Food Balance Sheets

TO DO

- The trade figures I quote here are based on the US data, but not exactly. We have HS6 trade data, and I can map that to CPC. However, some HS6 codes map to many CPC codes. My understanding is that the historical approach has been to not use split factors and to simply map the quantity straight into one of the CPC codes. For this simple example, I map the HS data to CPC and randomly split it.
- The commodity trees used are derived based on the FCL commodity tree. They will likely need to be updated, but for now I just simply map the FCL elements to their corresponding CPC codes.
- We need to include proteins/fats/calories
- We should include an example where the primary product is eaten as such.
- We should include an example where a processed product can be made from many parents.

Wheat

For this example, we'll first consider the full process for creating a food balance sheet for wheat. We start off with an empty table:

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	0	0	0	0	0	0	0	0	0	0	0	0
Wheat flour	0	0	0	0	0	0	0	0	0	0	0	0
Bulgur	0	0	0	0	0	0	0	0	0	0	0	0
Breakfast cereals	0	0	0	0	0	0	0	0	0	0	0	0
Wheat starch	0	0	0	0	0	0	0	0	0	0	0	0
Wheat bran	0	0	0	0	0	0	0	0	0	0	0	0

Production

For production data, we first fill in the table with any available official figures. To impute production, we must also consider yield and area harvested data as yield is defined as production divided by area harvested (and thus with any two elements the third is uniquely defined). Suppose we have the following official data:

Name	Area Harvested	Yield	Production
Wheat	18496174	0	0

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Name	Area Harvested	Yield	Production
Wheat flour	NA	NA	18652048

In this case, the production value is only known for wheat flour (it is missing for wheat), and for wheat we are also missing the yield value. The first step in the imputation process is to impute the yield, using the previously described production imputation methodology.

Name	Area Harvested	Yield	Production
Wheat	18496174	2.9422	0
Wheat flour	NA	NA	18652048

Now, we have enough information to impute the production data:

Name	Area Harvested	Yield	Production
Wheat	18496174	2.9422	54418808
Wheat flour	NA	NA	18652048

Now, we fill in the table with our production values. Production is only imputed for primary products, and so in this case no additional values are filled in.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	**54418808**	0	0	0	0	0	0	0	0	0	0	0
Wheat flour	**18652048**	0	0	0	0	0	0	0	0	0	0	0
Bulgur	-	0	0	0	0	0	0	0	0	0	0	0
Breakfast cereals	-	0	0	0	0	0	0	0	0	0	0	0
Wheat starch	-	0	0	0	0	0	0	0	0	0	0	0
Wheat bran	-	0	0	0	0	0	0	0	0	0	0	0

Trade

For the next example, we'll show how the imputation, mirroring and balancing works. In this case, we just take the country totals and insert into this table.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	54418808	**1999076**	**32789894**	0	0	0	0	0	0	0	0	0
Wheat flour	18652048	**341529**	**572794**	0	0	0	0	0	0	0	0	0
Bulgur	-	**182485**	**486282**	0	0	0	0	0	0	0	0	0
Breakfast cereals	-	**285400**	**217289**	0	0	0	0	0	0	0	0	0
Wheat starch	-	**624947**	**224528**	0	0	0	0	0	0	0	0	0
Wheat bran	-	**258937**	**2343712**	0	0	0	0	0	0	0	0	0

Stock Changes

We now estimate the stock changes. Note that for most products, we assume that countries do not hold stocks. Generally, stocks will only be held for primary level products, and not even all of these products. The numbers below represent the estimated stock changes (by the stock imputation methodology described previously) for the example country we're considering.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	54418808	1999076	32789894	**-230630**	0	0	0	0	0	0	0	0
Wheat flour	18652048	341529	572794	**-**	0	0	0	0	0	0	0	0
Bulgur	-	182485	486282	**-**	0	0	0	0	0	0	0	0
Breakfast cereals	-	285400	217289	**-**	0	0	0	0	0	0	0	0
Wheat starch	-	624947	224528	**-**	0	0	0	0	0	0	0	0
Wheat bran	-	258937	2343712	**-**	0	0	0	0	0	0	0	0

Food

The allocation to food, on the other hand, can potentially be considered at any processing level, although some commodities (such as wheat) are assumed to not be eaten as such. We impute food consumption numbers for the example country and update the FBS table below.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	54418808	1999076	32789894	-230630	0	0	0	0	0	0	0	0
Wheat flour	18652048	341529	572794	-	**18539484**	0	0	0	0	0	0	0
Bulgur	-	182485	486282	-	**3684**	0	0	0	0	0	0	0
Breakfast cereals	-	285400	217289	-	**98131**	0	0	0	0	0	0	0
Wheat starch	-	624947	224528	-	0	0	0	0	0	0	0	0
Wheat bran	-	258937	2343712	-	0	0	0	0	0	0	0	0

Losses

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	54418808	1999076	32789894	-230630	0	0	0	**560306**	0	0	0	0
Wheat flour	18652048	341529	572794	-	18539484	0	0	-	0	0	0	0
Bulgur	-	182485	486282	-	3684	0	0	-	0	0	0	0
Breakfast cereals	-	285400	217289	-	98131	0	0	-	0	0	0	0
Wheat starch	-	624947	224528	-	0	0	0	-	0	0	0	0
Wheat bran	-	258937	2343712	-	0	0	0	-	0	0	0	0

```
## Warning: Standard error for loss data is currently just 10% of loss value,
## it is not estimated in any way.
```

Feed

Feed allocation must be done at this phase in order to ensure that we have reduced the feed demand by the corresponding amounts of feed products (i.e. wheat bran, wheat germ, etc.).

Seed

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	54418808	1999076	32789894	-230630	0	0	0	560306	**1929614**	0	0	0
Wheat flour	18652048	341529	572794	-	18539484	0	0	-	-	0	0	0
Bulgur	-	182485	486282	-	3684	0	0	-	-	0	0	0
Breakfast cereals	-	285400	217289	-	98131	0	0	-	-	0	0	0
Wheat starch	-	624947	224528	-	0	0	0	-	-	0	0	0
Wheat bran	-	258937	2343712	-	0	0	0	-	-	0	0	0

```
## Warning: Standard error for seed data is currently just 10% of seed value,
## it is not estimated in any way.
```

Industrial Utilization

Work in progress. . .

Tourist Consumption

The tourist consumption estimation approach uses tourist data from the WTO as well as last year's consumption patterns to estimate the impact of tourism on local consumption. Note that tourist consumption can be negative; as an extreme example consider a case where many nationals travel abroad but no tourists enter. In this case, that country will certainly have a negative "tourist consumption" because more calories will be assumed abroad than locally.

Residual Other Uses

Work in progress. . .

Standardization and Balancing

Now, suppose we have the following commodity tree:
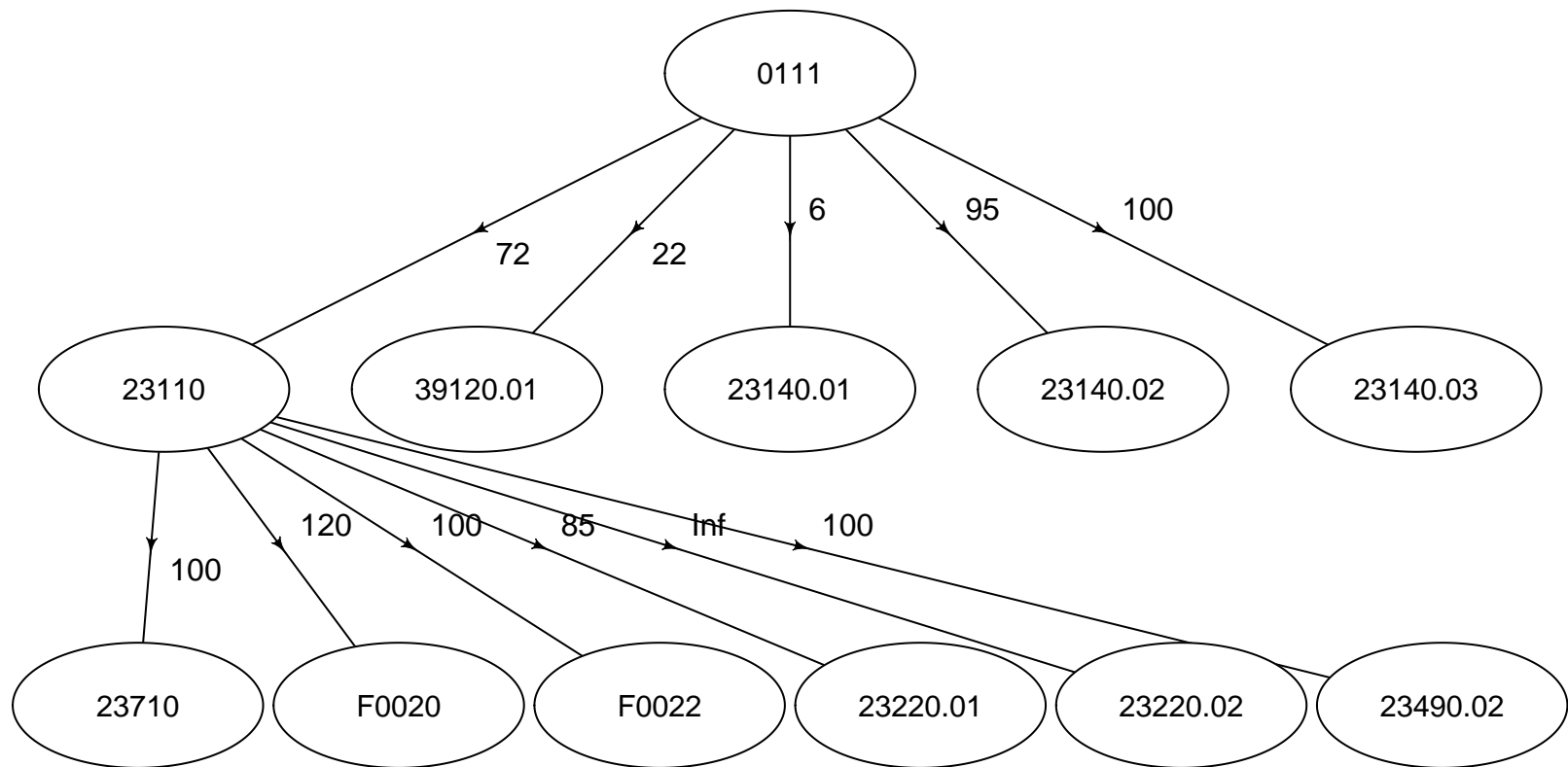
We first start with the pre-standardized table:

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	54418808	1999076	32789894	-230630	0	0	0	560306	1929614	0	0	0
Wheat flour	18652048	341529	572794	-	18539484	0	0	-	-	0	0	0
Bulgur	-	182485	486282	-	3684	0	0	-	-	0	0	0
Breakfast cereals	-	285400	217289	-	98131	0	0	-	-	0	0	0
Wheat starch	-	624947	224528	-	0	0	0	-	-	0	0	0
Wheat bran	-	258937	2343712	-	0	0	0	-	-	0	0	0

We then compute the required "production" of each of the processed products to satisfy any deficits due to exports or consumption (note that we can allow production to be zero if supply exceeds utilization).

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	54418808	1999076	32789894	-230630	0	0	0	560306	1929614	0	0	0
Wheat flour	18652048	341529	572794	-	18539484	0	0	-	-	0	0	0
Bulgur	**307482**	182485	486282	-	3684	0	0	-	-	0	0	0
Breakfast cereals	**30019**	285400	217289	-	98131	0	0	-	-	0	0	0
Wheat starch	**0**	624947	224528	-	0	0	0	-	-	0	0	0
Wheat bran	**2084775**	258937	2343712	-	0	0	0	-	-	0	0	0

Since wheat starch is produced from wheat flour, we would first need to ensure the wheat flour "food to processing" can cover any deficits of wheat starch. However, since wheat starch imports exceed exports plus food, we don't have to worry about this requirement. Instead, we can just standardize all the first processed level products back to food to processing of wheat.

Name	Production (processed)	SD(Production)	Wheat Equivalent	SD(Wheat Equivalent)
Wheat flour	18652048	0	25905622	0
Bulgur	307482	884	323665	931
Breakfast cereals	30019	1481	30019	1481
Wheat bran	2084775	0	9476252	0

Now, we wish to compute the distribution for food to processing for wheat. The main requirement is in the wheat flour, and it should be noted that the 9 million kilogram requirement for wheat bran will automatically be satisfied if the 26 million kilogram requirement for wheat flour is satisfied (as they are by-products). Thus, the food to processing element for wheat has a mean of 26,198 thousand kilograms (the sum of the first three) and a standard deviation of 63 thousand kilograms (the square-root of the sum of the squares of the first three standard deviations). Thus, we now have the following table:

Now, we must balance this table. To do this, we need to extract the computed **standard deviations (is this the word we're using???)** of each element. The table below shows the expected value and estimated **standard deviation** for each of the elements for wheat:

Variable	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Mean	54418808	1999076	32789894	-230630	0	26259504	0	560306	1929614	0	0	0
Standard Dev.	326513	0	0	89854	0	1724	0	56031	192961	0	0	0

Note that in this case, the standard deviation for food for processing is very small; this is because it's mostly determined by the production of wheat flour, and this value is an official figure.

Variable	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Mean	57774574	1999076	32789894	-488425	0	26259408	0	458867	759348	0	0	0
Standard Dev.	326513	0	0	89854	0	1724	0	56031	192961	0	0	0

Now, when balancing, we find that food is adjusted down slightly. This adjustment to food of wheat implies that the production of children commodities must also be updated (and hence their food values as well).

Name	Production (processed)	SD(Production)	Wheat Equivalent	SD(Wheat Equivalent)	Adjustment
Wheat flour	18652048	0	25905622	0	0
Bulgur	307511	884	323693	931	-28
Breakfast cereals	30088	1481	30088	1481	-68
Wheat bran	2084775	0	9476252	0	0

We can now update the production numbers for each of the first level primary elements. Note that in the process of creating flour, we also create bran and germ. The amount of bran and germ created, in this case, is determined by the amount of flour we need to create (as that was our most stringent requirement). Thus, we have:

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	57774574	1999076	32789894	-488425	0	26259408	0	458867	759348	0	0	0
Wheat flour	18652048	341529	572794	-	18539484	0	0	-	-	0	0	0
Wheat germ	**1554350**	**0**	**0**	**0**	**0**	0	**1554350**	**0**	**0**	0	0	0
Bulgur	**307564**	182485	486282	0	**3767**	0	0	0	0	0	0	0
Breakfast cereals	**30029**	285400	217289	0	**98140**	0	0	0	0	0	0	0
Wheat starch	0	624947	224528	-	0	0	0	0	-	-	0	0	0

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat bran	**7784058**	258937	2343712	0	0	0	**5699282**	0	0	0	0	0

Our food balance sheet is nearly completed, except that some commodities haven't been handled yet. In particular, wheat starch had imports exceeding exports and so we have not balanced that commodity yet; also, wheat flour has official production and so we haven't modified that commodity either. These unbalanced elements must be updated, and since the production is already fixed (either because it's an official figure or because it's 0) the balancing is very straight-forward: the uncertainty will be entirely allocated to food (or, in general, to either food or feed).

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	57774574	1999076	32789894	-488425	-5442	26259408	0	458867	759348	0	0	0
Wheat flour	18652048	341529	572794	-	**18420783**	0	0	-	-	0	0	0
Wheat germ	1554350	0	0	0	0	0	1554350	0	0	0	0	0
Bulgur	307564	182485	486282	0	3767	0	0	0	0	0	0	0
Breakfast cereals	30029	285400	217289	0	98140	0	0	0	0	0	0	0
Wheat starch	0	624947	224528	-	**400420**	0	0	-	-	0	0	0
Wheat bran	7784058	258937	2343712	0	0	0	5699282	0	0	0	0	0

NOTE (Josh): At this point, we should also compute calories/proteins/fats. But, I can't find the nutrient factors. . .

Now, the final step is aggregating this full table back into primary equivalent. For most elements, this is trivial: for example, the final stock change for wheat will simply be the current stock change because there is no stock change for processed products. However, there are three elements that must be handled differently: imports, exports, and food. Note that the final value for wheat equivalent production is simply the current value for wheat production: this is because "production" of flour (or any other processed product) isn't really production in the sense that the flour is acquired from a different commodity (whereas production of wheat is truly a production as it is not derived from anything else).

To standardize trade, we can simply aggregate the trade of the children commodities up into their primary equivalent by dividing by the extraction rate. We add these primary equivalents to the current value of trade of wheat, and we have our final, primary equivalent trade of wheat. For food, the food of wheat isn't really "food" but rather the amount of wheat allocated to food. Thus, when computing food equivalent of wheat, we standardize all the children commodities but do not add in the current value of food of wheat.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	57774574	5149085	45334722	-488425	26335591	26259408	51811659	458867	759348	0	0	0

Problem: We process wheat to create flour/bran/germ. Then, We standardize back that flour/bran/germ to the wheat balance (flour to food, bran and germ to feed). This gives us a huge imbalance, as the feed is being triple counted. How should we correct this? Don't divide by the extraction rate? Don't standardize feed?

Cattle Meat

```
## Warning in rm(cattleData): object 'cattleData' not found
```
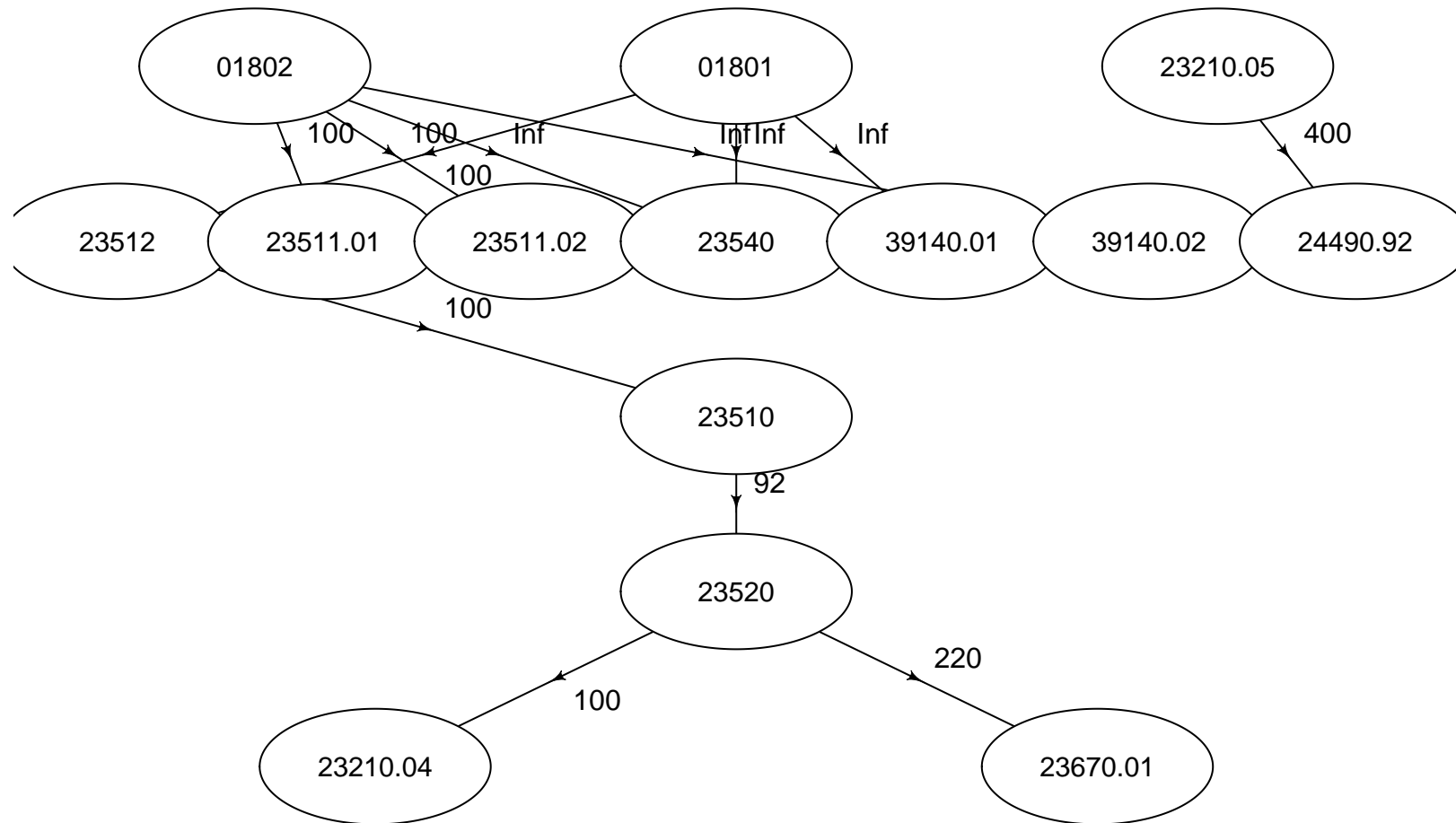
NOTE (Josh): We should include an example where the primary product is eaten as such.

NOTE (Josh): We should include an example where a processed product can be made from many parents.

Palm Oil

```
## Warning in rm(palmData): object 'palmData' not found
```

Sugar

```
## Warning in rm(sugarData): object 'sugarData' not found
```