in or outside the country (including imported food products from the global market).

Finally for **import-dependant countries some imported commodities** can be considered. Lessons from the 2008 global food price crisis suggest that global price increases transmitted on prices of imported food commodities as well as the prices of local substitutes, leading to generalised or localized crises on local markets.

4.1.2. Leading local markets are priority

Inclusion of **leading food markets** is necessary. Basically, a leading market is defined as a market where the price influences the price on other markets. Leading markets are generally wholesale/assembly markets which gather a large share

> **In summary, we need to know**
> - What are the major food crops produced in the country?
> - Where are the main crop production areas?
> - What is the seasonal calendar of each main food crop produced locally?
> - What are the main food commodities imported in the country?
> - What are the main commodities consumed by the population?
> - What are the main markets in the country in terms of supply or consumption and their locations?

of supplies in the country. Consumption can also drive market dynamics. In that case, it is common to select major retail/consumption markets in district capitals or major urban centres as leading markets.

In some instances, foreign border markets can also be considered, especially when the price of a commodity is more determined by the supply performance at regional level rather than by local factors.

4.1.3. Knowledge of the seasonal calendar is important

The ALPS is based on the seasonal calendar as it aims at detecting abnormal price movements from the trend as early as the post-harvest season. For this reason it is important to know the seasonal calendar and price seasonality of locally produced food commodities.

4.2. Procedure to analyse the ALPS

4.2.1. Where to find the ALPS?

The ALPS is available within WFP's food price database. The indicator is updated each month using the last price data available for the main staples in more than 30 countries. These local food prices are either collected directly by the World Food Programme or collated from its partners (including governments). The analyst who would like to calculate the indicator for her/his own dataset can also find Stata programming code in the appendix.

The page "chart" allows the user to select the specific market and commodity. The graph presents the price series (black line), the estimated price (doted blue line) and the level of the ALPS for each period with the shaded areas. The red dotted line is a projection of the price trend for the 6 coming months. As this line is only a projection of the trend, the values should not be used as price forecasts for the next 6 months. This projection is done without specific regards of the current and recent situation and only reflects the long term movement and seasonal pattern.

In addition to the value of the ALPS for the current month, the chart presents historical information on unusual food price levels. Shaded areas reflect the ALPS value corresponding to the last trend calculated.

The page "At-a-glance" presents all markets monitored within WFP's food price database and the number and name of markets which have been in *stress*, *alert* or in *crisis* at least one time in the last 6 months.

Figure 6: "Charts" page from WFP's food price data base, Alert for Price Spikes (screen shoot on 05/02/2014)

Figure 7: "At-a-glance" page from WFP's food price data base, Alert for Price Spikes (screen shoot on 05/02/2014)

4.2.2. The different dimensions to analyse

The ALPS enables the analysis of different aspects of food price dynamics:

- The **detection**,
- The **severity** (depth),
- The **prevalence,** and
- The **persistence** of unseasonal high food prices.

Whether an identified unseasonal high food price is **severe** or not (i.e. the depth) is given by the value of the ALPS for the month of the last observation. The market is qualified as "*normal*", "*in stress*", "*in alert*" or "*in crisis*" with regard to their price levels. As mentioned in part 4.1.2, the situation on leading markets is of critical value given their potential trickle down effects.

The **prevalence** of unseasonal high food prices within a country is determined by the percentage of markets experiencing "*stress*", "*alert*" or "*crisis*" situations during the last month of observation or over a limited period of time. An understanding of why markets are on *alert* or in *crisis* and the potential spill-over effects is also worth documenting.

The **persistence** of a food price crisis situation is given by the number of consecutive months a specific market experiences abnormal food price levels. An analysis of the transmission effect is also possible, starting from the markets that showed abnormal price levels first and whether or not the severity and prevalence increased.

Combining these findings with the knowledge on local seasonal calendars, the analyst can trigger an alert about a potential aggravation of the depth of abnormal food price levels on local markets.

4.2.3. Illustration: Analysis of historical food price crises on millet markets in Niger

The historical information presented on the ALPS charts provides an overview of the performance of the ALPS in detecting price alerts and price crises. The aim of the Niger example is to illustrate the use of the ALPS in a real situation. The method is applied to millet price series of Maradi market, one of the leading cereal markets in the country.

A methodological limitation mentioned in paragraph 3.2.4 should be repeated here: The seasonal price trend calculation is based on the complete price time series available *up to now* and includes, therefore, information that was not available at the time of the periods classified now as stress/alert/crisis. Trend and ALPS values could have been different then from the ones calculated now. Yet, long time series with substantial price information, like Maradi market in Niger, are less prone to this criticism because the trend would not change significantly.

The periods during which Maradi markets experienced *stress, alert* or *crisis* levels for ALPS are summarized in the graph below (Figure 8).

Figure 8 : Alert and crisis on Maradi market (Niger)[9]
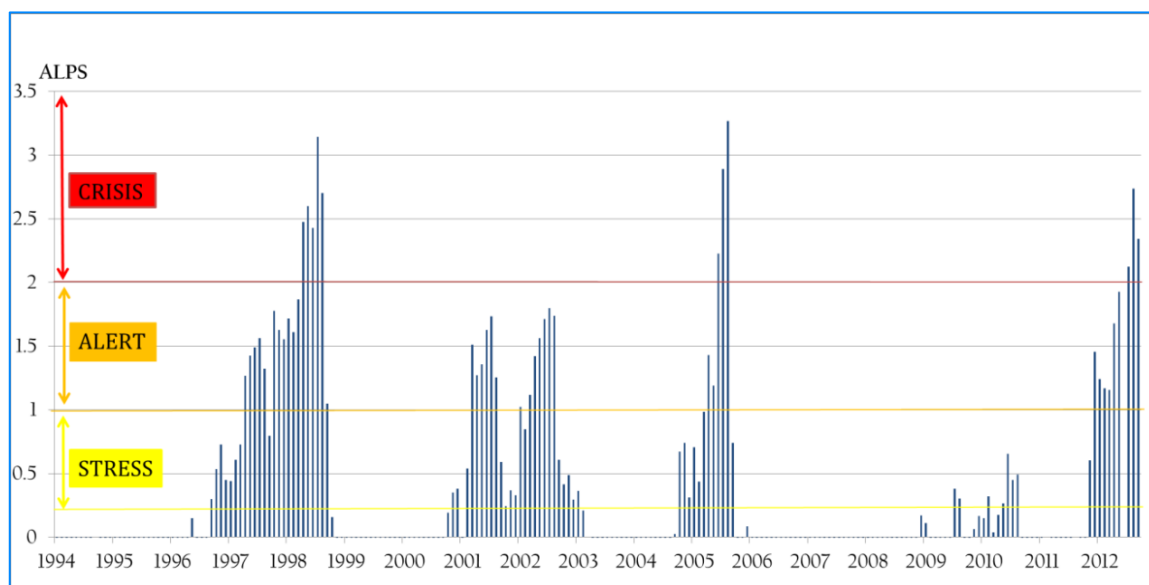
Source: WFP Food price database

The ALPS identifies 3 periods of price crisis on Maradi millet market since 1994: 1998, 2005 and 2012. In general, price crises start with the lean season but are preceded by periods of *stress/alert* (see Figure 9 below). In the case of Maradi in Niger, price *crises* are preceded by *stress* phases during the harvest season (September-December), *alert* phase take place during the post-harvest period (January-April), while price *crises* generally occur at the end of the post-harvest period through the lean season (Mai-September), as schematized on the graph below with the 2005 price crisis.

Figure 9: Crop year 2004/2005 on Maradi market (crisis year)
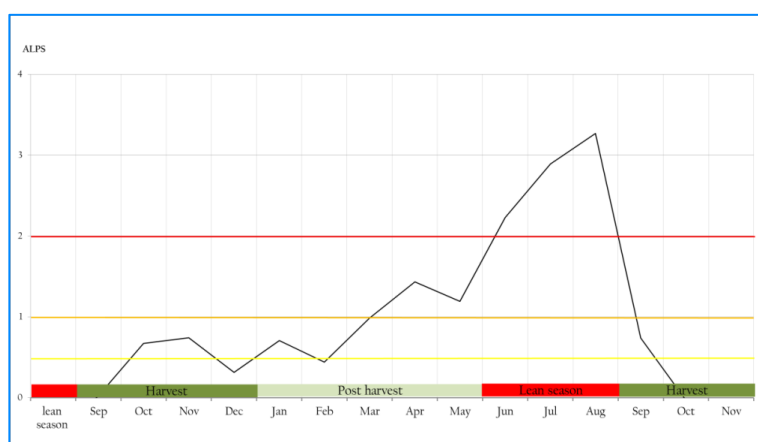
Source: WFP Food price database

Seasonal price trend and agricultural calendar

The hypothesis is that the seasonal trend as constructed by the ALPS reflects the seasonal calendar of national crops. In that sense, the indicator is mainly oriented toward an early warning for market situations of national crops. In that case, the analysis of the alert, stress and crisis period would be done in consideration of the seasonal calendar, the commodity flows throughout the country and complementary analysis.

The relevance of the ALPS for early detection of food security crisis in Niger was further explored. The correlation between identified price crises and humanitarian crises was established assuming

---

[9] Millet retail prices, monthly data from 1994 to 2012, in XOF/kg, taken from VAM Food price database.

that the periods during which WFP Emergency Operations (EMOPs) were approved and implemented are a good proxy of food security and humanitarian crises in Niger.

The graph below shows the overlay between price alerts and price crisis periods and WFP EMOPs. It suggests that several price crises correspond to humanitarian crises as captured by WFP EMOPs in 2002 and 2006 and that they are preceded by several price alert phases in 2000-2001, 2004-2005, and 2011. Such results could be further explored through correlation analyses between food security indicators (e.g. Food Consumption Score – FCS) and the ALPS, pending availability of series of food security indicators.

Figure 10 : Alerts and Crises on Maradi market (monthly data)
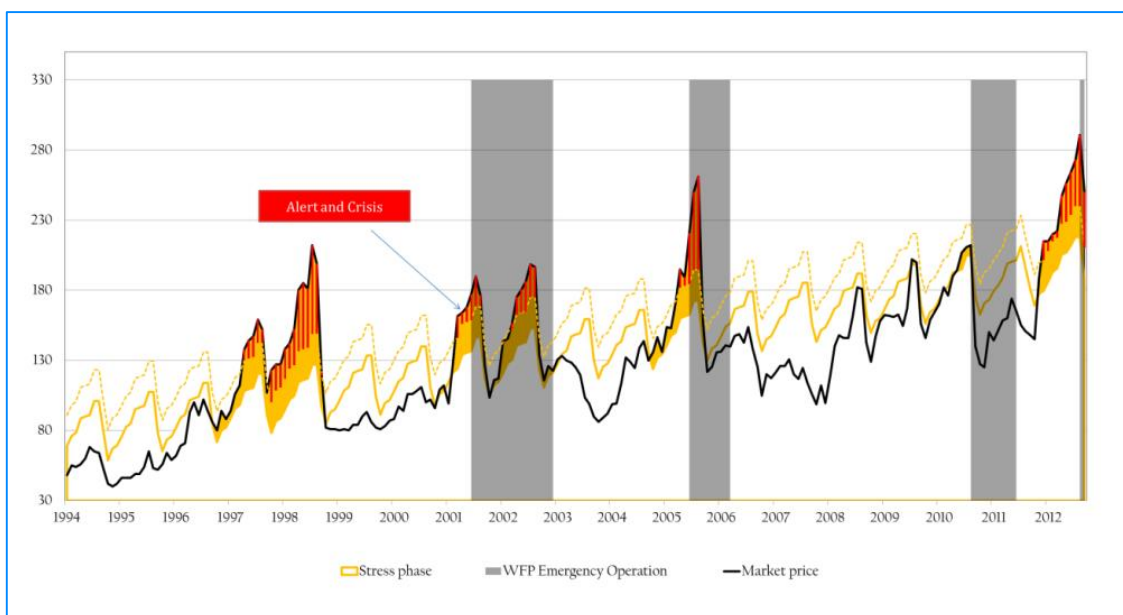
Source: WFP Food price database

5. Appendix: What is the syntax for constructing the ALPS?

On Stata, the syntax is as follows.

```
clear
cd "link to the folder which contains the database"
use database.dta
preserve
capture log close
log using resultats.log, text replace
set memory 128m
set more off
tsset time-related variable
* Preparing the data: setting monthly dummy variables

forvalues j = 1/12 {
generate d`j'=0
}
        replace d1=1 if month==1
        replace d2=1 if month==2
        replace d3=1 if month==3
        replace d4=1 if month==4
        replace d5=1 if month==5
        replace d6=1 if month==6
        replace d7=1 if month==7
        replace d8=1 if month==8
        replace d9=1 if month==9
        replace d10=1 if month==10
        replace d11=1 if month==11
        replace d12=1 if month==12
* Setting the data as a timeseries
        gen t=ym(year, month)
        format %tm t
        tsset t, monthly
* Renaming the time series to analyse to avoid changing the codes
rename  name_price_timeseries prices
* Unit root tests
dfuller prices ,trend lag(1) regress
pperron prices, constant trend lag(1) regress
* Regression
regress prices t d1-d12 , noconstant
predict p_est if e(sample), xb
predict p_res if e(sample), res
ereturn list
* Calculate the Standard deviation
egen p_sd=sd(p_res)
* Indicator
generate p_indicator = p_res/ p_sd
* Stress period
generate p_stress= p_indicator if p_indicator>=0.25
* Alert period
```

```
generate p_alert= p_indicator if p_indicator>=1
* Crisis period
generate p_crisis = p_indicator if p_indicator>=2
* Information on regression
list t p_alert
* Plotting the Graphs with ALPS
label var prices "Actual prices"
label var p_stress "Stress"
label var p_alert "Alert"
label var p_crisis "Crisis"
sort t
twoway (line prices t) (line p_est t, lpattern(dash)) (bar p_res t)
twoway (line prices t) (line p_est t, lpattern(dash)) (bar p_stress t, bcolor(yellow) yaxis(2)) ///
(bar p_alert t, bcolor(orange) yaxis(2)) (bar p_crisis t, bcolor(red) yaxis(2))

rename prices name_price_timeseries
```