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ADVANCES IN HUNGER MEASUREMENT:

TRADITIONAL FAO METHODS AND RECENT INNOVATIONS

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Advances in hunger measurement

Traditional FAO methods and recent innovations[1]

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1. Introduction. Assessing food insecurity: a complex task

Food security has come to be customarily defined as the situation that occurs "when all people, at all times, have physical, social and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 1996). Food security is thus more than simply "freedom from hunger"; more dimensions are included to highlight that it is a condition that applies at the individual level on a continued basis, that health and nutritional aspects associated with food consumption and individual tastes and preferences are as important as the mere fulfillment of basic dietary energy needs, and that the right to food extends well beyond mere survival, being the basis for a healthy and productive life.

Recognition of the complexity of the problem presents obvious challenges for monitoring it. Despite the fact that in recent policy forums achieving food security has been described as "a measurable and monitorable goal" (FAO, 2001), and as unpalatable to many as it may be, it should be clearly recognized that, if reference is made to the broad definition involving "all people at all times" and to both "dietary needs and food preferences," *no direct measure of the state of food insecurity in the World will ever be possible*. Such a measure, in facts, would imply the ability to continuously monitor all the dimensions that constitute food security at the level of individuals in a population. It would mean, for example, to frequently record individual food consumption of single food items, convert it into nutrient intakes, and compare both quantity and quality of nutrients to supposedly known individual requirements and preferences. Such an endeavor is clearly impossible.

Real progress in our ability to inform the international community and to guide policy can be achieved if scope and limitations of any attempt at measuring hunger and food security are properly recognized. Our opinion, and the philosophy underlying this article, is that to give a sensible meaning to the task of monitoring the achievement of food security, several points must be considered. First, and foremost, as departures from the food security ideal pictured in the definition above include many different situations (inadequate dietary energy intake, inability to satisfy food preferences, uncertainty about the future ability to access food, etc.), hardly any single indicator can ever be deemed sufficient to respond

[1] Original paper written in May 2012.

to the need of adequate monitoring. More likely, a number of appropriately chosen indicators, each focusing on one key dimension of the problem, should be considered as element of a coherent suite.

Second, "to measure" in this context must be taken as to mean "to estimate" which implies that the question is to be addressed in probabilistic terms. Consequently, due attention needs to be devoted to the statistical aspects of the inference that can be drawn from available data. This is particularly problematic when monitoring is needed in real-time fashion and must be based on scattered, and often rather imprecise, data.

Many indicators have been proposed, used and sometimes unfairly criticized over the years for lack of consideration of the many statistical problems involved. In order to properly address the qualities of an indicator and of the methods used to estimate it, in fact, a clear definition of the concept that the indicator is meant to capture must be provided and understood. Failure to do so might contribute to create a gap between the statistical measurement and the public perception of the problem. That such a gap exists with reference to food security is not surprising, given the attention that the problem receives in the public. In analyzing a similar state-of-affairs with respect to the measurement of economic progress, Stiglitz, Sen and Fitoussi (2009, pp. 7-8) have pointed out that the gap may be created either because the statistical concept may be correct, but the actual measurement process is imperfect, or because there are questions on what the right concepts are, and what the appropriate use of different concepts is. Though criticisms can be raised and attention should be devoted to both aspects in discussions about measuring social phenomena, one main message in this article is that it is important to avoid confusion between two levels: the appropriateness of a given concept to capture aspects of a socially relevant phenomenon, and the possible problems in the measurement process.

This paper elaborates on some of the methodological aspects linked to the issues introduced above, with special reference to the practice that FAO has been following in monitoring the state of food insecurity in the world. The FAO indicator of the prevalence of undernourishment is described with the aim of clarifying the statistical concept that informs it and the way it is estimated. The objective is to shed light on some of the aspects that have contributed to make the debate on food security assessment over the past decade less productive of what might have been, while advancing suggestions for possible improvements in our collective ability to effectively monitor food security.

2. The FAO methodology

Since its establishment, FAO has been charged with the responsibility of monitoring the state of the world food situation to enable the international community to appropriately direct actions aimed at promoting the universal achievement of the right to adequate food. FAO's statistics division has been at the forefront of such an effort by developing methods and tools for data and information dissemination to respond to the demand for effective food security monitoring.

This section discusses the current state of the FAO's food security monitoring effort as performed through estimation of the "Prevalence of Undernourishment" (PoU) indicator, routinely published in the State of Food Insecurity (SOFI). It does so by clarifying a) which aspects of food insecurity are captured by the indicator, b) what is the statistical concept informing the methodology, and c) how the available data are used in the inferential process leading to the estimates.

2.1. The operational definition of "undernourishment" embedded in the FAO indicator.

FAO has received a mandate from the international community to monitor progress towards achievement of the objectives set by the World Food Summit and the UN Millennium Development Goal.[2] The terms "undernourishment" and "hunger", as used in describing the two targets, have been usually interpreted as referring to a situation of *continued inability to obtain enough food*, i.e., a quantity of food sufficient to conduct a healthy and active life. The meaning of terms as "undernourishment" or "hunger" is clearly narrower than that of food insecurity as implied in the definition reported above. Even once established that undernourishment is not synonym with food insecurity[3], the definition as "inability to obtain enough food" is still too vague to lead to practical monitoring. To reach a valid operational definition of undernourishment several issues need to be addressed.

First, considering the complexity of the process of human nutrition, and the fact that there are both quantity and quality dimensions associated with food, the expression '*enough food*' needs to be qualified. The FAO method has been traditionally based on the assumption that the most relevant aspect to be monitored is *dietary energy intake*, and that 'enough' ought to be evaluated with reference to a normative benchmark described as *dietary energy requirement* as established by nutritionists. According to such a definition, a human being is considered undernourished if the level of his or her habitual dietary energy intake is below the minimum level that nutritionists would deem appropriate.

Second, the definition calls for a *continued* inability to access enough food over a certain period of time that must be defined. The question of what is the appropriate time span to assess undernourishment is not a trivial one. If our interest is towards highlighting deep, chronic undernourishment, the reference period should be long enough for the consequences of low food intake to be detrimental to health. Though temporary food shortage may be stressing, the FAO definition of the indicator is based on a year, and the relevant average consumption of food over that period is referred to as the *habitual* level.

Next, although the proper comparison between caloric intake and caloric requirement ought to be conducted, in principle, at the *individual* level, this is still deemed too difficult to be operational on a broad scale, as food access data is usually collected only at the household level. Most of the methods proposed so far for the assessment of countries' food insecurity must thus be recognized as referring to households, rather than to individuals, and this is a clear limitation in trying to assess the relevance of food and nutritional disparities due, for example, to problems with intra-household allocation of food.[4]

It should thus be clear that the FAO indicator is designed to capture a clearly (and somehow narrowly) defined concept of undernourished, namely a *state of food deprivation lasting over an extended period of time*. As such, it is certainly not sufficient to assess the overall welfare cost associated with food and

[2] The 1996 World Food Summit pledged to "... to eradicate hunger in all countries, with an immediate view to reducing the number of **undernourished** people to half their present level no later than 2015" (FAO, 1996) while the MDG Target 1.C is defined as to "halve, between 1990 and 2015, the proportion of people who suffer from **hunger**." (UN, 2000)

[3] In a sense, FAO's "undernourishment" can be considered as the extreme form of food insecurity, arising when even the mere caloric supply is inadequate to cover basic needs.

[4] As will be made clear below, the FAO has made an effort to provide proper inference based on the individual state of undernourishment, even when lacking ideal data, through proper statistical treatment of the available ones, something that critics of the method have failed to recognize.

nutrition problems. It does not capture, for example, costs associated with food procurement that do not result in reduced food consumption which may nevertheless have strong impacts on the quality of life of people being forced to strive to maintain adequate caloric intake levels. Equally importantly, the FAO indicator is not meant to capture short-lived effects of temporary crises, or to distinguish the roles and impacts of external causes (i.e., production or trade shocks) from those of the possible inadequacies of coping strategies (i.e., savings, changes in overall consumption patterns, food item substitution, etc.) One conclusion of all this is that, rather than aiming at substituting the PoU indicator with alternative single food security measures, we need to continue discuss how to broaden the set of indicators to monitor food security in its various dimensions. As will be hopefully clear after reading the following pages, the FAO indicator on the prevalence of undernourishment remains an indispensable component of any such a set of indicators.

2.2. The inferential process

As it has been abundantly documented over the years (see for example FAO 1996, Appendix 3, Naiken 2003), the FAO method is defined with reference to a probability distribution for the individuals' yearly habitual Dietary Energy Consumption in a population, x, and a threshold level, called Minimum Dietary Energy Requirement (*MDER*) relevant for the same population.

The Prevalence of Undernourishment (*PoU*) is then defined as:

$$PU \equiv \int_{x<MDER} f(x)dx \qquad (1)$$

that is, the probability that consumption falls below the threshold.

In such a framework, the distribution of yearly habitual dietary energy consumption $f(.)$ across individuals is intended to capture both the overall level and the distribution of food consumption in the population, thus capturing two of the recognized dimensions of food security, namely *availability*, through the location parameter (i.e., the *mean*), and differential *access, through* the higher moments (*dispersion*, *skewness* and *kurtosis)*.

In evaluating the merits of this estimator, one of the most common sources of misinterpretation is the fact that the probability distribution in (1) has tended to be interpreted as the empirical distribution of the actual food consumption in the population, that is, the distribution that could be obtained, for example, through a food consumption census of the population, but such interpretation is largely misleading. Under such an interpretation, in fact, it would be very difficult for example to make sense of a unique threshold level to be applied to all individuals, as it is obvious that energy requirements vary among individuals. If reference were to be made to the empirical distribution of food consumption in the population, than the proper measure of the prevalence of undernourishment ought to be:

$$PU_2 = \iint_{(x,r)\in\{x<r\}} f(x,r)drdx \qquad (2)$$

where the possibility of a *joint distribution* of dietary energy consumption (x) and requirements (r) is explicitly recognized.[5] The attractiveness of an approach as in (2) is that it gives the impression that it

[5] In the past, the FAO approach has been described with reference to a joint distribution, most notably by Svedberg (2000), who claimed that under such an approach, the choice of a single threshold level would necessarily lead to estimation errors. As pointed out by Naiken (2007) and Cafiero and Gennari (2011), Svedberg criticism is vitiated by a fundamental misrepresentation of the FAO methodology (see also below.)

may be possible to classify *individuals* in the population as being undernourished or not, based on the comparison between the individual intake x_i and the individual requirement r_i. Estimating the prevalence of undernourishment in the population would then amount to simply head-count those who are classified as undernourished.

The major obstacle to the proper application of a joint distribution framework as in (2) is that *individual dietary energy requirement is practically unobservable.* It is in fact widely recognized that individual dietary energy requirement proper depends not only on clearly identifiable individual characteristics such as body mass and level of physical activity, but also on a rather elusive individual degree of efficiency in the metabolism of food. As an important practical consequence of this fact, normative food requirement standards can only be given as *ranges valid for groups of individuals* (usually defined by age, sex, and physical activity) in recognition of the many unobservable factors affecting the individual requirement.[6] When the only information available on an individual is the combination of sex, age and level of physical activity, only a range of energy requirement levels that are compatible with good health can be given, and the FAO/WHO/UNU experts repeatedly make a point that the norm corresponding to the average of the range provided should not be used at the individual level, lacking a more comprehensive assessment of other individual characteristics.

Contrary to what seems to have been implied by some critics of the FAO methodology, the difficulty to precisely assess individual energy requirement thresholds (which led to the suggestion of monitoring anthropometrics as an indirect way to assess undernutrition) does not exclude the possibility of conducting a valid inference at the *population* level, based on a probabilistic statement and a proper understanding of the concepts involved. To facilitate such an understanding, we suggest that the distribution in (1) is interpreted as the probability distribution of the possible levels of habitual dietary energy consumptions for the population's representative individual (that is, the "average" individual in terms of all the observed and unobserved characteristics that may affect energy requirements), and the threshold level be interpreted with reference to that 'special' individual. In other words, x can be interpreted as the level of dietary energy consumption that would be observed on a randomly-selected individual in the population. The PoU is then a statement on the probability that a randomly selected individual would found to be undernourished.

Admittedly, the procedure may appear as too convoluted to readers who are not familiar with the principles of statistical inference. Unfortunately, conceptually simpler procedures (such as for example the one proposed by Smith, 2003 and Smith *et al.*, 2006) would need to confront such fundamental issues of data availability that they cannot be considered valid alternative for the same objective of assessing country level undernourishment at the global level (see further below).