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Incorporating Nutritional Accounts in the GTAP Data Base

by

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Abstract

In this paper, we develop an approach towards incorporation of nutritional accounts for the Global Trade Analysis Project (GTAP) Data Base. We rely on the Food and Agricultural Organization (FAO) food balance sheets data and nutritive indicators to estimate nutritional content of primary commodities and derived commodities represented in primary equivalent within the 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 Data Base primary commodity sectors, food processing sectors and service sectors that supply food. To redistribute nutritional data according to GTAP Data Base sectors, we calculate Leontief inverses, operating only over those sectors (and uses) that supply food. Trade in both primary and processed commodities is taken into account. The approach is applied to all four GTAP 10 Data Base reference years and can be replicated in a dynamic modelling framework for each simulated year (time step).

JEL classification: D57, D58, L66, Q11, Q18.

Keywords: Nutritional accounts; Food balance sheets; GTAP; Computable general equilibrium.

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1. Introduction

Elimination of global hunger is identified as one of the key goals in the sustainable development agenda, as over 820 million people worldwide (approximately 1 in 9) are undernourished (UN, 2015; FAO, et al., 2019). At the same time, more than 1.9 billion adults worldwide are estimated to be overweight and of these over 650 million are obese (WHO, 2020). The dual burden of under- and over-nourishment poses significant challenges for the future of food systems.

Major transformations in food systems are also required to reduce the agricultural and food 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 incomes are expected to further push the global diet towards more emission-intensive meat consumption, 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 gigatonnes (Gt) CO₂-equivalent per year in 2000 to 13 Gt CO₂-eq. per year in 2070, which would make it almost impossible to keep the global temperature increase well below 2°C, a stated objective of the Paris Climate Agreement (UNFCCC, 2020). Therefore, reducing food-related GHG emissions is a crucial policy component in meeting the stringent climate mitigation 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 assessed with a set of modelling tools that account for such 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 have not been many applications of IAMs and CGE models, with an explicit representation of nutritional information. Several exceptions include Sands et al. (2014), Hasegawa et al. (2015) and Bouët et al. (2014). Nevertheless, in the available literature most studies focus on changes in agricultural and food production and consumption patterns, without explicitly tracing nutritional content embodied in final consumption. Some selected studies that deal with the latter question are discussed below.

At the country level, Minot (1998) examines distributional and nutritional impacts of devaluation in Rwanda by linking a CGE model with a microsimulation framework. A similar approach is applied by Pauw and Thurlow (2011) to link growth, poverty and nutrition in Tanzania using a CGE-microsimulation framework. At the multi-country level, several studies rely on the Global Trade Analysis Project (GTAP) Data Base and global CGE models to undertake an assessment of different policies for nutritional outcomes. Hertel et al. (2007) provide an assessment of nutritional impacts from 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. Chepeliev and Aguiar (2019) explore the economy-wide, environmental and dietary impacts of the global greenhouse gas taxes on food products.

All 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 the transformation from primary to processed commodities.

This limitation is partly addressed in Rutten et al. (2013), who develop an approach for calculating nutritional indicators in a CGE framework, with particular application for the MAGNET model. Authors combine the Food and Agricultural Organization (FAO) nutritive indicators 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, a second round considers input of processed food (outcome 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. The authors implement scaling factors to match the FAO data.

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

Another limitation presented in Rutten et al. (2013) and several other available studies includes the fact that the developed methodology does not explicitly account for (or track) non-food use categories, such as feed, seed, losses and other non-food uses. While this might not be critical for the nutritional data distribution in the base year, in a dynamic simulation framework, it is important to track the primary food supply and its redistribution through the whole supply-use chain for each simulated year. For instance, if the share of losses or feed efficiency changes, these should be taken into account within the developed framework.

One other point not being properly addressed in the existing literature includes consistent representation of out-of-home food consumption. For instance, similar to the Rutten et al. (2013), Britz (2020) designs a method where nutritional information is redistributed through the input-output table using a Leontief inverse, though the out-of-home food consumption is not captured within this framework.

At the same time, in many 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 the U.S. is around 34%. In some other developed countries, this share is somewhat lower, but still substantial—27.8% in Denmark, 25.8% in Sweden, 23.5% in the United Kingdom, 21.4% in Germany and 15.4% in Greece (Orfanos et al., 2009).

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' (FBS) incorporation to the CGE models and IAMs.

In this paper, we address some of the limitations discussed above and develop an approach toward incorporation of nutritional information to the GTAP Data Base with FAO-based

agricultural production targeting (Aguar et al., 2019; Chepeliev, 2020).³ We rely on the FAO FBS data and nutritive indicators to estimate nutritional content of primary commodities and derived commodities represented in primary commodity equivalent within FBS. 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 the 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 Leontief inverses, operating only over those sectors (and uses) that supply food. Such inverses are constructed separately for the redistribution of domestic, exported and imported commodities. Estimates of food supplied by service sectors are compared toward available country-specific data. The approach is applied to all four GTAP 10 reference years and nutritional data are mapped to the domestic and imported use flows in the final database. The approach can be replicated for each simulated year in the context of dynamic policy runs.

The rest of the paper is organized as follows. Section 2 provides an overview of the methodology for incorporating the nutritional accounts into the GTAP Data Base. Section 3 provides an overview of the constructed nutritional database and showcases how it can be used to track the greenhouse gas (GHG) intensity of food consumption across countries. Section 4 showcases and illustrative application of the developed nutritional database by linking it to the static GTAP model. Finally, Section 5 discusses directions toward further enrichment of the GTAP nutritional data framework and concludes.

2. Methodological approach

In this section, we discuss a general approach to the incorporation of nutritional accounts to the input-output modelling framework. We first showcase this using a simplified example of a single region economy with four commodities and activities, export and import flows, and one final consumer. We then discuss in more details the specific data processing steps for the incorporation of nutritional accounts into the GTAP Data Base.

2.1. Single country example

To illustrate the general concept of the incorporation of nutritional accounts to the input-output (IO) framework, we first focus on a single-country example. Assume that we have an IO table with four sectors—Agriculture, Food (processing), Industry and Services.⁴ Each of these sectors supplies goods and services for final consumption, intermediate use and exports. Domestic and imported commodities are used as intermediate inputs and for final consumption. Appendix A provides an IO table, as well as matrixes of imports and domestic use for the corresponding example.

³ This paper is targeting Version 10 of the GTAP Data Base with 4 reference years: 2004, 2007, 2011 and 2014.

⁴ To distinguish names of the IO table sectors from the cases, when corresponding word/notation is used in a general sense, we capitalize their names within this section of the document (e.g. Food (as a sector) and food (in a general sense)).

Though this is a stylized example, the cost shares of the input-output table (Table A.1, Appendix A) approximately follow the structure of the U.S. IO table from the GTAP 10 Data Base for the 2014 reference year. With a total final consumption of 165.4 USD, one might interpret this IO table as a representation of the economy per one person per day (in such case, annual final consumption would be 60371 USD). Agricultural output and nutritional supply considered in the example could then be interpreted as a daily per capita indicator.

We further assume that the following nutritional information is available—trade in primary agricultural commodities (exports—600 kcal and imports—600 kcal), domestic supply of domestically produced primary agricultural commodities (3500 kcal) and imports of the processed agricultural commodities (600 kcal). For simplicity, we assume that caloric content is available for all these data flows, though in general this might not be the case. In some cases of primary and processed agricultural commodity uses, such as seed, feed, losses or other uses, caloric content might not be explicitly available. Specific assumptions could be made regarding the caloric content in such cases, for instance, one may assume that caloric content of losses is lower than the caloric content of commodities used for food or that seed has the same caloric content as food, but we do not discuss such cases in order not to complicate the example. We assume that all primary agricultural commodities correspond to a single sector in the IO table—Agriculture, while all imported processed food commodities are associated with the Food sector.

Different treatment is applied to the redistribution of the primary and imported processed commodities. We start with the redistribution of primary commodities. From the total primary commodity supply (domestic + imported) we subtract losses (in our case we assume that these are 100 kcal) and redistribute the rest (4000 kcal) between direct food consumption of primary commodities and other uses. In order to do this we estimate the value shares of Agriculture commodities (domestic + imported) used by Agriculture, Food, Industry, Services and Final consumers. We assume that although Industry uses some primary agricultural commodities, these correspond to non-food uses and thus do not supply any food to final consumers. We also assume that the self-consumption by Agriculture corresponds to seed (corresponding category can be implied directly from FAO database). This approach suggests that out of 4000 kcal of primary commodities, 1129.4 kcal are consumed directly (final consumption of Agriculture) and the rest (2870.6 kcal) corresponds to the intermediate use. Out of these 2870.6 kcal, 390.9 kcal is self-consumption by Agriculture (e.g. seed), 270.5 kcal are consumed by Industry (other uses), 1947.7 kcal are consumed by Food industry and 261.5 kcal by Services. In our example, the two latter sectors further transform primary commodities to supply food to final consumers and for exports (a total of 2209.2 kcal), while the rest 661.4 kcal (Agriculture and Industry) correspond to the non-food use and are not further redistributed.

In the next step, we estimate caloric value per food-related output (kcal/USD) for Food and Services. We take into account only output associated with the supply of food (Table A.1, Appendix A). In particular, in the case of the Food industry, this excludes intermediate use of Food by Agriculture and Industry. In the case of Services, all categories except final consumption are excluded, as we assume Services neither provide any food to other sectors of economy nor export

any food. As a result, the Food sector supplies 134.9 kcal/USD for food-related output, while Services supply 2.1 kcal/USD for food-related output (Table A.3).

Next, we estimate intermediate use shares for the domestic product use (Table A.4), but only for the case of food-related uses. To estimate such shares, we use food-related output estimated in the previous step. Such instances include Agriculture and Food use by Food and Services (a total of four instances in our case). Appendix A (Table A.5) reports this matrix with intermediate consumption shares. This matrix is further inverted and multiplied by the vector of caloric values per food-related output (Table A.6). As a result, we estimate that out of 2209.2 kcal supplied by Food and Services, 613.5 kcal are supplied to final consumers by Services, 918.7 kcal are supplied to final consumers by Food sector and 677.1 kcal are exported by Food sector. Adding 1129.4 kcal from the first two categories from the above will give us an estimate of direct and indirect consumption of primary commodities by final consumers (2661.6 kcal).

To account for all sources of nutritional supply, imported processed commodities need to be introduced to the accounting framework (600 kcal in our example). An approach to the redistribution of these calories is similar to the redistribution of primary agricultural commodities, though several modifications apply. First, to estimate the share of the final consumption of imported Food, the matrix of imports is used (Table A.2, Appendix A), instead of the IO table shares (in the case of primary commodities supply). In our example out of 600 kcal of imported Food, 460.9 kcal are consumed by final consumers directly. The rest 139.1 kcal are further redistributed between Food and Services.

For simplicity, in this example, we assume that all imported Food ends up in the final consumption, so it does not go for exports or other uses (e.g. feed, seed, etc.). Therefore, when caloric values per food-related output (kcal/USD) are estimated, exports of both Food and Services is excluded from the food-related output. When intermediate use shares are estimated (Table A.7, Appendix A), only instances of Food use by Food and Services are considered. As in the case of primary agricultural commodities redistribution, the inverted matrix of use shares is multiplied by the vector of caloric values per food-related output to get the estimate of calories supplied to final consumers. We estimate that 63.6 kcal of imported processed food are supplied to final consumers by the Food sector and 75.5 kcal by Services, in addition to the 460.9 kcal directly supplied by Food sector (Table A.8, Appendix A).

In the example above, we assume that the quantity of exported processed commodities is not given and thus is estimated by the redistribution process. In general, this is not the case. FAO database reports quantities of exported primary and processed agricultural commodities, as well as corresponding nutritional content. This situation complicates data processing steps in our example, as FAO-reported and estimated by the redistribution process kcal embodied into exports do not necessarily match. In such cases, if one would need to replicate the FAO-reported nutritional accounts, including bilateral trade flows, it could be reasonable to assume that the nutritional content of food that goes to exports is different from the nutritional content of food that goes to domestic final consumption.

2.2. Overview of the processing steps for the case of GTAP Data Base

The single country example discussed above provides an overview of the general approach to the incorporation of nutritional accounts in the IO framework. Transition to the multi-region framework with a higher number of primary agricultural, food processing and service sectors, introduces additional elements to the general approach. Figure 1 provides an overview of the overall approach toward incorporation of the nutritional accounts into the GTAP Data Base.

(1) Estimation of the Leontief inverses	• Data: GTAP 10 Data Base, four reference years (2004, 2007, 2011 and 2014). • Identify food, feed, seed and other supplying instances. Estimate Leontief inverses for the redistribution of primary and processed commodities.
(2) Construction of the bilateral trade data	• Data: FAOSTAT, FishstatJ trade data for 446 primary and processed commodities. • Data gap-filling and mapping, construction of the bilateral trade in fish and aquaculture.
(3) Estimation of the primary domestic supply	• Data: FAOSTAT primary commodity production; data on non-food categories (feed, seed, loss, etc.) from FBS; bilateral trade data; commodity balances for non-food supply (e.g. oil cake); nutritive factors. • Estimation of the primary food supply, processing-related food supply (e.g. oils) and non-food supply by primary commodity equivalents.
(4) Redistribution of the nutritional supply by GTAP sectors	• Data: Primary domestic supply estimates; Leontief inverses. • Domestic nutritional supply by GTAP sectors in primary commodity equivalents.
(5) Redistribution of the trade-related nutritional supply	• Data: Bilateral trade data; nutritive factors; technical conversion factors. • Trade-related nutritional supply by GTAP sectors in primary commodity equivalents.
(6) Construction of the final database	• Data: Domestic and trade-related nutritional supply; FBS data. • Redistribution of food supply between domestic and imported flows.

Figure 1. Overview of the data processing steps toward nutrition accounts incorporation to the GTAP Data Base

Source: Author.

In the **first step**, we identify sectors of the GTAP 10 Data Base that supply food to final consumers, as well as intermediate uses associated with food supply. We split sectors into three categories – those that supply primary agricultural commodities for food; processed food sectors and service sectors that supply food. Appendix B provides corresponding sectoral classification listing. As in the single country example above (Section 2.1), we estimate food-related output for the redistribution of primary agricultural commodities and imported processed commodities. We then estimate intermediate use matrixes, considering only instances associated with food-related uses. This is done separately for the redistribution of primary agricultural commodities and imported processed commodities. For each of the 141 GTAP 10 Data Base regions we find an inverse of the two matrixes (65 sectors x 65 sectors), following a single country example above. First inverse is constructed for intermediate consumption shares of primary commodities (similar to the matrix A.5 in a single country case). Second inverse is constructed for intermediate

consumption shares of imported processed commodities (similar to the matrix A.7 from the single country example). We store these matrixes for use during the next data processing steps.

In the **second step**, we process the bilateral trade data. We source the quantities of bilateral imports and exports from FAO (2020a). We rely on imports (rather than exports) to construct the bilateral trade flows, assuming that importers are more reliable trade data reporters, as it is in their interest for taxation purposes to provide more precise trade flows accounting (compared to the accounting of exports). However, in some commodity instances of bilateral trade flows, only exports are reported. In such cases, we gap fill bilateral imports using exports. Bilateral trade data are collected for 424 commodities, 255 countries for the 2003-2015 timeframe.

For the case of aquaculture and fish commodities, FAO does not report quantities of bilateral trade. We source data on quantities of fish and aquaculture exports and imports by country from FishStatJ (FAO, 2020b). Aquaculture and fish trade data are sourced for 64 commodities, 220 countries and 2003-2015 reported years. These data are first adjusted to exclude re-exports and then scaled at the commodity level, so that global exports match global imports. Exports are adjusted to match imports. 64 commodities reported in the FishStatJ database are further aggregated to match a more aggregate commodity classification used in the construction of the nutritional accounts for the GTAP Data Base. Appendix C reports mapping between 64 FishStatJ commodities and 22 aggregate commodity categories, consistent with the FBS classification. For this purpose, we split 10 (out of 12) fish and aquaculture FBS categories into primary and processed parts (this gives us 20 categories in total), which can then be mapped as many-to-one to the FBS categories.

To construct the bilateral trade flows in fish and aquaculture, we use the unilateral data on quantities of exports and imports from FishStatJ and GTAP 10 Data Base bilateral trade data (value flows) in fish ('fish' sector). We first bilateralize the FishStatJ trade flows using GTAP bilateral trade in fish as weights. We then use the RAS⁵ technique to balance the bilateral trade data (in tonnes), matching the FishStatJ-reported totals by exporting and importing countries. This is done for 22 commodity categories and 220 countries.

In the **third step**, we collect data on quantities of crops and primary livestock production (FAO, 2020a). Nutritive factors that report calories, proteins, fats and carbs per 100 grams of primary and processed commodities are collected from several data sources (FAO, 2020c; FAO, 2013; Gebhardt and Thomas, 2002). These nutritive factors are estimated for 402 products and are used to estimate the nutritional content of traded commodities at a later data processing step (Appendix D). Some of the agricultural commodities with reported trade and production data are not used for food, feed or seed, but utilized in other non-food related processes (e.g. textiles industry, chemical products, etc.). For such commodity cases, we do not collect nutritive factors and thus they are not reported in Appendix D.

Nutritional information from the FBS is also collected at this stage. FAO provides FBS in two different formats – using new and old methodology. FBS that uses the new methodology

⁵ For the discussion of RAS balancing method see e.g. Trinh and Phong (2013).

covers the 2014-2017 timeframe, while FBS based on the old methodology provides estimates prior to 2014. As in the data construction approach we are covering the 2004-2014 timeframe, using a three-year average to represent each GTAP reference year, we need to use both forms of the FBS and thus some harmonization steps are required. In particular, this includes remapping of the residuals and tourist use categories from the new FBS format to stock changes and non-food use in the old FBS format.

In terms of the data inputs, as of mid-2021 FAO has provided two releases of the Food Balance Sheets using new methodology – 2020 and 2021 revisions (both covering data for 2014 and onwards). While the 2021 revision is the most recent one, a comparisons with 2020 revisions and nutritional accounts for the historical data years (2013 and earlier) revealed some inconsistent reporting patterns for the selected food categories in the 2021 FBS revision. In particular, in 16 FBS categories,⁶ the share of food that goes for processing has increase significantly – in some cases over 100 times. To keep the methodological consistency across years, we have used the 2020 FBS release to represent nutritional accounts for these 16 food categories, while the remaining 80 food categories are approximated using the 2021 FBS release.

While FAO provides FBS accounts for over 178 countries worldwide, these do not cover all countries reported by FAO agricultural production accounts or considered in the GTAP Data Base. To estimate the FBS nutritional accounts for non-reported countries, we assign each missing country a ‘like’ country from the same region and with the closest per capita GDP level. Appendix E reports mapping between countries without available FBS, but with reported FAO production and trade data, and ‘like’ countries. In all these cases, we assume that the per capita nutritional profile of countries without reported FBS is the same as in the ‘like’ countries. To estimate the per capita nutritional indicators we rely on the GTAP population data, rather than FAO population accounts, to be consistent with the GTAP 10 Data Base. The only exception is the South Sudan population data, which we source from the World Bank (WB, 2020). While most of the missing countries are small economies with population below 0.5 million people (38 out of 56 gap-filled countries), there are some cases of larger countries (with population above 10 million people) that need to be gap-filled. These include Democratic Republic of the Congo (74.9 million people as of 2014), Syrian Arab Republic (18.8 million), Burundi (10.8 million), South Sudan (10.6 million) and Somalia (10.5 million) (Appendix E). But even with several larger countries without reported FBS, such gap-filling covers a relatively small portion of the global nutritional supply, as the share of population of the gap-filled countries in the world totals is around 2.3%.

In a number of cases, there are inconsistencies within FBS accounts. For instance, reported production does not match supply and use accounts or reported food supply is negative. In terms of the first point, by construction of the FBS, production should equal (food + feed + seed + processing + other uses + exports – imports – stock variation). However, this identity does not hold for all countries and commodities. To overcome this issue, we adjust production using the

⁶ The corresponding 16 categories include the following: Sweet potatoes, Palm kernels, Soyabean Oil, Sunflowerseed Oil, Rape and Mustard Oil, Cottonseed Oil, Palmkernel Oil, Palm oil, Coconut Oil, Ricebran Oil, Maize Germ Oil, Oranges, Mandarines, Lemons, Limes and products, Citrus, Other, Cocoa Beans and products, Milk - Excluding Butter.

identity listed above. We re-estimate domestic supply after adjusting the production volumes. If some cases of negative domestic supply are still present after these two adjustment steps, we set the domestic supply to “0” and adjust stock variation to be consistent with the reported production volumes. Though it should be noted that such adjustments are applied mostly to the small economies and do not occur at a large scale. For instance, for 2014 the number of country-commodity cases with negative food supply is 47, which is around 0.2% of all reported cases.

We next estimate primary domestic supply for crops, livestock and fish commodities. To accomplish this task we combine several data sources – production data from FAO, trade in primary and processed commodities and FBS accounts. Several steps are implemented to align and harmonize these data. We distinguish five supply categories for which we construct production and trade accounts. These include production, imports of primary commodities, imports of processed commodities, exports of primary commodities and exports of processed commodities. Similar to the example in the Section 2.1, we apply different approaches to the redistribution of nutritional content associated with primary and processed commodities, as discussed below.

We first map primary commodity production, exports and imports to the supply categories listed above. In the case of processed commodities, while their exports and imports are reported in actual weight, their representation in FBS varies. Some of the processed commodities are converted to primary equivalents in FBS and reported aggregately with primary commodities. For instance, this is the case for flour, bread, pastry and macaroni that are reported in FBS aggregately with wheat under ‘Wheat and products’ category and converted to primary equivalent. However, some processed commodities, such as wine or cream are reported under separate processed commodity categories, though also in primary equivalents – grapes and milk respectively. To align trade data with FBS accounts, we convert processed commodities to primary equivalents using technical conversion factors (TCFs). The TCFs are compiled for 284 commodities based on FAO (2013) and Bruckner et al. (2019). Appendix F reports TCF values by commodity.

For the treatment of processed commodities, we distinguish three cases—(a) Processed commodities with 1-to-1 mapping to primary commodities; (b) Processed commodities with 1-to-many mapping to primary commodities; and (c) Processed commodities mapped to the processed FBS categories. Appendix G identifies such commodity categories and provides their mapping to primary commodities or processed FBS categories. In the case of 1-to-1 mapping between processed and primary commodities, first TCF conversion factors are applied and then commodities are mapped to processed trade categories.

In the case of 1-to-many mapping, the redistribution of processed commodity between different primary commodities is done based on the quantity shares of processed FBS categories that correspond to primary commodities. For instance, distilled alcoholic beverages (as a processed commodity) is mapped to four primary commodities – wheat, maize, barley and rye, thus we assume in every country a combination of these primary commodities is used to produce distilled alcoholic beverages. Each of these four primary commodities are further mapped to the FBS categories that include the mix of primary and processed commodities. For instance, wheat is mapped to FBS category wheat and products, maize to maize and products, barley to barley and

products, and rye to rye and products. FBS further reports the share of commodities within each category that goes for processing, i.e. transformation into other food commodities outside specific category. We take corresponding volumes of commodities that go for processing for each FBS category corresponding to the primary commodity and use these as shares to distribute processed commodity between primary commodities.

For instance, assuming that in country A 50 tons of wheat and products, 10 tons of maize and products, 20 tons of barley and products, and 20 tons of rye and product go for processing, we would redistribute primary equivalent of distilled alcoholic beverages between the four primary commodities in proportions of 50%, 20%, 20% and 10% respectively.

We next adjust the primary production data so that these match the production in primary equivalents reported by the FBS. Out of 98 FBS categories, 73 are reported in primary commodity equivalents (include primary (and processed) commodities), while another 25 include processed commodities only. The mapping between 211 primary commodities with available production data and 73 FBS categories is provided in Appendix H. In most cases primary commodity production data mapped to the FBS categories show only minor discrepancies, but for the full consistency with FBS accounts we further scale the primary commodity production volumes to exactly match the FBS data.

Next, we harmonize the bilateral trade data volumes with imports and exports reported by FBS. As discussed within *Step two* above, we have collected the bilateral trade data in primary and processed commodities, as reported by FAO. At the same time when such data are compared with unilateral exports and imports reported by FBS, these do not match exactly. To align these two data sources, we use the FBS trade data to target unilateral country level exports and imports by FBS categories, while bilateral trade data constructed on the *Step two* are used to derive the first approximation of bilateral flows. These bilateral trade flows are further balanced using a RAS technique. This is done separately for primary and processed commodities.

We finalize the *Step three* of the data processing approach by constructing the FBS in primary and processed commodity equivalents for 252 primary and processed commodities—compared to the 98 standard FBS categories. Country coverage is increased to 233 countries (versus 178 countries reported in the raw FBS data). Bilateral trade is estimated and reported separately for primary commodities and processed commodities. We estimate calories, protein and fat supply by primary and processed commodities using nutritional content data provided in Appendix D. In addition, we estimate carbohydrates supply using the general Atwater factors (Atwater, 1916).⁷ These estimates could be further refined by using the specific Atwater factors (Merrill and Watt, 1974), identified at the commodity level. However, such refinement should not substantially impact the estimates, as the differences implied by the application of general and specific Atwater factors are in general under 1%-1.5% (FAO, 2003).

⁷ According to the Atwater system, the supply of carbohydrates per 100 g can be estimated as following, assuming that we know the supply of calories, protein and fats for the commodity of interest (per 100 g):

$$\text{Carbohydrates} = [\text{Calories} - 4 * \text{Protein} - 9 * \text{Fats}] / 4;$$

Before aligning proteins, fats and carbohydrates supply with the food balance sheets (by adjusting nutritional content at the individual commodity level), we address some inconsistencies within the FBS themselves. In particular, in a number of cases FBS report total per capita proteins and fats supply that exceeds food supply, meaning that per 100 g of food supplied to final consumers there are more than 100 g of fats and proteins. In such cases, we proportionally downscale fats and proteins supply to match food supply. There are also cases with “0” food supply, but positive fat and protein supply. To address such cases we set fat and protein supply to zero. Although in most cases such inconsistencies are relatively small in absolute volumes, in 2014 they constituted around 10% of all reported food supply instances. We then estimate carbohydrate supply for the 98 FBS categories and if the Atwater formula results in negative carbohydrate supply, we set it to “0”. We further verify that the total fat, protein and carbohydrate supply does not exceed food supply and if this happens, we adjust carbohydrate supply to match food supply.

In the *fourth step*, we provide mapping and integration of the constructed nutritional accounts to the GTAP 10 Data Base. We rely on the identified primary agriculture, processed food and service sectors that supply food to final consumers (Appendix B). Nutritional accounts constructed in the *Step three* and available by country are mapped to the 141 GTAP 10 Data Base regions. We also take a three-year average of the FBS accounts and production data to smooth out variations between years.

To simplify the nutritional data redistribution process by GTAP use categories, we are avoiding cases when domestic production is below exports within the same GTAP sector, thus implying re-exports at the GTAP sectoral level. And although at the commodity level we have removed cases of re-exports, when trade data are aggregated to the GTAP sectoral level, some cases when domestic production is below exports are observed. To address this issue, we increase production and other use categories by the same amount (the value of the difference between exports and domestic production observed before adjustment). For most sectors, corresponding upward adjustment does not exceed 0.01% at the global level. One outstanding case is the “Other crops” sector, where the corresponding adjustment is 9%. At the same time, the share of “Other crops” output (in tons) in global food production in 2014 was only around 0.3%, therefore such adjustment does not have any significant impact on the global food production patterns. It should also be noted that this adjustment impacts only production volumes and not the food supply.

We next estimate quantities of the agricultural commodities by use categories (i.e. feed, seed, loss, other uses and food) and three supply categories – domestic supply, imported primary supply and imported processed supply. It is assumed that the shares of different use categories (in the total use) for specific region and sector are the same for domestic and imported commodities. We also assume that imported processed commodities are not used for seed. We ensure that estimated imported primary and processed commodity volumes match the bilateral trade data constructed on *Step 2*.

The redistribution of the nutritional data is treated differently for different supply categories. *First*, non-food uses (feed, seed, loss, other uses) by primary GTAP sectors are deducted from the primary commodity supply. These uses are then mapped to different GTAP sectors and reported

separately. The rest corresponds to processing and food supply. *Second*, domestic and imported primary commodities directly consumed by households are estimated using the value shares of the GTAP Data Base (i.e. the value share of the final consumption of the corresponding commodity in the total processing and food-related use of the corresponding primary commodity). *Third*, domestic and imported primary commodities (not directly consumed by households) are redistributed by users using the Leontief inverse (as described in Section 2.1). *Fourth*, the redistribution of commodity flows from the previous step are split into domestically consumed and exported. Exports match the bilateral trade data accounts constructed at the earlier processing step. *Fifth*, processed commodities consumed domestically are split into different use categories (feed, seed, loss, other use and food). *Sixth*, exports of the processed commodities are tracked by destinations using the bilateral trade data flows and are then redistributed using the Leontief inverse (constructed for the redistribution of processed commodities only) in the country of destination.

For the representation of *seed* use, we assume that this category corresponds to the self-consumption by primary agricultural sectors.

In the case of *feed* use, we assume that it corresponds to the consumption of primary and processed agricultural commodities by cattle ('ctl'), other animal products ('oap'), raw milk ('rmk'), wool ('wol') and fishing ('fsh') sectors.

In the case of *other uses* it is assumed that primary and processed agricultural commodities are distributed between 18 GTAP sectors: textiles ('tex'), wearing apparel ('wap'), leather products ('lea'), wood products ('lum'), paper products ('ppp'), chemical products ('chm'), basic pharmaceuticals ('bph'), rubber and plastics ('rpp'), mineral products ('nmm'), ferrous metals ('i_s'), other metals ('nfm'), metal products ('fmp'), computers and electronics ('ele'), electrical equipment ('eeq'), other equipment ('ome'), motor vehicles ('mvh'), transport equipment ('otn') and other manufacturing ('omf').

In the case of *losses*, all losses that correspond to the primary supply or processing of domestic commodities and imported primary commodities are mapped to the corresponding primary sector. In the case of imported processed commodities, losses are mapped to all non-primary agricultural sectors that supply food to final consumers.

In the case of all non-food categories redistribution, GTAP value flows are used as shares, where needed. For instance, in the case of feed supplied by the wheat sector the following values are used as shares for redistribution—value of domestic and imported wheat used by 'ctl', 'oap', 'rmk', 'wol' and 'fsh', value of wheat supplied (as intermediate inputs) to all food processing sectors and then used as an intermediate input (from corresponding food processing sectors) to 'ctl', 'oap', 'rmk', 'wol' and 'fsh' sectors.

In the final database, nutritional accounts are represented in a 5-dimensional header NUTR(TRAD_COMM, USE_CAT, SUPL_CAT, SRCR, REG),

Where:

"TRAD_COMM" represents the set of the GTAP 10 Data Base 65 traded commodities;

“USE_CAT” corresponds to use categories, which include TRAD_COMM, households and loss;

“SUPL_CAT” is the set of supply categories that include feed (Feed_Kt), seed (Seed_Kt), losses (Loss_Kt), Other uses (Othu_Kt), food in 1000 tonnes (Food_Kt), food in Terra calories (Food_Tcal), proteins (Protein_Kt), fats (Fats_Kt) and carbohydrates (Carbs_Kt); all flows apart from “Food_Tcal” are measured in Kilotons (Kt);

“SRCR” is the set of domestic (“doms”) and imported (indexed by 141 regions) sources;

“REG” is the set of the GTAP 10 Data Base 141 regions.

Primary and processed imported commodities that are supplied to final consumers via agricultural or food processing sectors are mapped to the final consumption of imported commodities. Imported primary and processed agricultural commodities that are supplied to final consumers via service sectors are mapped to the final consumption of domestic services. For simulations with the static CGE model one can assume that volume flows of the constructed nutritional database change proportionally to the corresponding volume flows of the CGE model, following a specific policy implementation.

3. Overview of the constructed nutritional database

One of the indicators readily available in the GTAP nutritional database is the composition of calories consumed by final users. As can be seen from Figure 2, due to the differences in production, consumption and trade patterns, the sectoral composition of calories supplied to the final users differs significantly across countries. For instance, while in the case of USA the share of calories supplied by rice (in the total value of per capita calories supplied) is around 1.5%, in India rice accounts for 26.2% of total calories supplied. On the other hand, the share of calories that comes from sugars is only 0.3% in China, while in US it reaches 6.4%. In most countries and regions processed food and beverages sector accounts for the largest share in the supplied calories, with a global average of around 25.9%.

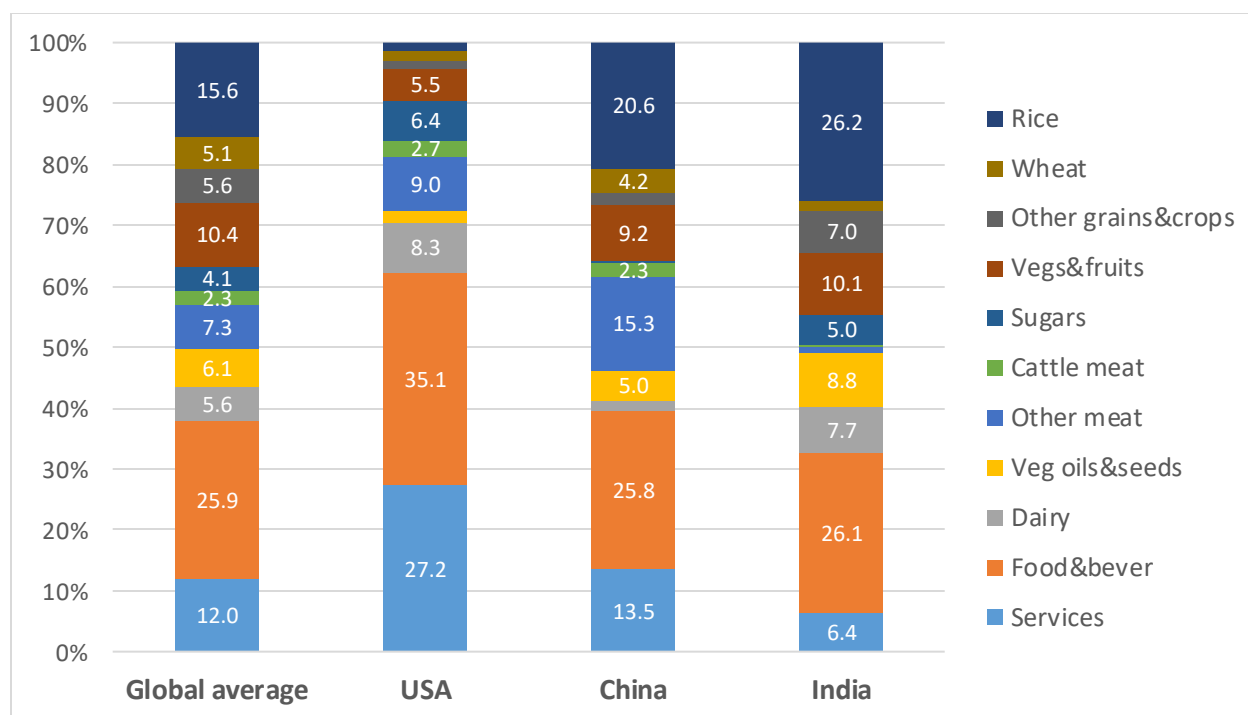


Figure 2. Distribution of calories supplied by GTAP sectors in 2014, % (selected countries)

Source: own estimates.

As discussed in Section 2, in the constructed nutritional database we allocate some share of food supply to service sectors, including hotels, restaurants, educational institutions, etc. As available surveys suggest, the share of the out-of-home food consumption is exceeding 20% (in the total volume of consumed calories) in many developed countries (Saksena et al., 2018; Orfanos et al., 2009). Estimates from the GTAP nutritional database imply that the global average share of calories supplied by service sectors is around 12% for the 2014 reference year. In most countries and regions, hotels and restaurants supply the largest amount of calories compared to other service sectors. Though this is not the case for all countries, as, for instance, in the U.S. over half of all calories in the service sector is supplied by recreational and other services. It should be noted that such composition of calories supplied by service sectors in U.S. can be partly driven by an outdated 2002 input-output table that underlies the GTAP 10 Data Base (Aguiar et al., 2019).

Comparisons between shares of calories supplied by the service sectors implied by the GTAP nutritional database with the shares of out-of-home food consumption from the available surveys for selected countries suggest a relatively close match, considering differences in reference years and methodology (Figure 3).

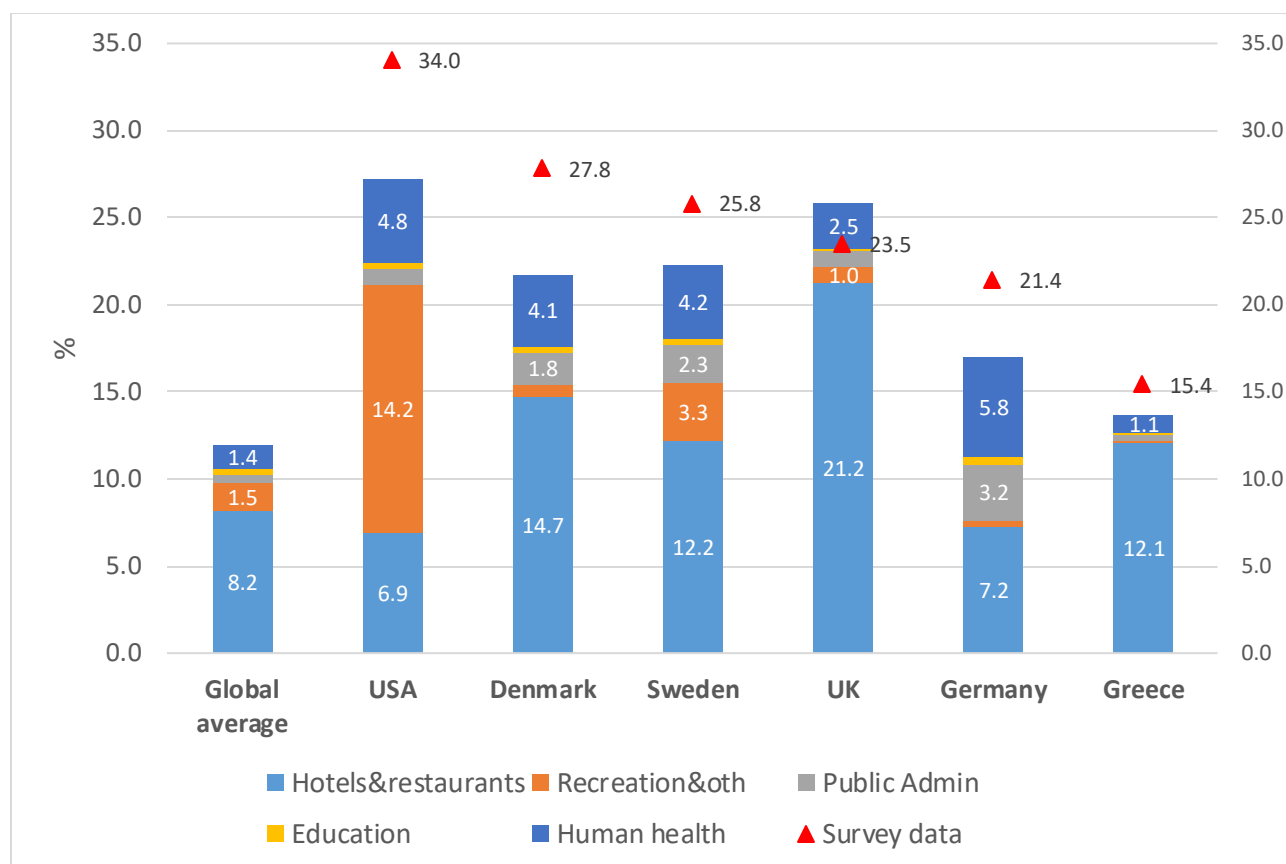


Figure 3. Share of calories supplied by GTAP service sectors in 2014, % of total calories supplied (selected countries)

Source: developed by author using GTAP nutritional database, Saksena et al. (2018) and Orfanos et al., (2009).

Due to the differences in commodity composition of the primary and processed GTAP agricultural sectors, variations in the caloric content of commodities (per unit of weight) and differences in prices of commodities across regions, there is a high variation in calories supplied per 1 USD (Figure 4). While in the case of fish, bovine meat, beverages and other crops less than 230 kcal can be purchased per 1 USD (world median value), in the case of such commodities like raw sugar, wheat, rice and other grains, each dollar can purchase over 4300 kcal (world median value).

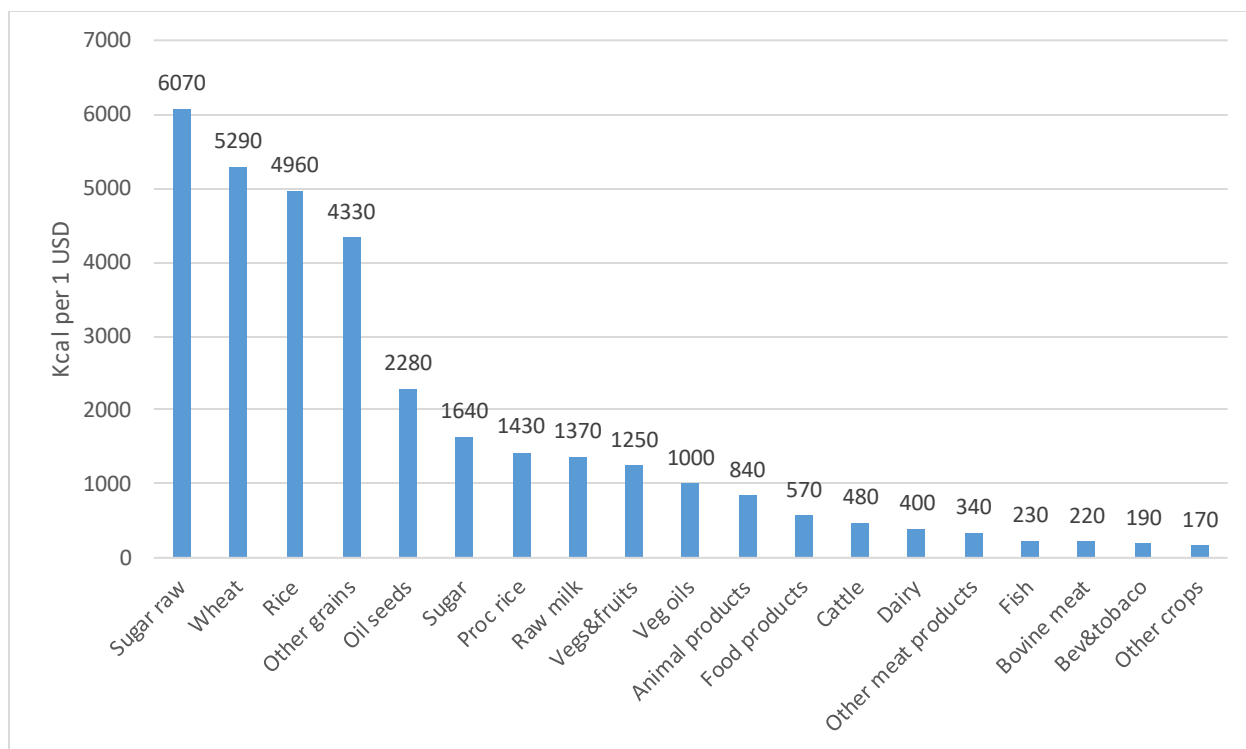


Figure 4. Kcal per 1 USD from domestic commodities supplied by selected GTAP sectors in 2014 (world median value)

Source: Own calculation.

Corresponding variations in domestically supplied calories that can be purchased per 1 USD are also large across regions, especially for the sectors that consist of many heterogeneous commodities, like vegetables fruits and nuts (Figure 5), and processed food (Figure 6). Some of the corresponding variations can be explained by variations in the sectoral commodity composition structure and differences in prices of the same commodity across regions. At the same time, part of the observed differences is coming from the merging of GTAP value flows and FAO-based quantities of production and consumption (nutritional information). Although such inconsistencies have been partially addressed via FAO-based agricultural production targeting, in some commodity and country cases, due to the necessity to preserve the GTAP trade data, it was impossible to exactly reach the FAO-based targets (Chepeliev, 2020). As a result, GTAP-implied commodity prices still show large deviations from the FAO-reported commodity prices, though considerably smaller than in the standard GTAP 10A Data Base (Aguar et al, 2019).

Even higher variations in calories per 1 USD are observed for imported commodities. In many cases these large variations are caused by differences between FAO and GTAP values of trade. While nutritional accounts are based on the FAO-reported quantities of traded food, trade values in the GTAP Data Base are constructed based on the reconciled UN Comtrade Database (Aguar et al., 2019). Therefore, one particular improvement of the constructed GTAP nutritional database would include further revision of production and trade accounts of the standard GTAP Data Base to bring it more in line with the FAO value and quantity flows.

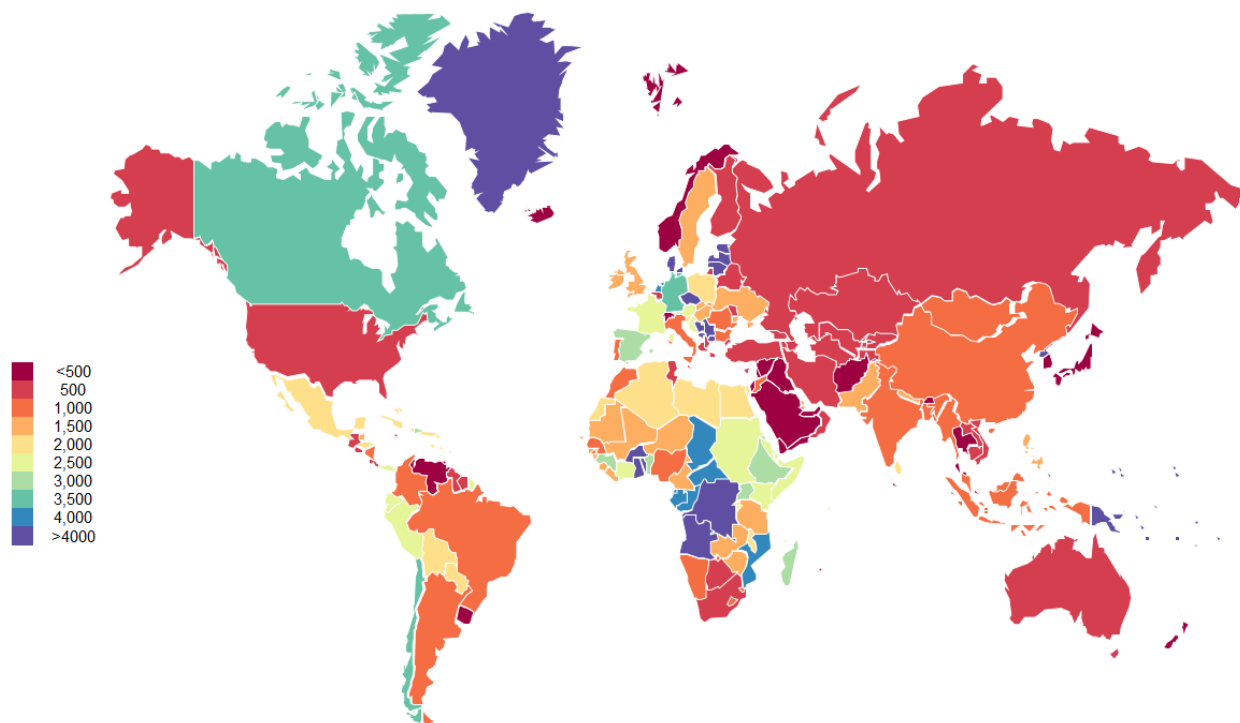


Figure 5. Kcal per 1 USD from domestic commodities supplied by the vegetables, fruits and nuts sector ('v_f') in 2014

Source: estimated by author.

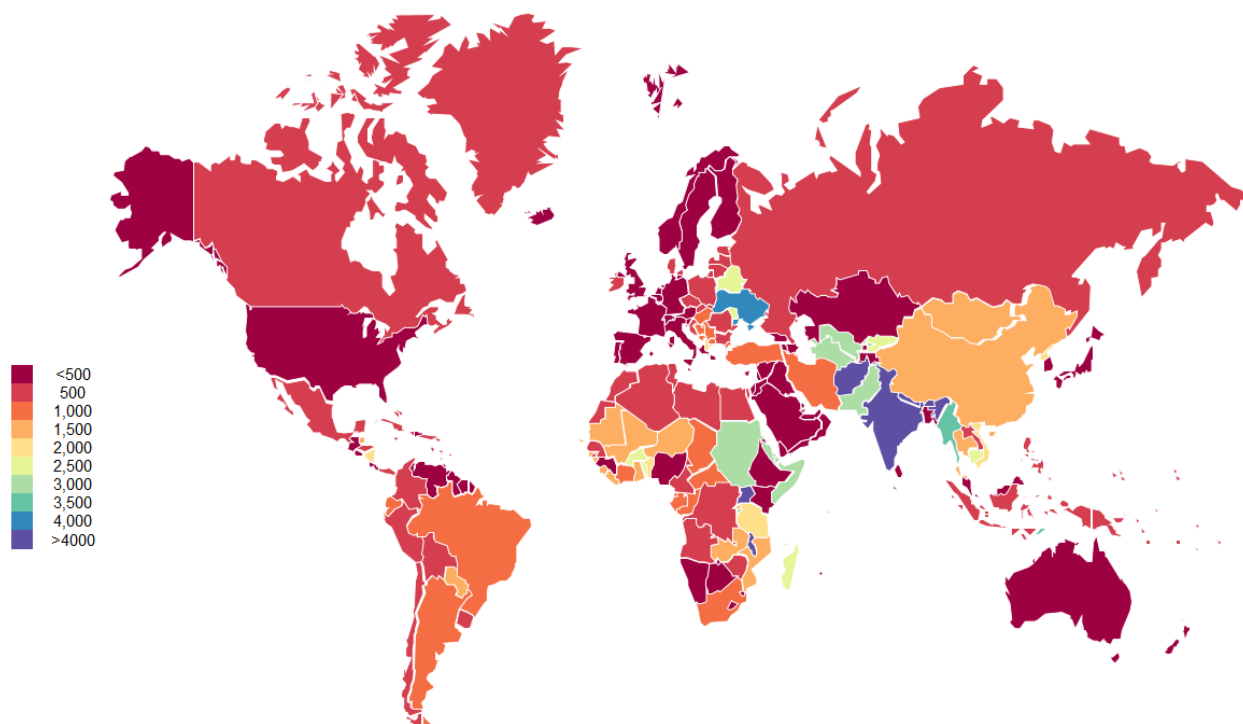


Figure 6. Kcal per 1 USD from domestic commodities supplied by the processed food sector ('ofd') in 2014

Source: estimated by author.

4. Illustrative application

In this Section we showcase how the constructed nutritional database can be linked to the standard GTAPv7 model (Corong et al., 2017) for the assessment of nutritional outcomes of various policies. For the illustrative purposes, we aggregate the GTAP 10a Data Base to 3 aggregate regions and 25 commodities (Appendix L). 2007 reference year is used for the application. Grouping of countries into aggregate regions is based on the per capita calories consumption: high (“HIGH”) with daily per capita calories consumption above 3000 kcal, medium “MED” with daily consumption between 2500 kcal and 3000 kcal and low (“LOW”) with daily consumption below 2500 kcal. Policy simulation includes elimination of import tariffs and subsidies on agricultural and food commodities by all three aggregate regions. Changes in the GTAP nutritional database flows are linked to the quantity changes reported by the standard GTAPv7 model (e.g. changes in demand for domestic and imported commodities by activities and final users, changes in domestic sales, etc.).

In terms of the trade patterns, “HIGH” region is importing 20% of their food (in terms of energy content – Kcal), which is equivalent to around 670 Kcal per capita per day, though almost 75% of these imported Kcal are associated with trade within the “HIGH” region (Figure 7). Both “LOW” and “MED” regions import much lower share of their Kcal compared to the “HIGH” region – 12% in both cases, at the same time the majority of these imports are coming from the “HIGH” region (Figure 2).

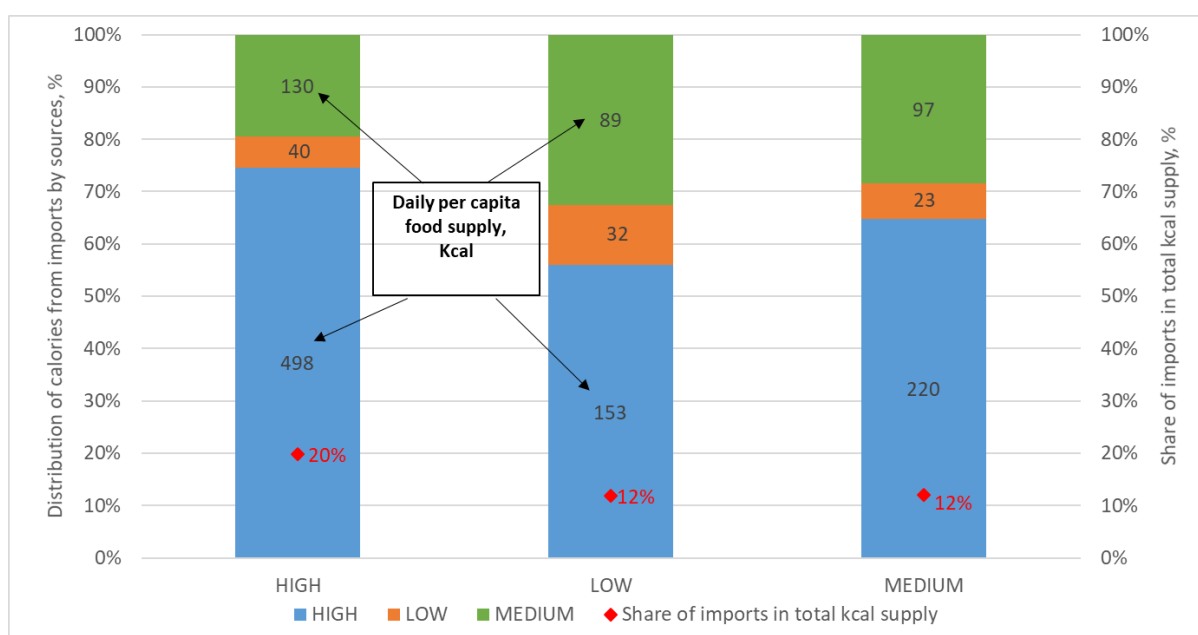


Figure 7. Distribution of Kcal per capita per day embodied into imports by aggregate regions in 2007

Source: estimated by author.

Import tariffs that are eliminated within the implemented policy experiment while on average range between 5%-10%, in some cases exceed 25% – e.g. other grains imports by “HIGH” region, vegetable oil imports by “LOW” and processed rice imports by “MED” (Figure 8). In many sectoral cases with relatively higher tariffs (e.g. above 15%) the share of imports in total kcal

consumption of the corresponding commodity is at least 20% (Figure 8). For instance, this is the case for other grains, oil seeds and sugar imports by “HIGH”, vegetable oils and beverages imports by “LOW” and cattle meat and beverages imports by “MED”.

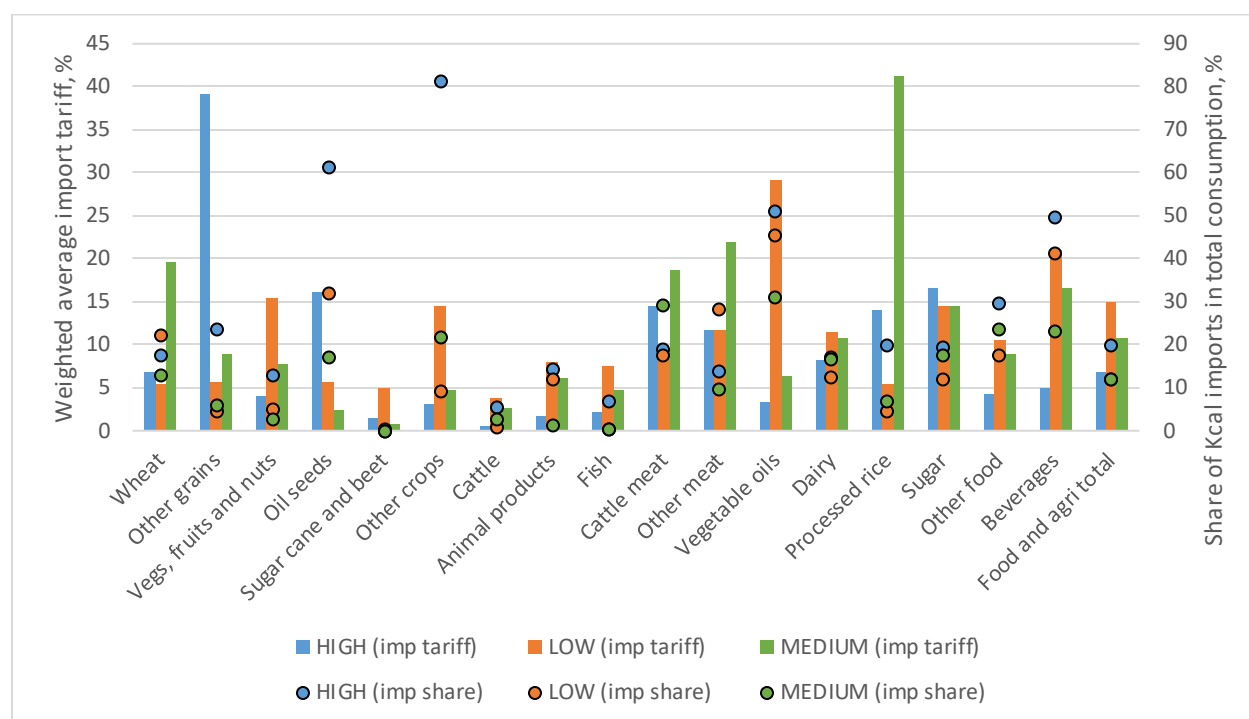


Figure 8. Import tariffs and import shares for selected agricultural and food sectors in 2007, %

Source: estimated by author.

Simulation results suggest that with elimination of import tariffs, kcal food supply increases in all regions ranging from +1.1% in the “LOW” and “MED” regions to +1.6% in the “HIGH” region (Figure 9). As in the reference year, most imported kcal in all regions were sourced from the “HIGH” region (Figure 7), most of the observed increases in imports are also associated with this region. In general, overall increases in kcal supply are rather moderate in absolute terms, as for instance the “LOW” region consumes an additional 26 kcal per day, while “HIGH” region increases daily per capita consumption by around 55 kcal.

Protein, fats and carbs supply are also increasing (Figure 9), though changes are more heterogeneous across regional aggregations, depending on the composition of reference year imports and tariff levels. For instance, a larger increase in proteins supply in “MED” can be explained by a substantial increase in the imports of rice and other food (Figure 10). Both commodities were substantially protected by the import tariffs in the reference year with a weighted average rate of 41% and 9% respectively (Figure 8). “LOW” region experiences relatively large increase in fats supply driven by the rising imports of vegetable oils (Figure 11) that initially were facing an import tariff of over 29% (Figure 8). In the case of carbs in “MED” region, we observe almost no change relative to the reference case, as increasing imports of other food and rice from “HIGH” are outweighed by reductions in domestic supply of rice and wheat (Figure 9).

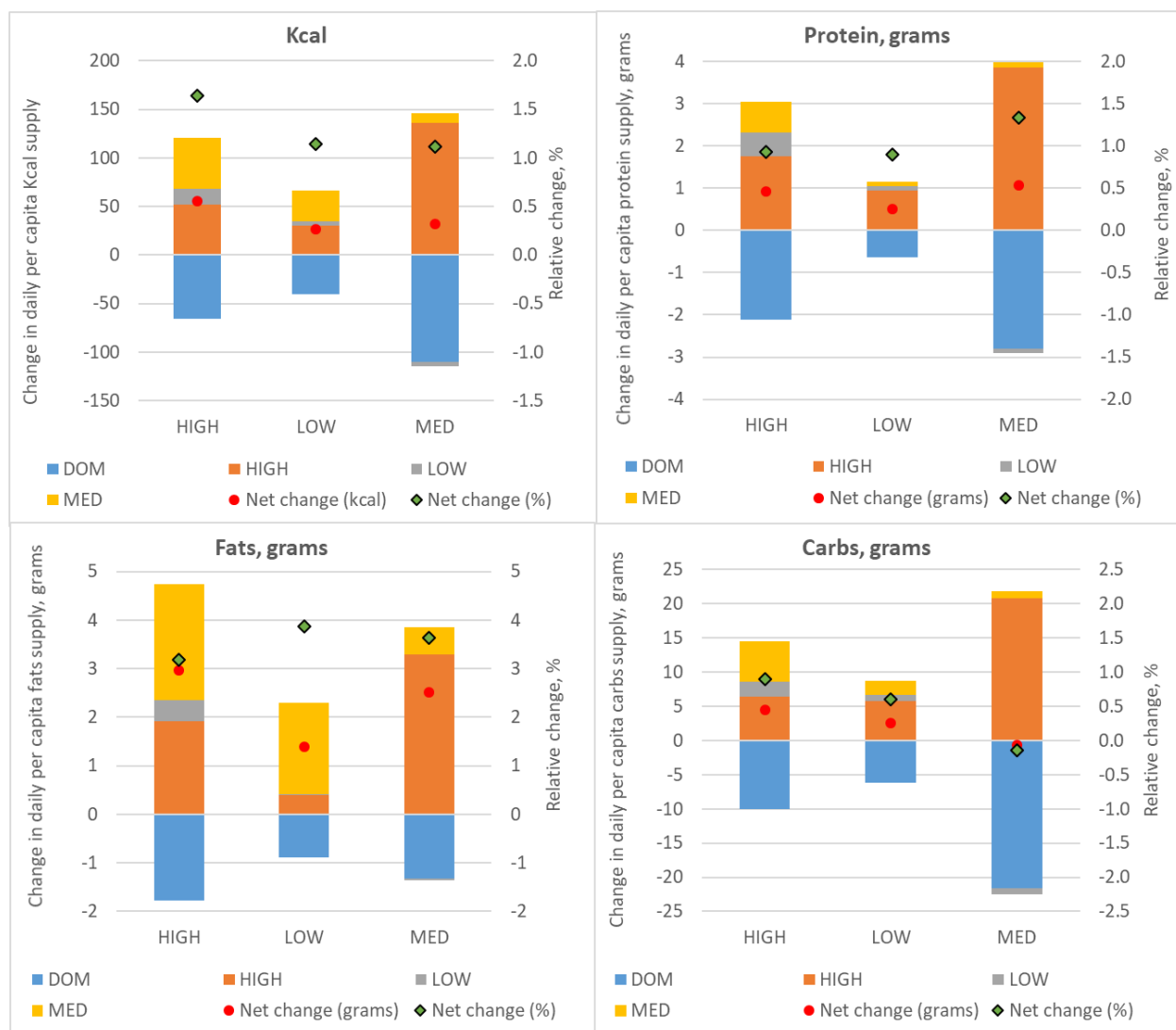


Figure 9. Change in daily per capita nutritional supply following import tariffs elimination
Source: estimated by author.

Figure 8 reports some other selected commodities that are experiencing a substantial increase in total kcal supply. In all regions we can see that there is a substantial increase in imports of other food commodity group. The latter one includes a diverse set of processed food items and constitutes a large share of the total food supply (in terms of kcal) – ranging from 18% in “LOW” to almost 26% in “HIGH” region.

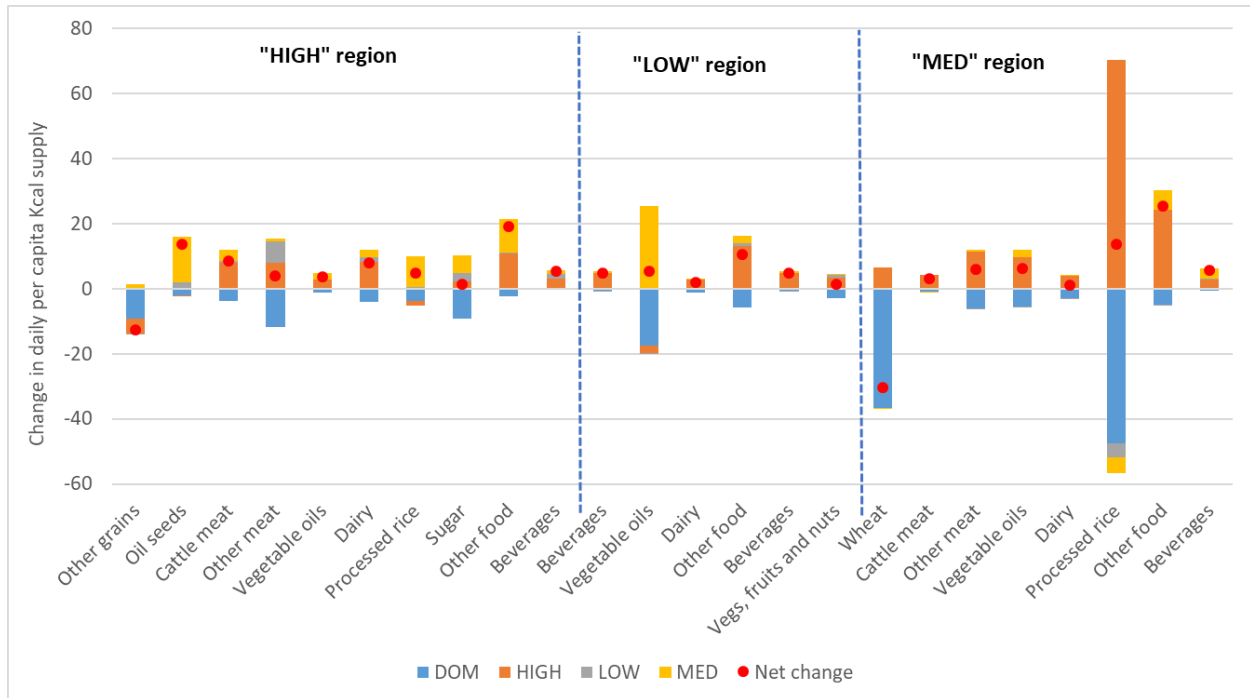


Figure 10. Change in the daily per capita kcal supply by sources for selected commodities

Source: estimated by author.

Notes: sectors with the change in daily per capita kcal supply over 10 Kcal are reported on the figure.

5. Discussion and conclusions

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 assessed with a set of modelling tools that properly account for all the involved interactions. IAMs and CGE models represent modelling approaches that fulfill such requirements. At the same time, as of today, there have not been many applications of these models, with an explicit representation of nutritional accounts. While those that are available have some major limitations in terms of the consistent representation of nutritional data flows, as discussed in the Introduction, and are not publicly available to the broad modelling community.

In this paper, we attempt to address some of the limitations identified in the literature and develop an approach toward incorporation of nutritional accounts to the GTAP 10 Data Base with FAO-based agricultural production targeting (Chepeliev, 2020). We rely on the FAO FBS data and nutritive indicators to estimate nutritional content of primary commodities and derived commodities represented in primary commodity equivalent within FBS. Calories, fats, proteins and carbohydrates are estimated and reported. We further identify use categories that account for food, feed, seed, losses and other uses. Food supply is attributed to GTAP primary commodity sectors, food processing sectors and selected service sectors. To redistribute nutritional data by GTAP sectors, we construct the Leontief inverse, operating only over those sectors (and uses) that supply food. Different Leontief inverses are used for redistributing domestic food supply, exported food and imported food. The approach is applied to all four GTAP 10 Data Base reference years.

While providing a consistent accounting of the food and non-food quantity flows within the GTAP data framework, there are several improvements and modification that the constructed database could benefit from. First, although being based on the special release of the GTAP Data Base with FAO-based APT (Chepeliev, 2020), these nutritional accounts would benefit from further revision of production and trade accounts of the standard GTAP Data Base to bring them more in line with the FAO value and quantity flows. This should reduce observed variations in kcal per 1 USD from domestic and traded food supply. Second, some use accounts in the constructed database could be represented in more details, as well as more explicitly distributed throughout the value chain. In particular, this includes better representation of the food loss and waste, which in the current version of the database is reported as a single category and thus not distributed between different commodity transformation stages (e.g. processing, transportation, storage, etc.). Third, for the case of countries not reported in the FAO FBS – mostly small agricultural producers – some assumptions were made to come up with nutritional accounts data (based on the mapping to the ‘like’ countries). Upon availability of the country-specific nutritional information, these assumptions could be revised. Fourth, the current version of the database reports supply of kcal, fats, proteins and carbohydrate, but does not report supply of micronutrients. Inclusion of the latter category could improve the representation of the developed nutritional accounts. Finally, while the developed database construction approach can be applied in the context of dynamic simulations (with nutritional account updated between simulated years), current implementation was done for in the static modelling framework and need to be further tested in the dynamic modelling applications.

Data availability. Two simulation archives are provided in the supplementary materials that accompany this paper and correspond to the simulations discussed in Section 4: RunGTAP simulation archive (“foodsubs.zip”) and a standalone nutritional outcomes assessment programs “fbsest.zip”. The latter one reads in the outcomes of the RunGTAP simulations and provides an assessment of the nutritional impacts. “Readme.txt” file in the “fbsest.zip” archive provides an overview of the simulation steps that should be implemented to replicate the results reported in this section.

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Appendix A. Stylized single country example of the nutritional accounts incorporation to the input-output framework

Table A.1. Input-output table, USD

	Agriculture	Food	Industry	Services	Final cons.	Exports	Imports	Total	Food-related output
Agriculture	0.6	3.0	0.4	0.4	1.7	1.4	-1.8	5.6	NA
Food	0.6	3.3	0.4	2.8	11.0	4.2	-7.2	15.1	14.4
Industry	0.8	1.6	49.3	25.8	22.7	46.9	-49.7	97.4	NA
Services	0.8	3.5	19.4	82.0	130.0	16.1	-14.7	237.1	127.6
Value added	2.8	3.7	28.0	126.2					
Total	5.6	15.1	97.4	237.1					

Table A.2. Matrix of imports, USD

	Agriculture	Food	Industry	Services	Final cons.	Total
Agriculture	0.1	0.8	0.1	0.1	0.6	1.8
Food	0.1	1.0	0.2	0.6	5.3	7.2
Industry	0.3	0.6	25.3	8.9	14.6	49.7
Services	0.1	0.4	2.8	9.0	2.4	14.7
Total	0.6	2.8	28.3	18.6	23.0	

Table A.3. Nutritional indicators for primary Agriculture commodities redistribution

	Supply of primary commodities, kcal	Food-related intermediate use, kcal	Caloric value per output, kcal/USD
Agriculture	390.9	-	-
Food	1947.7	1947.7	134.9
Industry	270.5	-	-
Services	261.5	261.5	2.1
Final consumption (direct)	1129.4	-	-
Losses	100	-	-
Exports	600	-	-
Total	4700	2209.2	-

Notes: numbers highlighted red indicate non-food use categories within the domestic supply accounting.

Table A.4. Matrix of domestic use, USD

	Agriculture	Food	Industry	Services	Final cons.	Total
Agriculture	0.5	2.1	0.3	0.3	1.1	4.3
Food	0.4	2.3	0.2	2.2	5.7	10.9
Industry	0.5	1.1	24.0	16.9	8.0	50.5
Services	0.8	3.1	16.6	72.9	127.6	221.0
Total	2.2	8.6	41.1	92.3	142.4	

Table A.5. Intermediate consumption shares corresponding to the food-related output for primary commodities redistribution

	Agriculture	Food	Industry	Services	Final cons.
Agriculture	0	0.147	0	0.002	0
Food	0	0.161	0	0.017	0
Industry	0	0	0	0	0
Services	0	0	0	0	0

Table A.6. Indicators for the redistribution of calories from primary commodities supplied by Food and Services

	kcal/USD of final consumption/exports	Total kcal from final consumption	Total kcal from exports
Agriculture	-	-	-
Food	160.8	918.7	677.1
Industry	-	-	-
Services	4.8	613.5	-
Total	-	1532.1	677.1

Notes: we assume that Services do not export any Kcal (food). Kcal that go directly to the final consumption, i.e. within Agriculture, are not represented in the table.

Table A.7. Intermediate consumption shares corresponding to the food-related output for imported processed commodities redistribution

	Agriculture	Food	Industry	Services	Final cons.
Agriculture	0	0	0	0	0
Food	0	0.228	0	0.017	0
Industry	0	0	0	0	0
Services	0	0	0	0	0

Table A.8. Indicators for the redistribution of imported processed Food

	Total supply, kcal	kcal/USD of final consumption	Total kcal to final consumption
Agriculture	-	-	-
Food	88.0	11.1	63.6
Industry	-	-	-
Services	51.1	0.6	75.5
Final consumption (direct)	460.9	-	460.9
Total	600.0	-	600.0

Appendix B. Mapping between GTAP 10 Data Base sectors and food supplying instances

No.	Code	Description	Primary agriculture	Processed food	Food-supplying service sectors
1	pdr	Paddy rice	+		
2	wht	Wheat	+		
3	gro	Other grains	+		
4	v_f	Vegetables, fruit and nuts	+		
5	osd	Oil Seeds	+		
6	c_b	Cane and beet	+		
7	pfb	Fiber crops			
8	ocr	Other Crops	+		
9	ctl	Cattle	+		
10	oap	Other Animal Products	+		
11	rmk	Raw milk	+		
12	wol	Wool			
13	frs	Forestry			
14	fsh	Fishing	+		
15	coa	Coal mining			
16	oil	Extraction of crude petroleum			
17	gas	Extraction of natural gas			
18	oxt	Other mining extraction			
19	cmt	Cattle meat		+	
20	omt	Other meat		+	
21	vol	Vegetable oils		+	
22	mil	Milk: dairy products		+	
23	pcr	Processed rice		+	
24	sgr	Sugar and molasses		+	
25	ofd	Other food		+	
26	b_t	Beverages and tobacco products		+	
27	tex	Textiles			
28	wap	Wearing apparel			
29	lea	Leather and related products			
30	lum	Lumber			
31	ppp	Paper and paper products			
32	p_c	Petroleum and coke			
33	chm	Chemicals and chemical products			
34	bph	Pharmaceuticals products			
35	rpp	Rubber and plastics products			
36	nmm	Other non-metallic mineral products			
37	i_s	Iron and steel			
38	nfm	Non-ferrous metals			
39	fmp	Fabricated metal products			
40	ele	Computer, electronic and optical products			
41	eeq	Electrical equipment			
42	ome	Machinery and equipment n.e.c.			
43	mvh	Motor vehicles, trailers and semi-trailers			
44	otn	Other transport equipment			
45	omf	Other Manufacturing			
46	ely	Electricity, steam and air conditioning supply			

No.	Code	Description	Primary agriculture	Processed food	Food-supplying service sectors
47	gdt	Gas manufacture, distribution			
48	wtr	Water supply			
49	cns	Construction			
50	trd	Wholesale and retail trade			
51	afs	Accommodation, food and service activities			+
52	otp	Land transport and transport via pipelines			
53	wtp	Water transport			
54	atp	Air transport			
55	whs	Warehousing and support activities			
56	cmn	Information and communication			
57	ofi	Other financial intermediation			
58	ins	Insurance			
59	rsa	Real estate activities			
60	obs	Other business services nec			
61	ros	Recreation and other services			+
62	osg	Other services (government)			+
63	edu	Education			+
64	hht	Human health and social work			+
65	dwe	Dwellings			
Total number of sectors			11	8	5

Source: developed by author based on GTAP (2020).

Appendix C. Mapping between FishStatJ commodities and aggregate fish and aquaculture categories used for the nutritional database construction

No.	FishStatJ category	Aggregate category code	Aggregate category description
1	Aquatic animals nei, cured	X2769_proc	Aquatic Animals, Others (processed)
2	Aquatic animals nei, meal from offal	X2769_proc	Aquatic Animals, Others (processed)
3	Aquatic plants	X2775_prim	Aquatic Plants (primary)
4	Cephalopods, fresh	X2766_prim	Cephalopods (primary)
5	Cephalopods, frozen	X2766_proc	Cephalopods (processed)
6	Crustaceans, canned	X2765_proc	Crustaceans (processed)
7	Crustaceans, fresh	X2765_prim	Crustaceans (primary)
8	Crustaceans, frozen	X2765_proc	Crustaceans (processed)
9	Demersal fish, fresh	X2762_prim	Demersal Fish (primary)
10	Demersal frozen, fillets	X2762_proc	Demersal Fish (processed)
11	Demersal, cured	X2762_proc	Demersal Fish (processed)
12	Demersal, frozen, whole	X2762_proc	Demersal Fish (processed)
13	Demersal, preparations nei	X2762_proc	Demersal Fish (processed)
14	Freshwater & diadromous fish, fresh	X2761_prim	Freshwater Fish (primary)
15	Freshwater & diadromous, canned	X2761_proc	Freshwater Fish (processed)
16	Freshwater & diadromous, cured	X2761_proc	Freshwater Fish (processed)
17	Freshwater & diadromous, frozen, whole	X2761_proc	Freshwater Fish (processed)
18	Marine fish nei, preparations nei	X2764_proc	Marine Fish, Other (processed)
19	Marine fish nei, body oils	X2781_proc	Fish, Body Oil
20	Marine fish nei, canned	X2764_proc	Marine Fish, Other (processed)
21	Marine fish nei, cured	X2764_proc	Marine Fish, Other (processed)
22	Marine fish nei, fresh	X2764_prim	Marine Fish, Other (primary)
23	Marine fish nei, fresh fillets	X2764_proc	Marine Fish, Other (processed)
24	Marine fish nei, frozen fillets	X2764_proc	Marine Fish, Other (processed)
25	Marine fish nei, frozen, whole	X2764_proc	Marine Fish, Other (processed)
26	Marine fish nei, liver oils	X2782_proc	Fish, Liver Oil
27	Marine fish nei, meal from offal	X2764_proc	Marine Fish, Other (processed)
28	Molluscs excl. ceph., canned	X2767_proc	Molluscs, Other (processed)
29	Molluscs excl. ceph., frozen	X2767_proc	Molluscs, Other (processed)
30	Molluscs excl. cephalopods, fresh	X2767_prim	Molluscs, Other (primary)
31	Pelagic fish, fresh	X2763_prim	Pelagic Fish (primary)
32	Pelagic, canned	X2763_proc	Pelagic Fish (processed)
33	Pelagic, cured	X2763_proc	Pelagic Fish (processed)
34	Pelagic, frozen fillets	X2763_proc	Pelagic Fish (processed)
35	Pelagic, frozen, whole	X2763_proc	Pelagic Fish (processed)
36	Pelagic, meals	X2763_proc	Pelagic Fish (processed)
37	Aquatic animals nei, fresh	X2769_prim	Aquatic Animals, Others (primary)

No.	FishStatJ category	Aggregate category code	Aggregate category description
38	Aquatic animals nei, preparations nei	X2769_proc	Aquatic Animals, Others (processed)
39	Aquatic mammals, oils	X2768_proc	Meat, Aquatic Mammals (processed)
40	Cephalopods, canned	X2766_proc	Cephalopods (processed)
41	Crustaceans, cured	X2765_proc	Crustaceans (processed)
42	Crustaceans, preparations nei	X2765_proc	Crustaceans (processed)
43	Demersal, canned	X2762_proc	Demersal Fish (processed)
44	Demersal, fresh fillets	X2762_proc	Demersal Fish (processed)
45	Freshwater & diadromous, fresh fillets	X2761_proc	Freshwater Fish (processed)
46	Freshwater & diadromous, frozen fillets	X2761_proc	Freshwater Fish (processed)
47	Freshwater & diadromous, preparations nei	X2761_proc	Freshwater Fish (processed)
48	Pelagic, fresh fillets	X2763_proc	Pelagic Fish (processed)
49	Aquatic plants, dried	X2775_proc	Aquatic Plants (processed)
50	Cephalopods, cured	X2766_proc	Cephalopods (processed)
51	Crustaceans, meals	X2765_proc	Crustaceans (processed)
52	Molluscs excl. ceph., cured	X2767_proc	Molluscs, Other (processed)
53	Molluscs excl. ceph., meal from offal	X2767_proc	Molluscs, Other (processed)
54	Pelagic, preparations nei	X2763_proc	Pelagic Fish (processed)
55	Pelagic, body oils	X2781_proc	Fish, Body Oil
56	Cephalopods, meal from offal	X2766_proc	Cephalopods (processed)
57	Cephalopods, preparations nei	X2766_proc	Cephalopods (processed)
58	Demersal, liver oils	X2782_proc	Fish, Liver Oil
59	Demersal, meals	X2762_proc	Demersal Fish (processed)
60	Freshwater & diadromous, meals	X2761_proc	Freshwater Fish (processed)
61	Aquatic mammals, meals	X2768_proc	Meat, Aquatic Mammals (processed)
62	Crustaceans, meal from offal	X2765_proc	Crustaceans (processed)
63	Demersal, body oils	X2781_proc	Fish, Body Oil
64	Aquatic plants, preparations nei	X2775_proc	Aquatic Plants (processed)

Source: developed by author based on FAO (2020b).

Appendix D. Nutritional content by primary and processed commodities

No.	Commodity code	Commodity name	Kcal/ 100 g	Proteins / 100 g	Fats/ 100 g	Carbs/ 100 g
1	X21422	Almonds shelled	589	20.0	52.2	9.8
2	X1371	Almonds, with shell	236	8.0	20.9	4.0
3	X1654	Anise, badian, fennel, coriander	345	15.8	14.9	36.9
4	X1341	Apples	48	0.1	0.3	11.2
5	X1343	Apricots	45	1.3	0.4	9.1
6	X21419_01	Apricots, dry	238	3.7	0.5	54.7
7	X2769_PRIM	Aquatic Animals, Others (primary)	30	4.0	0.2	3.1
8	X2769_PROC	Aquatic Animals, Others (processed)	30	4.0	0.2	3.1
9	X2775_PRIM	Aquatic Plants (primary)	54	2.8	0.6	9.4
10	X2775_PROC	Aquatic Plants (processed)	54	2.8	0.6	9.4
11	X1379_01	Areca nuts	245	4.9	4.4	46.5
12	X1216	Artichokes	20	1.1	0.1	3.7
13	X1211	Asparagus	12	1.6	0.1	1.2
14	X1311	Avocados	119	1.5	11.3	2.8
15	X21181	Bacon and ham	362	13.1	34.1	0.7
16	X1708	Bambara beans	365	17.7	6.3	59.4
17	X1312	Bananas	60	0.7	0.3	13.6
18	X115	Barley	332	12.0	1.8	67.0
19	X23140_05	Barley, pearled	346	9.0	1.4	74.4
20	X1701	Beans, dry	341	22.1	1.7	59.3
21	X1241_9	Beans, green	50	3.0	0.4	8.6
22	X24310_01	Beer of barley	49	0.5	0.0	11.8
23	X24310_04	Beer of sorghum	40	0.4	0.0	9.6
24	X1355_9	Berries nes	49	1.0	0.7	9.7
25	X2413	Beverages, distilled alcoholic	295	0.0	0.0	73.8
26	X24230_02	Beverages, fermented rice	133	0.3	0.0	33.0
27	X24490	Beverages, non alcoholic	39	0.0	0.0	9.8
28	X1355_01	Blueberries	120	0.7	0.4	28.4
29	X39120_09	Bran, buckwheat	213	12.1	3.1	34.2
30	X39120_1	Bran, fonio	213	12.1	3.1	34.2
31	X39120_04	Bran, maize	213	12.1	3.1	34.2
32	X39120_07	Bran, millet	213	12.1	3.1	34.2
33	X39120_08	Bran, sorghum	213	12.1	3.1	34.2
34	X39120_01	Bran, wheat	213	12.1	3.1	34.2
35	X21429_01	Brazil nuts, shelled	656	14.3	66.2	0.8
36	X1377	Brazil nuts, with shell	315	6.9	31.8	0.3
37	F0020	Bread	249	8.2	1.2	51.4
38	X1702	Broad beans, horse beans, dry	343	23.4	2.0	57.9

No.	Commodity code	Commodity name	Kcal/ 100 g	Proteins / 100 g	Fats/ 100 g	Carbs/ 100 g
39	X1192	Buckwheat	330	12.0	2.0	66.0
40	X23140_02	Bulgur	345	12.3	2.0	69.5
41	X21691_03	Butter of karite nuts	711	0.0	85.0	0.0
42	X22241_01	Butter, cow milk	717	0.9	81.1	0.0
43	X22230_03	Buttermilk, curdled, acidified milk	75	3.0	5.2	4.1
44	X1212	Cabbages and other brassicas	19	1.0	0.1	3.5
45	X1195	Canary seed	388	16.0	6.0	67.5
46	X1356	Carobs	111	1.6	0.5	25.0
47	X1251	Carrots and turnips	38	0.9	0.2	8.2
48	X21424	Cashew nuts, shelled	574	15.3	46.4	23.8
49	X1372	Cashew nuts, with shell	252	7.7	20.6	9.0
50	X1359_02	Cashewapple	43	0.8	0.6	8.6
51	X1520_01	Cassava	109	0.9	0.2	25.9
52	X1520_02	Cassava dried	212	2.8	0.7	48.6
53	X1219_01	Cassava leaves	53	5.8	1.1	5.0
54	X1213	Cauliflowers and broccoli	9	0.8	0.1	1.2
55	X2766_PRIM	Cephalopods (primary)	66	13.5	0.7	1.4
56	X2766_PROC	Cephalopods (processed)	66	13.5	0.7	1.4
57	X23140_08	Cereal preparations nes	340	8.0	1.5	73.6
58	X1199_9	Cereals nes	340	8.0	1.5	73.6
59	X23140_03	Cereals, breakfast	340	8.0	1.5	73.6
60	X22251_04	Cheese, processed	103	12.5	4.5	3.1
61	X22253	Cheese, sheep milk	310	23.2	22.8	3.0
62	X22251_01	Cheese, whole cow milk	387	25.0	31.0	2.0
63	X1344_02	Cherries	65	1.1	0.9	13.1
64	X1344_01	Cherries, sour	45	0.9	0.3	9.7
65	X1373	Chestnut	158	1.8	1.7	33.9
66	X1703	Chick peas	358	20.1	4.5	59.3
67	X1691	Chicory roots	60	1.1	0.2	13.5
68	X1652	Chillies and peppers, dry	337	11.3	15.5	38.1
69	X1231	Chillies and peppers, green	25	1.1	0.3	4.5
70	F0666	Chocolate products nes	393	4.2	35.7	13.7
71	X24230_03	Cider etc	47	0.1	0.0	11.7
72	X1655	Cinnamon (cannella)	261	3.9	3.2	54.2
73	X1656	Cloves	323	6.0	20.1	29.5
74	X1640	Cocoa, beans	414	4.0	40.0	9.5
75	X23620	Cocoa, butter	711	0.0	85.0	0.0
76	X23610_01	Cocoa, paste	472	1.7	44.0	17.3
77	F0665	Cocoa, powder & cake	261	17.3	19.0	5.2
78	X1460	Coconuts	184	1.7	17.4	5.2

No.	Commodity code	Commodity name	Kcal/ 100 g	Proteins / 100 g	Fats/ 100 g	Carbs/ 100 g
79	X21429_07	Coconuts, desiccated	660	6.9	64.5	13.0
80	X23912_02	Coffee, extracts	129	4.0	0.0	28.3
81	X1610	Coffee, green	47	6.7	0.0	5.1
82	X23911	Coffee, roasted	56	8.0	0.0	6.0
83	X23912_01	Coffee, substitutes containing coffee	56	8.0	0.0	6.0
84	X1492	Copra	636	6.0	61.4	14.9
85	X143	Cottonseed	253	17.3	17.9	5.7
86	X1706	Cow peas, dry	342	23.4	1.8	58.1
87	X1355_02	Cranberries	47	0.4	0.2	10.9
88	X22120	Cream fresh	195	2.7	19.3	2.6
89	X2765_PRIM	Crustaceans (primary)	47	9.3	0.5	1.3
90	X2765_PROC	Crustaceans (processed)	47	9.3	0.5	1.3
91	X1232	Cucumbers and gherkins	13	0.5	0.1	2.5
92	X1351_01	Currants	59	1.4	0.3	12.7
93	X1314	Dates	156	1.5	0.4	36.6
94	X2762_PRIM	Demersal Fish (primary)	42	8.3	0.8	0.4
95	X2762_PROC	Demersal Fish (processed)	42	8.3	0.8	0.4
96	X1233	Eggplants (aubergines)	21	0.9	0.1	4.1
97	X23993_03	Eggs, dried	594	45.8	41.8	8.7
98	X231	Eggs, hen, in shell	139	10.7	9.8	2.0
99	X23993_02	Eggs, liquid	158	12.1	11.2	2.2
100	X232	Eggs, other bird, in shell	163	11.3	12.1	2.2
101	F1243	Fat nes, prepared	720	0.6	81.0	0.0
102	X21513	Fat, buffaloes	847	2.0	93.0	0.5
103	X21519_02	Fat, camels	847	2.0	93.0	0.5
104	X21512	Fat, cattle	847	2.0	93.0	0.5
105	X21515	Fat, goats	847	2.0	93.0	0.5
106	X21189_02	Fat, liver prepared (foie gras)	462	11.4	43.8	5.6
107	X21511_01	Fat, pigs	712	4.7	76.7	0.7
108	X21514	Fat, sheep	902	0.0	100.0	0.0
109	X1315	Figs	73	0.8	0.3	16.8
110	X21419_02	Figs dried	253	3.0	1.2	57.6
111	X2781_PROC	Fish, Body Oil	902	0.0	100.0	0.0
112	X2782_PROC	Fish, Liver Oil	902	0.0	100.0	0.0
113	X23170_01	Flour, cassava	338	1.5	0.6	81.7
114	X23120_9	Flour, cereals	364	10.0	1.1	78.5
115	X23120_08	Flour, fonio	355	9.0	2.2	74.8
116	X23120_03	Flour, maize	363	8.4	1.2	79.7
117	X23120_1	Flour, mixed grain	364	10.0	1.1	78.5
118	X23995_03	Flour, mustard	469	26.4	36.3	9.2

No.	Commodity code	Commodity name	Kcal/ 100 g	Proteins / 100 g	Fats/ 100 g	Carbs/ 100 g
119	X21392	Flour, potatoes	355	8.5	0.4	79.4
120	X23170_03	Flour, pulses	340	22.0	2.0	58.5
121	X23120_01	Flour, rice	366	6.4	0.8	83.3
122	X23170_02	Flour, roots and tubers nes	282	5.0	0.6	64.2
123	X23110	Flour, wheat	364	10.9	1.1	77.6
124	X1193	Fonio	338	8.0	3.0	69.8
125	F1232	Food prep nes	41	1.2	0.5	7.9
126	X23999_02	Food preparations, flour, malt extract	41	1.2	0.5	7.9
127	X2761_PRIM	Freshwater Fish (primary)	69	10.9	2.5	0.7
128	X2761_PROC	Freshwater Fish (processed)	69	10.9	2.5	0.7
129	X23210_03	Fructose and syrup, other	298	0.3	0.0	74.2
130	X1329	Fruit, citrus nes	26	0.5	0.2	5.6
131	X23991_03	Fruit, cooked, homogenized preparations	59	0.3	0.0	14.5
132	X21419_99	Fruit, dried nes	267	2.8	0.6	62.6
133	X1359_9	Fruit, fresh nes	45	0.5	0.5	9.6
134	X1349_1	Fruit, pome nes	48	0.4	0.3	10.9
135	F0623	Fruit, prepared nes	36	0.5	0.2	8.1
136	X1349_2	Fruit, stone nes	52	0.9	0.3	11.4
137	X1319	Fruit, tropical fresh nes	41	0.5	0.7	8.2
138	X1252	Garlic	130	12.0	0.4	19.6
139	X23140_06	Germ, maize	373	11.1	38.5	0.0
140	X22242_02	Ghee, buffalo milk	873	0.3	99.1	0.0
141	X1657	Ginger	347	9.1	6.0	64.2
142	X23210_05	Glucose and dextrose	368	0.0	0.0	92.0
143	X1351_02	Gooseberries	44	0.9	0.6	8.8
144	X1199_02	Grain, mixed	340	8.0	1.5	73.6
145	X1321	Grapefruit (inc. pomelos)	16	0.3	0.1	3.5
146	X1330	Grapes	53	0.5	0.4	11.9
147	X21495_01	Groundnuts, prepared	580	26.8	49.2	7.5
148	X21421	Groundnuts, shelled	567	25.7	49.2	5.4
149	X142	Groundnuts, with shell	414	18.7	35.9	4.0
150	X21423	Hazelnuts, shelled	632	13.0	62.6	4.2
151	X1374	Hazelnuts, with shell	291	6.0	28.8	2.0
152	X2910	Honey, natural	298	0.4	0.0	74.1
153	X22270	Ice cream and edible ice	149	2.0	6.7	20.2
154	X23991_01	Infant food	368	15.2	2.9	70.3
155	X21435_02	Juice, apple, concentrated	166	0.5	0.4	40.1
156	X21435_01	Juice, apple, single strength	47	0.1	0.1	11.4
157	X21439_05	Juice, citrus, concentrated	157	2.1	0.5	36.0
158	X21439_04	Juice, citrus, single strength	47	0.6	0.2	10.7

No.	Commodity code	Commodity name	Kcal/ 100 g	Proteins / 100 g	Fats/ 100 g	Carbs/ 100 g
159	X21439_9	Juice, fruit nes	48	0.5	0.1	11.3
160	X21434	Juice, grape	61	0.6	0.1	14.4
161	X21432	Juice, grapefruit	39	0.5	0.1	9.0
162	X21432_01	Juice, grapefruit, concentrated	146	2.0	0.5	33.4
163	X21439_03	Juice, lemon, concentrated	116	2.3	0.9	24.7
164	X21439_02	Juice, lemon, single strength	22	0.5	0.3	4.3
165	X21431_02	Juice, orange, concentrated	159	2.4	0.2	36.9
166	X21431_01	Juice, orange, single strength	42	0.6	0.1	9.7
167	X21433	Juice, pineapple	56	0.3	0.1	13.5
168	X21433_01	Juice, pineapple, concentrated	179	1.3	0.1	43.2
169	X21439_07	Juice, plum, concentrated	215	2.0	0.1	51.5
170	X21439_06	Juice, plum, single strength	71	0.6	0.0	17.2
171	X21321	Juice, tomato	17	0.8	0.1	3.2
172	X1499_01	Karite nuts (sheanuts)	579	6.8	49.0	27.7
173	X1352	Kiwi fruit	52	0.9	0.4	11.2
174	X1379_02	Kola nuts	355	9.0	2.0	75.3
175	X23210_06	Lactose	387	0.0	0.0	96.8
176	X21521	Lard	902	0.0	100.0	0.0
177	X1254	Leeks, other alliacious vegetables	37	0.7	0.1	8.3
178	X1322	Lemons and limes	15	0.6	0.2	2.7
179	X1704	Lentils	346	24.2	1.8	58.3
180	X1214	Lettuce and chicory	12	1.1	0.2	1.5
181	X1441	Linseed	498	18.0	34.0	30.0
182	X1709_02	Lupins	390	40.0	13.0	28.3
183	X23710	Macaroni	367	12.0	1.1	77.3
184	X112	Maize	356	9.5	4.3	69.8
185	X1290_01	Maize, green	56	2.1	0.8	10.1
186	X24320	Malt	368	13.1	1.9	74.6
187	X1316	Mangoes, mangosteens, guavas	45	0.4	0.2	10.4
188	X23530	Maple sugar and syrups	348	0.0	0.0	87.0
189	X21700_01	Margarine, liquid	720	0.6	81.0	0.0
190	X21700_02	Margarine, short	720	0.6	81.0	0.0
191	X2764_PRIM	Marine Fish, Other (primary)	64	10.3	2.2	0.8
192	X2764_PROC	Marine Fish, Other (processed)	64	10.3	2.2	0.8
193	X1630	Mate	40	10.0	0.0	0.0
194	X21118_02I	Meat indigenous, ass	94	15.0	3.0	1.8
195	X21170_01I	Meat indigenous, bird nes	185	17.1	12.4	1.3
196	X21112I	Meat indigenous, buffalo	77	11.3	3.1	1.0
197	X21117_01I	Meat indigenous, camel	174	12.7	13.2	1.1
198	X21111_01I	Meat indigenous, cattle	150	18.5	7.9	1.2

No.	Commodity code	Commodity name	Kcal/ 100 g	Proteins / 100 g	Fats/ 100 g	Carbs/ 100 g
199	X21121I	Meat indigenous, chicken	122	12.3	7.7	0.9
200	X21122I	Meat indigenous, duck	291	8.3	28.3	0.8
201	X21123I	Meat indigenous, geese	301	12.9	27.2	1.2
202	X21116I	Meat indigenous, goat	123	14.0	7.0	1.0
203	X21118_01I	Meat indigenous, horse	85	15.5	2.0	1.3
204	X21118_03I	Meat indigenous, mule	94	15.0	3.0	1.8
205	X21117_02I	Meat indigenous, other camelids	143	14.6	9.0	0.9
206	X21113_01I	Meat indigenous, pig	326	11.0	31.0	0.8
207	X21114I	Meat indigenous, rabbit	118	17.0	5.0	1.3
208	X21119_01I	Meat indigenous, rodents	81	16.2	1.4	0.9
209	X21115I	Meat indigenous, sheep	119	12.8	7.1	1.0
210	X21124I	Meat indigenous, turkey	126	16.1	6.3	1.2
211	X21119_9	Meat nes	126	16.4	6.0	1.6
212	X2768_PRIM	Meat, Aquatic Mammals (primary)	136	21.0	5.0	1.8
213	X2768_PROC	Meat, Aquatic Mammals (processed)	136	21.0	5.0	1.8
214	X21118_02	Meat, ass	94	15.0	3.0	1.8
215	X21184_01	Meat, beef and veal sausages	313	11.7	28.4	2.7
216	F0875	Meat, beef, preparations	233	25.0	14.0	1.8
217	X21170_01	Meat, bird nes	185	17.1	12.4	1.3
218	X21112	Meat, buffalo	77	11.3	3.1	1.0
219	X21117_01	Meat, camel	174	12.7	13.2	1.1
220	X21111_01	Meat, cattle	150	18.5	7.9	1.2
221	X21111_02	Meat, cattle, boneless (beef & veal)	225	14.7	18.0	1.1
222	X21121	Meat, chicken	122	12.3	7.7	0.9
223	F1061	Meat, chicken, canned	165	21.8	8.0	1.5
224	X21183	Meat, dried nes	250	55.4	1.5	3.7
225	X21122	Meat, duck	291	8.3	28.3	0.8
226	X21170_02	Meat, game	104	18.0	3.0	1.3
227	X21116	Meat, goat	123	14.0	7.0	1.0
228	X21123	Meat, goose and guinea fowl	301	12.9	27.2	1.2
229	X21118_01	Meat, horse	85	15.5	2.0	1.3
230	X21118_03	Meat, mule	94	15.0	3.0	1.8
231	X21117_02	Meat, other camelids	143	14.6	9.0	0.9
232	X21119_01	Meat, other rodents	81	16.2	1.4	0.9
233	X21113_01	Meat, pig	326	11.0	31.0	0.8
234	X21184_02	Meat, pig sausages	417	11.7	40.3	1.9
235	F1042	Meat, pig, preparations	239	16.1	18.8	1.4
236	X21113_02	Meat, pork	220	13.4	18.0	1.1
237	X21114	Meat, rabbit	118	17.0	5.0	1.3
238	X21115	Meat, sheep	119	12.8	7.1	1.0

No.	Commodity code	Commodity name	Kcal/ 100 g	Proteins / 100 g	Fats/ 100 g	Carbs/ 100 g
239	X21124	Meat, turkey	126	16.1	6.3	1.2
240	X1229	Melons, other(inc.cantaloupes)	17	0.4	0.1	3.6
241	X1449_01	Melonseed	400	18.2	33.9	5.5
242	X22290	Milk, products of natural constituents	496	26.3	26.7	37.6
243	X22110_03	Milk, reconstituted	61	1.8	3.4	5.8
244	X22110_02	Milk, skimmed cow	35	3.4	0.2	4.9
245	X22212	Milk, skimmed dried	362	36.2	0.8	52.5
246	X22222_01	Milk, whole condensed	321	7.9	8.7	52.8
247	X22211	Milk, whole dried	496	26.3	26.7	37.6
248	X22221_01	Milk, whole evaporated	134	6.8	7.6	9.6
249	X2212	Milk, whole fresh buffalo	97	3.8	6.9	4.9
250	X2293	Milk, whole fresh camel	73	3.8	4.5	4.3
251	X2211	Milk, whole fresh cow	61	3.3	3.3	4.5
252	X2292	Milk, whole fresh goat	69	3.6	4.1	4.4
253	X2291	Milk, whole fresh sheep	94	5.9	6.0	4.1
254	X118	Millet	340	9.7	3.0	68.6
255	X23180	Mixes and doughs	243.5	8.6	2.9	46.0
256	X23540	Molasses	232	0.0	0.0	58.0
257	X2767_PRIM	Molluscs, Other (primary)	15	2.3	0.2	1.0
258	X2767_PROC	Molluscs, Other (processed)	15	2.3	0.2	1.0
259	X1270	Mushrooms and truffles	24	2.0	0.4	3.1
260	X21397_01	Mushrooms, canned	24	1.9	0.3	3.4
261	X1442	Mustard seed	469	24.9	28.8	27.6
262	X1653	Nutmeg, mace and cardamoms	525	5.8	36.3	43.8
263	X1379_9	Nuts nes	262	7.0	25.0	2.3
264	F0235	Nuts, prepared (exc. groundnuts)	615	15.5	56.2	11.8
265	X117	Oats	385	13.0	7.5	66.4
266	X23140_07	Oats rolled	384	16.0	6.3	65.8
267	X21152	Offals, edible, buffaloes	105	18.4	2.5	2.2
268	X21159_02	Offals, edible, camels	105	18.4	2.5	2.2
269	X21151	Offals, edible, cattle	105	18.4	2.5	2.2
270	X21156	Offals, edible, goats	117	14.6	5.7	1.8
271	X21159_01	Offals, horses	105	18.4	2.5	2.2
272	X21160_01	Offals, liver chicken	137	20.0	4.0	5.3
273	X21160_03	Offals, liver duck	136	18.7	4.6	5.0
274	X21160_02	Offals, liver geese	133	16.4	4.3	7.2
275	X21153	Offals, pigs, edible	113	18.3	3.5	2.1
276	X21155	Offals, sheep,edible	117	14.6	5.7	1.8
277	X1491_01	Oil palm fruit	158	0.3	13.2	9.5
278	X34550	Oil, boiled etc	902	0.0	100.0	0.0

No.	Commodity code	Commodity name	Kcal/ 100 g	Proteins / 100 g	Fats/ 100 g	Carbs/ 100 g
279	X21691_04	Oil, castorbeans	884	0.0	100.0	0.0
280	X2166	Oil, coconut (copra)	884	0.0	100.0	0.0
281	X2168	Oil, cottonseed	884	0.0	100.0	0.0
282	X2162	Oil, groundnut	884	0.0	100.0	0.0
283	X21691_11	Oil, kapok	884	0.0	100.0	0.0
284	X21691_12	Oil, linseed	884	0.0	100.0	0.0
285	X21691_02	Oil, maize	884	0.0	100.0	0.0
286	X21673	Oil, olive residues	884	0.0	100.0	0.0
287	X2167	Oil, olive, virgin	884	0.0	100.0	0.0
288	X2165	Oil, palm	884	0.0	100.0	0.0
289	X21691_14	Oil, palm kernel	884	0.0	100.0	0.0
290	X21691_08	Oil, poppy	884	0.0	100.0	0.0
291	X21641_01	Oil, rapeseed	884	0.0	100.0	0.0
292	X21691_01	Oil, rice bran	884	0.0	100.0	0.0
293	X21631_02	Oil, safflower	884	0.0	100.0	0.0
294	X21691_07	Oil, sesame	884	0.0	100.0	0.0
295	X2161	Oil, soybean	884	0.0	100.0	0.0
296	X21631_01	Oil, sunflower	884	0.0	100.0	0.0
297	X21691_9	Oil, vegetable origin nes	884	0.0	100.0	0.0
298	X21529_03	Oils, fats of animal nes	847	2.0	93.0	0.5
299	X1449_9	Oilseeds nes	387	14.7	31.7	10.7
300	X1239_01	Okra	31	1.6	0.3	5.5
301	X1450	Olives	175	1.3	17.5	3.1
302	F0262	Olives preserved	109	1.1	11.1	1.2
303	X1253_02	Onions, dry	31	1.1	0.2	6.2
304	X1253_01	Onions, shallots, green	24	1.7	0.1	4.1
305	X1323	Oranges	34	0.7	0.1	7.6
306	X1491_02	Palm kernels	514	7.3	43.4	23.6
307	X1317	Papayas	26	0.4	0.1	5.9
308	F0022	Pastry	369	7.4	17.0	46.6
309	X1345	Peaches and nectarines	33	0.5	0.1	7.5
310	X21495_02	Peanut butter	589	24.3	50.0	10.5
311	X1342_01	Pears	54	0.4	0.4	12.2
312	X1705	Peas, dry	346	22.5	1.8	60.0
313	X1242	Peas, green	31	2.1	0.2	5.2
314	X2763_PRIM	Pelagic Fish (primary)	86	12.6	3.6	0.8
315	X2763_PROC	Pelagic Fish (processed)	86	12.6	3.6	0.8
316	X1651	Pepper (piper spp.)	276	10.7	2.7	52.2
317	X1930_01	Peppermint	70	0.4	0.1	16.9
318	X1359_01	Persimmons	82	0.6	0.3	19.2

No.	Commodity code	Commodity name	Kcal/ 100 g	Proteins / 100 g	Fats/ 100 g	Carbs/ 100 g
319	X1707	Pigeon peas	343	20.9	1.7	61.0
320	X1318	Pineapples	26	0.2	0.2	5.9
321	X21491	Pineapples canned	78	0.4	0.1	18.9
322	X1375	Pistachios	289	10.3	24.2	7.5
323	X1313	Plantains and others	75	0.8	0.3	17.3
324	X1346	Plums and sloes	52	0.7	0.6	11.0
325	X21412	Plums dried (prunes)	208	2.3	0.5	48.6
326	X68	Popcorn	356	9.5	4.3	69.8
327	X1448	Poppy seed	533	18.0	44.7	14.7
328	X1510	Potatoes	67	1.6	0.1	14.9
329	X21313	Potatoes, frozen	73	1.2	0.0	17.1
330	X1709_9	Pulses nes	340	22.0	2.0	58.5
331	X1235	Pumpkins, squash and gourds	19	0.9	0.1	3.6
332	X1342_02	Quinces	35	0.2	0.1	8.3
333	X1194	Quinoa	342	12.0	5.0	62.3
334	X21411	Raisins	299	3.2	0.5	70.4
335	X1443	Rapeseed	494	19.6	45.0	2.7
336	X1353_01	Raspberries	47	0.9	0.5	9.7
337	X30	Rice - total (Rice milled equivalent)	360	6.4	0.8	81.8
338	X23161_03	Rice, broken	360	6.7	0.7	81.7
339	X23162	Rice, husked	357	7.5	1.8	77.7
340	X23161_02	Rice, milled	360	6.4	0.8	81.8
341	X113	Rice, paddy	280	6.0	1.4	60.9
342	X1599_1	Roots and tubers nes	91	1.6	0.2	20.7
343	X116	Rye	319	12.0	1.9	63.5
344	X1446	Safflower seed	314	9.7	30.3	0.6
345	X1444	Sesame seed	573	17.7	49.7	13.7
346	X2920	Snails, not sea	42	6.3	0.5	3.1
347	X114	Sorghum	343	10.1	3.3	68.2
348	X23995_02	Soya paste	114	12.0	5.8	3.5
349	X23995_01	Soya sauce	56	12.0	0.5	0.9
350	X141	Soybeans	335	38.0	18.0	5.3
351	X1699	Spices nes	337	11.3	15.5	38.1
352	X1215	Spinach	16	2.1	0.3	1.2
353	X1354	Strawberries	28	0.6	0.4	5.5
354	X1241_01	String beans	27	1.6	0.1	4.9
355	X1801	Sugar beet	70	1.3	0.1	16.0
356	X1802	Sugar cane	30	0.2	0.0	7.3
357	X23670_01	Sugar confectionery	310	0.0	0.0	77.5
358	X1809	Sugar crops nes	390	0.0	0.0	97.5

No.	Commodity code	Commodity name	Kcal/ 100 g	Proteins / 100 g	Fats/ 100 g	Carbs/ 100 g
359	X23210_04	Sugar nes	310	0.0	0.0	77.5
360	X23511_02	Sugar non-centrifugal	351	1.0	0.0	86.8
361	X2351F	Sugar Raw Centrifugal	373	0.0	0.0	93.3
362	X23520	Sugar refined	387	0.0	0.0	96.8
363	X1445	Sunflower seed	308	12.3	26.8	4.4
364	X21319_01	Sweet corn frozen	54	1.8	0.4	10.8
365	X21399_03	Sweet corn prep or preserved	77	2.3	0.6	15.6
366	X1530	Sweet potatoes	92	0.7	0.2	21.9
367	X21523	Tallow	884	0.0	100.0	0.0
368	X1324	Tangerines, mandarins, clementines, satsumas	32	0.5	0.1	7.3
369	X1550	Taro (cocoyam)	86	1.5	0.2	19.6
370	X1620	Tea	40	10.0	0.0	0.0
371	X23914	Tea, mate extracts	18	4.5	0.0	0.0
372	X1234	Tomatoes	17	0.8	0.2	3.0
373	X21399_01	Tomatoes, paste	84	3.8	0.9	15.2
374	X21399_02	Tomatoes, peeled	19	0.9	0.2	3.4
375	X1191	Triticale	327	11.6	2.1	65.4
376	X1658	Vanilla	337	11.3	15.5	38.1
377	X21691_09	Vegetable tallow	884	0.0	100.0	0.0
378	X21340	Vegetables in vinegar	29	1.4	1.3	2.9
379	X21393_9	Vegetables, dehydrated	341	6.6	1.3	75.7
380	X464	Vegetables, dried nes	22	1.4	0.2	3.7
381	X1290_9	Vegetables, fresh nes	22	1.4	0.2	3.7
382	X1990_01	Vegetables, fresh or dried products nes	22	1.4	0.2	3.7
383	F0473	Vegetables, frozen	71	3.3	0.5	13.3
384	X23991_02	Vegetables, homogenized preparations	41	1.2	0.5	7.9
385	X1243	Vegetables, leguminous nes	23	2.3	0.1	3.2
386	F0472	Vegetables, preserved nes	38	2.1	0.3	6.7
387	F0475	Vegetables, preserved, frozen	71	3.3	0.5	13.3
388	X21330_9	Vegetables, temporarily preserved	65	3.3	0.3	12.3
389	X24220	Vermouths & similar	137	0.1	0.0	34.2
390	X1709_01	Vetches	325	31.5	1.9	45.5
391	X23490_01	Wafers	439	9.2	13.1	71.1
392	X21429_02	Walnuts, shelled	642	14.3	61.9	6.9
393	X1376	Walnuts, with shell	289	6.4	27.8	3.3
394	X1221	Watermelons	17	0.3	0.2	3.5
395	X111	Wheat	334	12.2	2.3	66.1
396	X22130_03	Whey, condensed	26	0.9	0.3	4.9
397	X22130_02	Whey, dry	346	12.3	0.8	72.4
398	X24212_02	Wine	68	0.0	0.0	17.0

No.	Commodity code	Commodity name	Kcal/ 100 g	Proteins / 100 g	Fats/ 100 g	Carbs/ 100 g
399	X1540	Yams	101	1.3	0.2	23.5
400	X1591	Yautia (cocoyam)	109	1.7	0.3	24.9
401	X22230_01	Yoghurt	61	3.5	3.3	4.3
402	X22230_02	Yoghurt, concentrated or not	82	4.7	1.5	12.4

Source: developed by author based on FAO (2020c), FAO (2013), Gebhardt and Thomas (2002).

Appendix E. Mapping between countries without reported FBS and ‘like’ countries

No.	ISO code	Countries without reported FBS Country name	Population, mn	Like countries ISO code	Country name
1	BHR	Bahrain	1.36	KWT	Kuwait
2	BTN	Bhutan	0.77	MDV	Maldives
3	BDI	Burundi	10.82	DJI	Djibouti
4	COK	Cook Islands	0.01	NCL	New Caledonia
5	COD	Democratic Republic of the Congo	74.88	AGO	Angola
6	ERI	Eritrea	6.38	DJI	Djibouti
7	LBY	Libya	6.26	DZA	Algeria
8	MHL	Marshall Islands	0.05	VUT	Vanuatu
9	NRU	Nauru	0.01	PYF	French Polynesia
10	PNG	Papua New Guinea	7.46	SLB	Solomon Islands
11	QAT	Qatar	2.17	KWT	Kuwait
12	SYC	Seychelles	0.09	SDN	Sudan
13	SGP	Singapore	5.47	HKG	China, Hong Kong SAR
14	SYR	Syrian Arab Republic	18.77	YEM	Yemen
15	TON	Tonga	0.11	WSM	Samoa
16	COM	Comoros	0.77	DJI	Djibouti
17	GUF	French Guyana	0.24	SUR	Suriname
18	FSM	Micronesia (Federated States of)	0.1	VUT	Vanuatu
19	PRI	Puerto Rico	3.53	TTO	Trinidad and Tobago
20	REU	Reunion	0.84	FRA	France
21	SOM	Somalia	10.52	DJI	Djibouti
22	ASM	American Samoa	0.06	PYF	French Polynesia
23	VGB	British Virgin Islands	0.1	LCA	Saint Lucia
24	CYM	Cayman Islands	0.06	BHS	Bahamas
25	GNQ	Equatorial Guinea	0.82	GAB	Gabon
26	FLK	Falkland Islands (Malvinas)	0	SUR	Suriname
27	FRO	Faroe Islands	0.05	MNE	Montenegro
28	GRL	Greenland	0.06	BMU	Bermuda
29	GLP	Guadeloupe	0.4	FRA	France
30	GUM	Guam	0.17	NCL	New Caledonia
31	LIE	Liechtenstein	0.04	ISL	Iceland
32	MTQ	Martinique	0.39	FRA	France
33	MSR	Montserrat	0.01	ATG	Antigua and Barbuda
34	NIU	Niue	0	NCL	New Caledonia
35	PSE	Palestine	4.29	YEM	Yemen
36	SHN	Saint Helena, Ascension and Tristan da Cunha	0.01	CPV	Cabo Verde

No.	ISO code	Countries without reported FBS Country name	Population, mn	ISO code	Like countries Country name
37	SPM	Saint Pierre and Miquelon	0.01	BMU	Bermuda
38	SSD	South Sudan	10.55	SDN	Sudan
39	TKL	Tokelau	0	NCL	New Caledonia
40	TUV	Tuvalu	0.01	WSM	Samoa
41	VIR	United States Virgin Islands	0.03	LCA	Saint Lucia
42	WLF	Wallis and Futuna Islands	0.02	NCL	New Caledonia
43	ESH	Western Sahara	0.55	DZA	Algeria
44	AND	Andorra	0.07	ISL	Iceland
45	AIA	Anguilla	0.02	BHS	Bahamas
46	ABW	Aruba	0.1	BHS	Bahamas
47	VAT	Holy See	0	MNE	Montenegro
48	MYT	Mayotte	0.25	DJI	Djibouti
49	MCO	Monaco	0.04	MNE	Montenegro
50	MNP	Northern Mariana Islands	0.05	NCL	New Caledonia
51	PLW	Palau	0.02	PYF	French Polynesia
52	PCN	Pitcairn	0	NCL	New Caledonia
53	SMR	San Marino	0.03	MNE	Montenegro
54	SJM	Svalbard and Jan Mayen Islands	0	NOR	Norway
55	TCA	Turks and Caicos Islands	0.03	BHS	Bahamas
56	NFK	Norfolk Island	0	AUS	Australia

Source: developed by author based on Aguiar et al. (2019) and WB (2020).

Appendix F. Technical conversion factors for processed commodities

No.	Code	Commodity name	TCF value
1	X21422	Almonds shelled	0.4
2	X21419_01	Apricots, dry	0.29
3	X21181	Bacon and ham	0.77
4	X24310_01	Beer of barley	1
5	X2960_01	Beeswax	1
6	X39140_01	Beet pulp	1
7	X2413	Beverages, distilled alcoholic	1
8	X24490	Beverages, non alcoholic	1
9	X39120_04	Bran, maize	1
10	X39120_01	Bran, wheat	1
11	F0020	Bread	0.9085
12	X22241_01	Butter, cow milk	1
13	X22230_03	Buttermilk, curdled, acidified milk	1
14	X21910_05	Cake copra	1
15	X21910_15	Cake cottonseed	1
16	X21910_04	Cake of groundnuts	1
17	X21910_16	Cake linseed	1
18	X21910_08	Cake rapeseed	1
19	X21910_03	Cake soybean	1
20	X21910_07	Cake sunflower	1
21	X21424	Cashew nuts, shelled	0.24
22	X1520_02	Cassava dried	1
23	X23140_08	Cereal preparations nes	0.95
24	X23140_03	Cereals, breakfast	0.95
25	X22251_04	Cheese, processed	0.2
26	X22251_01	Cheese, whole cow milk	0.2
27	F0666	Chocolate products nes	1.9928
28	X24230_03	Cider etc	1
29	X25020_01	Cigarettes	1
30	X25020_02	Cigars cheroots	1
31	X23620	Cocoa, butter	1
32	F0665	Cocoa, powder & cake	0.424
33	X21429_07	Coconuts, desiccated	0.44
34	X39211	Cocoons unreelable & waste	2
35	X23912_02	Coffee, extracts	0.33
36	X39150_01	Coffee husks and skins	1
37	X23911	Coffee, roasted	0.8
38	X23912_01	Coffee, substitutes containing coffee	0.5
39	X1929_08	Coir	1
40	X1921_02	Cotton lint	1

No.	Code	Commodity name	TCF value
41	F0769	Cotton waste	1
42	X22120	Cream fresh	1
43	X23993_03	Eggs, dried	0.3
44	X23993_02	Eggs, liquid	1
45	F1243	Fat nes, prepared	1
46	X21189_02	Fat, liver prepared (foie gras)	1
47	X34120	Fatty acids	1
48	X21932_02	Fatty substance residues	1
49	X23319_04	Feed compound nes	1
50	X39120_91	Feed vegetable products nes	1
51	X21419_02	Figs dried	1
52	X23120_9	Flour, cereals	0.95
53	X23120_03	Flour, maize	0.99
54	X23995_03	Flour, mustard	3.5
55	X21392	Flour, potatoes	0.19
56	X23170_03	Flour, pulses	0.22
57	X23170_02	Flour, roots and tubers nes	0.22
58	X23110	Flour, wheat	0.79
59	F1232	Food prep nes	1
60	X23999_02	Food preparations, flour, malt extract	0.85
61	X39170_01	Food wastes	1
62	X1919_96	Forage products	1
63	X23210_03	Fructose and syrup, other	1
64	X23991_03	Fruit, cooked, homogenized preparations	1.1
65	X21419_99	Fruit, dried nes	0.4
66	F0623	Fruit, prepared nes	0.9
67	X23210_05	Glucose and dextrose	1
68	F0994	Grease incl. lanolin wool	1
69	X21495_01	Groundnuts, prepared	0.75
70	X21421	Groundnuts, shelled	1
71	X2943_02	Hair fine	1
72	X21423	Hazelnuts, shelled	0.4
73	X2951_04	Hides cattle wet salted	0.8
74	X22270	Ice cream and edible ice	1
75	X23991_01	Infant food	1
76	X21435_02	Juice, apple, concentrated	0.65
77	X21435_01	Juice, apple, single strength	0.2
78	X21439_05	Juice, citrus, concentrated	0.3
79	X21439_04	Juice, citrus, single strength	0.8
80	X21439_9	Juice, fruit nes	0.6
81	X21434	Juice, grape	0.75
82	X21432	Juice, grapefruit	0.47

No.	Code	Commodity name	TCF value
83	X21432_01	Juice, grapefruit, concentrated	0.14
84	X21431_02	Juice, orange, concentrated	0.1
85	X21431_01	Juice, orange, single strength	0.45
86	X21433	Juice, pineapple	0.72
87	X21433_01	Juice, pineapple, concentrated	0.5
88	X21321	Juice, tomato	0.465
89	X1922_01	Jute	1
90	X23210_06	Lactose	1
91	X21521	Lard	1
92	X23710	Macaroni	0.79
93	X24320	Malt	0.73
94	X23530	Maple sugar and syrups	1
95	X21700_01	Margarine, liquid	1
96	X21700_02	Margarine, short	1
97	X21190_01	Meal meat	1
98	X21184_01	Meat, beef and veal sausages	0.8
99	F0875	Meat, beef, preparations	0.6
100	X21111_02	Meat, cattle, boneless (beef & veal)	0.71
101	F1061	Meat, chicken, canned	0.9
102	X21183	Meat, dried nes	0.46
103	X21184_02	Meat, pig sausages	0.85
104	F1042	Meat, pig, preparations	0.88
105	X21113_02	Meat, pork	1
106	X22290	Milk, products of natural constituents	0.8
107	X22110_02	Milk, skimmed cow	1
108	X22212	Milk, skimmed dried	0.1
109	X22222_01	Milk, whole condensed	0.35
110	X22211	Milk, whole dried	0.15
111	X22221_01	Milk, whole evaporated	0.4
112	X23180	Mixes and doughs	0.85
113	X23540	Molasses	1
114	X21397_01	Mushrooms, canned	1.1
115	F0235	Nuts, prepared (exc. groundnuts)	0.82
116	X23140_07	Oats rolled	0.95
117	X21160_01	Offals, liver chicken	1
118	X34550	Oil, boiled etc	1
119	X21691_04	Oil, castor beans	1
120	X2166	Oil, coconut (copra)	1
121	X2168	Oil, cottonseed	1
122	X35410_9	Oil essential nes	1
123	X2162	Oil, groundnut	1
124	X21691_12	Oil, linseed	1

No.	Code	Commodity name	TCF value
125	X21691_02	Oil, maize	1
126	X21673	Oil, olive residues	1
127	X2167	Oil, olive, virgin	1
128	X21691_14	Oil, palm kernel	1
129	X21641_01	Oil, rapeseed	1
130	X21691_07	Oil, sesame	1
131	X2161	Oil, soybean	1
132	X21631_01	Oil, sunflower	1
133	X21691_9	Oil, vegetable origin nes	1
134	X21529_03	Oils, fats of animal nes	1
135	F0262	Olives preserved	1
136	F0022	Pastry	0.8
137	X21495_02	Peanut butter	0.75
138	X23311	Pet food	1
139	X21491	Pineapples canned	0.72
140	X21412	Plums dried (prunes)	1
141	X21313	Potatoes, frozen	0.47
142	X21411	Raisins	0.25
143	X30	Rice - total (Rice milled equivalent)	0.72
144	X23161_03	Rice, broken	0.72
145	X23162	Rice, husked	0.8
146	X23161_02	Rice, milled	0.72
147	X1950_02	Rubber natural dry	1
148	X1950_01	Rubber natural	1
149	X26110	Silk raw	1
150	X2953_01	Skins sheep with wool	1
151	X23995_01	Soya sauce	3.5
152	X1913	Straw husks	1
153	X23670_01	Sugar confectionery	1.05
154	X23210_04	Sugar nes	1
155	X2351f	Sugar Raw Centrifugal	1
156	X23520	Sugar refined	1
157	X21319_01	Sweet corn frozen	0.35
158	X21399_03	Sweet corn prep or preserved	0.45
159	X21523	Tallow	1
160	X23914	Tea, mate extracts	1
161	X25090	Tobacco products nes	1
162	X1970	Tobacco unmanufactured	1
163	X21399_01	Tomatoes, paste	0.22
164	X21399_02	Tomatoes, peeled	0.75
165	X21340	Vegetables in vinegar	1.2
166	X21393_9	Vegetables, dehydrated	0.4

No.	Code	Commodity name	TCF value
167	X1990_01	Vegetables, fresh or dried products nes	0.8
168	F0473	Vegetables, frozen	1
169	X23991_02	Vegetables, homogenized preparations	1
170	F0472	Vegetables, preserved nes	1
171	F0475	Vegetables, preserved, frozen	1
172	X21330_9	Vegetables, temporarily preserved	1
173	X24220	Vermouths & similar	1
174	X23490_01	Wafers	0.79
175	X21429_02	Walnuts, shelled	0.44
176	X17400	Watersice etc	1
177	X22130_02	Whey, dry	0.1
178	X24212_02	Wine	1
179	X26130	Wool degreased	1
180	X2941	Wool greasy	1
181	F1009	Wool hair waste	1
182	X22230_01	Yoghurt	0.8
183	X22230_02	Yoghurt, concentrated or not	0.8
184	X23320	Alfalfa meal and pellets	1
185	X23140_05	Barley, pearled	0.95
186	X21429_01	Brazil nuts, shelled	0.44
187	X21910_02	Cake maize	1
188	X21910_06	Cake palm kernel	1
189	X23610_01	Cocoa, paste	0.8
190	X1492	Copra	0.21
191	X21800	Cotton linter	1
192	X26160	Cotton carded combed	1
193	F1293	Crude materials	1
194	X39160	Dregs from brewing distillation	1
195	X39130_04	Feed and meal gluten	1
196	X1929_9	Fibre crops nes	1
197	X26190_01	Flax fibre and tow	1
198	X1929_01	Flax fibre raw	1
199	X26190_02	Flax tow waste	1
200	X23120_1	Flour, mixed grain	0.95
201	X23140_06	Germ, maize	0.95
202	X1659	Hops	1
203	X21439_03	Juice, lemon, concentrated	0.06
204	X21160_03	Offals, liver duck	1
205	X21631_02	Oil, safflower	1
206	X1930_02	Pyrethrum dried	1
207	X2944	Silk-worm cocoons reelable	1
208	X2951_06	Skins calve wet salted	0.8

No.	Code	Commodity name	TCF value
209	X2954_01	Skins goat wet salted	1
210	X2953_04	Skins sheep dry salted	0.3
211	X2953_03	Skins sheep wet salted	0.6
212	X23220_06	Starch cassava	0.23
213	X21931	Waxes vegetable	1
214	X21910_11	Cake sesame seed	0.43
215	X23319_11	Feed minerals	1
216	X23319_06	Feed supplements	1
217	X2959_99	Hides nes	1
218	X35410_01	Oil citronella	1
219	X21910_01	Cake rice bran	1
220	X23170_01	Flour, cassava	0.22
221	X21160_02	Offals, liver geese	1
222	X22130_03	Whey, condensed	0.35
223	X1929_07	Manila fibre (abaca)	1
224	X23999_04	Pyrethrum extraction	1
225	X21691_03	Butter of karite nuts	1
226	X22253	Cheese, sheep milk	0.2
227	X21439_02	Juice, lemon, single strength	0.06
228	X23140_02	Bulgur	0.95
229	X1919_91	Forage and silage grasses nes	1
230	X2952_05	Hides horse dry salted	0.3
231	X39120_07	Bran, millet	1
232	X39120_15	Feed pulp of fruit	1
233	X23120_01	Flour, rice	0.99
234	X1919_11	Hay (unspecified)	1
235	X21910_12	Cake mustard	0.53
236	X2951_09	Hides buffalo dry salted	0.3
237	X24310_04	Beer of sorghum	1
238	X24230_02	Beverages, fermented rice	1
239	X21910_14	Cake kapok	1
240	X1919_03	Forage and silage clover	1
241	X23319_09	Vitamins	1
242	X21691_01	Oil, rice bran	1
243	X2942_02	Hair goat coarse	1
244	X21910_1	Cake safflower	1
245	X22242_02	Ghee, buffalo milk	1
246	X1929_03	Kapok fibre	1
247	X22110_03	Milk, reconstituted	1
248	X2951_08	Hides buffalo wet salted	0.6
249	X23511_02	Sugar non-centrifugal	1
250	X21439_06	Juice, plum, single strength	0.06

No.	Code	Commodity name	TCF value
251	X23995_02	Soya paste	3.5
252	X39120_08	Bran, sorghum	1
253	X21910_17	Cake hempseed	1
254	X23120_08	Flour, fonio	0.99
255	X1919_05	Turnips for fodder	1
256	X1499_06	Kapokseed in shell	1
257	X21691_11	Oil, kapok	1
258	X1919_92	Forage and silage legumes	1
259	X39130_03	Potato offals	0.47
260	X39120_09	Bran, buckwheat	1
261	X464	Vegetables, dried nes	0.2
262	X39120_1	Bran, fonio	1
263	X39120_17	Cane tops	1
264	X2959_08	Hides camel nes	0.6
265	X21691_08	Oil, poppy	1
266	X21439_07	Juice, plum, concentrated	0.3
267	X2953	Skins sheep fresh	0.6
268	X1499_07	Kapokseed shelled	0.5
269	X2959_06	Hides camel wet salted	0.6
270	X68	Popcom	1
271	X21691_09	Vegetable tallow	1
272	X1919_1	Hay (clover lucerneetc)	1
273	X2761_proc	Freshwater Fish (processed)	1
274	X2762_proc	Demersal Fish (processed)	1
275	X2763_proc	Pelagic Fish (processed)	1
276	X2764_proc	Marine Fish, Other (processed)	1
277	X2765_proc	Crustaceans (processed)	1
278	X2766_proc	Cephalopods (processed)	1
279	X2767_proc	Molluscs, Other (processed)	1
280	X2769_proc	Aquatic Animals, Others (processed)	1
281	X2775_proc	Aquatic Plants (processed)	1
282	X2768_proc	Meat, Aquatic Mammals (processed)	1
283	X2781_proc	Fish, Body Oil	0.1
284	X2782_proc	Fish, Liver Oil	0.1

Source: based on FAO (2013), Bruckner (2019) and additional estimates for selected commodities.

Appendix G. Mapping between primary commodities, processed commodities and food balance sheet categories

Table G.1. Mapping between processed and primary commodities for the case of 1-to-1

No.	Processed commodity code	Processed commodity name	Primary commodity code	Primary commodity name
1	X21422	Almonds shelled	X1371	Almonds, with shell
2	X21419_01	Apricots, dry	X1343	Apricots
3	X21181	Bacon and ham	X21113_01	Meat, pig
4	F0020	Bread	X111	Wheat
5	X22230_03	Buttermilk, curdled, acidified milk	X2211	Milk, whole fresh cow
6	X21424	Cashew nuts, shelled	X1372	Cashew nuts, with shell
7	X1520_02	Cassava dried	X1520_01	Cassava
8	X23140_08	Cereal preparations nes	X1199_9	Cereals nes
9	X23140_03	Cereals, breakfast	X111	Wheat
10	X22251_04	Cheese, processed	X2211	Milk, whole fresh cow
11	X22251_01	Cheese, whole cow milk	X2211	Milk, whole fresh cow
12	F0666	Chocolate products nes	X1640	Cocoa, beans
13	F0665	Cocoa, powder & cake	X1640	Cocoa, beans
14	X21429_07	Coconuts, desiccated	X1460	Coconuts
15	X23911	Coffee, roasted	X1610	Coffee, green
16	X23912_01	Coffee, substitutes containing coffee	X1610	Coffee, green
17	X23993_03	Eggs, dried	X231	Eggs, hen, in shell
18	X23993_02	Eggs, liquid	X231	Eggs, hen, in shell
19	X21419_02	Figs dried	X1315	Figs
20	X23120_9	Flour, cereals	X1199_9	Cereals nes
21	X23120_03	Flour, maize	X112	Maize
22	X23995_03	Flour, mustard	X1442	Mustard seed
23	X21392	Flour, potatoes	X1510	Potatoes
24	X23170_03	Flour, pulses	X1709_9	Pulses nes
25	X23170_02	Flour, roots and tubers nes	X1599_1	Roots and tubers nes
26	X23110	Flour, wheat	X111	Wheat
27	F1232	Food prep nes	X1199_9	Cereals nes
28	X23999_02	Food preparations, flour, malt extract	X111	Wheat
29	X39170_01	Food wastes	X1290_9	Vegetables, fresh nes
30	X23991_03	Fruit, cooked, homogenized preparations	X1359_9	Fruit, fresh nes
31	X21419_99	Fruit, dried nes	X1359_9	Fruit, fresh nes
32	F0623	Fruit, prepared nes	X1359_9	Fruit, fresh nes
33	X21495_01	Groundnuts, prepared	X142	Groundnuts, with shell
34	X21421	Groundnuts, shelled	X142	Groundnuts, with shell
35	X21423	Hazelnuts, shelled	X1374	Hazelnuts, with shell

No.	Processed commodity code	Processed commodity name	Primary commodity code	Primary commodity name
36	X2951_04	Hides cattle wet salted	X21111_01	Meat, cattle
37	X22270	Ice cream and edible ice	X2211	Milk, whole fresh cow
38	X21435_02	Juice, apple, concentrated	X1341	Apples
39	X21435_01	Juice, apple, single strength	X1341	Apples
40	X21439_05	Juice, citrus, concentrated	X1329	Fruit, citrus nes
41	X21439_04	Juice, citrus, single strength	X1329	Fruit, citrus nes
42	X21439_9	Juice, fruit nes	X1359_9	Fruit, fresh nes
43	X21434	Juice, grape	X1330	Grapes
44	X21432	Juice, grapefruit	X1321	Grapefruit (inc. pomelos)
45	X21432_01	Juice, grapefruit, concentrated	X1321	Grapefruit (inc. pomelos)
46	X21431_02	Juice, orange, concentrated	X1323	Oranges
47	X21431_01	Juice, orange, single strength	X1323	Oranges
48	X21433	Juice, pineapple	X1318	Pineapples
49	X21433_01	Juice, pineapple, concentrated	X1318	Pineapples
50	X21321	Juice, tomato	X1234	Tomatoes
51	X23710	Macaroni	X111	Wheat
52	X23530	Maple sugar and syrups	X1809	Sugar crops nes
53	X21184_01	Meat, beef and veal sausages	X21111_01	Meat, cattle
54	F0875	Meat, beef, preparations	X21111_01	Meat, cattle
55	X21111_02	Meat, cattle, boneless (beef & veal)	X21111_01	Meat, cattle
56	F1061	Meat, chicken, canned	X21121	Meat, chicken
57	X21183	Meat, dried nes	X21119_9	Meat nes
58	X21184_02	Meat, pig sausages	X21113_01	Meat, pig
59	F1042	Meat, pig, preparations	X21113_01	Meat, pig
60	X21113_02	Meat, pork	X21113_01	Meat, pig
61	X22290	Milk, products of natural constituents nes	X2211	Milk, whole fresh cow
62	X22110_02	Milk, skimmed cow	X2211	Milk, whole fresh cow
63	X22212	Milk, skimmed dried	X2211	Milk, whole fresh cow
64	X22222_01	Milk, whole condensed	X2211	Milk, whole fresh cow
65	X22211	Milk, whole dried	X2211	Milk, whole fresh cow
66	X22221_01	Milk, whole evaporated	X2211	Milk, whole fresh cow
67	X23180	Mixes and doughs	X111	Wheat
68	X21397_01	Mushrooms, canned	X1270	Mushrooms and truffles
69	F0235	Nuts, prepared (exc. groundnuts)	X1379_9	Nuts nes
70	X23140_07	Oats rolled	X117	Oats
71	X21160_01	Offals, liver chicken	X21121	Meat, chicken
72	X21529_03	Oils, fats of animal nes	X21512	Fat, cattle
73	F0262	Olives preserved	X1450	Olives
74	F0022	Pastry	X111	Wheat

No.	Processed commodity code	Processed commodity name	Primary commodity code	Primary commodity name
75	X21495_02	Peanut butter	X142	Groundnuts, with shell
76	X21491	Pineapples canned	X1318	Pineapples
77	X21412	Plums dried (prunes)	X1346	Plums and sloes
78	X21313	Potatoes, frozen	X1510	Potatoes
79	X21411	Raisins	X1330	Grapes
80	X30	Rice - total (Rice milled equivalent)	X113	Rice, paddy
81	X23161_03	Rice, broken	X113	Rice, paddy
82	X23162	Rice, husked	X113	Rice, paddy
83	X23161_02	Rice, milled	X113	Rice, paddy
84	X23995_01	Soya sauce	X141	Soybeans
85	X23210_04	Sugars	X1809	Sugar crops
86	X21319_01	Sweet corn frozen	X112	Maize
87	X21399_03	Sweet corn prep or preserved	X112	Maize
88	X23914	Tea, mate extracts	X1620	Tea
89	X21399_01	Tomatoes, paste	X1234	Tomatoes
90	X21399_02	Tomatoes, peeled	X1234	Tomatoes
91	X23490_01	Wafers	X111	Wheat
92	X21429_02	Walnuts, shelled	X1376	Walnuts, with shell
93	X17400	Watersice etc	X2211	Milk, whole fresh cow
94	X22130_02	Whey, dry	X2211	Milk, whole fresh cow
95	X22230_01	Yoghurt	X2211	Milk, whole fresh cow
96	X22230_02	Yoghurt, concentrated or not	X2211	Milk, whole fresh cow
97	X23140_05	Barley, pearled	X115	Barley
98	X21429_01	Brazil nuts, shelled	X1377	Brazil nuts, with shell
99	X23610_01	Cocoa, paste	X1640	Cocoa, beans
100	X1492	Copra	X1460	Coconuts
101	X23120_1	Flour, mixed grain	X1199_02	Grain, mixed
102	X23140_06	Germ, maize	X112	Maize
103	X21439_03	Juice, lemon, concentrated	X1322	Lemons and limes
104	X21160_03	Offals, liver duck	X21122	Meat, duck
105	X23170_01	Flour, cassava	X1520_01	Cassava
106	X22130_03	Whey, condensed	X2211	Milk, whole fresh cow
107	X22253	Cheese, sheep milk	X2291	Milk, whole fresh sheep
108	X21439_02	Juice, lemon, single strength	X1322	Lemons and limes
109	X23140_02	Bulgur	X111	Wheat
110	X23120_01	Flour, rice	X113	Rice, paddy
111	X22110_03	Milk, reconstituted	X2211	Milk, whole fresh cow
112	X21439_06	Juice, plum, single strength	X1346	Plums and sloes
113	X23995_02	Soya paste	X141	Soybeans
114	X23120_08	Flour, fonio	X1193	Fonio

No.	Processed commodity code	Processed commodity name	Primary commodity code	Primary commodity name
115	X464	Vegetables, dried nes	X1290_9	Vegetables, fresh nes
116	X21439_07	Juice, plum, concentrated	X1346	Plums and sloes
117	X68	Popcom	X112	Maize
118	X2761_proc	Freshwater Fish (processed)	X2761_prim	Freshwater Fish (primary)
119	X2762_proc	Demersal Fish (processed)	X2762_prim	Demersal Fish (primary)
120	X2763_proc	Pelagic Fish (processed)	X2763_prim	Pelagic Fish (primary)
121	X2764_proc	Marine Fish, Other (processed)	X2764_prim	Marine Fish, Other (primary)
122	X2765_proc	Crustaceans (processed)	X2765_prim	Crustaceans (primary)
123	X2766_proc	Cephalopods (processed)	X2766_prim	Cephalopods (primary)
124	X2767_proc	Molluscs, Other (processed)	X2767_prim	Molluscs, Other (primary)
125	X2769_proc	Aquatic Animals, Others (processed)	X2769_prim	Aquatic Animals, Others (primary)
126	X2775_proc	Aquatic Plants (processed)	X2775_prim	Aquatic Plants (primary)
127	X2768_proc	Meat, Aquatic Mammals (processed)	X2768_prim	Meat, Aquatic Mammals (primary)

Source: developed by author based on FAO (2020a) and FAO (2020b).

Table G.2. Mapping between processed and primary commodities for the case of 1-to-many

No.	Processed commodity code	Processed commodity name	Primary commodity code
1	X2413	Beverages, distilled alcoholic	X111, X112, X115, X116
2	X24490	Beverages, non-alcoholic	X1801, X1802,
3	X21189_02	Fat, liver prepared (foie gras)	X21519_02, X21512, X21515, X21514, X21511_01, X21513
4	X23670_01	Sugar confectionery	X1801, X1802
5	X2351f	Sugar Raw Centrifugal	X1801, X1802
6	X23520	Sugar refined	X1801, X1802
7	X21523	Tallow	X21519_02, X21512, X21515, X21514, X21511_01, X21513
8	X21340	Vegetables in vinegar	X112, X1234, X1232, X1290_9, X1216, X1215, X1510, X1219_01, X1235, X1233, X1252, X1254, X1214, X1231, X1213, X1251, X1212
9	X21393_9	Vegetables, dehydrated	X112, X1234, X1232, X1290_9, X1216, X1215, X1510, X1219_01, X1235, X1233, X1252, X1254, X1214, X1231, X1213, X1251, X1212
10	X1990_01	Vegetables, fresh or dried products nes	X112, X1234, X1232, X1290_9, X1216, X1215, X1510, X1219_01, X1235, X1233, X1252, X1254, X1214, X1231, X1213, X1251, X1212
11	F0473	Vegetables, frozen	X112, X1234, X1232, X1290_9, X1216, X1215, X1510, X1219_01, X1235, X1233, X1252, X1254, X1214, X1231, X1213, X1251, X1212
12	X23991_02	Vegetables, homogenized preparations	X112, X1234, X1232, X1290_9, X1216, X1215, X1510, X1219_01, X1235, X1233, X1252, X1254, X1214, X1231, X1213, X1251, X1212
13	F0472	Vegetables, preserved nes	X112, X1234, X1232, X1290_9, X1216, X1215, X1510, X1219_01, X1235, X1233, X1252, X1254, X1214, X1231, X1213, X1251, X1212
14	F0475	Vegetables, preserved, frozen	X112, X1234, X1232, X1290_9, X1216, X1215, X1510, X1219_01, X1235, X1233, X1252, X1254, X1214, X1231, X1213, X1251, X1212
15	X21330_9	Vegetables, temporarily preserved	X112, X1234, X1232, X1290_9, X1216, X1215, X1510, X1219_01, X1235, X1233, X1252, X1254, X1214, X1231, X1213, X1251, X1212
16	X21691_09	Vegetable tallow	X112, X1234, X1232, X1290_9, X1216, X1215, X1510, X1219_01, X1235, X1233, X1252, X1254, X1214, X1231, X1213, X1251, X1212
17	X2781_proc	Fish, Body Oil	X2762_prim, X2763_prim, X2764_prim
18	X2782_proc	Fish, Liver Oil	X2762_prim, X2763_prim, X2764_prim

Source: developed by author based on FAO (2020a) and FAO (2020b).

Table G.3. Processed commodities directly mapped to the FBS categories

No.	Processed commodity code	Processed commodity name	FBS category code	FBS category name
1	X23511_02	Sugar non-centrifugal	X2541	Sugar non-centrifugal
2	X23670_01	Sugar confectionery	X2542	Sugar (Raw Equivalent)
3	X2351f	Sugar Raw Centrifugal	X2542	Sugar (Raw Equivalent)
4	X23520	Sugar refined	X2542	Sugar (Raw Equivalent)
5	X2161	Oil, soybean	X2571	Soyabean Oil
6	X2162	Oil, groundnut	X2572	Groundnut Oil
7	X21631_01	Oil, sunflower	X2573	Sunflowerseed Oil
8	X21641_01	Oil, rapeseed	X2574	Rape and Mustard Oil
9	X2168	Oil, cottonseed	X2575	Cottonseed Oil
10	X21691_14	Oil, palm kernel	X2576	Palmkernel Oil
11	X2166	Oil, coconut (copra)	X2578	Coconut Oil
12	X21691_07	Oil, sesame	X2579	Sesameseed Oil
13	X21673	Oil, olive residues	X2580	Olive Oil
14	X2167	Oil, olive, virgin	X2580	Olive Oil
15	X21691_01	Oil, rice bran	X2581	Ricebran Oil
16	X21691_02	Oil, maize	X2582	Maize Germ Oil
17	X23620	Cocoa, butter	X2586	Oilcrops Oil, Other
18	X21700_01	Margarine, liquid	X2586	Oilcrops Oil, Other
19	X21700_02	Margarine, short	X2586	Oilcrops Oil, Other
20	X34550	Oil, boiled etc	X2586	Oilcrops Oil, Other
21	X21691_04	Oil, castorbeans	X2586	Oilcrops Oil, Other
22	X21691_12	Oil, linseed	X2586	Oilcrops Oil, Other
23	X21691_9	Oil, vegetable origin nes	X2586	Oilcrops Oil, Other
24	X21631_02	Oil, safflower	X2586	Oilcrops Oil, Other
25	X21691_03	Butter of karite nuts	X2586	Oilcrops Oil, Other
26	X21691_11	Oil, kapok	X2586	Oilcrops Oil, Other
27	X21691_08	Oil, poppy	X2586	Oilcrops Oil, Other
28	X21691_09	Vegetable tallow	X2586	Oilcrops Oil, Other
29	X24220	Vermouths & similar	X2655	Wine
30	X24212_02	Wine	X2655	Wine
31	X24310_01	Beer of barley	X2656	Beer
32	X24230_03	Cider etc	X2657	Beverages, Fermented
33	X24310_04	Beer of sorghum	X2657	Beverages, Fermented
34	X24230_02	Beverages, fermented rice	X2657	Beverages, Fermented
35	X2413	Beverages, distilled alcoholic	X2658	Beverages, Alcoholic
36	X23991_01	Infant food	X2680	Infant food
37	X22241_01	Butter, cow milk	X2740	Butter, Ghee
38	X22242_02	Ghee, buffalo milk	X2740	Butter, Ghee

39	X22120	Cream fresh	X2743	Cream
40	X2781_proc	Fish, Body Oil	X2781	Fish, Body Oil
41	X2782_proc	Fish, Liver Oil	X2782	Fish, Liver Oil

Source: developed by author based on FAO (2020a) and FAO (2020b).

Appendix H. Mapping between primary commodities and food balance sheet categories

No.	Primary commodity code	Primary commodity name	FBS category code	FBS category name
1	X1371	Almonds, with shell	X2551	Nuts and products
2	X1654	Anise, badian, fennel, coriander	X2645	Spices, Other
3	X1341	Apples	X2617	Apples and products
4	X1343	Apricots	X2625	Fruits, Other
5	X115	Barley	X2513	Barley and products
6	X1355_9	Berries nes	X2625	Fruits, Other
7	X143	Cottonseed	X2559	Cottonseed
8	X1315	Figs	X2625	Fruits, Other
9	X1329	Fruit, citrus nes	X2614	Citrus, Other
10	X1359_9	Fruit, fresh nes	X2625	Fruits, Other
11	X1349_2	Fruit, stone nes	X2625	Fruits, Other
12	X1330	Grapes	X2620	Grapes and products (excl wine)
13	X1441	Linseed	X2570	Oilcrops, Other
14	X112	Maize	X2514	Maize and products
15	X1229	Melons, other (inc.cantaloupes)	X2625	Fruits, Other
16	X118	Millet	X2517	Millet and products
17	X1379_9	Nuts nes	X2551	Nuts and products
18	X1450	Olives	X2563	Olives (including preserved)
19	X1253_02	Onions, dry	X2602	Onions
20	X1323	Oranges	X2611	Oranges, Mandarines
21	X1345	Peaches and nectarines	X2625	Fruits, Other
22	X1342_01	Pears	X2625	Fruits, Other
23	X1375	Pistachios	X2551	Nuts and products
24	X1346	Plums and sloes	X2625	Fruits, Other
25	X1510	Potatoes	X2531	Potatoes and products
26	X1709_9	Pulses nes	X2549	Pulses, Other and products
27	X113	Rice, paddy	X2805	Rice (Milled Equivalent)
28	X1444	Sesame seed	X2561	Sesame seed
29	X1699	Spices nes	X2645	Spices, Other
30	X1801	Sugar beet	X2537	Sugar beet
31	X1802	Sugar cane	X2536	Sugar cane
32	X1445	Sunflower seed	X2557	Sunflower seed
33	X1290_9	Vegetables, fresh nes	X2605	Vegetables, Other
34	X1376	Walnuts, with shell	X2551	Nuts and products
35	X1221	Watermelons	X2625	Fruits, Other
36	X111	Wheat	X2511	Wheat and products
37	X1701	Beans, dry	X2546	Beans
38	X1241_9	Beans, green	X2605	Vegetables, Other

No.	Primary commodity code	Primary commodity name	FBS category code	FBS category name
39	X1702	Broad beans, horse beans, dry	X2549	Pulses, Other and products
40	X1212	Cabbages and other brassicas	X2605	Vegetables, Other
41	X1251	Carrots and turnips	X2605	Vegetables, Other
42	X1213	Cauliflowers and broccoli	X2605	Vegetables, Other
43	X1344_02	Cherries	X2625	Fruits, Other
44	X1344_01	Cherries, sour	X2625	Fruits, Other
45	X1373	Chestnut	X2551	Nuts and products
46	X1231	Chillies and peppers, green	X2605	Vegetables, Other
47	X1232	Cucumbers and gherkins	X2605	Vegetables, Other
48	X1314	Dates	X2619	Dates
49	X1233	Eggplants (aubergines)	X2605	Vegetables, Other
50	X1252	Garlic	X2605	Vegetables, Other
51	X1254	Leeks, other alliaceous vegetables	X2605	Vegetables, Other
52	X1322	Lemons and limes	X2612	Lemons, Limes and products
53	X1214	Lettuce and chicory	X2605	Vegetables, Other
54	X1270	Mushrooms and truffles	X2605	Vegetables, Other
55	X117	Oats	X2516	Oats
56	X2165	Oil, palm	X2577	Palm Oil
57	X1239_01	Okra	X2605	Vegetables, Other
58	X1253_01	Onions, shallots, green	X2605	Vegetables, Other
59	X1242	Peas, green	X2605	Vegetables, Other
60	X1235	Pumpkins, squash and gourds	X2605	Vegetables, Other
61	X1342_02	Quinces	X2625	Fruits, Other
62	X116	Rye	X2515	Rye and products
63	X114	Sorghum	X2518	Sorghum and products
64	X141	Soybeans	X2555	Soyabeans
65	X1215	Spinach	X2605	Vegetables, Other
66	X1324	Tangerines, mandarins, clementines, satsumas	X2611	Oranges, Mandarines
67	X1234	Tomatoes	X2601	Tomatoes and products
68	X1243	Vegetables, leguminous nes	X2605	Vegetables, Other
69	X1709_01	Vetches	X2549	Pulses, Other and products
70	X1216	Artichokes	X2605	Vegetables, Other
71	X1312	Bananas	X2615	Bananas
72	X1356	Carobs	X2605	Vegetables, Other
73	X1703	Chick peas	X2549	Pulses, Other and products
74	X1652	Chillies and peppers, dry	X2641	Pimento
75	X1319	Fruit, tropical fresh nes	X2625	Fruits, Other
76	X1321	Grapefruit (inc. pomelos)	X2613	Grapefruit and products
77	X142	Groundnuts, with shell	X2556	Groundnuts (Shelled Eq)

No.	Primary commodity code	Primary commodity name	FBS category code	FBS category name
78	X1704	Lentils	X2549	Pulses, Other and products
79	X1705	Peas, dry	X2547	Peas
80	X1443	Rapeseed	X2558	Rape and Mustardseed
81	X1354	Strawberries	X2625	Fruits, Other
82	X1191	Triticale	X2520	Cereals, Other
83	X1520_01	Cassava	X2532	Cassava and products
84	X1640	Cocoa, beans	X2633	Cocoa Beans and products
85	X1460	Coconuts	X2560	Coconuts - Incl Copra
86	X1290_01	Maize, green	X2605	Vegetables, Other
87	X1318	Pineapples	X2618	Pineapples and products
88	X1550	Taro (cocoyam)	X2534	Roots, Other
89	X1540	Yams	X2535	Yams
90	X1372	Cashew nuts, with shell	X2551	Nuts and products
91	X1610	Coffee, green	X2630	Coffee and products
92	X1491_01	Oil palm fruit	X2562	Palm kernels
93	X1491_02	Palm kernels	X2562	Palm kernels
94	X1530	Sweet potatoes	X2533	Sweet potatoes
95	X1316	Mangoes, mangosteens, guavas	X2625	Fruits, Other
96	X1211	Asparagus	X2605	Vegetables, Other
97	X1311	Avocados	X2625	Fruits, Other
98	X1195	Canary seed	X2520	Cereals, Other
99	X1199_9	Cereals nes	X2520	Cereals, Other
100	X1709_02	Lupins	X2549	Pulses, Other and products
101	X1630	Mate	X2635	Tea (including mate)
102	X1449_9	Oilseeds nes	X2570	Oilcrops, Other
103	X1317	Papayas	X2625	Fruits, Other
104	X1930_01	Peppermint	X2645	Spices, Other
105	X1446	Safflower seed	X2570	Oilcrops, Other
106	X1241_01	String beans	X2605	Vegetables, Other
107	X1620	Tea	X2635	Tea (including mate)
108	X1374	Hazelnuts, with shell	X2551	Nuts and products
109	X1355_01	Blueberries	X2625	Fruits, Other
110	X1706	Cow peas, dry	X2549	Pulses, Other and products
111	X1351_01	Currants	X2625	Fruits, Other
112	X1352	Kiwi fruit	X2625	Fruits, Other
113	X1442	Mustard seed	X2558	Rape and Mustardseed
114	X1359_01	Persimmons	X2625	Fruits, Other
115	X1353_01	Raspberries	X2625	Fruits, Other
116	X1192	Buckwheat	X2520	Cereals, Other
117	X1351_02	Gooseberries	X2625	Fruits, Other

No.	Primary commodity code	Primary commodity name	FBS category code	FBS category name
118	X1199_02	Grain, mixed	X2520	Cereals, Other
119	X1448	Poppy seed	X2570	Oilcrops, Other
120	X1355_02	Cranberries	X2625	Fruits, Other
121	X1707	Pigeon peas	X2549	Pulses, Other and products
122	X1313	Plantains and others	X2616	Plantains
123	X1379_01	Areca nuts	X2551	Nuts and products
124	X1657	Ginger	X2645	Spices, Other
125	X1809	Sugar crops nes	X2543	Sweeteners, Other
126	X1349_1	Fruit, pome nes	X2625	Fruits, Other
127	X1691	Chicory roots	X2605	Vegetables, Other
128	X1658	Vanilla	X2645	Spices, Other
129	X1599_1	Roots and tubers nes	X2534	Roots, Other
130	X1591	Yautia (cocoyam)	X2534	Roots, Other
131	X1193	Fonio	X2520	Cereals, Other
132	X1499_01	Karite nuts (sheanuts)	X2570	Oilcrops, Other
133	X1379_02	Kola nuts	X2551	Nuts and products
134	X1449_01	Melonseed	X2570	Oilcrops, Other
135	X1651	Pepper (piper spp.)	X2640	Pepper
136	X1653	Nutmeg, mace and cardamoms	X2645	Spices, Other
137	X1377	Brazil nuts, with shell	X2551	Nuts and products
138	X1194	Quinoa	X2520	Cereals, Other
139	X1359_02	Cashewapple	X2625	Fruits, Other
140	X1219_01	Cassava leaves	X2605	Vegetables, Other
141	X1708	Bambara beans	X2549	Pulses, Other and products
142	X1655	Cinnamon (cannella)	X2645	Spices, Other
143	X1656	Cloves	X2642	Cloves
144	X231	Eggs, hen, in shell	X2744	Eggs
145	X21519_02	Fat, camels	X2737	Fats, Animals, Raw
146	X21512	Fat, cattle	X2737	Fats, Animals, Raw
147	X21515	Fat, goats	X2737	Fats, Animals, Raw
148	X21514	Fat, sheep	X2737	Fats, Animals, Raw
149	X2910	Honey, natural	X2745	Honey
150	X21117_01I	Meat indigenous, camel	X2735	Meat, Other
151	X21111_01I	Meat indigenous, cattle	X2731	Bovine Meat
152	X21121I	Meat indigenous, chicken	X2734	Poultry Meat
153	X21116I	Meat indigenous, goat	X2732	Mutton & Goat Meat
154	X21115I	Meat indigenous, sheep	X2732	Mutton & Goat Meat
155	X21117_01	Meat, camel	X2735	Meat, Other
156	X21111_01	Meat, cattle	X2731	Bovine Meat
157	X21121	Meat, chicken	X2734	Poultry Meat

No.	Primary commodity code	Primary commodity name	FBS category code	FBS category name
158	X21170_02	Meat, game	X2735	Meat, Other
159	X21116	Meat, goat	X2732	Mutton & Goat Meat
160	X21115	Meat, sheep	X2732	Mutton & Goat Meat
161	X2293	Milk, whole fresh camel	X2848	Milk - Excluding Butter
162	X2211	Milk, whole fresh cow	X2848	Milk - Excluding Butter
163	X2292	Milk, whole fresh goat	X2848	Milk - Excluding Butter
164	X2291	Milk, whole fresh sheep	X2848	Milk - Excluding Butter
165	X21159_02	Offals, edible, camels	X2736	Offals, Edible
166	X21151	Offals, edible, cattle	X2736	Offals, Edible
167	X21156	Offals, edible, goats	X2736	Offals, Edible
168	X21155	Offals, sheep,edible	X2736	Offals, Edible
169	X232	Eggs, other bird, in shell	X2744	Eggs
170	X21511_01	Fat, pigs	X2737	Fats, Animals, Raw
171	X21113_01I	Meat indigenous, pig	X2733	Pigmeat
172	X21119_9	Meat nes	X2735	Meat, Other
173	X21113_01	Meat, pig	X2733	Pigmeat
174	X2212	Milk, whole fresh buffalo	X2848	Milk - Excluding Butter
175	X21153	Offals, pigs, edible	X2736	Offals, Edible
176	X21118_01I	Meat indigenous, horse	X2735	Meat, Other
177	X21114I	Meat indigenous, rabbit	X2735	Meat, Other
178	X21124I	Meat indigenous, turkey	X2734	Poultry Meat
179	X21118_01	Meat, horse	X2735	Meat, Other
180	X21114	Meat, rabbit	X2735	Meat, Other
181	X21124	Meat, turkey	X2734	Poultry Meat
182	X21159_01	Offals, horses	X2736	Offals, Edible
183	X21122I	Meat indigenous, duck	X2734	Poultry Meat
184	X21123I	Meat indigenous, geese	X2734	Poultry Meat
185	X21122	Meat, duck	X2734	Poultry Meat
186	X21123	Meat, goose and guinea fowl	X2734	Poultry Meat
187	X21513	Fat, buffaloes	X2737	Fats, Animals, Raw
188	X21112I	Meat indigenous, buffalo	X2731	Bovine Meat
189	X21112	Meat, buffalo	X2731	Bovine Meat
190	X21152	Offals, edible, buffaloes	X2736	Offals, Edible
191	X21117_02I	Meat indigenous, other camelids	X2735	Meat, Other
192	X21119_01I	Meat indigenous, rodents	X2735	Meat, Other
193	X21117_02	Meat, other camelids	X2735	Meat, Other
194	X21119_01	Meat, other rodents	X2735	Meat, Other
195	X21118_02I	Meat indigenous, ass	X2735	Meat, Other
196	X21118_02	Meat, ass	X2735	Meat, Other

No.	Primary commodity code	Primary commodity name	FBS category code	FBS category name
197	X21170_01	Meat, bird nes	X2735	Meat, Other
198	X21118_03I	Meat indigenous, mule	X2735	Meat, Other
199	X21118_03	Meat, mule	X2735	Meat, Other
200	X2920	Snails, not sea	X2735	Meat, Other
201	X21170_01I	Meat indigenous, bird nes	X2735	Meat, Other
202	X2761_prim	Freshwater Fish (primary)	X2761	Freshwater Fish
203	X2762_prim	Demersal Fish (primary)	X2762	Demersal Fish
204	X2763_prim	Pelagic Fish (primary)	X2763	Pelagic Fish
205	X2764_prim	Marine Fish, Other (primary)	X2764	Marine Fish, Other
206	X2765_prim	Crustaceans (primary)	X2765	Crustaceans
207	X2766_prim	Cephalopods (primary)	X2766	Cephalopods
208	X2767_prim	Molluscs, Other (primary)	X2767	Molluscs, Other
209	X2769_prim	Aquatic Animals, Others (primary)	X2769	Aquatic Animals, Others
210	X2775_prim	Aquatic Plants (primary)	X2775	Aquatic Plants
211	X2768_prim	Meat, Aquatic Mammals (primary)	X2768	Meat, Aquatic Mammals

Source: developed by author based on FAO (2020a) and FAO (2020b).

**Appendix I. Mapping between primary commodities with developed nutritional accounts
and GTAP sectors**

No.	Primary commodity code	Primary commodity name	GTAP primary sector
1	X1371	Almonds, with shell	v_f
2	X1654	Anise, badian, fennel, coriander	ocr
3	X1341	Apples	v_f
4	X1343	Apricots	v_f
5	X115	Barley	gro
6	X1355_9	Berries nes	v_f
7	X143	Cottonseed	osd
8	X1315	Figs	v_f
9	X1329	Fruit, citrus nes	v_f
10	X1359_9	Fruit, fresh nes	v_f
11	X1349_2	Fruit, stone nes	v_f
12	X1330	Grapes	v_f
13	X1441	Linseed	osd
14	X112	Maize	gro
15	X1229	Melons, other(inc.cantaloupes)	v_f
16	X118	Millet	gro
17	X1379_9	Nuts nes	v_f
18	X1450	Olives	osd
19	X1253_02	Onions, dry	v_f
20	X1323	Oranges	v_f
21	X1345	Peaches and nectarines	v_f
22	X1342_01	Pears	v_f
23	X1375	Pistachios	v_f
24	X1346	Plums and sloes	v_f
25	X1510	Potatoes	v_f
26	X1709_9	Pulses nes	v_f
27	X113	Rice, paddy	pdr
28	X1444	Sesame seed	osd
29	X1699	Spices nes	ocr
30	X1801	Sugar beet	c_b
31	X1802	Sugar cane	c_b
32	X1445	Sunflower seed	osd
33	X1290_9	Vegetables, fresh nes	v_f
34	X1376	Walnuts, with shell	v_f
35	X1221	Watermelons	v_f
36	X111	Wheat	wht
37	X1701	Beans, dry	v_f
38	X1241_9	Beans, green	v_f

No.	Primary commodity code	Primary commodity name	GTAP primary sector
39	X1702	Broad beans, horse beans, dry	v_f
40	X1212	Cabbages and other brassicas	v_f
41	X1251	Carrots and turnips	v_f
42	X1213	Cauliflowers and broccoli	v_f
43	X1344_02	Cherries	v_f
44	X1344_01	Cherries, sour	v_f
45	X1373	Chestnut	v_f
46	X1231	Chillies and peppers, green	v_f
47	X1232	Cucumbers and gherkins	v_f
48	X1314	Dates	v_f
49	X1233	Eggplants (aubergines)	v_f
50	X1252	Garlic	v_f
51	X1254	Leeks, other alliaceous vegetables	v_f
52	X1322	Lemons and limes	v_f
53	X1214	Lettuce and chicory	v_f
54	X1270	Mushrooms and truffles	v_f
55	X117	Oats	gro
56	X2165	Oil, palm	osd
57	X1239_01	Okra	v_f
58	X1253_01	Onions, shallots, green	v_f
59	X1242	Peas, green	v_f
60	X1235	Pumpkins, squash and gourds	v_f
61	X1342_02	Quinces	v_f
62	X116	Rye	gro
63	X114	Sorghum	gro
64	X141	Soybeans	osd
65	X1215	Spinach	v_f
66	X1324	Tangerines, mandarins, clementines, satsumas	v_f
67	X1234	Tomatoes	v_f
68	X1243	Vegetables, leguminous nes	v_f
69	X1709_01	Vetches	v_f
70	X1216	Artichokes	v_f
71	X1312	Bananas	v_f
72	X1356	Carobs	v_f
73	X1703	Chick peas	v_f
74	X1652	Chillies and peppers, dry	ocr
75	X1319	Fruit, tropical fresh nes	v_f
76	X1321	Grapefruit (inc. pomelos)	v_f
77	X142	Groundnuts, with shell	osd
78	X1704	Lentils	v_f

No.	Primary commodity code	Primary commodity name	GTAP primary sector
79	X1705	Peas, dry	v_f
80	X1443	Rapeseed	osd
81	X1354	Strawberries	v_f
82	X1191	Triticale	gro
83	X1520_01	Cassava	v_f
84	X1640	Cocoa, beans	ocr
85	X1460	Coconuts	osd
86	X1290_01	Maize, green	v_f
87	X1318	Pineapples	v_f
88	X1550	Taro (cocoyam)	v_f
89	X1540	Yams	v_f
90	X1372	Cashew nuts, with shell	v_f
91	X1610	Coffee, green	ocr
92	X1491_01	Oil palm fruit	osd
93	X1491_02	Palm kernels	osd
94	X1530	Sweet potatoes	v_f
95	X1316	Mangoes, mangosteens, guavas	v_f
96	X1211	Asparagus	v_f
97	X1311	Avocados	v_f
98	X1195	Canary seed	gro
99	X1199_9	Cereals nes	gro
100	X1709_02	Lupins	v_f
101	X1630	Mate	ocr
102	X1449_9	Oilseeds nes	osd
103	X1317	Papayas	v_f
104	X1930_01	Peppermint	ocr
105	X1446	Safflower seed	osd
106	X1241_01	String beans	v_f
107	X1620	Tea	ocr
108	X1374	Hazelnuts, with shell	v_f
109	X1355_01	Blueberries	v_f
110	X1706	Cow peas, dry	v_f
111	X1351_01	Currants	v_f
112	X1352	Kiwi fruit	v_f
113	X1442	Mustard seed	osd
114	X1359_01	Persimmons	v_f
115	X1353_01	Raspberries	v_f
116	X1192	Buckwheat	gro
117	X1351_02	Gooseberries	v_f
118	X1199_02	Grain, mixed	gro

No.	Primary commodity code	Primary commodity name	GTAP primary sector
119	X1448	Poppy seed	osd
120	X1355_02	Cranberries	v_f
121	X1707	Pigeon peas	v_f
122	X1313	Plantains and others	v_f
123	X1379_01	Areca nuts	v_f
124	X1657	Ginger	ocr
125	X1809	Sugar crops nes	c_b
126	X1349_1	Fruit, pome nes	v_f
127	X1691	Chicory roots	ocr
128	X1658	Vanilla	ocr
129	X1599_1	Roots and tubers nes	v_f
130	X1591	Yautia (cocoyam)	v_f
131	X1193	Fonio	gro
132	X1499_01	Karite nuts (sheanuts)	osd
133	X1379_02	Kola nuts	v_f
134	X1449_01	Melonseed	osd
135	X1651	Pepper (piper spp.)	ocr
136	X1653	Nutmeg, mace and cardamoms	ocr
137	X1377	Brazil nuts, with shell	v_f
138	X1194	Quinoa	gro
139	X1359_02	Cashewapple	v_f
140	X1219_01	Cassava leaves	v_f
141	X1708	Bambara beans	v_f
142	X1655	Cinnamon (cannella)	ocr
143	X1656	Cloves	ocr
144	X231	Eggs, hen, in shell	oap
145	X21519_02	Fat, camels	ctl
146	X21512	Fat, cattle	ctl
147	X21515	Fat, goats	ctl
148	X21514	Fat, sheep	ctl
149	X2910	Honey, natural	oap
150	X21117_01I	Meat indigenous, camel	ctl
151	X21111_01I	Meat indigenous, cattle	ctl
152	X21121I	Meat indigenous, chicken	oap
153	X21116I	Meat indigenous, goat	ctl
154	X21115I	Meat indigenous, sheep	ctl
155	X21117_01	Meat, camel	ctl
156	X21111_01	Meat, cattle	ctl
157	X21121	Meat, chicken	oap
158	X21170_02	Meat, game	oap

No.	Primary commodity code	Primary commodity name	GTAP primary sector
159	X21116	Meat, goat	ctl
160	X21115	Meat, sheep	ctl
161	X2293	Milk, whole fresh camel	rmk
162	X2211	Milk, whole fresh cow	rmk
163	X2292	Milk, whole fresh goat	rmk
164	X2291	Milk, whole fresh sheep	rmk
165	X21159_02	Offals, edible, camels	ctl
166	X21151	Offals, edible, cattle	ctl
167	X21156	Offals, edible, goats	ctl
168	X21155	Offals, sheep,edible	ctl
169	X232	Eggs, other bird, in shell	oap
170	X21511_01	Fat, pigs	oap
171	X21113_01I	Meat indigenous, pig	oap
172	X21119_9	Meat nes	ctl
173	X21113_01	Meat, pig	oap
174	X2212	Milk, whole fresh buffalo	rmk
175	X21153	Offals, pigs, edible	oap
176	X21118_01I	Meat indigenous, horse	ctl
177	X21114I	Meat indigenous, rabbit	oap
178	X21124I	Meat indigenous, turkey	oap
179	X21118_01	Meat, horse	ctl
180	X21114	Meat, rabbit	oap
181	X21124	Meat, turkey	oap
182	X21159_01	Offals, horses	ctl
183	X21122I	Meat indigenous, duck	oap
184	X21123I	Meat indigenous, geese	oap
185	X21122	Meat, duck	oap
186	X21123	Meat, goose and guinea fowl	oap
187	X21513	Fat, buffaloes	ctl
188	X21112I	Meat indigenous, buffalo	ctl
189	X21112	Meat, buffalo	ctl
190	X21152	Offals, edible, buffaloes	ctl
191	X21117_02I	Meat indigenous, other camelids	ctl
192	X21119_01I	Meat indigenous, rodents	ctl
193	X21117_02	Meat, other camelids	ctl
194	X21119_01	Meat, other rodents	ctl
195	X21118_02I	Meat indigenous, ass	ctl
196	X21118_02	Meat, ass	ctl
197	X21170_01	Meat, bird nes	oap
198	X21118_03I	Meat indigenous, mule	ctl

No.	Primary commodity code	Primary commodity name	GTAP primary sector
199	X21118_03	Meat, mule	ctl
200	X2920	Snails, not sea	oap
201	X21170_01I	Meat indigenous, bird nes	oap
202	X2761_prim	Freshwater Fish (primary)	fsh
203	X2762_prim	Demersal Fish (primary)	fsh
204	X2763_prim	Pelagic Fish (primary)	fsh
205	X2764_prim	Marine Fish, Other (primary)	fsh
206	X2765_prim	Crustaceans (primary)	fsh
207	X2766_prim	Cephalopods (primary)	fsh
208	X2767_prim	Molluscs, Other (primary)	fsh
209	X2769_prim	Aquatic Animals, Others (primary)	fsh
210	X2775_prim	Aquatic Plants (primary)	fsh
211	X2768_prim	Meat, Aquatic Mammals (primary)	fsh

Source: developed by author based on FAO (2020a), FAO (2020b) and Aguiar et al. (2019).

Notes: full list of the GTAP 10 Data Base sectoral codes with description is provided in Appendix B and <https://www.gtap.agecon.purdue.edu/databases/contribute/detailedsector.asp>

**Appendix J. Mapping between processed commodities with developed nutritional accounts
and GTAP sectors**

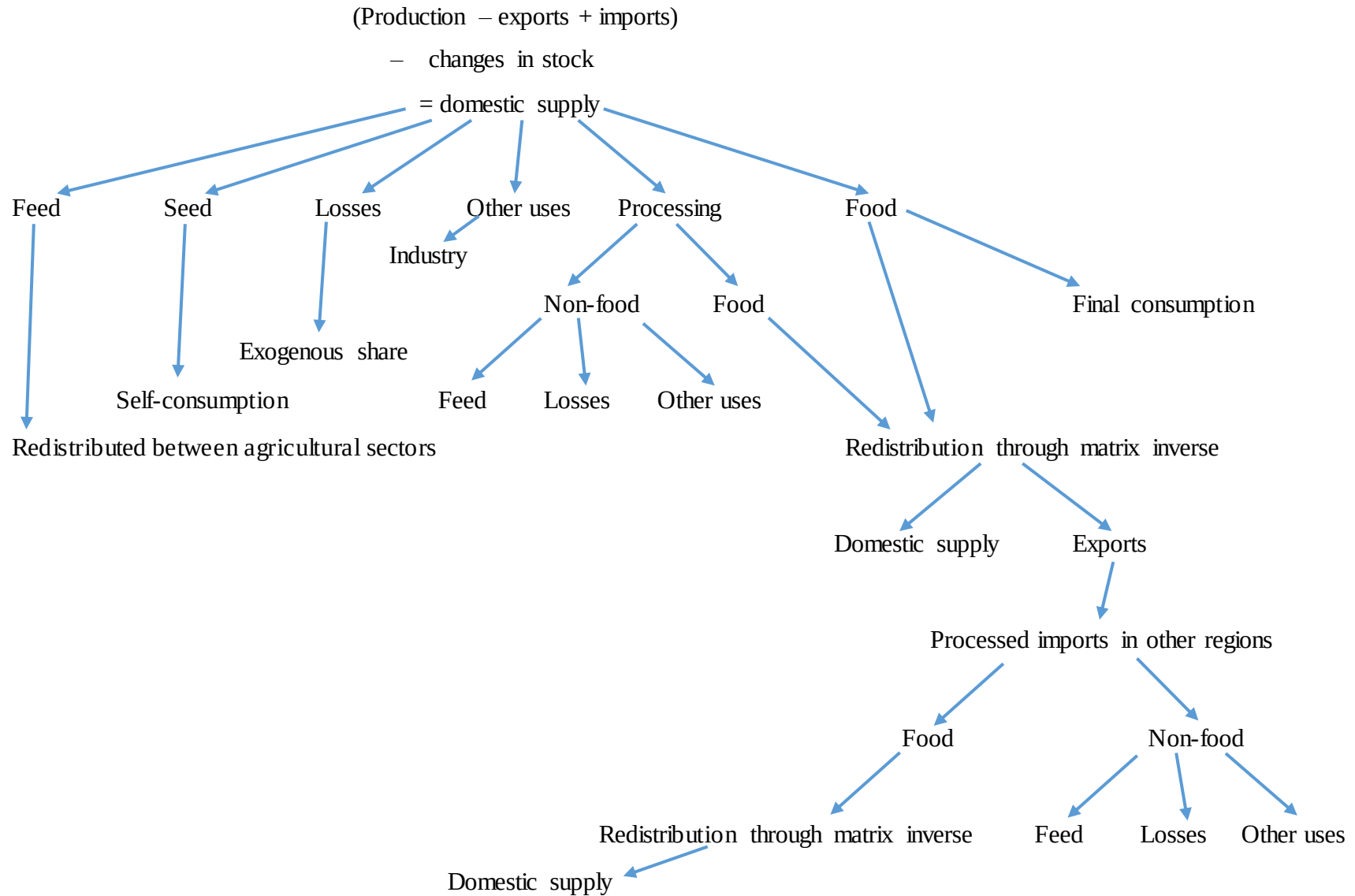
No.	Processed commodity code	Processed commodity name	GTAP primary sector	GTAP processed sector
1	X23511_02	Sugar non-centrifugal	c_b	sgr
2	X23670_01	Sugar confectionery	c_b	ofd
3	X2351f	Sugar Raw Centrifugal	c_b	sgr
4	X23520	Sugar refined	c_b	sgr
5	X2161	Oil, soybean	osd	vol
6	X2162	Oil, groundnut	osd	vol
7	X21631_01	Oil, sunflower	osd	vol
8	X21641_01	Oil, rapeseed	osd	vol
9	X2168	Oil, cottonseed	osd	vol
10	X21691_14	Oil, palm kernel	osd	vol
11	X2166	Oil, coconut (copra)	osd	vol
12	X21691_07	Oil, sesame	osd	vol
13	X21673	Oil, olive residues	osd	vol
14	X2167	Oil, olive, virgin	osd	vol
15	X21691_01	Oil, rice bran	pdr	vol
16	X21691_02	Oil, maize	gro	vol
17	X23620	Cocoa, butter	ocr	ofd
18	X21700_01	Margarine, liquid	osd	vol
19	X21700_02	Margarine, short	osd	vol
20	X34550	Oil, boiled etc	osd	chm
21	X21691_04	Oil, castorbeans	osd	vol
22	X21691_12	Oil, linseed	osd	vol
23	X21691_9	Oil, vegetable origin nes	osd	vol
24	X21631_02	Oil, safflower	osd	vol
25	X21691_03	Butter of karite nuts	osd	vol
26	X21691_11	Oil, kapok	osd	vol
27	X21691_08	Oil, poppy	osd	vol
28	X21691_09	Vegetable tallow	v_f	vol
29	X24220	Vermouths & similar	v_f	b_t
30	X24212_02	Wine	v_f	b_t
31	X24310_01	Beer of barley	gro	b_t
32	X24230_03	Cider etc	v_f	b_t
33	X24310_04	Beer of sorghum	gro	b_t
34	X24230_02	Beverages, fermented rice	pdr	b_t
35	X2413	Beverages, distilled alcoholic	gro	b_t
36	X23991_01	Infant food	rmk	ofd
37	X22241_01	Butter, cow milk	rmk	mil

No.	Processed commodity code	Processed commodity name	GTAP primary sector	GTAP processed sector
38	X22242_02	Ghee, buffalo milk	rmk	mil
39	X22120	Cream fresh	rmk	mil
40	X2781_proc	Fish, Body Oil	fsh	ofd
41	X2782_proc	Fish, Liver Oil	fsh	ofd

Source: developed by author based on FAO (2020a), FAO (2020b) and Aguiar et al. (2019).

Notes: full list of the GTAP 10 Data Base sectoral codes with description is provided in Appendix B and <https://www.gtap.agecon.purdue.edu/databases/contribute/detailedsector.asp>

Appendix K. Overview of the approach toward redistribution of the primary domestic and imported commodities between GTAP categories



Appendix L. Regional and sectoral aggregation used for the policy simulation

Table L.1. Regional aggregation

No.	Aggregate region code	Aggregate region description	GTAP 10 regions
1.	HIGH	Countries with daily per capita food consumption > 3000 kcal	Australia (aus), New Zealand (nzl), Hong Kong (hkg), Korea (kor), Singapore (sgp), Canada (can), United States of America (usa), Mexico (mex), Argentina (arg), Brazil (bra), Austria (aut), Belgium (bel), Croatia (hrv), Czech Republic (cze), Denmark (dnk), Estonia (est), Finland (fin), France (fra), Germany (deu), Greece (grc), Hungary (hun), Ireland (irl), Italy (ita), Latvia (lva), Lithuania (ltu), Luxembourg (lux), Malta (mlt), Netherlands (nld), Poland (pol), Portugal (prt), Romania (rou), Slovenia (svn), Spain (esp), Sweden (swe), United Kingdom (gbr), Switzerland (che), Norway (nor), Rest of EFTA (xef), Albania (alb), Belarus (blr), Russian Federation (rus), Ukraine (ukr), Rest of Europe (xer), Kazakhstan (kaz), Azerbaijan (aze), Georgia (geo), Bahrain (bhr), Iran Islamic Republic of (irn), Israel (isr), Jordan (jor), Kuwait (kwt), Qatar (qat), Saudi Arabia (sau), Turkey (tur), United Arab Emirates (are), Egypt (egy), Morocco (mar), Tunisia (tun), Rest of North Africa (xnf)
2.	MED	Countries with daily per capita food consumption 2500-3000 kcal	China (chn), Japan (jpn), Taiwan (twn), Brunei Darussalam (brn), Indonesia (idn), Malaysia (mys), Philippines (phl), Thailand (tha), Viet Nam (vnm), Chile (chl), Colombia (col), Paraguay (pry), Uruguay (ury), Venezuela (ven), Rest of South America (xsm), Costa Rica (cri), Honduras (hnd), El Salvador (slv), Rest of Central America (xca), Jamaica (jam), Puerto Rico (pri), Trinidad and Tobago (tto), Caribbean (xcb), Bulgaria (bgr), Cyprus (cyp), Slovakia (svk), Rest of Eastern Europe (xee), Kyrgyzstan (kgz), Rest of Former Soviet Union (xsu), Armenia (arm), Oman (omn), Benin (ben), Burkina Faso (bfa), Cote d'Ivoire (civ), Ghana (gha), Nigeria (nga), Mauritius (mus), Rest of Eastern Africa (xec), South Africa (zaf)
3.	LOW	Countries with daily per capita food consumption < 2500 kcal	Rest of Oceania (xoc), Mongolia (mng), Rest of East Asia (xea), Cambodia (khm), Lao People's Democratic Republ (lao), Rest of Southeast Asia (xse), Bangladesh (bgd), India (ind), Nepal (npl), Pakistan (pak), Sri Lanka (lka), Rest of South Asia (xsa), Rest of North America (xna), Bolivia (bol), Ecuador (ecu), Peru (per), Guatemala (gtm), Nicaragua (nic), Panama (pan), Dominican Republic (dom), Tajikistan (tjk), Rest of Western Asia (xws), Cameroon (cmr), Guinea (gin), Senegal (sen), Togo (tgo), Rest of Western Africa (xwf), Central Africa (xcf), South Central Africa (xac), Ethiopia (eth), Kenya (ken), Madagascar (mdg), Malawi (mwi), Mozambique (moz), Rwanda (rwa), Tanzania (tza), Uganda (uga), Zambia (zmb), Zimbabwe (zwe), Botswana (bwa), Namibia (nam), Rest of South African Customs (xsc), Rest of the World (xtw)

Source: developed by author.

Table L.2. Sectoral aggregation

No.	Aggregate sector code	Aggregate sector description	GTAP 10 sectors
1.	pdr	Paddy rice	Paddy rice (pdr)
2.	wht	Wheat	Wheat (wht)
3.	gro	Cereal grains nec	Cereal grains nec (gro)
4.	v_f	Vegetables, fruit, nuts	Vegetables, fruit, nuts (v_f)
5.	osd	Oil seeds	Oil seeds (osd)
6.	c_b	Sugar cane, sugarbeet	Sugar cane, sugarbeet (c_b)
7.	xagr	Other agriculture	Plant-based fibers (pfb), Wool, silk-worm cocoons (wol), Forestry (frs)
8.	ocr	Crops nec	Crops nec (ocr)
9.	ctl	Bovine cattle, sheep and goats	Bovine cattle, sheep and goats (ctl)
10.	oap	Animal products nec	Animal products nec (oap)
11.	rmk	Raw milk	Raw milk (rmk)
12.	fsh	Fishing	Fishing (fsh)
13.	xtr	Extraction	Coal (coa), Oil (oil), Gas (gas), Minerals nec (ox)
14.	cmt	Bovine meat products	Bovine meat products (cmt)
15.	omt	Meat products nec	Meat products nec (omt)
16.	vol	Vegetable oils and fats	Vegetable oils and fats (vol)
17.	mil	Dairy products	Dairy products (mil)
18.	pcr	Processed rice	Processed rice (pcr)
19.	sgr	Sugar	Sugar (gr)
20.	ofd	Food products nec	Food products nec (ofd)
21.	b_t	Beverages and tobacco products	Beverages and tobacco products (b_t)
22.	xmn	Other manufacturing	Textiles (tex), Wearing apparel (wap), Leather products (lea), Wood products (lum), Paper products, publishing (ppp), Petroleum, coal products (p_c), Chemical products (chm), Basic pharmaceutical products (bph), Rubber and plastic products (rpp), Mineral products nec (nmm), Ferrous metals (i_s), Metals nec (nfm), Metal products (fmp), Computer, electronic and optic (ele), Electrical equipment (eeq), Machinery and equipment nec (ome), Motor vehicles and parts (mvh), Transport equipment nec (otn), Manufactures nec (omf)
23.	util	Utilities	Electricity (ely), Gas manufacture, distribution (gdt), Water (wtr)
24.	xsrv	Other services	Construction (cns), Trade (trd), Transport nec (otp), Water transport (wtp), Air transport (atp), Warehousing and support activities (whs), Communication (cmn), Financial services nec (ofi), Insurance (ins), Real estate activities (rsa), Business services nec (obs), Dwellings (dwe)
25.	fsrv	Food supplying services	Accommodation, Food and services (afs), Recreational and other service (ros), Public Administration and defense (osg), Education (edu), Human health and social work activities (hht)

Source: developed by author.