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**Dietary Cost Severity Score**

**Methodological Note**

**World Food Programme – Policy and Programme Division**

**Analysis & Trends Service – Economic and Market Analysis Unit**

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# Introduction

Low-income countries spend a great proportion of their expenditure – between 56 and 78 percent – on food (Banerjee & Duflo, 2007), and studies show that food demand is highly responsive to food price changes (Regmi, Deepak, Seale, & Bernstein, 2001). However, Regmi *et al.* (2001) argue that price elasticity is not uniform across all food categories as demand for high value food items (e.g. meat) reacts more to price changes than demand for staple foods.

In some countries, household food expenditure may largely be influenced by the seasonality of food prices throughout the year. Price volatility creates uncertainty, but high seasonal prices – even if expected – also threaten the food security of poor households by limiting their purchasing power and thus their access to food.

With this in mind, the Economic and Market Analysis Unit in VAM (OSZA) has developed two interlinked indicators: the *Dietary Cost Score* (DCoS) and the *Dietary Cost Severity Score* (DCoS2).

The DCoS is a monthly indicator that captures potential threats to household food security arising from high seasonal food prices. It looks at changes in the cost of a food basket over the course of a year and detects months in which high seasonal prices have a major impact on the cost of the food basket. The DCoS is not meant to detect price anomalies; instead it describes ‘normal’ market conditions. The idea behind it is that the diet of poor families is mainly based on staples, and price elasticities for staples are low. Thus, a price increase will put a potentially heavy burden on the household budget and may threaten the ability of a household – who spend already a large part of their income on food – to satisfy their food needs.

The DCoS2 is a forward-looking indicator. Building on the DCoS, each month it summarizes how much more expensive the food basket will be in the six upcoming months compared to the yearly average cost.

Both the DCoS and the DCoS2 are based on the national average cost of the food basket; the scores range from 1 to 5 and allow the ranking of countries where WFP operates.[[1]](#footnote-1) The higher the score, the more the cost of the food basket is expected to exceed the average yearly cost.

VAM has developed these indicators to support the Budget and Programming Unit (RMBP) in prioritizing countries for additional funding from WFP. The six-month window for the DCoS2 is aligned with the RMBP’s budget allocation process, which also uses windows of six months.[[2]](#footnote-2)

# The Food Basket

The food basket is a combination of food products that reflects the usual diet of a population and adequately meets the energy requirements of an individual. The use of caloric intake to construct the food basket finds its justification in the vast literature on poverty measurement (Khandker & Haughton (2009), Ravallion (2016), Deaton (2006)), which constructs the food poverty line by estimating the cost of purchasing 2,100 kcal/per capita/day.[[3]](#footnote-3) It is based on the idea that a minimum consumption of calories is needed to ensure biological efficiency. Yet this methodology has its limitations. In particular, it neglects nutritional requirements and disregards the fact that food consumption varies according to household preferences and income level (Deaton A. , 1980). Thus, the choice of commodities to be used in estimating the cost of obtaining 2,100 kcal is not a trivial one (World Bank, 2014). Its definition is crucial as the DCoS is derived from the seasonal index of the cost of the food basket. Accordingly, this section describes how the composition and the cost of the food basket are determined.

## Food Basket Composition

The composition of the food basket is country-specific and time invariant to allow for comparability across time. In fact, any change in the composition over time could determine a level shift in the cost of the basket and consequently affect the detection of seasonal patterns.

|  |
| --- |
| Table 1 - Armenia’s Food Basket |
| Source: FAO/ESS (2016) |

The choice of the products in the food basket used to calculate the DCoS is based on the caloric contribution of each food to the Dietary Energy Consumption (DEC) as reported by FAO (2016)[[4]](#footnote-4). The proportional caloric contribution to the DEC is used as a proxy of the relative importance of the item in the food basket; thus, the higher the proportional caloric contribution of a product, the more likely it is to be included in the food basket. The item’s caloric share of the DEC is transformed into quantity consumed, assuming a Dietary Energy Requirement (DER) of 2,100 kcal/person/day;[[5]](#footnote-5) however, the food basket used for the DCoS is unlikely to provide 2,100 kcal because for some items, there is often a lack of price data over a sufficiently long period.[[6]](#footnote-6) As an example, Table 1 reports the list of items for Armenia’s food basket and the caloric contribution of each item. Due to a lack of prices for many items and other price series not meeting the minimum data requirements,[[7]](#footnote-7) only wheat and potatoes could be used to calculate the DCoS. Thus, the food basket provides only 36 percent of the DER, equivalent to 756 kcal/person/day. The basket only includes food items for which prices are always available for the time span in question. In the Armenia example, the prices of the items highlighted in green only became available in April 2012. If they were included, the food basket would cover 71 percent of DER. However, their series is too short for the purposes of the DCoS.

To obtain a food basket that represents a bigger caloric contribution, older observations are dropped and the DCoS is built using only the last five years of observations if the last five years of observations only allows for a higher caloric content of the food basket.[[8]](#footnote-8) In the Armenia example, in April 2017 the DCoS will be calculated using a food basket covering 71 percent of DER, but this will mean considering a shorter time span (starting in April 2012 rather than in 2011).

There may be different price series available for the same commodity[[9]](#footnote-9) (e.g. the price for different varieties of rice). However, only one item per group is included in the basket. Priority for inclusion is assigned to price series with most recent data and according to the following criteria:

* + - * 1. the longest and most complete series, and within this group, the cheapest[[10]](#footnote-10) item;
        2. the longest series, and within this group, the cheapest item;
        3. the series meeting the minimum data requirements,[[11]](#footnote-11) and within this group, the cheapest item.

In the Armenian example, six different commodities are available to represent the wheat food group in the food basket (Table 2). Four of them meet the first criteria (i.e. the longest and most complete series). Thus, first grade wheat flour is chosen because has been the cheapest form of wheat in the last five years.

Table 2 Summary statistics on the wheat food group in Armenia



*Source: authors’ calculation using VAM/WFP and GIEWS/FAO data*

The composition of each country’s food basket – along with its caloric contribution to the DER and the caloric contribution of each item in the basket – are reported in Annex I in a separate spreadsheet.

## Food Basket Cost

Based on the assumptions that (i) the composition of the food basket is time-invariant, (ii) the per capita daily caloric requirement is equal to 2,100 Kcal for each country, and (iii) the energy density and the edible portion of each food item is time- and space-invariant, the cost of the basket is computed in four simple steps:

1. calculate the per capita daily caloric intake deriving from the consumption of each item in the food basket:
2. derive the per capita daily quantity consumed of each item in the food basket:
3. compute the daily cost of the quantity consumed:
4. obtain the total monthly cost of the food basket across time:

,

*where* is the per capita daily DER, is the percentage caloric contribution of each item *i* to the per capita daily intake in country *c,*[[12]](#footnote-12)is the energy content of each food item,[[13]](#footnote-13) is the percentage waste of each food item,[[14]](#footnote-14) and is the price of each food item at time *t.*[[15]](#footnote-15)

The cost of the food basket is only calculated at the national level. If national and market-specific prices are both available, national prices are preferred[[16]](#footnote-16) unless they do not meet data requirements. If this is the case, national averages are computed as a simple average of market-specific prices.

An example of the calculation of the food basket is shown in Table 3.

Table 3 - Cost of the food basket in Côte d'Ivoire in August 2013



*Source: authors’ calculation using VAM/WFP, NutVal.Net, USDA and GIEWS/FAO data*

Once the time series for the cost of country-specific food baskets are computed, the seasonal index of the food bundle is constructed for each country.

# The Seasonal Index

The seasonal index describes the predictable average seasonal pattern of the cost of the food basket over a year.

A seasonal index is obtained by separating trend and seasonal components of the time series. To calculate the DCoS, the seasonal index is obtained from the modified centered moving average of logged data (Log CMA). This procedure is advocated and described by Ittig (2004) and involves five steps:

1. compute the centered moving averages of order 12 for the logarithms of the cost of the food basket () for each country *c*, month *m*, and year *y*:
2. compute the deviation of the logarithm cost of food basket from the centered moving average:
3. calculate the average deviation for each month of the whole time period available in order to obtain 12 values, one for each month (often referred to as the Grand Seasonal Index):

, where *Y* is the count of *y*

1. apply the exponential function with base *e*:*[[17]](#footnote-17)*
2. normalize the seasonal index:

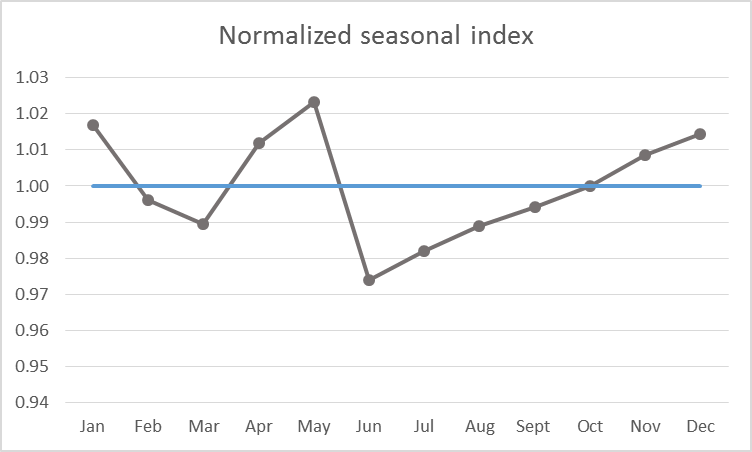
An example of the calculation of the seasonal index is shown in Table 4.

Table 4 - Calculation of the seasonal index of the food basket for Afghanistan

|  |  |  |
| --- | --- | --- |
|  |  |  |
| *Note: avg1 and avg2 indicate the simple averages of the logarithm cost of the food basket for all of 2007 and the period between February 2007 and January 2008 respectively. The centered moving average for July 2007 (highlighted in blue) is given by the average of avg1 and avg2 – the first step of the Log CMA procedure. Column (b) contains the differences between the logarithm cost of the food basket and Log CMA – the second step. In column (c), the logarithm of the seasonal index for each month is obtained as a simple average of all values for that month in column (b) – the third step. The seasonal index in column (d) is obtained by exponentiation of the values in column (c) – the fourth step. Finally, the normalized seasonal index for each month is given by the corresponding value in column (d) divided by the mean of column (d) – the fifth step.*  *In this example, the food basket covers 66 percent of the DER.* | | |

The normalized seasonal index calculated in Table 4 is displayed in Figure 3. The values quantify to what extent, on average, the monthly cost of the food basket deviates from the 12-month average. The graph exhibits a typical seasonal pattern. It shows that May is the most expensive month, when the food basket is 2 percent more expensive than the yearly average. The cost of the daily basket also rises above the yearly average in the last quarter of the year.

Figure 3 - Normalized seasonal index for a food basket in Afghanistan

*Source: authors’ elaboration using VAM/WFP, NutVal.Net, USDA and GIEWS/FAO data*

Yearly average

The Log CMA procedure described above identifies a *c x 12* matrix containing a value for each month/country combination (Table 4).

Table 5 - The normalized seasonal index by country and month ()

*Note: extracted on 4 October 2016; last price data used are from June 2016*

# The Dietary Cost Score

The Dietary Cost Score (DCoS) is a monthly indicator that scores months based on the cost of the country’s food basket. It aims to detect potential threats to household food security arising from high seasonal food prices.

The DCoS is obtained from the seasonal index of the cost of a country-specific food basket. Once Table 5 has been filled in, the DCoS can be computed**.** The new *c x 12* matrix containing the DCoS (Table 6) is derived by assigning a score between 1 and 5 to each month/country combination. The score is based on the value of the and the following rule:

|  |  |  |
| --- | --- | --- |
| **DCoS** |  |  |
| **1** | ≤ 1 |  |
| **2** | 1 < ≤ 1+w | , where |
| **3** | 1+w < ≤ 1+2w |  |
| **4** | 1+2w < ≤ 1+3w |  |
| **5** | 1+3w < ≤ 1+4w |  |

The first class (DCoS equals 1) contains all country/months where the cost of the food basket is equal to or less than that country’s yearly average cost (i.e. SI<=1). The other four classes (2 to 5) have the same width *w* and containall months where the cost of the food basket is higher than the mean. The higher the score, the more the cost of the food basket in that month is expected to exceed the average yearly cost. The upper threshold of the higher class (4*\*w*) equals the highest deviation from the mean among all months and countries (i.e. the highest values in Table 5). As the class boundary values are endogenously defined, they can change when new estimations for the DCoS are produced. Consequently, the scores cannot be compared across time, but only across space (i.e. only the ranking of the countries is comparable when new estimates are available).

Table 6 - The Dietary Cost Score (DCoS)

 *Note: extracted on 25 November 2016; last price data used are from June 2016*

The full *c x 12* matrix containing the DCoS and the class boundary values are reported in Annex II in a separate spreadsheet.

# The Dietary Cost Severity Score

The Dietary Cost Severity Score (DCoS2) is a forward-looking indicator that scores months based on how much more expensive the food basket is expected to be in the six upcoming months compared to the yearly average cost.

The calculation method for the DCoS2 borrows from the literature on poverty measurement. In particular, it recalls the squared poverty gap index, also known as the poverty severity index.

The poverty severity index is the weighted average, over all people, of the gaps between poor people’s living standards and the poverty line (as a percentage of the poverty line); the weights are the poverty gaps themselves. The measure belongs to the family of measures proposed by Foster, Greer, and Thorbecke (1984):

*with* *α* ≥ 0 , *z* the poverty line, () the poverty gap, and ()=0 if .

Similarly to the poverty severity index, the weighted average – over the next six months – of the positive deviation of the cost of the food basket from the yearly average cost can be computed. The starting point for the calculation is the DCoS, and the benchmark (i.e. the poverty line, in the case of the poverty severity index) is equal to 1. Indeed, a score of 1 for DCoS reflects a ‘harmless situation’: months where the cost of food basket is equal to or less than the average yearly cost. The Squared Gap of the DCoS (SG\_ DCoS) is given by:

By setting *α*=2, the measure implicitly puts more weight on months with higher DCoS.

The new *c x 12* matrix containing the DCoS2 (Table 7) is derived with a procedure similar to that used for the DCoS. A score between 1 and 5 is assigned to each month/country combination based on the value of the and the following rule:

|  |  |  |
| --- | --- | --- |
| **DCoS2** |  |  |
| **1** | = 0 |  |
| **2** | 0 < ≤ δ | , where |
| **3** | δ < ≤2δ |  |
| **4** | 2δ < ≤3δ |  |
| **5** | 3δ < ≤4δ |  |

The DCoS2 is equal to 1 only if the cost of the food basket is equal to or less than the yearly average cost in all of the six upcoming months. The upper threshold of the highest class (4\* δ) detects the average squared deviation of the six consecutive months with the highest cost of the food basket among all countries. Thus, the higher the score, the more (on average) the cost of the food basket in the six upcoming months is expected to exceed the average yearly cost.

Similarly to the DCoS, the class boundaries are endogenously defined. Consequently, the scores cannot be compared across time, but only across space.

Table 7 - The Dietary Cost Severity Score



*Note: extracted on 25 November 2016; last price data used are from June 2016*

The complete *c x 12* matrix containing the DCoS2 is reported in Annex III in a separate spreadsheet.

# References

Banerjee, A., & Duflo, E. (2007). The Economic Lives of the Poor. *Journal of Economic Perspective*, 141-167.

Deaton, A. (1980). The Measurement of Welfare: Theory and Practical Guidelines. *LSMS Working Paper*(7).

Deaton, A. (2006). Measuring Poverty. In A. Banerjee, R. Benabou , & D. Mookerjee, *Understanding Poverty.* Oxford: Oxford University Press.

Eurostat. (2015). ESS guidelines on seasonal adjustment. *Manuals and guidelines*. Luxembourg: European Union.

FAO. (2016). GIEWS Food Price Data and Analysis Tool. Rome, IT. Retrieved from http://www.foodsecurityportal.org/fao-giews-food-price-data-and-analysis-tool?print

FAO Statistic Division. (2016). *FAOSTAT - Food and Balance Sheet*. Retrieved from http://faostat3.fao.org/download/FB/FBS/E

Foster, J., Greer, J., & Thorbecke, E. (1984). A Class of Decomposable Poverty Measures. *Econometrica*, 761-766.

Ittig, P. T. (2004). Comparison of Efficient Seasonal Indexes. *Journal of Applied Mathematics and Decision Sciences*, 87-105.

Khandker, S., & Haughton, J. (2009). *Handbook on poverty and inequality.* Washington: DC: The World Bank.

Ravallion, M. (2016). *The Economics of Poverty: History, Measurement, and Policy.* New York: Oxford University Press.

Regmi, A., Deepak, M., Seale, J. L., & Bernstein, J. (2001, May). Changing Structure of Global Food Consumption and Trade. (A. Regmi, Ed.) *WRS: International Agriculture and Trade Outlook*(01-1), pp. 14-22. Retrieved from http://www.ers.usda.gov/media/293645/wrs011\_1\_.pdf

US Department of Agriculture, Agricultural Research Service, Nutrient Data Laboratory. (2015, September). USDA National Nutrient Database for Standard Reference. (Release 28). Retrieved from https://ndb.nal.usda.gov/ndb/search/list

Warner, R. (1998). *Spectral analysis of time-series data.* New York: The Guilford Press.

WFP. (2016, July). *The Market Monitor.* Retrieved from http://www.wfp.org/content/market-monitor

WFP. (2016). VAM Food and Commodity Prices Data Store. Rome, IT. Retrieved from http://foodprices.vam.wfp.org/

World Bank. (2014). Introduction to Poverty Analysis. Washington, DC.

1. The number and list of countries is contingent upon data availability. [↑](#footnote-ref-1)
2. RMBP will use the DCoS2 in conjunction with other indicators (i.e. IFPRI Global Hunger Index and a qualitative ‘Regional Attention’ indicator) to prioritize countries and allocate multilateral funds. [↑](#footnote-ref-2)
3. “This standard is widely used and has been proposed by the Food and Agricultural Organization of the United Nations. It is also an approximation, given that food needs vary across individuals, by climate, by the level of an individual’s activity, and seasonally.” (Khandker & Haughton, 2009). [↑](#footnote-ref-3)
4. The dietary energy supply from the FAO/Food Balance Sheets is used as a proxy for the Dietary Energy Consumption [↑](#footnote-ref-4)
5. See equation (a) and (b) at the end of this section for more details. [↑](#footnote-ref-5)
6. Series should cover at least 5 years, have less than a 30 percent data gap and have at least one observation for all months. However, exception is made for some countries whose price series only cover a period of three to five years. The exceptions are listed in the Annex. [↑](#footnote-ref-6)
7. See Footnote 5. [↑](#footnote-ref-7)
8. Although there is not a rule of thumb, experts suggest that time-series analysis requires at least 50 observations and the length of the time series should be an integer multiple (five or preferably ten repetitions) of the cycle length of primary interest (Warner, 1998). Eurostat (2015) also recommends a minimum of three to five years. Furthermore, to calculate the indicators, price observations older than 20 years are disregarded as "over such a long period the underlying data generating process may change, determining changes also in the components and in the components structure" (Eurostat, 2015). [↑](#footnote-ref-8)
9. Here the term *commodity* can indicate a specific food item (e.g. soybean oil) or a group (e.g. vegetable oil). [↑](#footnote-ref-9)
10. I.e. the lowest average price in the last five years. [↑](#footnote-ref-10)
11. See Footnote 5. [↑](#footnote-ref-11)
12. Source: The Market Monitor, quarterly publication (WFP, 2016). [↑](#footnote-ref-12)
13. Source: NutVal 4, available at http://www.nutval.net/2007/05/downloads-page.html [↑](#footnote-ref-13)
14. Source: USDA National Nutrient Database (2015). [↑](#footnote-ref-14)
15. Source: VAM Food Price Database, partly integrated by the FAO/GIEWS Food Price Database. [↑](#footnote-ref-15)
16. The assumption is that ready-to-use national averages are a better proxy of the real national average. In fact, often only a few markets are available per country. [↑](#footnote-ref-16)
17. *e* is the base of the natural logarithm, approximately equal to 2.71828. [↑](#footnote-ref-17)