



Issues in food security measurement

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Introduction

- Food security can be considered as a fundamental component of human well-being
- Food security has a complex nature
 - multidimensional
 - multi-scalar
 - process
- This poses theoretical and methodological problems to its measurement, not always taken into account in the literature.

Outline and objectives

- This paper has three objectives
 - To highlight some key features of food security
 - To review main approaches to food security measurement
 - To present a conceptual framework for the measurement of food security built on sound theoretical foundations
 - empirical relevance (applicable)
 - policy relevance

FS as a fundamental component of human well-being

- Well-being is many-sided, because is made up of different doings and beings (or “achieved functionings”) (Sen 1985, 1987, 1992) and includes nutrition: being healthy, being safe, being mobile, being educated, being well nourished, ...
- Also threats to well-being should be considered, that is “human security”. UNDP defined human security as including ‘safety from such chronic threats as hunger, disease and repression, and protection from sudden and hurtful disruptions in the patterns of daily lives, whether in homes, jobs or communities’ (UNDP, *HDR*, 1994, p. 1). UNDP explicitly includes FS into human security.

FS is multidimensional, but...

- As well-being, also FS is many-sided: not just food availability (WFS 1996)
- Such feature has been widely acknowledged, and there is a consensus about the need to create multidimensional measures of FS
- This lead some authors to measure FS putting together several variables (usually “all those that are available”) related in a way or another to FS
- In these attempts, a certain number of variables of very different nature are usually aggregated somehow
- It should be noticed that this is a merely empirical/statistical approach, which is almost completely based on the selection of available data. The selection is often done using statistical/econometric techniques, rather than on a solid theoretical foundation (maybe because a “theory” of food security has been not yet well established). Therefore, FS is another case of “measurement without theory” (Koopmans, 1947)

Socioeconomic		Availability	Access (physical, economic, social)	Utilization (nutrition security)	Stability
Dimensions					
Spatial					
Macro	Global	****			****
	Regional/ National	***	(*)	*	***
Meso	Local/ community	**	**	**	**
Micro	Household	(*)	***	****	****
	Individual		****	***	***

Review of methods to measure food security

Five main methodologies are commonly used:

1. Parametric approaches to estimate the Prevalence of Undernourishment (PoU)
2. Non-parametric methods based on Household Income/Expenditure Surveys (HIES)
3. Anthropometric indicators
4. Qualitative surveys
5. Composite indicators

1. Parametric approaches to estimate the PoU

FAO estimates the PoU, i.e. the share of population not meeting their minimum dietary energy requirements, by relying on three key inputs:

- (i) data on dietary energy supply calculated from Food Balance Sheets (FBS);
- (ii) a threshold of minimum energy requirements based on the demographic structure of the population (by age and sex);
- (iii) a log-normal distribution characterized by two main parameters, respectively the value of 'dietary energy supply' (DES) in kilocalories per capita and the coefficient of variation in the distribution of the households' expenditure levels for acquiring calories

2. Non-parametric methods based on HIES

- In analogy with the literature on income poverty metrics this approach derives 'head-count' measures of food deprivation by using data on households' food acquisitions from HIES (Smith 2003, Smith *et al.* 2006)
 - data have to be first converted in calories, which are then compared to a threshold based on the household's *average* energy requirement

3. Anthropometric indicators

- Indicators used for the diagnosis of malnutrition throughout the life cycle (WHO, 1995)
- Height and weight of children aged 0-5 years:
 - stunting (height per age): long-term malnutrition
 - wasting (weight per height): acute malnutrition
 - underweight (weight per age): combine both aspects
- Svedberg (2000)

4. Self-reported food security assessments

- Subjective or qualitative indicators look at people's perceptions about hunger and food insecurity. They may be related to emotional dimensions, such as anxiety over not being able to meet basic food requirements of the household or behavioral changes due to variations in the household's entitlement, such as reducing food quantities or quality or skipping meals.
- USDA

5. Composite indices of food security

- Given the intrinsic multidimensionality of the concept, several composite indicators of food security have been proposed
 - focusing at national level (IFPRI's GHI)
 - focusing at household level
 - based on quantitative indicators (Rural Household Food Insecurity index by De Muro and Burchi, 2007)
 - qualitative/perception-based indicators
 - households' dietary diversity (Hoddinnott & Yohannes 2002)
 - households' access and stability of food supplies (Maxwell *et al.* 2008)

Comparison

Method	Pros	Cons
PoU	yearly estimates of global undernourishment trends	<ul style="list-style-type: none"> only Availability and Access biased estimates
HIES	<ul style="list-style-type: none"> no distributional assumptions required reliability disaggregation 	<ul style="list-style-type: none"> only Availability and Access neglect consumption outside HH
Anthropomet.	<ul style="list-style-type: none"> Utilization (⇒ Availability and Access) disaggregation intraHH distribution 	<ul style="list-style-type: none"> country in nutrition transition data availability and representativeness
Self-reported	<ul style="list-style-type: none"> Access and Stability quick, and low cost 	<ul style="list-style-type: none"> perception may vary substantially comparability over time
Composite ind.	multidimensional	<ul style="list-style-type: none"> loss of information lack of transparency

FS as the outcome of a process

- Like well-being (De Muro 2010), FS it is not just multidimensional but is also the outcome of a process (of achievement)
- For the sake of simplicity, let's represent national FS achievement as a simple production process (this is a simplification because WB and FS are not commodities)
- For this purpose, let start with an elementary production function (single output, multiple variable inputs)

$$y = f(x_1, x_2, \dots, x_n)$$
- For instance, if we apply this production function to FS access, we could have for example

$$AN = f(AV, IN, PR, \dots)$$
 AN = prevalence of adequate nourishment (= 1 - PoU)
 AV = per capita food availability (from FBS)
 IN = income per capita
 PR = food price index

A theoretically informed approach to FS

- An approach with a sound theoretical foundation is needed. We will use to the framework proposed by Burchi and De Muro (2011), that is a capability approach to food security based mainly on the landmark work of Dréze and Sen (1989) and on the human development paradigm.
- Let us consider the "classical" four dimensions of FS
- Firstly, let us analyze the relations between the first three dimensions. It is evident that in order to have a proper utilization of food, a logical pre-requisite is to have access to food; and that in order to have access to food, a logical prerequisite is food availability. Therefore, the FS process is characterized by a logical (not necessarily temporal) sequence: the final step is utilization, the intermediate step is access and the first step is availability.

FS achievement as a pseudo-production function /I

- Hence, generally speaking:

$$Utilization = g(Access, Determinants\ of\ Utilization)$$

$$Access = h(Availability, Determinants\ of\ Access)$$

$$Availability = Food\ supply/Population$$
 where $g(\cdot)$ is an *Utilization* function that maps *Access* (food accessed) and other factors into proper *Utilization* (adequate nutrition), and $h(\cdot)$ is an *Access* function that maps *Availability* (food available) and other factors into *Access*.
- Then

$$Utilization = g(h(Availability, Det.\ Access), Det.\ Utilization)$$
 that means that the achievement of FS can be represented by a nested (or multi-level) pseudo-production function.

FS achievement as a "production" function /II

- Therefore in multidimensional measurement of FS it is clear that we should not just assemble indicators of the three dimensions, but rather:
 - verify if there is sufficient availability of food (in quantity and quality);
 - analyze if people can access to an adequate amount (and quality) of available food;
 - analyze if people are capable to utilize properly the food that they accessed.
- In other terms, in order to measure FS we should:
 - measure *separately* food utilization, availability and access;
 - estimate the *Access* function;
 - estimate the *Utilization* function

The estimated parameters of these two functions can be used to analyze the relations among the three dimensions.

Availability

- Food availability is relatively less difficult to measure, because agricultural statistics are well established in most countries and FAO has developed an advanced knowledge in this field. Food availability can be obtained through Food Balance Sheets (FAO, 2001). Food supply, expressed usually in volume, is calculated for each single food item. Then, supply of all food items can be aggregated in one single total figure by converting each item in the corresponding calories. Therefore, food supply can be expressed either as a vector of single food items in volume (\mathbf{a}), or as a scalar in calories (a). Dividing supply by population we obtain per capita availability.

Access

- An appropriate way to analyze the problem of access to food is to use the "entitlement approach" proposed by Sen (1981a): «the entitlement that each person enjoys [is] the commodities over which she can establish her ownership and command» (Sen, 1999, p. 162), including food.
- The entitlement of a person can be expressed as $E(x_i)$, where x_i is the endowment vector of person i , and $E(\cdot)$ is «an exchange entitlement mapping ... which specifies the set of commodity bundles any one of which person i can choose to have through "exchange" (trade and production)» (Sen, 1981b, p. 435).
 - The endowment vector include all assets and resources, material and immaterial, of person i (including labor power).
- We can use $E(x_i)$ to measure and analyze Access.
 - As Sen emphasized, in most cases of food insecurity any element of $E(x_i)$ is smaller than the per capita availability. In those cases, the problem is not agricultural or demographic. Therefore, in order to understand food insecurity we rather need to analyze those "entitlement failures", that can depend on many different causes related both to x_i and/or $E(\cdot)$. *Mutatis mutandis*, we can apply this approach also to household level.

Utilization

- Regarding Utilization, we could adopt the comprehensive approach proposed by Dréze and Sen (1989) that introduce the concept of "nutritional capabilities":
 - «it is important to link up the question of entitlement guarantees with the importance of non-food items in ensuring the capability to be nourished, as well as other capabilities closely associated with nourishment, e.g. avoiding escapable morbidity and mortality. [...] it is a mistake to view hunger in terms of food deprivation only. This is not merely because there are significant interindividual and intraindividual variations in food requirements for nutritional achievement. But also, the capability to be nourished depends crucially on other characteristics of a person that are influenced by such non-food factors as medical attention, health services, basic education, sanitary arrangements, provision of clean water, eradication of infectious epidemics, and so on. If we compare different countries, or different regions within a country, we may find considerable dissonance between the ranking of food intakes and the ranking of nutritional achievements».

Nutritional capabilities /I

- Following Ruggeri-Laderchi (2008, p. 209), we can try to formalize the nutritional capabilities. We have modified her representation in order to: 1. integrate the entitlement into the capability, as suggested by Burchi and De Muro (2011); 2. include enlarged capabilities as suggested by Dréze and Sen (1989). The nutritional capability of individual i living in household h (composed by her and other n members) could be represented by her achieved nutritional functioning b_i :

$$b_i = g_i(E(x_i), t_i, d_i, z_i, l) + e_i$$

with

- x_i = a measure of household endowment (resources)
- t_i = a set of individual characteristics
- d_i = a set of characteristics of other members of the household
- z_i = a set of demographic characteristics of the household
- z_i = a set of public goods, relevant to FS, and available to the household
- l = a location variable capturing other area-specific influences on FS

- $E(x_i)$ is the enlarged entitlement, that is any basket of food and non food commodities, obtained from x_i , that are necessary to avoid hunger. These commodities are then combined and converted, under the influence of the above listed factors, according to the *Utilisation* function $g(\cdot)$.

Nutritional capabilities /II

- Finally, if we consider also availability (as an exogenous variable), we have:

$$b_i = g_i(E(x_i, \bar{F}), t_i, d_i, z_i, l) + e_i$$

where \bar{F} is per capita food supply

- While b is in itself a synthetic measure of FS, the parameters of this function measure the contributions of the different dimensions to overall FS.
- Regarding stability, a simple way to include it is to introduce for volatile variables in the formula (such as prices and supply) standard deviations around their trends. A better way is to create a dynamic version of the model.

Merits and limitations

- This approach does not necessarily require additional data respect to current HH surveys, therefore it can be implemented. Therefore, beside being theoretically sound, it is also empirical relevant.
- Limitations
 - The traditional (neoclassical) production function is the simplest but not the best way to represent a (well-being or food security) achievement process, because it can not adequately consider some fundamental feature of the process:
 - peculiar aspects of fixed capital and public goods
 - joint production
 - stock, funds and flows
 - time
 - Therefore, other more appropriate models could be utilized.

Conclusions

- FS is complex (not fuzzy)
- FS is a fundamental dimension of human well-being (and security)
 - being adequately nourished at all time
 - not independent from other WB dimensions
 - not just an agricultural or demographic issue
- FS, like well-being, should be seen as a process of achieving a functioning
- FS dimensions are interdependent, rather than additive
- Nutritional capabilities (*Utilization*), measured in terms of achieved nutritional functioning, are a synthetic index of FS
- FS achievement can be represented and analyzed with a pseudo-production function