Incorporating Nutritional Information to the GTAP 10 Data Base

Elimination of global hunger is identified as one of the core goals in the sustainable development agenda, as over 820 million people (approximately 1 in 9 people in the world) were undernourished in 2017 (UN, 2015). At the same time, as of 2016, more than 1.9 billion adults worldwide were overweighed and of these over 650 million were obese (WHO, 2020). Both these aspects pose significant challenges for the future of food systems.

Major transformations in food systems are also required to reduce impact on the environment. According to the Intergovernmental Panel on Climate Change (IPCC), agriculture, forestry and other land use activities contribute approximately a quarter of the global greenhouse gas (GHG) emissions. Demographic changes and increasing income are expected to further push the global diet towards more meat-oriented and emission-intensive, as a result agricultural GHG emissions could significantly increase in the long-run. According to Hedenus et al. (2014), with no shifts in the global diet, food-related emissions could grow from 7.1 Gton CO_2-equivalent per year in 2000 to 13 Gton CO_2-eq./year in 2070, which would make it almost impossible to keep the global temperature increase well below 2^{o}C, as desired by the Paris Climate Agreement. Therefore, reducing the food-related GHG emissions is a crucial policy component in meeting the stringent climate change targets.

With a wide range of implications for welfare, food security, land use, trade and environment, nutrition-related policies represent a complex question that should be accessed with a set of modelling tools that account for these interactions. Integrated assessment models (IAMs) and computable general equilibrium (CGE) models represent modelling approaches that fulfill such requirements. At the same time, as of today, there has not been many applications of IAMs and CGE models, with an explicit representation of nutritional information. Most studies focus on changes in agricultural and food production and consumption patterns, without explicitly tracing nutritional content embodied into final consumption. Some selected studies that deal with the latter question using different approaches are listed below.

At the country level, Minot (1998) examines distributional and nutritional impacts of devaluation in Rwanda by linking CGE with microsimulation model. Similar approach is applied by Pauw and Thurlow (2011) to link growth, poverty and nutrition in Tanzania within a CGE-microsimulation framework. At the multi-country level, several studies relied on the Global Trade Analysis Project (GTAP) Data Base and global CGE models to undertake the assessment of different policies for nutritional outcomes. Hertel et al. (2007) provide assessment of nutritional impacts form rapid economic growth in China and India. Verma and Hertel (2009) examine the impact of commodity price volatility on nutritional attainment of households at the nutritional poverty line in Bangladesh. Both these studies directly map nutritional content by commodities to the GTAP agricultural and food sectors, without accounting for out-of-home food consumption or explicitly tracking transition between primary and processed commodities.

This limitation is partly addressed in Rutten et al. (2013), who develop an approach for calculating nutrition indicators in a CGE framework, with particular application for the MAGNET model. Authors combine the Food and Agricultural Organization (FAO) nutritive factors with the FAO primary production data, map these estimates to the GTAP primary sectors, and calculate the nutrient content of processed food and food related services. The latter step is performed via an iterative procedure. The first approximation is used to distribute primary commodities to processed food sectors, second round considers input of processed food (result of the first approximation) used to produce processed food and so on. After performing these operations, Rutten et al. (2013) estimate per capita nutrition outcomes, which are on average 10% to 45% higher (at the global level) than those reported by FAO. Authors further implement scaling factors to match the FAO data.

Latter adjustment implies that some loss of nutritional content that happens during transformation process is not accounted in the developed procedure. In particular, when primary commodities are combined to produce processed commodity, calorific content of processed commodity (in primary commodity equivalent), in general, is lower than calorific content of corresponding primary commodity (per unit of weight).

Another limitation presented in Rutten et al. (2013) and other available studies includes the fact that developed methodology does not explicitly account for non-food use categories, such as feed, seed, losses, etc. While this might not be critical for the nutritional data distribution in the base year, in the dynamic simulations, one would like to track the primary food supply and its redistribution through the whole value chain for each simulated year, so that if the share of losses or feed efficiency change, these would be taken into account under developed framework.

One other point not being properly addressed in the existing literature includes appropriate representation of out-of-home food consumption. In many developed countries, the share of food consumed out of home represents a significant part of the nutritional intake. For instance, according to Saksena et al. (2018), out of home food consumption in US is around 30%. Furthermore, this food consumption is distributed among different service activities, such as hotels, restaurants, hospitals, schools, government sector, etc. Proper representation of this nutritional intake channel is an important part of the food balance sheets incorporation to the CGE models.

In this paper, we try to address some of the limitations discussed above and develop an approach towards incorporation of nutritional information to the GTAP

10 Data Base (Aguiar et al., 2019). We rely on the FAO food balance sheets data and nutritive factors to estimate nutritional content of primary commodities and derived commodities represented in primary equivalent within food balance sheets. Calories, fats, proteins and carbohydrates are estimated and reported. We further identify use categories that account for food, feed, seed, losses and other uses. In terms of food supply, we identify GTAP primary commodity sectors, food processing sectors and service sectors that supply food. To redistribute nutritional data by GTAP sectors, we construct the Leontief inverse, operating only over those sectors (and uses) that supply food. Trade in both primary and processed commodities is taken into account. We further verify our estimates of food supplied by service sectors with available statistics by countries. Developed approach is applied to all four GTAP 10 reference years and could be replicated for each simulated year in the context of dynamic policy runs.

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