Safety Nets Alert Platform
Methodological note on how to simulate the impact of a shock

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Safety Nets Alert Platform (SNAP)

The World Food Programme’s (WFP) Safety Nets Alert Platform (SNAP) is a demand-driven and innovative online platform that uses state-of-the-art analytical tools to produce food security early warning, and enhance risk management and social protection. SNAP helps devise timely and evidence-based policies and interventions in support of the most vulnerable.

SNAP uses a set of tools to monitor markets and provide automated analysis, linked to a system that detects anomalies and triggers early warning for early action. SNAP is a powerful policy-advisory tool, designed to estimate the impact of shocks and policy changes on the food security and poverty of the population. The platform:

- produces timely and high coverage market data;
- forecasts and warns about market volatility;
- recommends adjustments to the cash transfer value;
- analyzes household data and estimates household food security and vulnerability;
- builds food security post-shock scenarios for contingency planning, emergency response and policy making.

WFP initiated the discussion around SNAP with governments and partners in 2014, confirming the interest and need for such a solution. SNAP was first introduced, together with the International Food Policy Research Institute (IFPRI), in Sendai (Japan) at the UN World Conference on Disaster Risk Reduction in 2015. Since then, WFP received several requests from Country Offices and governments to use SNAP in their country.

SNAP Phase 1 (2015-2017) was generously funded by the C-Adapt Fund of the Swedish Government and by the Government of Japan. An in-kind donation was received from iMMAP, an information management non-profit that assigned dedicated staff to the database management and the development of the online platform.

The first phase of SNAP helped WFP and partners focused on testing and validating both the technical and policy-oriented approach at the core of the initiative and advocate for the need of such solution. Since then SNAP became integral part of the analytical and information management work of the agency in the region.

The second phase will focus on two main pillars, namely enhancement and expansion. The enhancement plan aims at augmenting the existing features of the platform as well as the full handover to COs and governments, with capacity strengthening and policy advisory. Regarding the expansion, WFP registered the interest of several governments throughout the development of the first phase of the project. Among the interested countries, priority will be given to those countries that have enough capacity and meet all data requirements. Requests from countries outside the region will be met in the plan of expanding the project globally.

Drawing from the experience gained during the first phase of the project and with in mind the objectives of the second phase, this document serves as methodological notes on how to effectively analyze household data and simulate the impact of shocks on the food security and vulnerability of the population in a given country.

This methodological note is targeting technical staff from WFP, partners and governments. It has the objective of disseminating the practical steps used for the development of the shock impact simulation models, thus strengthening its validation and supporting its results when applied in a specific context or country.
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The Middle East, North Africa and Central Asia regions face extraordinary challenges to food and nutrition security. These regions are exceptionally vulnerable to global food price shocks due to the high dependency on food imports. Socioeconomic shocks can result in a disproportionate burden for the most vulnerable, due to imperfect safety nets. Other countries face these issues too. The International Labour Organization's (ILO) World Social Protection Report 2017-2019 estimates that 4 billion people worldwide are left without social protection. Most developing countries have also limited capacities to anticipate shocks, assess potential impact and provide targeted support. SNAP fills the need of having in place an agile monitoring system that can enhance early warning, risk management and social protection.

Reduced funds in governments to respond to crisis and poor targeting require better organized and properly analyzed data, which is identified as one of the main challenges WFP, partners and governments face when preparing for or responding to a shock. There is a lot of data that is not properly used for evidence-based planning, especially in emergencies when time and resources are limited.

The WFP’s Safety Nets Alert Platform (SNAP) bridges this gap. It translates data into easy-to-read information for decision-makers to take rapid actions and prepare interventions in support of vulnerable populations, based on best available evidences.

Shocks arise from rapid changes in economic, political, market or climatic conditions, affecting different population groups differently. These shocks can have lasting impacts on livelihoods, food security and development progress. A shock impact simulation can be used for estimating ex-ante, current, and ex-post shock impacts to support intervention decisions, contingency planning and wider policy-making. Thanks to the application of SISMod and its integration into SNAP, WFP aims at achieving the goal of Zero Hunger by 2030 and ensuring food and nutrition security for all at all time. It does so through five main comparative advantages:

- **Better and faster analysis and reports.** WFP and government technical staff reduce drastically their time and resources dedicated to analysis and reporting thanks to SNAP. The quality of data and reports is also ensured.
- **Emergency preparedness and contingency planning.** By knowing in advance possible risks and measured impact, WFP and governments can better prepare, prevent and respond. Beyond the financial benefit, this will allow to assist the affected population with preventive and efficient safety nets, making sure no lives and livelihoods are at risk.
- **Less assessments and more effective planning.** Once a shock happens, humanitarian actors go for assessments. With SNAP, costs and time related to an assessment could be eliminated and substituted with simulations.
- **Vulnerable people are better targeted.** SNAP uses categorical targeting, which is considered among the most cost-effective targeting methods in developing countries.
- **Stronger partnership with governments to achieve zero hunger.** SNAP supports governments renewed commitment in achieving SDGs and achieve zero hunger. SNAP builds national capacity in the field of data and analysis, and advocates for social policies that can contribute to alleviate poverty and reach food security. Thanks to SNAP, governments can easily monitor their achievements on SDG2.
Introduction

The Vulnerability Analysis and Mapping (VAM) team of the World Food Programme (WFP) and the Global Information and Early Warning System (GIEWS) team of the Food and Agriculture Organization (FAO) initiated a joint project in 2009 and developed the Shock Impact Simulation Model (SISMod) to address the food security situation in low-income food deficit countries.

The model used to run shock impact simulations is country specific and is based on baselines derived from national household surveys or, in specific cases, WFP and partner assessments. SISMod is a macroeconomic modelling system that brings new possibilities to allow timely quantitative assessments on the ex-ante and ex-post impact of various types of shocks (market, economic, sociopolitical, climatic, etc.) on household vulnerability. It identifies and profiles the vulnerable groups, and estimates to what extent they are in need. SISMod can help governments anticipate shocks derived from specific policies or externalities and make sure the most vulnerable are protected with the most adequate safety nets. In shock-affected countries, SISMod provides early estimates of the impacts of shocks before field assessments are carried out, informing the initial development of response scenarios. The shock simulation models are designed ad hoc for each country, based on context-specific data and informing on particular output variables of interest.

SISMod is converted from a statistical software model to an online interactive tool integrated into the Safety Nets Alert Platform (SNAP). As part of SNAP, WFP Regional Bureau in Cairo (RBC) developed SISMod models in target countries in partnership with local actors, including hosting governments.

The foundation of SISMod analysis is a set of modules that take into account household income, expenditure and consumption. The model estimates demand, supply and price transmission elasticities based on household data, national food price collection systems, and integrated with other assessments. The process determines the interaction between production and income-generation decisions (income effects) and consumption decisions (price effects), which quantify the impacts of price changes and income changes on household food consumption.

The methodological approach is to incorporate baseline data and shock factors to model the impact of shocks on the food security and vulnerability situation of the country. Therefore, the analytical work starts with secondary data analysis, collection of background information on the history of the country in terms of price changes of food and non-food items and income changes and a review of the impact of past shocks and their impact. This is then used as a basis for identifying the magnitude of shock impacts to measure their effect on food security and other vulnerability indicators relevant to the country context. The methodology of SISMod can be divided into three steps:

1. **Data preparation**, where the analyst prepares income, expenditure, and food consumption modules to be entered in the economic models;

2. **Parameter creation**, where the analyst creates elasticities for income, expenditure, and food consumption;

3. **Shocking factors**, where the analyst simulates possible impacts of shock factors on the household’s food security situation, particularly in terms of expenditure and food consumption behavioral changes after a shock.

The final outcomes of the analysis are specific estimated indicators of vulnerability relevant to the country context. Among the output indicators used in RBC countries, there are, for instance absolute/extreme poverty, depth of hunger, food assistance needed, food deficient population, food gap, etc.

In SNAP, to overcome data availability limitations, the analysis is carried out using the light version of SISMod. SISMod-Light adopts the Agricultural Household Model (AHM) approach developed by Singh et al. (1986). In this model, household consumption decisions are based on household income, which comprises agricultural profits as well as wages, social provisions and any other source of income. Income generation and the allocation of income to expenditure are based on separable decisions, which maximize income and utility in a two-step process. The AHM incorporates both household production and consumption. It integrates price effects – presumed to be exogenous – and takes the relation between them into account.

SISMod was recognized internally at FAO and WFP and externally by other governmental and non-governmental institutions. During 2016-2017 WFP Regional Bureau in Cairo developed four models for Yemen, Lebanon, Kyrgyz Republic and Egypt. Each of these countries has different background, in terms of food security situation and data available.

SISMod is converted from an econometric model to a user-friendly online platform for easy use at country office level. The **SNAP online platform** (available for RBC and its oversight countries), allows users to run different impact simulations or scenarios for those countries where the model was built, without using any additional software. The model is expected to be expanded to other shock-prone countries in the region and beyond.
Methodology

The primary idea of running a shock impact simulation is to incorporate a certain shock and estimate the number of food insecure people accordingly. However, the model could be transformed to be more flexible and include other socio-economic outcomes, such as poverty.

For the purpose of this guidelines, a shock is defined as an event which triggers negative (or positive) effects on well-being, health and environment of individuals, HHs, a community, a region, or a country. Shocks are distributed across space and time and can be natural, health-related, social, economic, political, or environmental. For SISMod purposes, a change in policy is also considered as a shock.

The model used in SNAP examines the links between shocks on the one hand, and food security, vulnerability and poverty on the other. Analysis identifies possible scenarios for developing ex-ante and ex-post strategies that can be used by communities, regions or countries to protect household wellbeing and enhance the country response management.

Depending on the scale of the shock, effects on the well-being of the people can be large or small and can differ across locations in a country. The model can be functional at the regional level, if the baseline data is representative at the regional level.

Generally, a national shock can have impact on all socio-economic indicators of the country, such as Gross Domestic Product (GDP), Consumer Price and Food Price Indices (CPI/FPI), unemployment rate, etc. Any kind of shock impacts production and consumption of the affected country (or region), through physical or economic disruptions of production cycles, market supply and purchasing abilities of the people and businesses. These are reflected in the model.

However, the magnitude of those shocks on individuals and HHs, their food security and well-being is the core focus of SISMod analysis. A disruption of production cycles in the country directly affects market supply and availability of products, which leads to a price increase in the market. It also affects the job market, employment and livelihood opportunities. These factors have negative effects on government revenues and could be a threat for social payments and performance of the public social system.

Therefore, the assumption is that shocks are reflected on household's lives and well-being through an impact on their income levels and livelihoods; and access to the consumption through prices on the market for food and non-food commodities and services. As household income and purchasing abilities are shocked, expenditure and food consumption patterns change.

The impact of a shock on household expenditure is a consequence of a change in income and/or prices. Examples of shocks that a household can face are increase in taxation, change in social benefits, decrease of agricultural income, etc. The household's reaction to a shock is thus highly reliant on the nature of the shock and the parameters associated with it.

On the other hand, a shock could cause price instability through interruptions of supply, reduced availability on the market or monetary policy effects. Increase of the prices would affect consumption and food affordability of the household. Depending on elasticities, it would likely affect the
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quantity of food or other goods and services consumed by increasing the expenditure associated to them, especially when income levels remain unchanged.

A reduction of income and/or the increase of prices caused by a shock would affect both expenditure and consumption of households. The model gives estimates on how expenditure and consumption of household will change if a specific shock would apply, with a specific focus on food expenditure and consumption. Simulation results are very relevant in case of policy making, emergency response and in conflict situations, when access to a field assessment is limited.

SISMod adopted the Agricultural Household Models (AHM) approach developed by Singh et al (1986) which incorporates both the production and consumption sides. This means, that household consumption includes goods that are both purchased from the market and self-produced. SISMod gives thus an opportunity to estimate food security and vulnerability indicators even for those households that rely mainly on own produced food.

As aforementioned, shock affects households through income and prices change. It is therefore very important to have a comprehensive list of income sources, since different shock scenarios will influence income sources in distinctive ways. By summing up all estimated income, the total income value after shock is calculated (see Step 3).

When an estimation of the income-shocked value is made, the analyst can calculate how this could affect total expenditure. Relationship between income-expenditure in the model are estimated by an elasticity coefficient through regression (see Step 2). Since expenditure will also be adjusted by price change, the model applies shock values also on the CPI.

The correlation between expenditure groups include own price and cross-price elasticities estimations. The Two-Stage

In the case of Yemen, based on the latest available data collected in 2014 through a Comprehensive Food Security Survey (CFSS), WFP estimated that the depth of hunger among the Yemeni population, measured by the aggregated household food energy consumption deficit, was, in November 2016, almost double than the level of the pre-crisis period, pushing those who were already food insecure into a severe level of food insecurity. The results of this simulation were shared on a Special Focus Report and were later on confirmed with the Emergency Food Security Assessment (EFSA) of April 2017.
Demand System methodology is applied to quantify economic relationships between expenditure groups (see Step 2). This allows to estimate expenditure values after shock for each expenditure group.

When shocked expenditure groups are calculated, the next step is to estimate food expenditure/consumption by food groups. At this stage, food price changes between the baseline and after the shock are used. Based on the food price changes, own price and cross-price elasticities between food groups are applied.

With the shocked food expenditure data, one can easily calculate the consumption of food after shock, food needs and all other output variables of interest. This topic is discussed in details in Step 3.

As indicated above, several country- and context-specific variables can be used as output indicators. The model generates outcomes with the options to disaggregate by livelihood, gender, poverty quintiles and geographical differences.

The model is run using the econometric package Stata. In this document, Stata codes are used to give an idea of the formulas and calculations of the model. Applications of the syntax using a different software is thus possible, subject to slight code adaptations.

Note: the primary source of the methodology is available online on SISMod website.
THE STEPS
Step 1—Data Management

In Step 1, the analyst focuses on data management with the aim of calculating and preparing necessary variables for further analysis in the following steps. The main components of the necessary data are the income, expenditure and food consumption modules.

The first step of the work includes:

- Survey data cleaning (missing values, outliers)
- Aggregation and disaggregation of variables
- Preparation of input variables:
  - Per capita income values, sources and income groups, and shares;
  - Per capita food and non-food expenditure, and expenditure shares;
  - Per capita food consumption by Kcal and shares of food groups.

Data cleaning is the process of detecting and correcting (or removing) inaccurate records from a dataset as well as identifying incomplete, incorrect, inaccurate or irrelevant parts of the data and then replacing, modifying, or deleting the inaccurate or false data.

**SURVEY DATA CLEANING**

**Missing Values**

Missing data is present in almost all quantitative surveys especially when it refers to income and expenditure.

To deal with missing data, the first step is to determine the reason behind the missing data. Sometimes observations have missing values due to non-responses during the survey. Non-responses could be a distraction for the study. On the other hand, a dataset may include variables which are not relevant for some responders. For instance, a questionnaire may include a question on wage income, but wages will be missing for people who do not have salaried jobs.

The three rules used to prepared a dataset for SISMod are:

1. **Remove incomplete observations.** In case, there is no pattern in the missing data for any variable, the practice is to delete all observations with missing values if the cleaned sample would still be representative.
2. **Recover the values.** In case WFP or its partners conducted the survey, the analyst is encourage to contact enumerators and participants, asking them to fill the missing values and/or explain the reason of the missing data.
3. **Replace missing values with substitute values.** Imputations of missing data through average values, using information from related observations, regression substitution, multiple imputation etc. This practice is common when the dataset would not be sufficiently representative if the missing data observations are removed.

**Outliers**

Outliers could be another problem an analyst could face during SISMod data management process. An outlier is an observation point that is far from the median of data. An outlier may be due to variability in the measurement or it may indicate experimental errors. Sometimes outliers need to be excluded from the dataset or to be substituted, following the above practices for missing data.

**AGGREGATION, DISAGGREGATION AND PREPARATION OF INPUT VARIABLES**

To produce convincing results for the next step of the model, the analyst should pay attention to the level of aggregation and frequency of collecting data.

In SISMod analysis, the model can deal with various levels of data aggregation. Data is usually collected at household level with identification of geographical location. However, during the analysis, often the same indicators is used on individual (per capita) level, which could be misleading when moving ahead with the next steps. The same mistake can happen at a higher level of, for instance, geographical aggregation like a city, sub-region, region, country, etc.

The frequency with which the data is captured is critically important when you work with governmental data. The frequency
refers to the rate at which measurements are obtained. Food consumption data is usually captured at one or two weeks recall period. On the other hand, income and expenditure data could be collected on monthly, quarterly or even an annual basis. Sometimes the same data is collected for several recall periods during each quarter of the year. Therefore, analyst should be cautious to the recall period as well as to the timeframe of the collected variables.

**Income**

Household income sources should be divided by income source depending on the different sources of income that are available in the country (or region). Main sources of income are usually agricultural activities (crop and livestock income), wages (private and governmental), social benefits including governmental (e.g. pensions, social transfers, etc.) and non-governmental (e.g. insurance), self-employment, income earned from properties (financial and non-financial), and remittances. These variables could differ from one country to the other, and can be disaggregated further, especially when dealing with governmental surveys.

In the assessment, the household total income includes all types of monetary and non-monetary income, and all types of social assistance, including subsidies for reimbursement of expenses for housing, communal goods and services, gifts, income from the sale of personal and real estate property, etc. (*Note: savings is not considered as income, and is thus not part of the total income*)

Household monetary income consists of the sum of cash and non-cash (in monetary value) revenues received by members of the household in the form of wages (with the exception of income tax and compulsory deductions), income from entrepreneurial activity and self-employment, income from property in the form of interest, dividends, sale of shares and other proceeds, proceeds from the sale of products of a personal auxiliary farm, pensions, scholarships, social contributions (cash benefits and subsidies for housing and utilities, electricity and fuel, compensation for unused entitlement on spa treatments, transport subsidies for certain categories of citizens, etc.), financial assistance from relatives and other persons and other income.

Non-monetary income includes the value of products received from a private smallholding (private plot, farm), the cost of gifts made by relatives and other persons of food products, the amount of benefits and cashless subsidies for the payment of housing and communal services, electricity and fuel, as well as the amount of cashless payments for goods and healthcare services, travel services, vouchers for recreation facilities, for payment of transport and communication services, etc.

Usually income data is collected on monthly basis, in governmental surveys. Sometimes quarterly or annual aggregations are used in the final datasets. The analyst needs thus to carefully calculate the average monthly income from difference sources per capita. As data was recorded for each source of income and month in a separate row, the analyst needs to start by summing all income variables by household unique variable (code) using **collapse** function in Stata (see below).

```
collapse (sum) HH_INCOME HH_OTHER_INCOME_VARIABLES, by (hh_code)
```

When dealing with annual (or quarterly) incomes, the model requires the analyst to derive the per capita monthly income variable, which could be calculated by dividing annual income values by 12 (number of months) and by the HH size (please see below). For creation of the new variable **generate** command is used.

```
generate PC_M_INCOME = HH_INCOME/(12*hsize)
```

If there is more than one income variable, the best and fastest way to calculate is to use the loop command **foreach**. Using **foreach** command requires creating **local macro**, which defines the list of income variables required for calculations. **Local** syntax assigns strings to local macro names. (see below example).

```
local inclist HH_INCOME HH_OTHER_INCOME_VARIABLES
foreach inc of local inclist {
    generate pc_m_`inc'= hh_m_`inc'/(12*hsize)
}
```

This will result in a calculation of per capita monthly income for each variable in

```
inclist (HH_INCOME and HH_OTHER_INCOME_VARIABLES).
```

Total income should include not only monetary income, but also in-kind income of the household. Smallholding income includes the estimated monetary value of products received from a private smallholding (private plot, farm), regardless if they were sold on market (cash smallholding income) or consumed inside the household. Therefore, all in-kind income received
through the household own production should be transferred into monetary values according to the local market prices. Price statistics are not always available for specific commodities produced by the household. Another way to derive local prices could be calculation based on the monetary revenue from the selling of the products divided by its quantity.

\[
gen \text{ price } = \frac{\text{revenue}}{\text{quantity}}
\]

Since it is not a must that each household who produces products will sell it, the average price of each commodity should be calculated.

\[
gen \text{ Mean}_{uv} = \text{mean}(\text{price}), \text{ by} (\text{commodities})
\]

The last step to derive own production income is to multiply the average price of the commodity by the quantity produced. \textit{Note: data for crop and livestock production and consumption is usually separated and all calculations should be done accordingly.}

**Expenditure**

The simulation of income and price changes are calculated in the expenditure and consumption modules. This part of the model can be divided into two stages.

In the first stage, total household expenditures are broken down over broad commodity groups which usually include: food and beverages; clothing and footwear; housing including utilities; durable goods; health; education; transport; communication; and others. However, final list of the commodity groups should be done based on the country/region context and the national statistical practice (i.e. the categories defined in the CPI).

The household expenditure should include all resources spent by the household members during the surveyed period. The expenditures are estimated in total and monetary form. Total expenditure includes monetary and in-kind expenditure at market values.

Smallholding expenditure includes the estimated monetary value of all cost related to the production as well as given as a gift to other households or consumed inside the household.

Some expenditures are considered consumption and others non-consumption.

By definition (Eurostat, 2003), additions to savings, amounts invested or loaned, repayments of loans (e.g. interests on mortgages) and outlays, gambling losses, cash grants and donations (except small contributions of a recurrent nature to churches and charitable institutions) for other financial transactions are non-consumption expenditures.

As aforementioned for the income section, all expenditure variables should be calculated per capita per month.

In the second stage, food expenditure in monetary terms and food consumption converted to kilocalories should be calculated for all relevant food sub-groups. Household food expenditure should be allocated over few food sub-groups which usually include: cereals, pulses, animal protein group (i.e. meat, fish, eggs, diary), vegetables and fruits, fats and oils, sweets and sugar, and other food. However, the final list of food commodity groups should be done based on the country/regional context and the national statistical practice.

**Consumption**

The food consumption in quantity should be converted to caloric intake by using a food composition table, either provided by the national statistical office or FAO. Grouping of the food consumption should follow the same rationale applied for food expenditure.
Step 2—Two-Stage Food Demand System

This part provides a description of methods applied for the calculation of own price elasticities, cross-price elasticities, expenditure and income elasticities to estimate changes of the expenditure and consumption of the people after simulating the impact of a shock.

The own-price elasticity, cross-price elasticities, expenditure and income elasticities need to be estimated by a demand system based on household survey data prepared in Step 1.

THE NEED OF ESTIMATING ELASTICITIES

As the inputted shock is going to influence the income of a household, the idea is to estimate the relationship between total income and total expenditure through elasticity coefficients. It helps to understand how a change of income will affect total expenditure of a household.

When obtained an estimation of total expenditure after income shock, the task is to estimate how household expenditure behavior will be affected within each expenditure group. For that, the analyst needs to use expenditure, own-price and cross-price elasticities (see below description of the parameters).

In the last stage of the parameters calculation, the analyst produces the estimations of the food expenditure own-price and cross-price elasticities.

Therefore, the elasticity coefficients play a connecting role between the shock parameters and the pre-shock values of variables.

Income elasticities

This simple regression describes the nature of the relationship between total expenditure, as dependent, and income.

The practice to assess how income changes impact expenditure is by using a constant percentage. To obtain a constant elasticity model, natural logarithms of income and expenditure data is used. Since variables are expressed in logarithms, the coefficient of change represents the percentage adjustment of variable y after one percent shock in variable x.

The Average Propensity to Consume (APC) is defined as the ratio of a household’s spending or consumption to its disposable income. In turn, the Average Propensity to Save (APS) is the ratio of the household savings to its disposable income. The resulting sum of APC and APS is 1, or one hundred percent of disposable income.

The equation for total expenditure is specified as a function of household income, controlling for households social and demographic characteristics such as household size, location, gender of household head, age of household head, education of household head, etc.

\[ \text{Total expenditure} = f(\text{total income, HH size, other indicators}) \]

The elasticities derived are used for the shock simulation model.

Differences in income and household characteristics lead to different household behavior in the acquisition of goods. Usually total expenditure is higher than income levels for low income households, while for high income household total expenditure is lower than total income and it is more dependent on other factors such as household demographic

NOTE: ELASTICITY BASICS

Elasticity describes the relationship between two variables as a measurement of how responsive one of them is to a change in the other. It is defined as the percentage change in a dependent variable caused by a percentage change in an independent variable.

It can be shown in formula:

\[ \frac{\Delta Y}{\Delta X} \]

where

- \( \Delta Y \) is the elasticity coefficient
- \( \Delta X \) is the % change in an independent variable

An elastic variable responds equally or more than proportionally to changes in other variables.

An inelastic variable changes less than proportionally in response to changes in other variables.

For SISMod model there are four types of elasticities used: income, expenditure, own price and cross-price.

Income elasticity describes how a change in income shifts the household total expenditure.

\[ \text{Income Elasticity} = \% \text{ change in HH Expenditure} / \% \text{ change in HH Income} \]

Expenditure elasticity describes how a change in household total expenditure shifts specific group of expenditure.

\[ \text{Expenditure Elasticity group} = \% \text{change in HH Expenditure Group} / \% \text{ change in HH Total Expenditure} \]

Own price elasticity of household expenditure is a measure of the percentage change in the expenditure “caused” by a percentage change in price of the same item.

\[ \text{Price elasticity of expenditure} = \% \text{ change in Quantity of Expenditure} / \% \text{ change in Price} \]

Cross elasticity is a measure of the responsiveness of HH of a good to changes in the prices of related goods.

\[ \text{Cross elasticity} = \% \text{ change in HH expenditure for good Y} / \% \text{ change in the price of good X} \]
characteristics. That’s why it is critical to calculate elasticities for different income groups. To create income groups the analyst can use \texttt{xtile} command on Stata.

\texttt{xtile inc gp = pc m income, nq (5)}

**First stage demand system**

The first stage allocates total household expenditure to (generally) eight broad groups of goods: food, clothing, fuel, housing, durable goods, education, medical items, and other items.

A non-Linear Seemingly Unrelated Regression (NLSUR) is used to estimate a Linear Expenditure System (LES) of eight equations for the first-stage budget allocation. The advantage of the LES is that it is simple and provides an intuitive economic interpretation, despite its strong separability assumption. The separability assumption is not overly restrictive for such commodities as food, housing, or clothing (Timmer and Aldermand, 1979).

To run NLSUR in Stata, the command \texttt{nlsur} is used. The \texttt{nlsur} fits a system of nonlinear equations by Feasible Generalized Nonlinear Least Squares (FGNLS).

In the LES, demand equations are assumed to be linear for all prices and incomes and the set of demand functions is expressed in expenditure form:

\[
P_I X_I = P_I R_I + \beta_I (Y - \sum P_I R_I^I)\]

with \(0 < \beta_i < 1\), \(\sum \beta_i = 1\) and \(Y > X_i\),

where \(P_I X_I\) (\(P_i\) and \(X_i\) are aggregated price and quantity indices for commodities within group \(I\)) is the expenditure, and \(R_i\) and \(\beta_i\) are parameters. \(Y\) is the household total expenditure.

The uncompensated own-price and cross-price elasticities associated with the equation are:

\[
\eta_{II} = (1 - \beta_i) R_i / (P_I X_I) - 1
\]
\[
\eta_{IJ} = -\beta_i (P_J R_J) / (P_I X_I)
\]

The expenditure elasticities are:

\[
\mu_I = \beta_i Y / (P_I X_I)
\]

The aggregated prices for the grouped goods in the first stage could be derived based on the specific CPI database with their expenditure shares as weights of each group. Usually National Statistics Offices already calculate expenditure group shares.

The outcome of the first stage calculations are the expenditure cross-price and own price elasticities, which are used in Step 3. The estimated elasticity coefficients should be saved in a separate file (table) for further use.

In Stata do-file, the systems of equations for eight expenditure groups will be:

\[
\texttt{nlsur (pc m exp foodtobaco = (a1) * uv cmd foodtobaco + (b1) * (pc m exp total - (a1) * uv cmd foodtobaco + (a2) * uv cmd housing + (a3) * uv cmd utilities + (a4) * uv cmd healthedu + (a5) * uv cmd transport + (a6) * uv cmd cloth + (a7) * uv cmd commun + (a8) * uv cmd others )))}
\]
\[
\texttt{(pc m exp housing = (a2) * uv cmd housing + (b2) * (pc m exp total - (a1) * uv cmd foodtobaco + (a2) * uv cmd housing + (a3) * uv cmd utilities + (a4) * uv cmd healthedu + (a5) * uv cmd transport + (a6) * uv cmd cloth + (a7) * uv cmd commun + (a8) * uv cmd others )))}
\]
\[
\texttt{(pc m exp utilities = (a3) * uv cmd utilities + (b3) * (pc m exp total - (a1) * uv cmd foodtobaco + (a2) * uv cmd housing + (a3) * uv cmd utilities + (a4) * uv cmd healthedu + (a5) * uv cmd transport + (a6) * uv cmd cloth + (a7) * uv cmd commun + (a8) * uv cmd others )))}
\]
\[
\texttt{...}
\]
\[
\texttt{(pc m exp others = (a8) *uv cmd others + (1 - (b1) * (b2) + (b3) * (b4) * (b5) * (b6) * (b7)) * (pc m exp total - ((a1) * uv cmd foodtobaco + (a2) * uv cmd housing + (a3) * uv cmd utilities + (a4) * uv cmd healthedu + (a5) * uv cmd transport +
}
\]

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The expenditure elasticities in Stata are calculated as follows.

\[ \text{gen } e_{\text{exp}}_{\text{group1}} = b1 * \frac{\text{avg}_{\text{pc}}_{\text{m}}_{\text{exp}}_{\text{total}}}{\text{avg}_{\text{pc}}_{\text{m}}_{\text{exp}}_{\text{group1}}} \]

The uncompensated own-price and cross-price elasticities in Stata are calculated as follows.

\[ \text{gen } e_{\text{group1\_group1P}} = (1 - b1) * \frac{(\text{avg}_{\text{uv}}_{\text{group1}} * a1)}{\text{avg}_{\text{pc}}_{\text{m}}_{\text{exp}}_{\text{group1}}} - 1 \]
\[ \text{gen } e_{\text{group1\_group2P}} = -b1 * \frac{(\text{avg}_{\text{uv}}_{\text{group2}} * a2)}{\text{avg}_{\text{pc}}_{\text{m}}_{\text{exp}}_{\text{group1}}} \]

**Second stage of food demand system**

The second stage of food demand system, a Linear Almost Ideal Demand System (LAIDS) is applied for consumed food groups. The number of food consumed groups depends on local food consumption patterns which usually includes cereals and grains (could be disaggregated if needed); milk and dairy products, meat and fish, fruits, vegetables, pulses and nuts, tubers and roots, sugar, beverage and drinks, oils/fats, and others. Aggregation or disaggregation of the food commodities depends on the importance and weight in the consumption in the country. On the other hand, it should be responsive and matching in the food demand system calculations.

The synthetic food demand equation for each food item is defined in per-capita terms and is a function of real price of the commodity, real consumer expenditures per capita and real prices of other foods:

\[ d_{\text{food}} = f(P_{\text{food}} \ P \ X_{P}) \]

The real price of the commodity is expected to be negatively related to food demand. The signs of the other two variables are ambiguous because expenditure elasticities can be positive or negative, and other foods can be substitutes or complements. Given the income and price elasticities, the percentage change in each food item consumed will be determined by percentage of change in price (own and cross price) and percentage of change in income.

Consider the Linear Almost Ideal Demand System (LAIDS) with \( L \) equations for latent share of each food group in total consumption (\( S_{hi} \)) for household \( h \) (Deaton and Muellbauer 1980):

\[ S_{hi} = \sum_{i=1}^{k} a_{ik} X_{i}^{p} + \sum_{i=1}^{L} \gamma_{i} \ln P_{i}^{x} + \beta_{i} \ln \left(\frac{M_{h}}{P_{h}}\right) + \varepsilon_{i} \quad i = 1, ..., L \]

Where \( S_{hi} \) is the budget (expenditure) share of the \( i \)-th good (group), \( X_{i} = 1, X_{1}, ..., X_{k} \) are demographic variables, \( k \) is number of demographic variables, \( L \) is number of food items (groups), \( P_{i} \) represents the price of \( i \)-th good (group), \( M \) is total expenditure, \( P \) is Price Index, \( \varepsilon_{i} \) is the disturbance term, \( a_{ik} \), \( \gamma_{i} \) and \( \beta_{i} \) are parameters.

The adding-up, homogeneity, and symmetry restrictions are in following equations respectively:

\[ \sum_{i=1}^{L} a_{ik} = 1, \sum_{i=1}^{L} \gamma_{i} = 0, \sum_{i=1}^{L} \beta_{i} = 0 \]

Then expenditure and price elasticity can be derived from the parameter estimates obtained in AIDS equation:

\[ \eta_{i} = 1 + \left( \frac{\beta_{i}}{S_{i}} \right) \]
\[ \eta_{ii} = -1 + \left( \frac{\gamma_{ii}}{S_{i}} \right) - \beta_{i} \]
\[ \eta_{ij} = (\gamma_{i} / S_{i}) - \beta_{j} S_{j} / S_{i} \]

where \( \mu_{i} \) is the expenditure elasticity, \( S_{i} \) is the budget share of good \( i \), \( \eta_{ii} \) is the own-price elasticity, and \( \eta_{ij} \) represents the cross-price elasticity (uncompensated).

The outcome of the first stage calculations are food groups cross-price and own price elasticities, which are used in Step 3. The estimated elasticity coefficients should be saved in a separate file (table) for further use.

*Note: all Stata codes for the calculation of stage two can be found in Annex 2.*
Step 3—Shock simulations and scenarios

The third step explains the process of identifying specific shock factors for the countries (or a specific region or social group within it) and simulating their possible impacts on the household expenditure and, ultimately, food consumption (and any other relevant vulnerability variable of interest).

At this stage, the analyst needs to input the percentage change from the baseline for each shock factor which is being modeled. One or more factors can be changed depending on the scenario being modeled.

SHOCK SIMULATIONS

The model currently focuses on changes in key factors that affect income and prices, such as:

- **Income sources and levels**: salary rates (different sectors depending on country context); remittances; social payments etc.
- **Agricultural production** at national and regional levels;
- **Commodity Retail and Wholesale Prices**: main commodities in main markets;
- **Macro-Economic factors and regional/national/local policies**, including Consumer Price Index, exchange rate, population, tariffs, subsidies, social allowances, etc.

The shock model should simulate different scenarios to provide the most likely situations of socio-economic or natural shocks impact. Development of the possible scenarios should be done on a consensus basis with the Government, national and international experts, economists and other related partners.

The main outcomes of each scenario for the model are estimations of the impact of a shock on the income sources and levels, as well as consumer prices and food prices. The income generation module is used to link shocks to household income, which can be disaggregated at different levels based on the context and data representativeness. Each income category is subject to different shocks, directly or indirectly. Consumer prices and food price changes should be disaggregated into expenditure groups and food groups (see Step 2). These estimations are applied in the model to calculate outcomes of the shocks on the household level. Socio-economic and natural shocks could be measured directly by the changes in production, wages, and prices from the baseline period (generally the assessment date) to any given moment when a shock takes place (or is projected). The changes in the shock factors are then used to estimate new incomes in the post-shock to show the impact it has (or might have) on the vulnerability variables of interest.

The per capita total monthly expenditure after shock is calculated based on the income elasticity coefficient obtained in Step 2 and after income changed following the shock. Total expenditure after shock is distributed through consumer groups based on the cross-price and own price expenditure elasticities calculated in Step 2 (First Stage Demand System).

The obtained food expenditure values after shock are distributed between food groups with food cross-price and own price elasticities calculated in the Second Stage of Food Demand System (Step 2). The per capita daily food consumption in Kcal after shock is the main outcome indicator of the model. However, daily food consumption in Kcal is subject to further analysis and considerations.

The chain of calculations follows the eight points indicated in the box on page 20.

CALCULATING THE IMPACT OF A SHOCK

As previously explained, the model starts with the calculation of the income value after shock. To derive it, the per capita monthly income of the household is multiplied with the coefficient of the estimated percentage changed of the income affected by the shock. **For example, if the estimate is that income will decrease by 20%, than the pre-shock value will be multiplied by (1 - 0.2) to obtain the after-shock income.**

As there are more sources of income impacted by different shocks, each of them needs to be shocked according to the estimation. At the end of the calculation of this stage, a general coefficient of for the total income change should be derived. Mathematically it looks like a ratio of shocked and pre-shocked values.

In Stata, this is done by creating a local macro with a list of the income variables and then multiplying each of them for the estimated coefficients.

```stata
foreach inc of local inclist {
```


\texttt{gen\ pc\_m\ inc\_'inc'_S = pc\_m\ inc\_'inc'*r\_inc\_'inc'}

\texttt{egen\ pc\_m\ income\_S = rowtotal(pc\_m\ inc\_*S)}

\texttt{gen\ r\_inc = pc\_m\ income\_S / pc\_m\ income}

In the next stage, income elasticities are applied to total expenditure using the income change. Mathematically it looks like multiplication of total expenditure variable and coefficient which is calculating as multiplication of the income change coefficient and the income elasticity coefficient (Stata code below). As a result of these calculations, total expenditure after shock is derived.

\texttt{gen\ pc\_m\ exp\ total\_S = pc\_exp\ total * (1+(r\_inc - 1) * e\_inc\_exp)}

In the next stage, the total expenditure of the household after shock should be distributed among expenditure groups. The distribution of total expenditure are done with the application of expenditure, own-price and cross-price elasticities.

With the focus on food security, the per capita monthly expenditure on food is calculated as follow:

\texttt{gen\ pc\_m\ exp\ food\_S = pc\_m\ exp\ food * (1 +((r\_cpi\_foodtobaco - 1) * e\_foodtobaco\_foodtobacoP + (r\_cpi\_housing - 1) * e\_foodtobaco\_housingP + (r\_cpi\_cloth - 1) * e\_foodtobaco\_clothP + (r\_cpi\_healthedu - 1) * e\_foodtobaco\_healtheduP + (r\_cpi\_transport - 1) * e\_foodtobaco\_transportP + (r\_cpi\_communication - 1) * e\_foodtobaco\_communicationP + (r\_cpi\_others - 1) * e\_foodtobaco\_othersP + (r\_exp - 1) * e\_exp\_foodtobaco))}

The coefficient of food expenditure is calculated as ratio of shocked and pre-shocked food expenditure values:

\texttt{gen\ r\_exp\ food = pc\_m\ exp\ food\_S / pc\_m\ exp\ food}

Having obtained the ratio of food expenditure change, the analyst can estimate how the shock will affect food consumption in Kcal using expenditure, own-price and cross-price elasticities of each food group.

Stata code to calculate food consumption per capita in energy terms will be as follows.
local foodlist staple pulses vegfru prot oilfat sugars other

foreach fd of local foodlist {
    gen pc_d_con_kcal_`fd'_S = pc_d_con_kcal_`fd' * (1+((r_rp_staple -1) * e_`fd'_stapleP + (r_rp_pulses -1) * e_`fd'_pulsesP + (r_rp_vegfru -1) * e_`fd'_vegfruP + (r_rp_protein -1) * e_`fd'_protP + (r_rp_oilfat -1) * e_`fd'_oilfatP + (r_rp_sugar -1) * e_`fd'_sugarsP + (r_rp_other -1) * e_`fd'_otherP + (r_exp_food -1) * e_exp_`fd'))
} 
egen pc_d_con_kcal_S = rowtotal (pc_d_con_kcal_*_S)

OUTPUT VARIABLES
Based on the derived data, SISMod estimates the output indicators of interest. Among them:

- **Per Capita Dietary Energy Consumption** – the dietary energy consumption per person is the amount of food, in kilocalorie (Kcal) per day.
- **Depth of Hunger (1,870)** – the energy deficit to the threshold of 1,870 Kcal per person per day.
- **Depth of Hunger (2,100)** – the energy deficit to the threshold of 2,100 Kcal per person per day.
- **Food Assistance Needed** – the monthly metric tons of food (in cereal-equivalent) needed to fill the energy gap up to 2,100 Kcal countrywide.
- **Food Deficient Individuals** – the absolute number of individuals of the population under the daily energy intake of 2,100 Kcal per person. It is calculated based on the most recent demographic profile.
- **Food Deficient Population** – represents the share of a country population under the daily energy intake of 2,100 Kcal per person.
- **Depth of hunger (in kcal/person/day)** – deficit in absolute terms between the average dietary energy consumption and the dietary energy consumption threshold. Depth of hunger indicates how many calories would be needed to meet the Dietary Energy Consumption (DET). The depth of hunger is calculated as the product of average food dietary energy consumption of the food deficient population and the number of food deficient people, which is then normalized by the total population.
- **Share of Staple Food Consumption** - the share of household consumption of staple food in Kcal as a percentage from the total household food consumption.
- **Gap in Kg** – the energy deficit to the threshold of 2,100 Kcal per person per day, converted into the kilograms of cereal-equivalent. Food gap is usually presented in cereal equivalent terms.
- **Income to Expenditure Ratio** – the ratio of the total household income to the total household expenditure as an indicator for the debt dependency of the household.
- **Share of Food Expenditure** – the share of household expenditure on food as a percentage from the total household expenditure.
- **Absolute Poverty** – the percentage of population under the absolute poverty line is established by the government of each country.
- **Extreme Poverty** – the percentage of population under the extreme poverty line established by the government of each country.
- **Others** – according to context specific requirements and data availability.

For the calculation of these indicators, the reader can refer to the Technical Notes in Annex 3.
Conclusions

With the advent of the Safety Nets Alert Platform (SNAP), WFP integrated its highly technical analytical capacity with information management, policy advisory and capacity building. As part of the SNAP initiative, WFP indeed expanded the application of SISMod to support governments and partners in producing relevant analysis through a user-friendly platform.

However, what is available to public users on the SNAP website is only the front-end and it was thus required to share a methodological note on the analytical tools available in the platform. SNAP uses indeed the FAO/WFP-developed Shock Impact Simulation Model (SISMod) to assess the impact of a shock (either past or expected) on the well-being of the population in a specific context. SISMod was initially developed to address the notable rise in the number of people facing various types of shocks (market, economic, political and climatic), which led to challenges in addressing food insecurity in developing countries. Previously, it had proved difficult to provide quantitative estimates on the impact that various shock factors have on the livelihoods and food security of different population groups at a nationally representative level.

On SNAP, users are provided with all relevant information to understand a past shock or expect a future one. Shocks arise from rapid changes in economic, political, market or climatic conditions, and affect different population groups differently. These shocks can have lasting impacts on livelihoods and food security, impeding development and progress. Interventions are often criticized for being “too little, too late”, but often actors do not have the necessary tools to make quantitative assessments that can help them identify who is most affected, to what extent and where.

The model can be used for comprehensive situation analysis, simulation and monitoring of the impact of shocks on household livelihoods and food consumption. It can also generate values for estimated populations with food needs, which can be used in WFP operations and other interventions.

By regularly updating the time series data, the model can be used to monitor situations of changing market conditions. Such regular updates would enable the SISMod to be applied in crisis situations.

For policy purposes, the model can be used to deduce the effect of shocks in past situations and draw lessons for future shocks, in order to better understand how to target interventions to protect those at the greatest risk of loss of income and food consumption.

The model is country specific; users will observe that the impact of shocks is largely context specific. Similar shocks in different parts of the country can lead to similar or different outcomes, depending on the type of shock, its magnitude and the profile of the household.

The model can be run and compared with the results from other countries to better understand the need to tailor interventions and policy in food security to country needs.

SISMod allows timely assessment of emerging issues by generating up-to-date subnational food security data, and simulates the outcome of different intervention/policy scenarios. This will be valuable to a wide range of potential users including governments and national/international humanitarian/development organizations that carry out food assistance interventions and economic/policy analysis.

The initial phase of SISMod focused on shock-prone food-deficit countries representing different levels of exposure to shocks: Bangladesh, Nepal, Pakistan, Tajikistan, Niger, Tanzania and Uganda. Starting from 2015, thanks to the implementation of SNAP, WFP expanded applied the model to Lebanon, Yemen, Kyrgyz Republic and Egypt. Other countries are on the pipeline and the shock impact simulation analysis will soon be available for them too.
Annex 1—Stata Glossary

ABBREVIATION LIST FOR VARIABLES IN STATA CODES

**hh_code** – household individual code

**price** – price (for specific commodity or group)

**avg** – average

**pc** – per capita

**m** – monthly

**exp** – expenditure

**total** – total

**pc_m_exp_total** – per capita monthly total expenditure

**HH_INCOME** – household income

**pc_m_income** – per capita monthly income

**pc_m_income_S** – per capita monthly income after shock

**foodtobaco, housing, utilities, healthedu, transport, cloth, commun, others** – names of the consumer groups

**pc_m_exp_foodtobaco** – per capita monthly expenditure for food and tobacco consumption group

**uv_cmd_foodtobaco** –

**e_inc_exp** – income elasticity coefficient

**e_exp** – expenditure elasticity

**e_group_groupP** – price elasticity

**r_exp_food** – ratio of food expenditure

**r_inc** – income ratio

**pc_d_con_kcal** – per capita daily food consumption in kcal

{a1}, {b1} ... – parameters to estimate

BASIC STATA COMMANDS

**collapse (sum)** – converts the dataset in memory into a dataset sums etc.

**mean(price)** – estimate means

**generate or gen** – create or change contents of variable

**egen** – extensions to generate command where depending on the functions, arguments refers to an expression, varlist, or numlist, and the options

**local** – assigns strings to local macro names (lclnames)

**foreach** – loop over items. Repeatedly sets local macro Iname to each element of the list and executes the commands enclosed in braces.

**nlsur** – estimation of nonlinear systems of equations

**reg** – linear regression

**rowtotal** – extension to **egen** command. Sums all variables included.

**use** – load Stata dataset

**merge** – merge datasets

**drop** – drop variables or observations

**save** – save Stata dataset

**import** – overview of importing data into Stata

**label** – manipulate labels

**rename** – rename variable

**replace** – create or change contents of variable

**tabstat** – compact table of summary statistics

**mat** – summary of matrix commands

**matrix mkmat** – convert variables to matrix and vice versa

**destring** – convert string variables to numeric variables and vice versa

**ptile** – Create variable containing percentiles

**xtile** – Create variable containing quantile categories

**codebook** – describe data contents

**summarize** – summary statistics
Annex 2—Stata Codes Description

**** Stage 2. Allocating PC Food Expenditure to PC Food Group Expenditure, by income group
**** Linear Almost Ideal Demand System (LAIDS)
**** Preparation of working variables

local foodlist staple pulses vegfru prot oilfat sugars others

* check zero value and mean of each food group
foreach gp in `foodlist'{
    count if pc_d_con_kcal_`gp' > 0
}
foreach gp in `foodlist'{
    sum pc_d_con_kcal_`gp' if pc_d_con_kcal_`gp' > 0, meanonly
    scalar mean_kcal_food_`gp' = r(mean)
    di mean_kcal_food_`gp'
}

gen ln_exp_food = ln(pc_m_exp_food/30)
gen ln_exp = ln(pc_m_exp_total/30)

* create food group unit price
foreach gp in `foodlist'{
gen p_food_`gp' = cond(pc_d_con_kcal_`gp' > 0, pc_m_exp_`gp'/pc_d_con_kcal_`gp',.)
}

* replace missing unit values with geo-level median by food group
* gen median variable for each geo-level
local geolist "id_region2"
foreach var of varlist p_food_* {
    local j=1
    foreach geo of local geolist{
        egen mid_`var'`j' = median(`var') if `var' > 0, by(`geo')
        local j= `j'+1
    }
}

* input of geo-level median
foreach var of varlist p_food_* {
    foreach i of numlist 1{
        qui replace `var' = mid_`var'`i' if `var'==. | `var'==0
    }
    drop mid_*
}

* create the log of prices
foreach v of varlist p_food_* {
    gen ln_`v' = ln(`v')
}

* create the log of the price index
* applied the Stone's index
* Note: The Stone index is widely used for LA/AIDS estimation.
* create the budget shares
local foodlist staple pulses vegfru prot oilfat sugars others
foreach gp in `foodlist'{
gen r_`gp' = `gp'/hh_m_exp_food
}
foreach gp in `foodlist'{
gen m_r_food_`gp' = mean(r_exp_food_`gp'), by (inc_gp)
gen temp_food_`gp' = m_r_food_`gp' * ln_p_food_`gp'
}
gen ln_price_index = rowtotal(temp_food_*)
gen ln_M_over_P = ln_exp_food - ln_price_index
drop temp*

***************
* Note: * Since budget shares sum to 1 in the system,
* one of the share equations is deleted to deal with the singularity problem.
* whichever one is eliminated should not have any effect on the results.
The parameters associated with the share equation that is deleted will be recovered through the parameter restrictions implied by the homogeneity, symmetry, and adding-up properties.

```stata
local foodlist staple pulses vegfru prot oilfat sugars other
local J = 0
foreach fd in `foodlist' { local J=`J'+1
  di "`J''
  local fd`J' `fd'
  di "`fd`J''"
}
di "`food1''
```

* define constraint for homogeneity restriction
```
local i=1
foreach gp in `foodlist'{
  foreach num of numlist 1/`J'{
    if `J'>`num'{
      local constr_hom `constr_hom' [r_exp_food_`gp']ln_p_food_`fd`num''+
    }
    if `J'==`num'{
      local constr_hom `constr_hom' [r_exp_food_`gp']ln_p_food_`fd`num'' = 0
    }
  }
  constraint define `i' `constr_hom'
  di "`constr_hom''
  local constr_hom
  local i =`i'+1
}
di "`regarg1''
di "`regarg2''
```

* define constraint for symmetry restriction
```
foreach num of numlist 1/`J'{
  if `J'>`num'{
    local exclude "`fd`num''"
    local foodlist: list foodlist - exclude
    foreach gp in `foodlist'{
      constraint define `i' [r_exp_food_`fd`num'']ln_p_food_`gp' = [r_exp_food_`gp']ln_p_food_`fd`num''
      local i =`i'+1
      di "`fd`num'' `gp''
    }
  }
}
di "`I''
```

**************
```
foreach incgp of num 1/5{
  sureg `regarg2' ln_M_over_P, constraint(1/`I')
  restore foodlist
}
```

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local i=`i'+1
}

* get the means of the share
foreach gp in `foodlist' {
  summ r_exp_food_`gp' if inc_gp==`incgp', meanonly
  scalar mean_r_`gp' = r(mean)
}

* expenditure elasticity
local Jp = `J'-1
foreach i of num 1/`Jp' {
  local nlcom i"("e_exp_`f`i'' : 1 + _b[r_exp_food_`f`i'' : ln_M_over_P]/mean_r_`f`i'"")"
}

** parameters of the last (4th equation) are recovered by adding-up restrictions*
local lastcostr =
foreach num of numlist 1/`Jp' {
  local lastcostr `lastcostr' -_b[r_exp_food_`fd`num'' : ln_M_over_P]
}
#delimit ;
local nlcom J"("e_exp_`fd`J'' : 1 + (lastcostr) / mean_r_`fd`J'"")"
#delimit cr
forvalues i=1/`J' {
  local nlcom `nlcom' `nlcom`i''
}
  \textit{di} "`nlcom'"
#delimit cr

* save coefficient matrix
qui mat gp'`incgp'_e_fd= r(b)

* Uncompensated price elasticity (Marshallian)
foreach p of num 1/`Jp' {
  foreach q of num 1/`J' {
    local delta = cond(p==`q',1,0)
    local nlc p`"("e_`f`p'' : delta + (_b[r_exp_food_`f`p'' : ln_p_food_`f`q''] - (_b[r_exp_food_`f`p'' : ln_M_over_P] * mean_r_`f`q''))/mean_r_`f`p'"")"
  }
}

* parameters of the last (Jth equation) is recovered by adding-up restrictions
foreach j of num 1/`J' {
  local delta = cond(j==`J',1,0)
  foreach num of numlist 1/`Jp' {
    local unc_el_last1 `unc_el_last1' -_b[r_exp_food_`fd`num'' : ln_p_food_`fd`j'']
    local unc_el_last2 `unc_el_last2' -_b[r_exp_food_`fd`num'' : ln_M_over_P]
  }
  #delimit ;
  local nlc J"("e_`f`J'' : delta + ( unc_el_last1' - unc_el_last2') / mean_r_`f`j'"")"
#delimit cr
  local nlc "`nlc'"
foreach p of num 1/`Jp' {
  foreach j of num 1/`J' {
    local nlc p"("nlc p_"j"
  }
}
*save coefficient matrix*

```stata
mat gp : incgp_e_fd_fdP = r(b)
mat e_fd = gp1_e_fd gp2_e_fd gp3_e_fd gp4_e_fd gp5_e_fd
drop *
mat inc_gp = (1 2 3 4 5)
svmat KYR_KHIS_2015_elasticity, names(col)
```

---

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DERIVING PER CAPITA DIETARY ENERGY CONSUMPTION

The dietary energy consumption per person is the amount of food, in kilocalories (Kcal) per day, for each individual in the total population (FAO, 2008). Food consumption in quantities is converted into Dietary Energy Consumption (DEC) by using energy conversion factors for energy-yielding macronutrients (proteins, fats and carbohydrates). The changes in dietary energy consumption are given by the changes in food consumption.

Following the FAO methodology (FAO, 2010), the total dietary energy consumed by individuals depends on the quantity of food consumed and its caloric content:

Dietary Energy Consumption:

\[ DEC = \sum_j C_j X_j (p.y). \]

Food consumption is usually measured at the household level, so we define \( X_j \) as the per-capita quantity of food \( j \), \( C_j \) is the energy content of food \( j \), and \( DEC \) the total dietary energy intake, measured in kilocalories per capita. As the energy conversion factors are fixed and they depend on the energy contents of the various macronutrients, the changes in dietary energy consumption are given by the changes in food consumption.

DERIVING FOOD NEEDS

Undernourishment refers to the condition of people whose DEC is continuously below a Minimum Dietary Energy Requirement (MDER) for maintaining a healthy life and carrying out light physical activity. In a specified age and sex group, the MDER is the amount of dietary energy per person adequate to meet the energy needs for minimum acceptable weight for attained-height maintaining a healthy life and carrying out a light physical activity. For a population, the MDER is the weighted average of the minimum energy requirements of the different age groups (male and female) in the population. Prevalence of undernourishment is defined as the proportion of the population in a condition of undernourishment. This study measures the prevalence of undernourishment as the percentage of people with daily kilocalorie (kcal) intake.

The following indices capture different aspects of hunger, presenting a comprehensive picture. The headcount simply counts the number of the undernourished. The Hunger Gap contains a measure of the Depth of Hunger and can provide an estimation of the food needs.

Headcount (HC):

\[ H_{H\ell} = h_0(w_i) = \begin{cases} 1 & \text{if } w_i < z \\ 0 & \text{if } w_i \geq z \end{cases} \]

Hunger Gap (HG):

\[ H_{HG} = h_1(w_i) = \begin{cases} \frac{z-w_i}{z} & \text{if } w_i < z \\ 0 & \text{if } w_i \geq z \end{cases} \]

Where \( z \) is the value of the undernourished line, \( w \) is the per adult equivalent consumption expenditure of the individual \( i \), and \( N \) is the total population. For all the indices, when the individual values are summed up they are multiplied by the household size and properly weighted to represent the whole population.

Applying additional definitions of food deficiency, such as the MDER of 2100 kcal/person/day and the MDER of 1870 kcal/person/day, can be useful to target the varying degrees of food deficiency with specific interventions.

In Stata codes calculation are done in this way:

- \texttt{gen dm\_kcal\_2100} = \texttt{cond(pc\_d\_con\_kcal < 2100,1,0)}
- \texttt{gen dm\_kcal\_2100\_S} = \texttt{cond(pc\_d\_con\_kcal\_S < 2100,1,0)}
- \texttt{gen depth\_kcal\_2100} = \texttt{cond(pc\_d\_con\_kcal < 2100,2100 – pc\_d\_con\_kcal,0)}
- \texttt{gen depth\_kcal\_2100\_S} = \texttt{cond(pc\_d\_con\_kcal\_S < 2100,2100 – pc\_d\_con\_kcal\_S,0)}
Gen gap_kg_2100 = depth_kcal_2100 * 30 / 3400
Gen gap_kg_2100_S = depth_kcal_2100_S * 30 / 3400

For a rapid food security assessment, one important indicator is the calculation of the food assistance needed. Food Gap (FG) in quantity of grain (such as wheat) equivalent is calculated for households with DEC below the requirement. The formula is the following:

⇒ Food Gap in grain per household = (kcal consumed or available per capita - requirement) x HH size /conversion factor from kcal to kg of grain).

For calculations of the food assistance needed in case of Yemen model, the equivalent of whole wheat flour (WWF) was used (3,400 Kcal/Kg).

**CALCULATING POVERTY**

Poverty has traditionally been measured by the expenditure levels of the households. The practice, when dealing with national surveys, is to use the government methodology to measure poverty. In the Kyrgyz Republic, for instance, the methodology is based on the calculation of extreme and absolute poverty lines on the regional level. The poverty lines are defined as the costs a household needs to sustain to satisfy all the essential goods and services. To calculate the poverty lines, the government uses regional price data for the goods and services included in the minimum expenditure of a household.

Poverty levels are calculated as percentage of households having less total expenditure per capita than poverty line level when compared to the whole population.

\[ H_i = h(\exp_i) = \begin{cases} 1 & \text{if } \exp_i < PL \\ 0 & \text{if } \exp_i \geq PL \end{cases} \quad HC = \frac{1}{N} \sum_{i=1}^{N} h(\exp_i) \]

Where \( PL \) is the poverty line, \( \exp \) is total household expenditure per capita of household \( i \), and \( N \) is the total population. In Stata, the code will look as follows.

```
gen dm_PL=0
replace dm_PL=1 if pc_exp_total < PL
ngen dm_PL_S=0
replace dm_PL_S=1 if pc_m_exp_total <PL
```

Impacts can be simulated or projected across various disaggregation levels, including:

- Gender disaggregation: Female/Male Headed household
- Geographical disaggregation: by Urban/Rural (e.g. Yemen) or by Region (e.g. Kyrgyz Republic, Egypt)
- Income disaggregation (income level groups)
- Demographic disaggregation
- Poverty disaggregation
- Other disaggregations based on the objectives of intervention program and/or policy analysis.

**May 2018 | A methodological note on how to simulate the impact of a shock**
Examples of shock impact simulations in SNAP

**YEMEN SPECIAL FOCUS—Nov 2016**
In this report, WFP used SISMod to assess the impact of the conflict-induced public sector crisis mean on food security in Yemen. Thanks to this analysis, WFP was able to estimate the number of food insecure people in the country at a time in which access and information were scarce.

**EGYPT IMPACT ASSESSMENT—Oct 2017**
In November 2016, the IMF imposed strong policy reforms to Egypt as a condition for a USD 12bln grant. The Government of Egypt did not have statistics to assess poverty levels after the new policies having conducted the last national survey in 2015. For this reason WFP estimated the impact that the new reforms had on the well-being of the Egyptian population and adjusted its interventions accordingly.

**LEBANON FUNDING SCENARIOS—Mar 2017**
With the unforeseeable future of funding, the WFP operation in support of Syrian refugees in Lebanon was subject in 2015 to a strong funding cut and therefore had to adjust its assistance to its beneficiaries. SNAP Shock Impact Simulation was used to predict the impact of future funding shortages and how that would affect the food security and poverty of the Syrian refugee population in the country.

**KYRGYZ REPUBLIC IMPACT ASSESSMENT—Dec 2017**
WFP conducted this shock impact simulation due to the tension that at the time was arising between Kazakhstan and the Kyrgyz Republic. Initial news reported a shortage of wheat products (imported from Kazakhstan) and price spikes in the Kyrgyz markets close to the border. However the emergency impact assessment showed that the effect of the border closure was contained. Hence WFP contingency planning was not needed.

**KYRGYZ REPUBLIC POLICY NOTE—Oct 2017**
In this policy note, WFP used SISMod to retroactively assess the impact of the decision to join the Eurasian Economic Union by the Kyrgyz government in 2015. The report looks at vulnerability from different angles. The report showed how joining the Eurasian Economic Union led to some at-the-time unexpected outcomes that SNAP and its shock impact simulation would have foreseen.

**KYRGYZ REPUBLIC TECHNICAL REVIEW—May 2018**
Under the request of the Government of the Kyrgyz Republic, WFP used the SNAP Shock Impact Simulation tool to assess the impact of the reform of the state social benefits system which entailed a move from a targeted approach to a universal approach. The social system designed by the new law was proved to have left behind some of the most vulnerable and the Government of the Kyrgyz Republic took immediate measures to adjust the public safety nets.

**Contacts**

**Hazem Al Mahdy**
Head of Vulnerability Analysis & Mapping
WFP Regional Bureau in Cairo (RBC)
hazem.almahdy@wfp.org

**Filippo Minozzi**
Economic and Market Analysis Lead
WFP Regional Bureau in Cairo (RBC)
filippo.minozzi@wfp.org

**Lyubomyr Kokovskyy**
SNAP Coordinator
WFP Regional Bureau in Cairo (RBC)
lyubomyr.kokovskyy@wfp.org

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