Training on SDG 2.c.1 Indicator of Food Price Anomalies

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Training purpose

To understand the Indicator of food price anomalies and the methodology to estimate it

Training objectives

• Understand basic concepts of price volatility
• Have a firm grasp of how to calculate the indicator
• Comprehend the use and limitations of the indicator
• Equip with the capacity to calculate the indicator
SDG INDICATORS UNDER FAO CUSTODIANSHIP

2.1.1 Hunger
2.1.2 Severity of food insecurity
2.3.1 Productivity of small-scale food producers
2.3.2 Income of small-scale food producer
2.4.1 Agricultural sustainability
2.5.1 Conservation of genetic resources for food and agriculture
2.5.2 Risk status of livestock breeds
2.a.1 Public Investment in agriculture
2.c.1 Food price volatility

5.a.1 Women's ownership of agricultural land
5.a.2 Women's equal rights to land ownership

6.4.1 Water use efficiency
6.4.2 Water stress

14.4.1 Fish stocks sustainability
14.6.1 Illegal, unreported unregulated fishing
14.7.1 Value added of sustainable fisheries
14.b.1 Access rights for small-scale fisheries

15.1.1 Forest area
15.2.1 Sustainable forest management
15.4.2 Mountain Green Cover

12.3.1 Global food losses
**SDG Goal, Target & Indicator**

**SDG 2:** End hunger, achieve food security and improved nutrition and promote sustainable agriculture

**SDG Target 2.c**
Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help **limit extreme food price volatility**.

**SDG Indicator 2.c.1: Indicator of Food Price Anomalies (IFPA)**
The IFPA is an indirect indicator of Target 2.c, as it is a measure of food price volatility, detecting **abnormal growth** of prices in food markets.
Price volatility and relevance of stable markets in achieving Goal 2

The connection between food prices and food security was brought into sharp focus during the food price crisis of 2007/2008.

Extreme price movements of agricultural commodities pose a threat to agricultural markets and to food security.

In many countries, market prices are sometimes the only source of information available to assess the severity of a local shock to either access or availability of food.
The Indicator of Food Price Anomalies (IFPA) may help to put in place policies that limit extreme price volatility.

- **Improving market information:** Information on prices allow markets to function more efficiently and monitoring food prices is crucial for evidence-based policy decisions.

- **Stockholding:** accumulated stocks might reduce volatility, as long as they are accumulated in periods of excess supply and released in times of excess demand.

- **Trade policies and buffer stocks:** governmental interventions to stabilize prices, including the use of a combination of import/export levies, as well as food reserve stockpiles.

- **Coping mechanism:** targeted safety-net mechanisms in an effort to reduce the negative consequences of price volatility, while in the long term, investment in agriculture can prevent price volatility.

(Policy options to address price volatility and high prices - FAO)
Price volatility is the variability of price series around its central value – i.e. the tendency for individual price observations to vary significantly from their mean value.

- Price volatility differs from the price level, which in agricultural markets, varies because production supply and consumption demand are variable.

- The extent to which given production and consumption shocks translate into price volatility depends on supply and demand elasticity.

- It is generally supposed that the most important source of price variability in agriculture is weather shocks to agriculture yields (Gilbert and Morgan, 2010).

- Price volatility generates uncertainty, which increases risks for producers, traders, consumers and governments and may lead to sub-optimal decisions compared with those achieved under more stable price conditions.
When prices surge unexpectedly, vulnerable consumers may have to lower their food intake, take children out of school, save on healthcare services or sell productive assets, such as land and livestock.

High volatility brings with it considerable downside price risks, which affect planting decisions and undermine agriculture investment where it is needed most.
**FINALIZING THE INTRODUCTION**

**SDG 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture**

**SDG Target 2.c**
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**SDG Indicator 2.c.1: Indicator of Food Price Anomalies (IFPA)**
The IFPA is an indirect indicator of Target 2.c, as it is a measure of food price volatility, detecting **abnormal growth** of prices in food markets.
INTRODUCTION TO IFPA

Is the rate of change in prices normal for the period of time being observed?

- The IFPA provides an answer to this question, as it detects abnormal price growth by measuring the normalized differences of compound growth rates of prices from their historic mean.

- The IFPA uses a weighted sum of quarterly and annual compound growth rates (CGR). By using both CGRs, the indicator captures price variations (seasonality and shocks) within the year and across years.
INTRODUCTION TO IFPA (2)

The IFPA can be measured with Food CPI and commodity prices.

- **Data sources**
  - Commodity prices
    - National market information systems
  - Consumer Food Price Index
    - National statistics agencies
    - International Monetary Fund (IMF)

- The main challenge in implementing the indicator is **data availability** and **data quality**. The indicator is very sensitive to both issues and in particular data gaps. A time series of **at least 5-year monthly data points** are required to calculate the indicator.

- In terms of data availability countries have made significant investments in collecting and disseminating commodity price data at a national level. However, **accessing** this information at a global level still at times remains challenging.
The steep drop in the Egyptian pound's value in late 2016 has made imports more expensive, while recent government measures such as a cut in subsidies for fuel, the introduction of a value-added tax and increases in import tariffs have sharply increased the cost of living.


While many Egyptians have been forced to cut spending even on essentials, consumption in some sectors, notably food, has picked up as consumers adapt to higher prices.

Source: https://www.ft.com/content/6f7c2c64-25ec-11e8-b27e-cc62a39d57a0
Prices of sorghum rose further in August and reached record highs, three times their year-earlier values. The exceptionally high level of prices follows a sustained upward trend, which began in late 2017, due to the strong depreciation of the local currency and the removal of the wheat subsidies in the 2018 budget, which triggered demand for millet and sorghum as substitute foods and underpinned markets for these commodities. Fuel shortages and high prices of agricultural inputs contributed to raise concerns over the impact on the 2018 harvest.


Source: FAO (www.fao.org/sustainable-development-goals/indicators/2c1/en/)
A compound growth rate is a geometric mean which assumes that a random variable grows at a steady rate, compounded over a specific period of time.

\[
CGR_t = \left( \frac{P_{t_B}}{P_{t_A}} \right)^{\frac{1}{n}} - 1
\]

\[\text{Equation 1}\]

\[P_{t_A} = \text{The price at the beginning of the period}\]
\[P_{t_B} = \text{The price at the end of the period}\]
\[n = \text{The time in months between periods A and B}\]

The growth in any random variable from the beginning of the period \(t_A\) to the end of the period \(t_B\), raised to the power of one over the length of the period of time being considered \(n\).

The Compound Growth Rate is a geometric and not an arithmetic mean, as the latter is affected by the level of volatility in prices.
A compound growth rate is good to deal with price volatility.

Assuming a steady rate of growth, the compound growth rate smooths the effect of volatility of periodic price movements. This is of advantage especially when dealing with highly volatile price series, as it establishes a baseline from which to measure abnormal.

\[
\text{Compound growth rate} = \left( \frac{75}{50} \right)^{\frac{1}{5-1}} - 1 \times 100 = 10.6\%
\]
The IFPA for a particular year $y$ in month $t$ is the following weighted sum of quarterly and annual IFPA:

$$IFPA_t = \alpha \left( \frac{CQGR_{yt} - \overline{CQGR}_t}{\hat{\sigma}_{CQGR_t}} \right) + (1 - \alpha) \left( \frac{CAGR_{yt} - \overline{CAGR}_t}{\hat{\sigma}_{CAGR_t}} \right)$$

$CQGR_{yt}$ and $CAGR_{yt}$ are the quarterly and annual compound growth rates in year $y$ and month $t$ respectively.

$\overline{CQGR}_t$ and $\overline{CAGR}_t$ are weighted means of the quarterly and annual compound growth rates in month $t$.

$\hat{\sigma}_{CQGR_t}$ and $\hat{\sigma}_{CAGR_t}$ are weighted standard deviations of the quarterly and annual compound growth rates in month $t$.


The IFPA of December 2016 contains information of the reference growth rates of September-December 2016 and December 2015-December 2016, compared to the price increases in these periods of other years.
The IFPA is defined at three levels:

- $-0.5 \leq IFPA_y < 0.5$ (Normal price growth)
- $0.5 \leq IFPA_y < 1$ (Moderately high price growth)
- $IFPA_y \geq 1$ (High price growth)

An example of IFPA in graph

It is important to underline that the indicator is only a guide to understand market dynamics.

It cannot be relied on as the sole element to determine whether a food security alert should be given.

Results must be weighed with other available information on market fundamentals, macroeconomic context and external shocks that can explain these price movements.

This is especially important when evaluating whether the observed price shocks will persist or are transitory.
0. **Deflate** nominal prices/food CPI by general **CPI** to net out the effects of inflation and compare prices in constant money terms over time.

There are two versions of the price series, a **nominal** and the **real** term series, which has been deflated using the domestic consumer price index (CPI 2010= 100) as reported by the International Monetary Fund (IMF).

\[
\text{Real price} = \frac{\text{Nominal price}}{\text{CPI}}
\]

The series used in this example is Wholesale Prices for Rice in Mongolia from 2006 to 2017.
INDICATOR CALCULATION (2)

Before start, please note the order of the calculation.

1. Calculate **Compound Quarterly** and **Annual Compound Growth Rates**.

   
   1. Calculate the CQGR

   \[
   CQGR_{Dec2016} = \left( \frac{Pr_{Dec2016}}{Pr_{Sep2016}} \right)^{\frac{1}{3}} - 1
   \]

   2. Calculate the CAGR

   \[
   CAGR_{Dec2016} = \left( \frac{Pr_{Dec2016}}{Pr_{Dec2015}} \right)^{\frac{1}{12}} - 1
   \]
1a. Compound Quarterly Growth Rates

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Please note: The CQGR can only be calculated from the second quarter of 2016, as there are no price data of the last quarter of 2015, which would enable the calculation.
Both **average** and **standard deviation** are multiplied by a **weight** \((W)\). The weights are **linear time weights** (i.e. built in such a way that the most recent past has a higher weight) and **employed only to the past values**.

2. Build the linear time weights

\[
\begin{array}{cccccccccccccccc}
\text{2006} & \text{2007} & \text{2008} & \text{2009} & \text{2010} & \text{2011} & \text{2012} & \text{2013} & \text{2014} & \text{2015} & \text{2016} & \text{2017} \\
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10 & 10 & 10 & 10 & 10 & 10 & 10 & 10 & 10 & 10 & 10 & 10 \\
\end{array}
\]

QN6 | QN7 | QN8 | QN9 | QN10 | QN11 | QN12 | QN13 | QN14 | QN15 | QN16 | QN17
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0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11
2a. Calculate the weights

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E.g. the weight of 2006 for the quarterly IFPA of 2016 has a value of 0.0182, which is 1/55 (one over the sum of all weights from 2006 to 2016).
The same procedure will apply to the annual weighted average.
**Indicator Calculation (7)**

i.e. Calculate weighted average of January 2017 quarterly CGR

\[
W_{\text{CXGR}_t} = \frac{1}{\sum_{y=1}^{Y} w_y} \sum_{y=1}^{Y} w_y \text{CXGR}_{yt}
\]

- The weighted average for month \( t \) of the \( X \) (quarterly or annual) CGR
- The weight for year \( y \)
- \( \text{CXGR}_{yt} \) = The un-weighted compound growth rate in year \( y \) in month \( t \)
- \( \sum_{y=1}^{Y} \) = The summation operator over years \( Y \)

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3. Calculate the Weighted Standard Deviation

\[
\hat{\sigma}_{W,\text{CXGR}_t} = \sqrt{\frac{\sum_{y=1}^{Y} w_y (\text{CXGR}_{yt} - W_{\text{CXGR}_t})^2}{\sum_{y=1}^{Y} w_y (\bar{\gamma} - 1)/\bar{\gamma}}}
\]

\(\hat{\sigma}_{W,\text{CXGR}_t}\) = The weighted standard deviation for month \(t\) of the X (quarterly or annual) CGR

\(\bar{\gamma}\) = The total number of weights

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The same procedure will apply to the annual weighted standard deviation.
i.e. Calculate the Weighted Standard Deviation January 2017 quarterly CGR

\[
\hat{\sigma}_{W-CXGR_t} = \sqrt{\frac{\sum_{y=1}^{Y} w_y (CXGR_{yt} - W_{-CXGR t})^2}{\sum_{y=1}^{Y} w_y (\bar{y} - 1)/\bar{y}}}
\]

\[
(XIFPA_{yt}^Z) = \left( \frac{CXGR_{yt} - W_{CXGR_t}}{\hat{\sigma}_{W-CXGR_t}} \right)
\]

\[
\text{SQRT(SUMPRODUCT(QW_2017*(CQGRJAN-WAvg)^2))/(SUM(QW_2017)*(NoW2017-1)/NoW2017))}
\]

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<th>WAvg</th>
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</table>

\[
\text{SQRT(0.00005)} = 0.90909 \\ = 0.00774
\]
4. Calculate and compile quarterly and annual IFPAs.

The quarterly IFPA of December 2016 compares the reference growth rate of Sep-Dec 2016 with the price movements in the respective period of past years.
5. Build IFPAs

Once you have calculated the quarterly and the annual IFPAs, the IFPA for a particular year $y$ in month $t$ is $0.4 \text{ (QIFPA)} + 0.6 \text{ (AIFPA)}$.

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**Annual IFPA:**

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Quarterly Indicator of Food Price Anomalies

Annual Indicator of Food Price Anomalies

$f(x) = 0.4*\text{M56} + 0.6*\text{A56}$
Feeding into FAO’s Global Information and Early Warning System (GIEWS) and its activities of Food Price Monitoring and Analysis (FPMA) the indicator of food price anomalies offers governments regular price information on a basket of goods.

Results are disseminated and analysed through the FPMA website and bulletin on a monthly basis with the aim of providing early warning to countries where there is a potential impact on economic access to key food products as a result of abnormally high food prices. It helps countries ensure appropriate measures can be taken to soften the blow when consumer markets fluctuate.

The FPMA Tool has been adapted for use at country level. The tool is linked to existing data collection systems and allows national and international stakeholders to easily monitor, analyze and disseminate price information for a wide range of commodities in markets of their choice with daily or monthly frequency. Currently the FPMA Tool is being deployed in a number of countries.

An example of a national price tool: Bangladesh

FAO has also a dedicated page on the annual results of IFPA

SDG Indicator 2.c.1 - Food price volatility

**Indicator 2.c.1 - Indicator of (food) price anomalies**

The proposed indicator of food price anomalies measures the number of "Price Anomalies" that occur on a given food commodity price series over a given period of time. This indicator will measure progress towards SDG Target 2.c.

The indicator monitors key commodities for food security at a national level and at a regional/global level the overall price level of food. To accomplish this the indicator is calculated for a set of commodities (Maize, Rice, Wheat, Millet/Sorghum) and on the food price sub-index of the consumer price index as reported by the IMF and National sources.

- The analysis facilitates cross country and regional comparisons and monitoring as it is based on a nationally defined food basket
- For the commodity prices please visit FAOs Food Price Monitoring and Analysis (FPMA) Tool http://www.fao.org/giews/food-prices/tool/public/#/home
- For the Consumer Price Indices (Food/General) http://www.fao.org/faostat/en/#data/CP

<table>
<thead>
<tr>
<th>Consumer Prices, Food Indices (2015 = 100)</th>
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<tbody>
<tr>
<td>Consumer Prices, General Indices (2015 = 100)</td>
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All the information on **SDGs** and **SDG 2.c.1** can be found at

- *Sustainable Development Goals*

- **SDG Indicator 2.c.1**

- In addition an **e-learning course** can be found at

The course is a clear and easy-to-use guide to understand Indicator 2.c.1 (Indicator of food price anomalies) and the methodology to estimate it. It covers basic concepts related to market functioning, prices determination and price volatility and explains how to calculate the indicator and use the online Food Price Monitoring and Analysis (FPMA) tool to interpret indicator results, at national and international level.

This course is primarily intended for: staff of public institutions responsible for monitoring domestic food markets or involved in price data collection, dissemination and analysis within the reporting of SDG Indicator 2.c.1; as well as professionals working in public or private organizations interested in price monitoring and market stability.

You only need to register (free of charge) to get access to the course.
Thank you

For more information, please contact:

JUNGEUN.SOHN@FAO.ORG