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Klaus Grünberger

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Estimating Food Consumption Patterns by Reconciling Food Balance Sheets and Household Budget Surveys

Klaus Grünberger

Consultant, Statistics Division, FAO

Abstract

Food Balance Sheets (FBS) are one of the most important sources of data on food availability for human consumption. This paper presents a method to improve the information on food consumption patterns of FBS by using national household budget surveys (HBS).

In this paper, food commodities are categorized into 16 major food groups. For each food group, the contribution to the overall caloric intake is represented in shares. Item group shares of 64 surveys from 51 low and middle income countries are compared with shares from country-specific FBS. Given the countries represented in the data, the analysis evaluates food consumption of over 3 billion persons worldwide.

A model based on a cross-entropy measure of information has been developed in order to reconcile aggregate food consumption patterns suggested by FBS and HBS. The latter model accounts for the fact that data from both data sources are prone to measurement errors.

Overall, the results of the reconciliation suggest that average consumption of cereals, eggs, fish products, pulses and vegetables are likely to be underestimated in FBS, while fruits, meat, milk and sugar products are likely to be overestimated in FBS. Even though the suggested changes in average food consumption are moderate, the results imply considerable relative changes in the aggregate consumption of single food groups. Furthermore, the results imply that the aggregate consumption of fats is 2% higher than currently assumed.

The updated consumption patterns provide valuable information from an agro-industrial perspective. Differences in updated consumption pattern with respect to the original FBS might suggest a re-evaluation of FBS elements of the value chain, starting from production and ending at food losses.

Key words: Food Balance Sheets, Household Budget Surveys, Generalized Cross-Entropy Estimation, Food Consumption

JEL codes: I12, L66, O13, Q11, Q18

1 Introduction

Food balance sheets (FBS) provide a comprehensive picture of national food supply and are of fundamental importance to measure global food security (FAO et al., 2013). Furthermore, FBS are widely used in research of agriculture, nutrition and public health. In FBS, food availability for human consumption is calculated by taking into account production, imports, exports, stock variation and utilization elements such as feed, seed, losses and industrial uses. In most countries it is a big challenge to collect accurate data about all the elements and the quality of the data cannot always satisfy high quality standards. As a result, FBS figures of food consumption are prone to measurement errors.

This paper presents a method that seeks to improve the quality of FBS by making use of 64 national household budget surveys (HBS) from 51 low and middle income countries. Altogether, these 51 countries have over 3 billion inhabitants. Hence, the analysed data represent the average food consumption of more than 40% of the world population.

While FBS provide data from a macro perspective, HBS are looking at food availability at the micro level. Each HBS collects information on household food acquisition or consumption[1] of a presumably representative sample of the country's population. However, like FBS, also HBS have their specific problems in providing a comprehensive picture of a country's food consumption. For this reason information on food is consolidated by combining the strength of both data sources.

Food data from HBS and FBS are aggregated into 16 major commodity groups (cereals, fruits, etc.) and compared in terms of calories. The reconciliation of HBS and FBS data will be performed on the basis of calorie shares of food item groups, i.e. the contribution of each food item group to the total calorie consumption. Hereby an estimation procedure based on a cross-entropy measure will be employed, allowing for measurement errors in HBS shares.

The procedure produces updated FBS with adjusted item group calorie shares. Overall, the results suggest that the consumption of cereals, eggs, fish products, pulses and vegetables might be higher than supposed by the original FBS, while the consumption of fruits, meat, milk, starchy roots and sugar products might be lower. The reconciliation results can be taken as benchmark for reviewing consumption patterns in FBS figures.

In Section 2 describes the data and Section 3 presents the reconciliation model. Results are presented in Section 4 and Section 5 concludes.

[1] In this paper 'consumption' is not defined as food eaten (commonly assessed by specific nutrition surveys), but as food available for actual human consumption. Moreover, the definitions of food consumption slightly differ between FBS and HBS. Section 2 will discuss the data in detail.

2 The data

Both, FBS and HBS, have their own strengths and weaknesses. Neither of the two data sources can be regarded as a 'gold standard' for making inference about the food consumption in a country. When comparing FBS and HBS it is important to identify their main shortcomings and to highlight the difference between the two data sources.

2.1 FBS data

FBS are aggregate data which include information about food commodities for more than 180 countries and about 100 food items. The main components of FBS are provided by national statistical offices. In case of missing data, imputation techniques are used to fill the data gaps. FBS reflect the countries' food supply during a specified reference period by subtracting utilization from supply. Domestic food supply is given by the sum of production (already harvested crops), stock variation and the foreign trade balance. Domestic utilization consists of the following elements: feed, seed, post-harvest losses and industrial uses. FBS's food supply reflects therefore food available for human consumption, without considering food wasted at the household level. Furthermore, there is some evidence that in FBS, food losses during distribution at the retail level might not be sufficiently captured (Naska et al., 2009; Grünberger, 2013 and Sibrián et al., 2006). As a result, FBS's food supply might overestimate the amount of food available for human consumption.

Each component of both sides, elements of supply as well as from utilization, are prone to measurement error. Since the estimate of food consumption is in most cases derived as a residual of these (often highly uncertain) elements, its reliability is often called into question (Jacobs et al., 2002).[2]

2.2 HBS data

In principle, household data should solve most of the problems related to the measurement of countries' food availability. A perfectly representative household survey which assesses food consumption over a whole calendar year might be regarded as a 'gold standard' for the measurement of food availability. However, in practise, surveys have their own shortcomings too.[3]

It begins with the fact that most surveys are designed as household expenditure surveys and are not primary planned for measuring food expenditure alone, but measure all types of consumption. Since they do not primarily focus on nutrition, the picture of the country's food consumption is often incomplete. In fact, it is difficult to obtain complete information of what an entire household has consumed. The reference person who responses to the survey questionnaire may either have incomplete information about the consumption of

[2] FAO is currently working on a new framework to compile FBS (see Mahjoubi et al., 2012).
[3] A comprehensive overview of household surveys and their use for estimating food consumption is provided in Smith et al. (2014).

other household members, or simply forgets to mention apparently insignificant items (like small snacks).

Some surveys assess food consumption, while others measure food acquisition. Consumption comprehends all purchases, auto-produced food and stock withdrawals minus food put into stocks. Expenditure/acquisition surveys take into account auto-produced food but do account for food put into, or taken out of stocks.[4] However, after taking the average of all observations, both, consumption and expenditure surveys, should get the same result. For that reason, in the following discussion, no difference will be made between food consumption and food purchase.

Even if most HBS assess food consumed away from home, it can be expected that not all food flowing into the non-household sector (restaurants, canteens, schools, etc.) is captured. Furthermore, food waste in the non-household sector is a factor that cannot be assessed in HBS. As a result, food consumption in countries with a high fraction of food away from home might be underestimated in HBS.

Finally, representation of the country's population and the coverage of seasonal variation might be incomplete in the HBS. A lack of representativeness of timing is therefore an additional source of measurement error of HBS.

On the other hand, a clear advantage of household surveys is that own consumption is explicitly captured in most HBS. Under the definition of own consumption are falling domestic produces and food gathered wild. In many countries own consumption represents a relevant fraction of countries total food consumption. By definition of the FBS, own consumption should be already included in countries' food production. However, collecting data on own consumption is difficult and FBS might not always sufficiently capture these factors in its accounts. In this respect, HBS may provide valuable information to identify possible measurement errors in FBS production figures.

This study uses 64 HBS from 51 low and middle income countries. The sample of surveys covers all major regions of the developing world: Caribbean (1), Central America (4), Central Asia (1), Eastern Africa (8), Eastern Europe (3), Melanesia (1), Middle Africa (2), Northern Africa (2), Northern Europe (1), South-Eastern Asia (6), South America (7), Southern Asia (5), Southern Europe (1), Western Africa (7) and Western Asia (3).[5] A table listing all surveys can be found in Appendix A.

[4] In both cases household waste is not detracted.

[5] The number of countries represented in the sample is reported in parenthesis. Sub-regions are categorized according to the United Nations geoscheme (based on the M49 coding classification). The latter categorization assigns, in contrast to other geoschemes, Lithuania to Northern Europe and Albania to Southern Europe.

2.3 Data construction

Household surveys used for this analysis are converted to the ADePT[6] format and contain detailed information on household's food consumption. Nutritional properties of the food items are retrieved by food composition tables. Food composition tables assign calories and macronutrients to each food item and differ from country to country. In case of generic food purchases, like undefined meals away from home, calories and macronutrients are imputed (Moltedo et al., 2014).

It is not possible to compare commodity-specific data from HBS and FBS, because an exact matching of specific food items between HBS and FBS is not possible. Item descriptions in HBS are often very generic and cannot meet the precision of FBS. However, food items of household surveys are categorized in 19 major food groups. Since the classification of food groups of HBS is similar to those of FBS, food can be compared on this level of aggregation. Table 1 shows how food groups of HBS and FBS are harmonized to a common categorization. Finally we end up with 16 common food groups on whose basis the comparison will be performed.

Table 1: Formation of item groups

(1) **FBS Item Groups**	(2) **HBS/ADePT Item Groups**		(3) **Common Groups**
Cereals	Cereals		Cereals
Starchy Roots	Roots & Tubers		Starchy Roots
Sugar Crops	Sugar & Syrups	→	Sugar & Products
Sugar & Sweeteners	Soft drinks		
Pulses	Pulses		Pulses
Tree Nuts	Tree Nuts	→	Oil Crops & Tree Nuts
Oil Crops	Oil Crops		
Vegetable Oils	Vegetable Oils		Vegetable Oils
Vegetables	Vegetables		Vegetables
Fruits - Excl. Wine	Fruits		Fruits
Alcoholic Beverages	Alcoholic Beverages		Alcoholic Beverages
Meat	Meat & Offals	→	Meat & Offals
Offals			
Eggs	Eggs		Eggs
Milk - Excl. Butter	Milk & Cheese		Milk & Cheese
Animal Fats	Animal Fats		Animal Fats