PROJECT: CIRCULAR FASHION ECONOMY

TECHNICAL NOTE No 1

DEVELOPING SOCIAL ACCOUNTING MATRIXES

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Introduction

In real life most of the clothing and related fashion products end up in landfills, burnt or decomposed naturally. However, not all the goods go to disposal after their first use. A fraction of used fashion products will be sorted, recycled, upcycled or downcycled. Some may go through many various cycles before they come to the end of their life.

Aim: This document provides technical details of how circular fashion datasets are organised and assembled. It also explains the methodology, rationale (assumptions) and data sources used to form the datasets. Final datasets represent five Social Accounting Matrixes (SAMs) with circular fashion logic.

Procedure: Final SAMs were formed in four stages. First, standard SAMs were constructed for each of the five regions using economic data from GTAP 10 database. Second, fashion recycling and rental data were incorporated into the SAMs and rebalanced. Third, key fashion sectors were decomposed into subsectors. Finally, disaggregated SAMs were enhanced with satellite employment data by gender & occupations.

Organisation: Section 1 provides details of how core dataset (SAMs) were formed. Section 2 explains how fashion recycling, reuse and rental data were added to the core SAMs. Section 3 shows how key fashion sectors were disaggregated into feasible subsectors. Section 4 discusses how satellite employment and gender data were incorporated.

Section 1: Forming Standard Social Accounting Matrixes

Data File: GTAP 10 data accounts are stored as an excel file named "**`GTAP10_SAMAC_5_17_8.xls`**". Each individual sheet with abbreviated header contains separate data records (accounts). Sheet named "**notes**" provides the full list and definition of all accounts and their abbreviations.

Data Source: Core data comes from Global Trade Analysis Project data version 10 (GTAP10). This version contains economic data of 140 regions of the world for 2014. The source data includes standardized input-output tables, value added tables, international and domestic trade of intermediate, final and capital goods among the define regions and agents (firms, households, governments, and investors). All accounts contain nominal values of transactions given in millions of US$ terms. Values are given either in market prices (before frictions) or in agent prices (including frictions). Frictions include taxes, subsidies, transport, tariffs, sales taxes, production taxes, income and direct taxes etc.

Data Structure: GTAP 10 has been used to form the core part of SAMs. Scheme 1 provides schematic look into the data structure. The structure can be divided into four blocks: activities, consumption, trade and regional income. Activities block includes input-output and value-added data accounts. Account names are abbreviations inside the square brackets. Consumption block includes data on consumption by private sector, government and investment sector. Trade block includes import and export records. Regional income block is factor earnings plus taxes/tariffs collected from every production activity, consumption, and international trade operation.

Scheme 1: GTAP SAM accounts (with abbreviations)

	ACTIVITIES			CONSUMPTION			
IMP **[vims]** **[vtwr]**	IO **[viam]** **[vdam]**	VA **[vfm]**		PRIV **[vipm]** **[vdpm]**	GOV **[vigm]** **[vdgm]**	INV **[viim]** **[vdim]**	EXP **[vxmd]** **[vtwr]** **[vst]**
	REGIONAL INCOME						
TRF	TAX	TAX	VA	TAX	TAX	TAX	TAX
[vims-viws]	**[viaa-viam]** **[vdaa-vdam]**	**[evfa-vfm]**	**[vfm]**	**[vipa-vipm]** **[vdpa-vdpm]**	**[viga-vigm]** **[vdga-vdgm]**	**[viia-viim]** **[vdia-vdim]**	**[vxwd-vxmd]**

Next, definition of each account is provided.

Data Dimensions: The dataset has been aggregated to 17 sectors, 5 regions and 8 factors of production which are also seen as data dimensions (or sets). Following consistent notation used to represent each set/subset:

```
s (ss) - set of sectors;
```

```
r (rr) - set of regions;
f (ff) - set of factors;
```

Sheet named "**dim**" of the file provides the full list of regions, sectors and factors in use.

SAM Accounts: Further part of this section provides explicit definition of each separate data account with assigned unique abbreviation for each account. These account abbreviations correspond to separate sheet name in the data file where the account data is stored (the data file name is defined in Scheme 1 and in Data Dimensions).

Imported Intermediate input use in production:

```
viam(s,ss,r) = VIAM(s,ss,r);
```

where ***VIAM*** from file GTAPDATA header "VIAM", value of imported input s by ss in r;

Domestic Intermediate input use in production:

```
vdam(s,ss,r) = VDAM(s,ss,r);
```

where VDAM from file GTAPDATA header "VDAM", value of domestic input from s to ss in r;

Factor use in production:

```
vfm(f,s,r) = VFM(f,s,r);
```

where VFM from file GTAPDATA header "VFM", value of f used by s in r;

Tax on imported Intermediate input use in production:

```
viaa-viam(s,ss,r) = VIAA-VIAM(s,ss,r);
```

where ***VIAA-VIAM*** from file GTAPDATA header "VIAA-VIAM", value of the tax on imported input s by ss in r;

Tax on Domestic Intermediate input use in production:

```
vdaa-vdam(s,ss,r) = VDAA-VDAM(s,ss,r);
```

where ***VDAA-VDAM*** from file GTAPDATA header "VDAA-VDAM", value of the tax on domestic input s by ss in r;

Tax on Factor use in production:

```
evfa-vfm(f,s,r) = EVFA(f,s,r)-VFM(f,s,r);
```

where EVFA-VFM from file GTAPDATA header "EVFA-VFM", tax value on f used by s in r;

Production tax:

```
prodtax(s,r) = PRODTAX(s,r);
```

where PRODTAX from file GTAPDATA header "PRODTAX", production tax value on s production in r;

Total Domestic Output Value:

```
vom(s, r)= sum(ss, viam(s,ss, r)+vdam(s,ss,
r)+sum(f,vfm(f,ss,reg)) + viaa-viam(s,ss, r)+vdaa-vdam(s,ss,
r)+sum(f, evfa-vfm(f,ss,r)))
```

where vom of each s is the sum of domestic and imported intermediates, factor inputs at agent prices plus production taxes.

Tax and subsidy on Export:

```
vxwd-vxmd(r,rr,s) = VXWD-VXMD(r,rr,s);
```

where VXWD-VWMD from file GTAPDATA header "VXWD-VWMD", export tax and subsidy value by s of r origin to rr destination;

Transport services associated with international trade:

```
vst(s,r) = VST(s,r);
```

where VST from file GTAPDATA header "VST", transport margin on imported commodities by r destination;

Export:

```
vxwd(r,rr,s) = VXWD(r,rr,s);
```

where VXWD from file GTAPDATA header "VXWD", export of s from r to rr;

Consumption of domestic commodities by private sector:

```
vdpm(s,r) = VDPM(s,r);
```

where VDPM from file GTAPDATA header "VDPM", private consumption of domestic commodities from s;

Consumption of domestic commodities by government:

```
vdgm(s,r) = VDGM(s,r);
```

where VDGM from file GTAPDATA header "VDGM", government consumption of domestic commodities from s;

Consumption of domestic commodities by investment sector:

```
vdim(s,r) = VDIM(s,r);
```

where VDIM from file GTAPDATA header "VDIM", consumption of domestic commodities from s by investment sector;

Import:

```
viws-vtwr(r,rr,s) = VIWS-VTWR(r,rr,s);
```

where VIWS-VTWR from file GTAPDATA header "VIWS-VTWR", export of s from r to rr;

Transport Services:

```
vtwr(r,s,rr) = VTWR(r,s,rr);
```

where VTWR from file GTAPDATA header "VTWR", transport of s from r to rr;

Tariffs on Imported Commodities:

```
vims-viws(r,s,rr) = VIMS-VIWS(r,s,rr);
```

where VIMS-VIWS from file GTAPDATA header "VIMS-VIWS", import tariffs on s from r to rr;

Consumption of imported commodities by private sector:

```
vipm(s,r) = VIPM(s,r);
```

where VIPM from file GTAPDATA header "VIPM", private consumption of domestic commodities from s;

Consumption of imported commodities by government:

```
vigm(s,r) = VIGM(s,r);
```

where VIGM from file GTAPDATA header "VIGM", consumption of imported commodities of s by government of r;

Consumption of imported commodities by investment sector:

```
viim(s,r) = VIIM(s,r);
```

where VIIM from file GTAPDATA header "VIIM", consumption of imported commodities of s by investment sector of r;

Income Tax

```
ptaxfact(f,r) = PTAXFACT(f,r);
```

where PTAXFACT from file GTAPDATA header "PTAXFACT", income tax applied on f of r;

Capital Depreciation

```
vdep(f,r) = VDEP(f,r);
```

where VDEP from file GTAPDATA header "VDEP", transfers to capital accumulation funds in each r;

Regional income of households

```
yh (r) = sum(f, evoa-vdep (f,r)) + sum(s, tmtax (s,r)) +sum(s ,
tetax(s,r)) +sum(s , istax(s,r) +dstax(s,r)) +sum(f, ftax(f,r))
+ptax(r) +dtax(r) - yg(r) -save(r)
```

where **yh** is total income including earnings and tax/tariff revenues from all sources minus government purchases and transfers to regional savings fund

Regional government's income

```
yg (r) = YG(r)
```

where YG from file GTAPDATA header "YG", part of regional income used by government of each r;

Regional savings

```
save (r) = SAVE(r)
```

where SAVE from file GTAPDATA header "SAVE", part of regional income saved by each r;

Import Tariff Revenue

```
tmtax (r,rr) = sum(s,viws-vims(r,rr,s))
```

where **tmtax** is total amount of import tariffs collected by r and applied on rr;

Export Tax Revenue

```
tetax (r,rr) = sum(s,vxwd-vxmd(r,rr,s))
```

where **tetax** is total amount of export tax collected by r applied on exports to rr;

Imported Commodity Sales Tax Revenue

```
istax (r,c) =vipa_vipm(r,c)+viga_vigm(r,c)+viia_viim(r,c)+
sum(c,viaa_viam(r,c,cc))
```

where **istax** is total amount of sales tax collected in r from sales of imported c ;

Domestic Commodity Sales Tax Revenue

```
dstax (r,c) =vdpa_vdpm(r,c)+vdga_vdgm(r,c)+vdia_vdim(r,c)+
sum(c,vdaa_vdam(r,c,cc))
```

where **dstax** is total amount of sales tax collected in r from sales of domestic c ;

Factor Use Tax Revenue

```
ftax (f,r) = sum(c,evfa-vfm(f,c,r));
```

where **ftax** is total amount of tax collected from use of f in production in r ;

Production Tax Revenue

```
ptax (r) = sum(c,prodtax(r,c));
```

where **ptax** is total amount of production tax collected in r ;

Production Tax Revenue

```
ptax (r) = sum(c,prodtax(r,c));
```

where **ptax** is total amount of production tax collected in r ;

Sales Tax on Imported Goods Consumption by Private sector

```
vipa-vipm (s, r) = VIPA-VIPM (s,r);
```

where VIPA-VIPM from file GTAPDATA header "VIPA-VIPM", sales tax on finished imported goods consumed by private sector in r;

Sales Tax on Domestic Goods Consumption by Private sector

```
vdpa-vdpm (s, r) = VDPA-VDPM (s,r);
```

where VDPA-VDPM from file GTAPDATA header "VDPA-VDPM", sales tax on finished domestic goods consumed by private sector in r;

Sales Tax on Imported Goods Consumption by Government sector

```
vigm-viga (s, r) = VIGM-VIGA (s,r);
```

where VIGM-VIGA from file GTAPDATA header "VIGM-VIGA", sales tax on finished imported goods consumed by government sector in r;

Sales Tax on Domestic Goods Consumption by Government sector

```
vdgm-vdga (s, r) = VDGM-VDGA (s,r);
```

where VDGM-VDGA from file GTAPDATA header "VDGM-VDGA", sales tax on finished domestic goods consumed by government sector in r;

Sales Tax on Imported Goods Consumption by Investment sector

```
viia-viim (s, r) = VIIA-VIIM (s,r);
```

where VIIA-VIIM from file GTAPDATA header "VIIA-VIIM", sales tax on finished imported goods consumed by investment sector in r;

Sales Tax on Domestic Goods Consumption by Investment sector

```
vdia-vdim (s, r) = VDIA-VDIM (s,r);
```

where VDIA-VDIM from file GTAPDATA header "VDIA-VDIM", sales tax on finished domestic goods consumed by investment sector in r;

Trade balance in Investment goods market

```
ptaxinv (r) = PTAXINV (r);
```

where PTAXINV from file GTAPDATA header "PTAXINV", account to balance investment goods market in r;

Trade balance in transport services market

```
vtwr-vst (r) = VTWR-VST (r);
```

where VTWR-VST from file GTAPDATA header "VTWR-VST", account to balance transport services market in r;

Trade Balance for Goods Market

```
viws-vtwr-vxmd (r, rr) = sum(c, viws-vtwr (c, r)) - sum(c,
vxmd (c, r))
```

where **viws-vtwr-vxmd** is net difference between imports and exports for finished goods market in r;

International Transport Services

```
vtwr2 (r, rr) = sum(c, vtwr (c, r,rr))
```

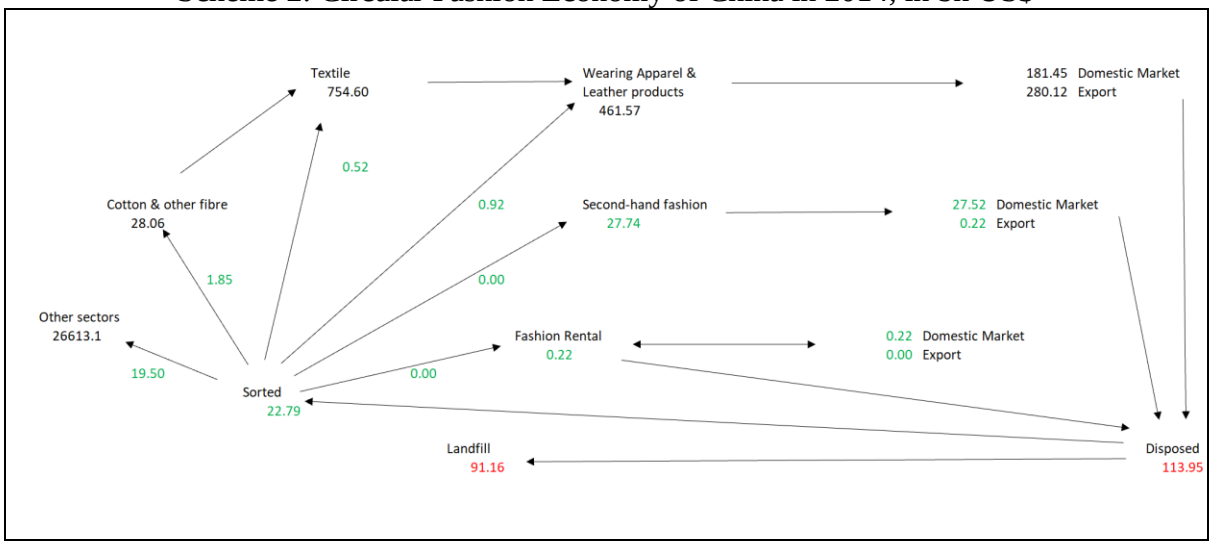
where **vtwr2** (r, rr) is international transport service provided by r for goods transport from rr

Section 2: Adding Fashion Recycling & Rental sectors to SAMs

Data File: An excel file that contains core GTAP 10 data accounts incorporating fashion recycling and rental data is named "**`GTAP10_SAMAC_5_17_8_1_recycle.xls`**". Each individual sheet with abbreviated header contains separate data records (accounts) as explained in the previous section. Sheet named "**notes**" provides the full list and definition of all accounts and their abbreviations.

Fashion Data Sources: There is no one single source of data. Records of international trade of textile and second-hand clothing come from ComTrade (data is in sheet named "**comtrade**"). Data on domestic production, reuse and consumption of fashion recycling and fashion rental goods is compiled from various reports (see sheet named "r&r" for details). The data for some regions like US and some EU countries is more accurate than for China and India. Partly this is because such sectors are more formal in developed economies (i.e. transactions associated with fashion recycling and rental are formally recorded and taxed) unlike developing economies where they are more associated with informal or shadow parts of the economy. Sheet "**r&r**" contains all collected, constructed or estimated data on fashion recycling (sector abbreviation **tcr**) and fashion rental (sector abbreviation **ocr**) sectors of each region. The same sheet also has a list of **references** to reports and studies broken down by regions (with web links to the sources where possible) and where possible by fashion production, trading, and consumption in each region of interest. When data was not available from any reliable source, parameters were estimated (such cells in the sheet also have comments attached detailing the methodology used and assumptions made).

Scheme 2: Circular Fashion Economy of China in 2014, in bn US$



Scheme 2 above provides an example of the schematic look at the construction of fashion data (in "**r&r**") and its circular flows for China (this is sheet "**chn(sh)**" in the file). China exports larger part of its textile products to other countries while about 40% goes to domestic consumers (approx. 181 bn US$). At the same year, old clothing and other apparel products worth 113 bn US$ is disposed where only about 11% (this number was 3% about 5 years prior to 2014) goes back into the economy to be primarily reused in production (most of which will be downcycled and turned into rugs and cleaning towels etc., or burnt) and smaller part of sorted clothing recycled or used in fashion rental business. Similar schematic graphs

are also available in the file (sheet "**ind(sh)**" for India, "**usa(sh)**" for USA, "**eur(sh)**" for EU28 countries, and "**row(sh)**" for rest of the World).

Data Dimensions: After including two new sectors, fashion recycling (tcr) and fashion rental (ocr), updated dataset has 19 sectors, 5 regions and 8 factors of production. Following notations are used to represent each set/subset:

```
c (cc) - set of sectors;
    s (ss) - subset of 17 sectors from GTAP;
    j (jj) - subset of 2 new fashion sectors;

r (rr) - set of regions;
f (ff) - set of factors;
```

Sheet named "**dim**" of the file provide the full list of regions, sectors and factors in use.

SAM Accounts: All the accounts were updated including the two new sectors. These account abbreviations correspond to a separate sheet name in the data file where the account data is stored (the data file name mentioned above) as before. Part of production, consumption and trading records comes from the first SAM (i.e. "**GTAP10_SAMAC_5_17_8.xls**") and such data accounts are marked/defined with **blue** below. New data included to each account associated with the two new fashion-related sectors (set j) are marker/defined with **dark-red** below. Further part of this section provides explicit definition of each separate data account with respective changes in **dark-red**.

Imported Intermediate input use in production:

```
viam(s,ss,r) = VIAM(s,ss,r);
```

where ***VIAM*** from file GTAPDATA header "VIAM", value of imported input s by ss in r;

```
viam(j,c,r) = sum(rr,imp(j,r,rr))*sh_minpt_use(j,c,r);
```

where ***imp*** is import of j by r from rr (from r&r/comtrade data flows transposed);

```
sh_minpt_use(j,c,r) = viam(j,c,r)/sum(c,viam(j,c,r);
```

where viam(j,c,r) is estimated using j in c by each r.

The gravity equation used in the estimates is described in box X below.

Box X: Gravity Estimation Model

Because our fashion data in "r&r" does not provide breakdown of production of each j sector of r but instead provides total output value of j in r in US$ terms, a gravity model of trade has been adopted to develop estimates of input-output distribution of outputs from each c to j and inputs to c from j. The assumed gravity model of internal bilateral flow of intermediate inputs among c sectors of r is specified as

IO(c,cc,r) = G * N(c,r) * M(cc,r) * D(c,cc,r),

where IO is intermediate input c used in cc of r, G is some global constant (this is also intercept estimate reported during estimation stage), N(c,r) is sector c-specific factors explaining use of c in cc, M(cc,r) is sector cc-specific factors explaining use of c in cc production, D(c,cc,r) is bilateral c-cc-specific factors explaining IO intermediate flow in r.

The data used with this model is Input-Output tables (i.e. viam and vdam accounts) where j columns and rows are empty. Since total output and total consumption of each j is known, we use them as N(j,r) and M(jj,r) proxy. In gravity literature it is normal to use economic sizes given with GDP of origin and destination country that are trading; in our case, we have origin and destination sector and their economic sizes are given with total output and total input. These are known and taken from "r&r". D(c,cc,r) is captured with bilateral fixed effect dummies. All estimates are done in Stata and predicted IO(c,cc,r) including estimates of IO(j,cc,r) and IO(c,jj,r) are imported back to the excel data file (sheet "viam" column AR-BK and "vdam" column AR-BK). To note goodness-of-fit (R^2) of the model is around 70% which suggest the model explain 70% variation in the data which is quite good.

Estimates are not meaningful in their form as the gravity model was inverted and in theory D(c,cc,r) =t(c,cc,r)^(1/(1-sigma_c)) where t is trade cost/barriers associated with flow of input from c to cc in r, and sigma is elasticity of substitution of c used in cc over other available substitutes for c. Sigma is not known in the literature but its level is in the range of 5-10 (Anderson, 2010). We considered level of sigma 8. Thus, estimates were first divided by (1/(1-sigma_c[=8])) and then rescaled to be consistent with total output and total input of j in r, i.e. with N(j,r) and M(jj,r) (this is done in sheet "viam" column W-AP and "vdam" column W-AP). Finally, once the estimates were rescaled they were put back into IO(c,cc,r).

Domestic Intermediate input use in production:

```
vdam(s,ss,r) = VDAM(s,ss,r);
```

where VDAM from file GTAPDATA header "VDAM", value of domestic input from s to ss in r;

```
vdam(j,c,r) = dinpt(j,r)*sh_dinpt_use(j,c,r);
```

where dinpt(j,r) is use of j by r (estimated value of use based on various reports; see r&r/references);

```
sh_dinpt_use(j,c,r) = vdam(j,c,r)/sum(c,vdam(j,c,r);
```

where vdam(j,c,r) is estimated use of j in c by each r; estimates are done with gravity equation (see Box X for details);

Factor use in production:

```
vfm(f,s,r) = VFM(f,s,r);
```

where VFM from file GTAPDATA header "VFM", value of f used by s in r;

Assumption: factor use in tcr is similar to its structure for trd for each r:

```
vfm(f,tcr,r) = totvfm(tcr,r)*sh_vfm(f,trd,r);
```

where totvfm(tcr,r) is use of f in tcr by r (estimated value of use based on various reports; see r&r/references);

```
sh_vfm(f,trd,r)= vfm(f,trd,r)/sum(f,vfm(f,trd,r));
```

where sh_vfm(f,trd,r) is the share of f in trd of r;

Assumption: factor use in ocr is similar to its structure for srv for each r:

```
vfm(f,ocr,r) = totvfm(ocr,r)*sh_vfm(f,srv,r);
```

where totvfm(ocr,r) is use of f in ocr by r (estimated value of use based on various reports; see r&r/references);

```
sh_vfm(f,srv,r)= vfm(f,srv,r)/sum(f,vfm(f,srv,r));
```

where sh_vfm(f,srv,r) is the share of f in srv of r;

Tax on imported Intermediate input use in production:

```
viaa-viam(s,ss,r) = VIAA-VIAM(s,ss,r);
```

where ***VIAA-VIAM*** from file GTAPDATA header "VIAA-VIAM", value of the tax on imported input s by ss in r;

```
viaa-viam(tcr, s, r)= minpt_taxrate(tcr,s, r)*viam(tcr,s, r)
```

where minpt_taxrate for tcr is tariff equivalent level of the tax and equal to:

```
minpt_taxrate(tcr,s, r)=viaa-viam(tex,s, r)/viam(tex,s, r)
```

Assumption: imported intermediate tax on ***tcr*** should be at similar level as on imported ***tex***

```
viaa-viam(ocr, s, r)= minpt_taxrate(ocr,s, r)*viam(ocr,s, r)
```

where minpt_taxrate for ocr is tariff equivalent level of the tax and equal to:

```
minpt_taxrate(ocr,s, r)=viaa-viam(wap,s, r)/viam(wap,s, r)
```

Assumption: imported intermediate tax on o***cr*** should be at similar level as on imported ***wap***

Tax on Domestic Intermediate input use in production:

```
vdaa-vdam(s,ss,r) = VDAA-VDAM(s,ss,r);
```

where ***VDAA-VDAM*** from file GTAPDATA header "VDAA-VDAM", value of the tax on domestic input s by ss in r;

```
vdaa-vdam(tcr, s, r)= dinpt_taxrate(tcr,s, r)*vdam(tcr,s, r)
```

where dinpt_taxrate for tcr is tariff equivalent level of the tax and equal to:

```
dinpt_taxrate(tcr,s, r)=vdaa-vdam(tex,s, r)/vdam(tex,s, r)
```

Assumption: domestic intermediate tax on ***tcr*** should be at similar level as on domestic ***tex***

```
vdaa-vdam(ocr, s, r)= dinpt_taxrate(ocr,s, r)*vdam(ocr,s, r)
```

where dinpt_taxrate for ocr is tariff equivalent level of the tax and equal to:

```
dinpt_taxrate(ocr,s, r)=vdaa-vdam(wap,s, r)/vdam(wap,s, r)
```

Assumption: domestic intermediate tax on o***cr*** should be at similar level as on domestic ***wap***

Tax on Factor use in production:

```
evfa-vfm(f,s,r) = EVFA(f,s,r)-VFM(f,s,r);
```

where EVFA-VFM from file GTAPDATA header "EVFA-VFM", tax value on f used by s in r;

Assumption: factor use tax in tcr is similar to its structure for trd for each r:

```
evfa-vfm(f,tcr,r) = (totevfa(tcr,r)-
totvfm(tcr,r))*sh_evfa_vfm(f,trd,r);
```

where totevfa(tcr,r)-totvfm(tcr,r) is tax on use of f in tcr by r (estimated value of use tax based on various reports; see r&r);

```
sh_evfa_vfm(f,trd,r)= evfa_vfm(f,trd,r)/sum(f,evfa_vfm(f,trd,r));
```

where sh_evfa_vfm(f,trd,r) is the share of tax on f in trd of r;

Assumption: factor use tax in ocr is similar to its structure for srv for each r:

```
evfa-vfm(f,ocr,r) = (totevfa(ocr,r)-
totvfm(ocr,r))*sh_evfa_vfm(f,ocr,r);
```

where totevfa(ocr,r)-totvfm(ocr,r) is tax on use of f in ocr by r (estimated value of use tax based on various reports; see r&r);

```
sh_evfa_vfm(f,srv,r)= evfa_vfm(f,srv,r)/sum(f,evfa_vfm(f,srv,r));
```

where sh_evfa_vfm(f,srv,r) is the share of tax on f in srv of r;

Production tax:

```
prodtax(s,r) = PRODTAX(s,r);
```

where PRODTAX from file GTAPDATA header "PRODTAX", production tax value on s production in r;

```
prodtax(tcr, r)= prodtax_rate(tcr,r)*sum(tcr,
viam(tcr,r)+vdam(tcr,r)+vfm(tcr,r)+(viaa-viam(tcr,r))+(vdaa-
vdam(tcr,r))+(evfa-vfm(tcr,r)))
```

where prodtax_rate is tariff-equivalent level of production tax which is equal to

```
prodtax_rate(tcr,r)=prodtax(tex,r)/sum(tex,
viam(tex,r)+vdam(tex,r)+vfm(tex,r)+(viaa-viam(tex,r))+(vdaa-
vdam(tex,r))+(evfa-vfm(tex,r)))
```

Assumption: prodtax rate on tcr production should be similar the tax level on textile production (tex)

```
prodtax(ocr, r)= prodtax_rate(ocr,r)*sum(ocr,
viam(ocr,r)+vdam(ocr,r)+vfm(ocr,r)+(viaa-viam(ocr,r))+(vdaa-
vdam(ocr,r))+(evfa-vfm(ocr,r)))
```

where prodtax_rate is tariff-equivalent level of production tax which is equal to

```
prodtax_rate(ocr,r)=prodtax(wap,r)/sum(wap,
viam(wap,r)+vdam(wap,r)+vfm(wap,r)+(viaa-viam(wap,r))+(vdaa-
vdam(wap,r))+(evfa-vfm(wap,r)))
```

Assumption: prodtax rate on ocr production should be similar the tax level on wearing apparel production (wap)

Total Domestic Output Value:

```
vom(c, r)= sum(cc, viam(c,cc, r)+vdam(c,cc, r)+sum(f,vfm(f,cc,reg)) +
viaa-viam(c,cc, r)+vdaa-vdam(c,cc, r)+sum(f, evfa-vfm(f,cc,r)))
```

where vom of each c is the sum of domestic and imported intermediates, factor inputs at agent prices plus production taxes.

Tax and subsidy on Export:

```
vxwd-vxmd(r,rr,s) = VXWD-VXMD(r,rr,s);
```

where VXWD-VWMD from file GTAPDATA header "VXWD-VWMD", export tax and subsidy value by s of r origin to rr destination;

```
vxwd-vxmd(r,rr,tcr) = vxwd_vxmd_xrate(r,rr,tcr)*vxwd(r,rr,tcr);
```

where vxwd_vxmd_xrate is the tariff equivalent level of export tax minus export subsidy and equal to

```
vxwd_vxmd_xrate(r,rr,tcr)= vxwd_vxwd(r,rr,tex)/vxwd(r,rr,tex);
```

Assumption: export tax and subsidy level for tcr should be similar to its level for tex in each r against export to rr

```
vxwd-vxmd(r,rr,ocr) = vxwd_vxmd_xrate(r,rr,ocr)*vxwd(r,rr,ocr);
```

where vxwd_vxmd_xrate is the tariff equivalent level of export tax minus export subsidy and equal to

```
vxwd_vxmd_xrate(r,rr,ocr)= vxwd_vxwd(r,rr,wap)/vxwd(r,rr,wap);
```

Assumption: export tax and subsidy level for ocr should be similar to its level for wap in each r against export to rr

Transport services associated with international trade:

```
vst(s,r) = VST(s,r);
```

where VST from file GTAPDATA header "VST", transport margin on imported commodities by r destination;

Export:

```
vxwd(r,rr,s) = VXWD(r,rr,s);
```

where VXWD from file GTAPDATA header "VXWD", export of s from r to rr;

```
vxwd(r,rr,j) = export(r,rr,j);
```

where ***export*** is export value of j from r to rr from Comtrade (see details in r&r)

Consumption of domestic commodities by private sector:

```
vdpm(s,r) = VDPM(s,r);
```

where VDPM from file GTAPDATA header "VDPM", private consumption of domestic commodities from s;

```
vdpm (j,r) = vom(j,r)+sum(rr,vxwd-vxmd(j,r,rr)) -sum(s,vdam(s,j,r)) -
vdgm(j,r) -vdim(j,r) - sum(rr,vxwd(j,r,rr))
```

where ***vdpm*** is consumption value of j output plus export tax/subsidy minus consumption by all agents other than private

Consumption of domestic commodities by government:

```
vdgm(s,r) = VDGM(s,r);
```

where VDGM from file GTAPDATA header "VDGM", government consumption of domestic commodities from s;

```
vdgm (j,r) = 0;
```

Assumption: government purchases none of tcr/ocr supplied domestically.

Consumption of domestic commodities by investment sector:

```
vdim(s,r) = VDIM(s,r);
```

where VDIM from file GTAPDATA header "VDIM", consumption of domestic commodities from s by investment sector;

```
vdim (j,r) = 0;
```

Assumption: investment sector purchases none of tcr/ocr supplied domestically.

Import:

```
viws-vtwr(r,rr,s) = VIWS-VTWR(r,rr,s);
```

where VIWS-VTWR from file GTAPDATA header "VIWS-VTWR", export of s from r to rr;

```
viws-vtwr(r,rr,j) = transpose[export(r,rr,j)];
```

where ***export*** is export value of j from r to rr from Comtrade (see details in r&r)

Transport Services:

```
vtwr(r,s,rr) = VTWR(r,s,rr);
```

where VTWR from file GTAPDATA header "VTWR", transport of s from r to rr;

Transport of tcr to destination r from origin rr depend on the value of tcr and transport margin level:

```
vtwr(r,tcr,rr) = viws-vtwr(r,tcr,rr)*trans_mrgn(r,tcr,rr);
```

Assumption: transport margin of tcr should be similar to its level for tex for each destination r from origin rr:

```
trans_mrgn(r,tcr,rr)= vtwr(r,tex,rr)/viws_vtwr(r,tex,rr);
```

Transport of ocr to destination r from origin rr depend on the value of ocr and transport margin level:

```
vtwr(r,ocr,rr) = viws-vtwr(r,ocr,rr)*trans_mrgn(r,ocr,rr);
```

Assumption: transport margin for ocr should be similar to its level as for wap for each destination r from origin rr:

```
trans_mrgn(r,ocr,rr)= vtwr(r,wap,rr)/viws_vtwr(r,wap,rr);
```

Tariffs on Imported Commodities:

```
vims-viws(r,s,rr) = VIMS-VIWS(r,s,rr);
```

where VIMS-VIWS from file GTAPDATA header "VIMS-VIWS", import tariffs on s from r to rr;

Import tariff revenue on imported tcr to r from rr depend on the reported value of tcr and tariff level for such category:

```
vims-viws(r,tcr,rr) = viws-vtwr(r,tcr,rr)*imp_tariffrate(r,tcr,rr);
```

Assumption: import tariff rate on tcr should be similar to its level for tex for each destination r from origin rr:

```
imp_tariffrate(r,tcr,rr)= vims-viws(r,tex,rr)/viws_vtwr(r,tex,rr);
```

Import tariff revenue on imported ocr to r from rr depend on the reported value of ocr and tariff level for such category:

```
vims-viws(r,ocr,rr) = viws-vtwr(r,ocr,rr)*imp_tariffrate(r,ocr,rr);
```

Assumption: import tariff rate on ocr should be similar to its level for wap for each destination r from origin rr:

```
imp_tariffrate(r,ocr,rr)= vims-viws(r,wap,rr)/viws_vtwr(r,wap,rr);
```

Consumption of imported commodities by private sector:

```
vipm(s,r) = VIPM(s,r);
```

where VIPM from file GTAPDATA header "VIPM", private consumption of domestic commodities from s;

```
vipm (j,r) = (vims-viws(r,rr,j))+vtwr(r,rr,j)+(viws-vtwr(r,rr,j)) -
viam(r,j) -vigm(r,j) -viim(r,j);
```

where ***vipm*** is total supply of import j minus consumption of j import by all agents (firms, govnt, investment) other than private sector.

Assumption: households purchase some of **tcr/ocr** supplied internationally.

Consumption of imported commodities by government:

```
vigm(s,r) = VIGM(s,r);
```

where VIGM from file GTAPDATA header "VIGM", consumption of imported commodities of s by government of r;

```
vigm (j,r) = 0;
```

Assumption: government purchases none of **tcr/ocr** supplied internationally.

Consumption of imported commodities by investment sector:

```
viim(s,r) = VIIM(s,r);
```

where VIIM from file GTAPDATA header "VIIM", consumption of imported commodities of s by investment sector of r;

```
viim (j,r) = 0;
```

Assumption: investment sector purchases none of **tcr/ocr** supplied internationally.

Disposable Income

```
evoa-vdep(f,r) = sum(c,vfm(f,c,r)) - (ptaxfact(f,r)+vdep(f,r));
```

where **evoa-vdep** is total factor income minus capital depreciation and income tax revenue of f in each r;

Income Tax

```
ptaxfact(f,r) = PTAXFACT(f,r);
```

where PTAXFACT from file GTAPDATA header "PTAXFACT", income tax applied on f of r;

Capital Depreciation

```
vdep(f,r) = VDEP(f,r);
```

where VDEP from file GTAPDATA header "VDEP", transfers to capital accumulation funds in each r;

Regional income of households

```
yh (r) = sum(f, evoa-vdep (f,r)) + sum(s, tmtax (s,r)) +sum(s ,
tetax(s,r)) +sum(s , istax(s,r) +dstax(s,r)) +sum(f, ftax(f,r))
+ptax(r) +dtax(r) - yg(r) -save(r)
```

where **yh** is total income including earnings and tax/tariff revenues from all sources minus government purchases and transfers to regional savings fund

Regional government's income

```
yg (r) = YG(r)
```

where YG from file GTAPDATA header "YG", part of regional income used by government of each r;

Regional savings

```
save (r) = SAVE(r)
```

where SAVE from file GTAPDATA header "SAVE", part of regional income saved by each r;

Import Tariff Revenue

```
tmtax (r,rr) = sum(s,viws-vims(r,rr,s))
```

where **tmtax** is total amount of import tariffs collected by r and applied on rr;

Export Tax Revenue

```
tetax (r,rr) = sum(s,vxwd-vxmd(r,rr,s))
```

where **tetax** is total amount of export tax collected by r applied on exports to rr;

Imported Commodity Sales Tax Revenue

```
istax (r,c) =vipa_vipm(r,c)+viga_vigm(r,c)+viia_viim(r,c)+
sum(c,viaa_viam(r,c,cc))
```

where **istax** is total amount of sales tax collected in r from sales of imported c ;

Domestic Commodity Sales Tax Revenue

```
dstax (r,c) =vdpa_vdpm(r,c)+vdga_vdgm(r,c)+vdia_vdim(r,c)+
sum(c,vdaa_vdam(r,c,cc))
```

where **dstax** is total amount of sales tax collected in r from sales of domestic c ;

Factor Use Tax Revenue

```
ftax (f,r) = sum(c,evfa-vfm(f,c,r));
```

where **ftax** is total amount of tax collected from use of f in production in r ;

Production Tax Revenue

```
ptax (r) = sum(c,prodtax(r,c));
```

where **ptax** is total amount of production tax collected in r ;

Production Tax Revenue

```
ptax (r) = sum(c,prodtax(r,c));
```

where **ptax** is total amount of production tax collected in r ;

Sales Tax on Imported Goods Consumption by Private sector

```
vipa-vipm (s, r) = VIPA-VIPM (s,r);
```

where VIPA-VIPM from file GTAPDATA header "VIPA-VIPM", sales tax on finished imported goods consumed by private sector in r;

```
vipa-vipm (tcr, r) = vipm(tcr,r)* istax_prate(tcr,r);
```

where istax_prate for ***tcr*** in r is equal to

```
istax_prate(tcr,r) = vipa-vipm(tex,r) / vipm(tex,r);
```

Assumption: rate of sales tax on finished imported ***tcr*** is similar to the rate on ***tex***

```
vipa-vipm (ocr, r) = vipm(ocr,r)* istax_prate(ocr,r);
```

where istax_prate for ***ocr*** in r is equal to

```
istax_prate(ocr,r) = vipa-vipm(wap,r) / vipm(wap,r);
```

Assumption: rate of sales tax on finished imported ***ocr*** is similar to the rate on ***wap***

Sales Tax on Domestic Goods Consumption by Private sector

```
vdpa-vdpm (s, r) = VDPA-VDPM (s,r);
```

where VDPA-VDPM from file GTAPDATA header "VDPA-VDPM", sales tax on finished domestic goods consumed by private sector in r;

```
vdpa-vdpm (tcr, r) = vdpm(tcr,r)* dstax_prate(tcr,r);
```

where dstax_prate for ***tcr*** in r is equal to

```
dstax_prate(tcr,r) = vdpa-vdpm(tex,r) / vdpm(tex,r);
```

Assumption: rate of sales tax on finished domestic ***tcr*** is similar to the rate on ***tex***

```
vdpa-vdpm (ocr, r) = vdpm(ocr,r)* dstax_prate(ocr,r);
```

where dstax_ptax for ***ocr*** in r is equal to

```
dstax_prate(ocr,r) = vdpa-vdpm(wap,r) / vdpm(wap,r);
```

Assumption: rate of sales tax on finished domestic ***ocr*** is similar to the rate on ***wap***

Sales Tax on Imported Goods Consumption by Government sector

```
vigm-viga (s, r) = VIGM-VIGA (s,r);
```

where VIGM-VIGA from file GTAPDATA header "VIGM-VIGA", sales tax on finished imported goods consumed by government sector in r;

```
vigm-viga (tcr, r) = vigm(tcr,r)* istax_grate(tcr,r);
```

where istax_grate for ***tcr*** in r is equal to

```
istax_grate(tcr,r) = viga-vigm(tex,r) / vigm(tex,r);
```

Assumption: rate of sales tax on finished imported ***tcr*** is similar to the rate on ***tex***

```
vigm-viga (ocr, r) = vigm(ocr,r)* istax_grate(ocr,r);
```

where istax_grate for ***ocr*** in r is equal to

```
istax_grate(ocr,r) = vigm-viga(wap,r) / vigm(wap,r);
```

Assumption: rate of sales tax on finished imported ***ocr*** is similar to the rate on ***wap***

Sales Tax on Domestic Goods Consumption by Government sector

```
vdgm-vdga (s, r) = VDGM-VDGA (s,r);
```

where VDGM-VDGA from file GTAPDATA header "VDGM-VDGA", sales tax on finished domestic goods consumed by government sector in r;

```
vdgm-vdga (tcr, r) = vdgm(tcr,r)* dstax_grate(tcr,r);
```

where dstax_gtax for ***tcr*** in r is equal to

```
dstax_grate(tcr,r) = vdga-vdgm(tex,r) / vdgm(tex,r);
```

Assumption: rate of sales tax on finished domestic ***tcr*** is similar to the rate on ***tex***

```
vdgm-vdga (ocr, r) = vdgm(ocr,r)* dstax_grate(ocr,r);
```

where dstax_gtax for ***ocr*** in r is equal to

```
dstax_grate(ocr,r) = vdgm-vdga(wap,r) / vdgm(wap,r);
```

Assumption: rate of sales tax on finished domestic ***ocr*** is similar to the rate on ***wap***

Sales Tax on Imported Goods Consumption by Investment sector

```
viia-viim (s, r) = VIIA-VIIM (s,r);
```

where VIIA-VIIM from file GTAPDATA header "VIIA-VIIM", sales tax on finished imported goods consumed by investment sector in r;

```
viia-viim (tcr, r) = viim(tcr,r)* istax_irate(tcr,r);
```

where istax_irate for ***tcr*** in r is equal to

```
istax_irate(tcr,r) = viia-viim(tex,r) / viim(tex,r);
```

Assumption: rate of sales tax on finished imported ***tcr*** is similar to the rate on ***tex***

```
viia-viim (ocr, r) = viim(ocr,r)* istax_irate(ocr,r);
```

where istax_itax for ***ocr*** in r is equal to

```
istax_irate(ocr,r) = viia-viim(wap,r) / viim(wap,r);
```

Assumption: rate of sales tax on finished imported ***ocr*** is similar to the rate on ***wap***

Sales Tax on Domestic Goods Consumption by Investment sector

```
vdia-vdim (s, r) = VDIA-VDIM (s,r);
```

where VDIA-VDIM from file GTAPDATA header "VDIA-VDIM", sales tax on finished domestic goods consumed by investment sector in r;

```
vdia-vdim (tcr, r) = vdim(tcr,r)* dstax_irate(tcr,r);
```

where dstax_irate for ***tcr*** in r is equal to

```
dstax_irate(tcr,r) = vdia-vdim(tex,r) / vdim(tex,r);
```

Assumption: rate of sales tax on finished domestic ***tcr*** is similar to the rate on ***tex***

```
vdia-vdim (ocr, r) = vdim(ocr,r)* dstax_irate(ocr,r);
```

where dstax_itax for ***ocr*** in r is equal to

```
dstax_irate(ocr,r) = vdia-vdim(wap,r) / vdim(wap,r);
```

Assumption: rate of sales tax on finished domestic ***ocr*** is similar to the rate on ***wap***

Trade balance in Investment goods market

```
ptaxinv (r) = PTAXINV (r);
```

where PTAXINV from file GTAPDATA header "PTAXINV", account to balance investment goods market in r;

Trade balance in transport services market

```
vtwr-vst (r) = VTWR-VST (r);
```

where VTWR-VST from file GTAPDATA header "VTWR-VST", account to balance transport services market in r;

Trade Balance for Goods Market

```
viws-vtwr-vxmd (r, rr) = sum(c, viws-vtwr (c, r)) - sum(c, vxmd
(c, r))
```

where **viws-vtwr-vxmd** is net difference between imports and exports for finished goods market in r;

International Transport Services

```
vtwr2 (r, rr) = sum(c, vtwr (c, r,rr))
```

where **vtwr2** (r, rr) is international transport service provided by r for goods transport from rr

Sector 3: Disaggregating Fashion Recycling & Rental sectors

Data File: An excel file that contains disaggregated core data accounts with fashion recycling and rental data is named "**GTAP10_SAMAC_5_17_8_1_disagg.xls".** In this version of SAM, we have 27 sectors, not 19 sectors as the version discussed in previous section. Each individual sheet with abbreviated header is still named in the same manner using abbreviations as explained in section 1. A sheet named "**note**" provides the full list and definition of all accounts/abbreviations.

Data Sources: 3 sectors, namely, textile products (tex), wearing apparel (wap), and leather products (lea) were considered to be disaggregated into smaller subsectors. Disaggregation of a SAM sector requires knowledge (richer national accounts data) on production, consumption, and trade structure for each pre-identified subsector of each region in the SAM. Thus, additional data collection work had been carried out. Various data in the form of Supply-Use Tables (SUTs) and Input-Output Tables (IOTs) have been collected. IOT-2014 of the US is obtained from the Bureau of Economic Analysis' website[1]. IOT-2014 of India is available from Asian Development Bank's website[2]. SUTs/IOTs of other regions and countries are taken from MRIO database[3]. Additional data related to bilateral internal flow of goods among EU countries are taken from WIOD and WITS databases[4].

Concordance: Collected SUTs/IOTs differ from region to region. For example, in US' IOT there are 20 subsectors related to textile and apparel, in Indian there are 11 subsectors, Chinese IOT has 7 subsectors, and EU IOT[5] just has the same 3 sectors (textile, apparel and leather products). In sheet named "**concord**" all relevant subsectors across five regions have been listed together and a common concordance table of subsections developed. The table X below provides the list of 11 subsectors identified across SUTs/IOTs for disaggregation work. Using this concordance table, all the 3 sectors of each account of the SAM have been disaggregated.

Data Dimensions: After the disaggregation process, final five SAMs have 27 sectors, 5 regions and 8 factors of production. Following notations used to represent each set/subset:

```
n (nn) - set of sectors;
     g (gg) - subset of 16 sectors;
     twl (twll) - subset of 3 sectors;
     m (mm) - subset of 11 subsectors;
          mt (mtt) - subsectors of 4 of tex sector;
          mw (mww) - subsectors of 3 of wap sector;
          ml (mll) - subsectors of 4 of lea sector;

r (rr) - set of regions;
f (ff) - set of factors;
```

Sheet named "**dim**" of the file provide the full list of regions, sectors and factors in use.

[1] https://www.bea.gov/data/economic-accounts
[2] https://data.adb.org/dataset/india-input-output-economic-indicators
[3] https://worldmrio.com/
[4] https://wiod.com/ and https://wits.com/
[5] Because EU IOT had only three sectors, UK's CIOT has been used as a proxy of EU's subsectoral breakdown.

Table 1: 3 Sectors with 11 Subsectors

1	swf	Spinning, weaving and finishing of textiles	tex	Manufacture of textiles;
2	mot	Manufacture of other textiles	tex	Manufacture of textiles;
3	mkc	Manufacture of knitted and crocheted fabrics and articles	tex	Manufacture of textiles;
4	mcr	Manufacture of carpets, rugs & similar	tex	Manufacture of textiles;
5	mwa	Manufacture of wearing apparel, except fur apparel	wap	Manufacture of wearing apparel;
6	aao	Apparel accessories and other apparel manufacturing	wap	Manufacture of wearing apparel;
7	ddf	Dressing and dyeing of fur; manufacture of articles of fur	wap	Manufacture of wearing apparel;
8	tdl	Tanning and dressing of leather	lea	Manufacture of leather and related products;
9	mfw	Manufacture of footwear	lea	Manufacture of leather and related products;
10	mlh	Manufacture of luggage & handbags	lea	Manufacture of leather and related products;
11	olp	Other leather and allied product manufacturing	lea	Manufacture of leather and related products;

SAM Accounts: All the accounts were updated in accordance with new disaggregation structure. These account abbreviations correspond to separate sheet name in the data file where the account data is stored (the data file name mentioned above) as before. Part of production, consumption, and trading records comes from the first SAM (i.e. "**GTAP10_SAMAC_5_17_8_1_recycle.xls**") and such data accounts are marked/defined with **blue** below. New disaggregated data included to each account associated with 11 subsectors (set m) are marker/defined with **dark-red** below. Further part of this section provides explicit definition of each separate data account with new changes in **dark-red**.

Imported Intermediate input use in production:

```
viam(s,ss,r) = VIAM(s,ss,r);
```

where ***VIAM*** from file GTAPDATA header "VIAM", value of imported input s by ss in r;

```
viam(j,c,r) = sum(rr,imp(j,r,rr))*sh_minpt_use(j,c,r);
```

where ***imp*** is import of j by r from rr (from r&r/comtrade data flows transposed);

```
sh_minpt_use(j,c,r) = viam(j,c,r)/sum(c,viam(j,c,r);
```

where viam(j,c,r) is estimated use of j in c by each r; estimates are done using gravity equation (see Box X for details);

Imported Intermediate input use in production:

```
viam(g,gg,r) = VIAM(g,gg,r);
```

where ***VIAM*** is imported input g to gg of r and a file from GTAP10_SAMAC_5_17_8_1_recycle/viam;

*Imported intermediate input of **subset mt of tex** calculated as:*

```
viam(mt,g,r) = viam(tex,g,r)*sh_subminpt(mt,g,r);

sh_subminpt(mt,g,r) = subminpt(mt,g,r)/sum(mt,subminpt(mt,g,r));
```

where sh_subminpt(mt,g,r) is the share of mt in tex and comes from relevant lines of raw IOTs/SUTs

*Imported intermediate input of **subset mw of wap** & **subset ml of lea** calculated as:*

```
viam(mw,g,r) = viam(wap,g,r)*sh_subminpt(mw,g,r);

sh_subminpt(mw,g,r) = subminpt(mw,g,r)/sum(mw,subminpt(mw,g,r));

viam(ml,g,r) = viam(lea,g,r)*sh_subminpt(ml,g,r);

sh_subminpt(ml,g,r) = subminpt(ml,g,r)/sum(ml,subminpt(ml,g,r));
```

Domestic Intermediate input use in production:

```
vdam(g,gg,r) = VDAM(g,gg,r);
```

where ***VDAM*** is domestic input g to gg of r and a file from GTAP10_SAMAC_5_17_8_1_recycle/vdam;

*Domestic intermediate input of **subset mt of tex** calculated as:*

```
vdam(mt,g,r) = vdam(tex,g,r)*sh_subdinpt(mt,g,r);

sh_subdinpt(mt,g,r) = subdinpt(mt,g,r)/sum(mt,subdinpt(mt,g,r));
```

where sh_subdinpt(mt,g,r) is the share of mt in tex and comes from relevant lines of raw IOTs/SUTs

*Domestic intermediate input of **subset mw of wap** & subset **ml of lea** calculated as:*

```
vdam(mw,g,r) = vdam(wap,g,r)*sh_subdinpt(mw,g,r);

sh_subdinpt(mw,g,r) = subdinpt(mw,g,r)/sum(mw,subdinpt(mw,g,r));
```

```
vdam(ml,g,r) = vdam(lea,g,r)*sh_subdinpt(ml,g,r);

sh_subdinpt(ml,g,r) = subdinpt(ml,g,r)/sum(ml,subdinpt(ml,g,r));
```

Factor use in production:

```
vfm(f,g,r) = VFM(f,g,r);
```

where ***VFM*** is factor f used in g of r and a file from GTAP10_SAMAC_5_17_8_1_recycle/vfm;

*Factor use in **subset mt of tex** calculated as:*

```
vfm(f,mt,r) = vfm(f,tex,r)*sh_mdinpt(mt,r);

sh_mdinpt(mt,r) =
(vdam(mt,r)+viam(mt,r))/sum(mt,(vdam(mt,r)+viam(mt,r)));
```

where sh_subdinpt(mt,r) is the share of all input use in mt of tex

***Assumption**: factor use in a subset of a set is proportional to size of input use in the subset of the set*

*Factor use in **subset mw of wap** and subset ml of lea are calculated in similar fashion:*

```
vfm(f,mw,r) = vfm(f,wap,r)*sh_mdinpt(mw,r);

sh_mdinpt(mw,r) =
(vdam(mw,r)+viam(mw,r))/sum(mw,(vdam(mw,r)+viam(mw,r)));

vfm(f,ml,r) = vfm(f,lea,r)*sh_mdinpt(ml,r);

sh_mdinpt(ml,r) =
(vdam(ml,r)+viam(ml,r))/sum(ml,(vdam(ml,r)+viam(ml,r)));
```

Tax on Imported Intermediate input use in production:

```
viaa-viam(g,gg,r) = VIAA-VIAM(g,gg,r);
```

where ***VIAA-VIAM*** is imported input tax on g used in gg of r and a file from GTAP10_SAMAC_5_17_8_1_recycle/viaa-viam;

*Imported intermediate input tax of **subset mt of tex** calculated as:*

```
viaa-viam(mt,g,r) = viaa-viam(tex,g,r)*sh_viam(mt,g,r);

sh_viam(mt,g,r) = viam(mt,g,r)/sum(mt,viam(mt,g,r));
```

where sh_viam(mt,g,r) is the share of imported input use in **mt in tex**

*Imported intermediate input tax of **subset mw of wap** & **subset ml of lea** are calculated similarly:*

```
viaa-viam(mw,g,r) = viaa-viam(wap,g,r)*sh_viam(mw,g,r);

sh_viam(mw,g,r) = viam(mw,g,r)/sum(mw,viam(mw,g,r));

viaa-viam(ml,g,r) = viaa-viam(lea,g,r)*sh_viam(ml,g,r);

sh_viam(ml,g,r) = viam(ml,g,r)/sum(ml,viam(ml,g,r));
```

Tax on Domestic Intermediate input use in production:

```
vdaa-vdam(g,gg,r) = VDAA-VDAM(g,gg,r);
```

where ***VDAA-VDAM*** is domestic input tax on g used in gg of r and a file from GTAP10_SAMAC_5_17_8_1_recycle/vdaa-vdam;

*Domestic intermediate input tax of **subset mt of tex** calculated as:*

```
vdaa-vdam(mt,g,r) = vdaa-vdam(tex,g,r)*sh_vdam(mt,g,r);

sh_vdam(mt,g,r) = vdam(mt,g,r)/sum(mt,vdam(mt,g,r));
```

where sh_vdam(mt,g,r) is the share of domestic input use in **mt in tex**

*Domestic intermediate input tax of **subset mw of wap** & **subset ml of lea** are calculated similarly:*

```
vdaa-vdam(mw,g,r) = vdaa-vdam(wap,g,r)*sh_vdam(mw,g,r);

sh_vdam(mw,g,r) = vdam(mw,g,r)/sum(mw,vdam(mw,g,r));

vdaa-vdam(ml,g,r) = vdaa-vdam(lea,g,r)*sh_vdam(ml,g,r);

sh_vdam(ml,g,r) = vdam(ml,g,r)/sum(ml,vdam(ml,g,r));
```

Tax on Factor use in production:

```
evfa-vfm(f,g,r) = EVFA-VFM(f,g,r);
```

where ***EVFA-VFM*** is tax on factor f used in g of r and a file from GTAP10_SAMAC_5_17_8_1_recycle/evfa-vfm;

*Tax on Factor use in **subset mt of tex** calculated as:*

```
evfa-vfm(f,mt,r) = evfa-vfm(f,tex,r)*sh_vfm(f,mt,r);

sh_vfm(f,mt,r) = vfm(f,mt,r)/sum(mt,vfm(f,mt,r));
```

where sh_vfm(f,mt,r) is the share of f use in mt of tex

***Assumption**: tax on factor use in a subset of a set is proportional to size of factor use in the subset of the set*

*Tax on Factor use in **subset mw of wap** and subset ml of lea are calculated in similar fashion:*

```
evfa-vfm(f,mw,r) = evfa-vfm(f,wap,r)*sh_vfm(mw,r);

sh_vfm(f,mw,r) = vfm(f,mw,r)/sum(mw,vfm(f,mw,r));

evfa-vfm(f,ml,r) = evfa-vfm(f,lea,r)*sh_vfm(ml,r);

sh_vfm(f,ml,r) = vfm(f,ml,r)/sum(ml,vfm(f,ml,r));
```

Production Tax:

```
prodtax(r,g) = PRODTAX(g,r);
```

where ***PRODTAX*** is production tax on g of r comes from GTAP10_SAMAC_5_17_8_1_recycle/prodtax;

*Production tax on **subset mt of tex** is calculated as:*

```
prodtax(mt,r) = prodtax(tex,r)*sh_mdinpt(mt,r);

sh_mdinpt(mt,r) =
(vdam(mt,r)+viam(mt,r))/sum(mt,(vdam(mt,r)+viam(mt,r)));
```

where sh_subdinpt(mt,r) is the share of all input use in mt of tex

***Assumption**: tax on production in a subset of a set is proportional to size of input use in the subset of the set*

*Production tax in **subset mw of wap** and **subset ml of lea** are calculated in similar fashion:*

```
prodtax(mw,r) = prodtax(wap,r)*sh_mdinpt(mw,r);

sh_mdinpt(mw,r) =
(vdam(mw,r)+viam(mw,r))/sum(mw,(vdam(mw,r)+viam(mw,r)));

prodtax(ml,r) = prodtax(lea,r)*sh_mdinpt(ml,r);

sh_mdinpt(ml,r) =
(vdam(ml,r)+viam(ml,r))/sum(ml,(vdam(ml,r)+viam(ml,r)));
```

Total Domestic Output Value:

```
vom(n, r)= sum(nn, viam(nn,n, r)+vdam(nn,n, r)+sum(f,vfm(f,n,r)) +
viaa-viam(nn,n, r)+vdaa-vdam(nn,n, r)+sum(f, evfa-vfm(f,n,r)))
```

where vom of each n is the sum of domestic and imported intermediates, factor inputs at agent prices plus production taxes.

Tax and subsidy on Export:

```
vxwd-vxmd(r,rr,g) = VXWD-VXMD(r,rr,g);
```

where VXWD-VWMD export tax and subsidy value by s of r origin to rr destination comes from GTAP10_SAMAC_5_17_8_1_recycle/prodtax;

*Export tax/subsidy on **subset mt of tex** is calculated as:*

```
vxwd-vxmd(r,rr,mt) = vxwd_vxmd(r,rr,tex)*sh_vxwd(r,rr,mt);

sh_vxwd(r,rr,mt) = vxwd(r,rr,mt)*sum(mt, vxwd(r,rr,mt));
```

where sh_vxwd(r,rr,mt) is the share of export of mt relative to export of tex from r to rr

***Assumption**: export tax minus subsidy of a commodity of subset mt is proportional to the export of mt relative to size of tex*

*Export tax in **subset mw of wap** and **subset ml of lea** are calculated in similar fashion:*

```
vxwd-vxmd(r,rr,mw) = vxwd_vxmd(r,rr,wap)*sh_vxwd(r,rr,mw);

sh_vxwd(r,rr,mw) = vxwd(r,rr,mw)*sum(mw, vxwd(r,rr,mw));

vxwd-vxmd(r,rr,ml) = vxwd_vxmd(r,rr,lea)*sh_vxwd(r,rr,ml);

sh_vxwd(r,rr,ml) = vxwd(r,rr,ml)*sum(ml, vxwd(r,rr,ml));
```

Transport services associated with international trade:

```
vst(n,r) = VST(n,r);
```

where VST transport service used by n of r from GTAP10_SAMAC_5_17_8_1_recycle/vst;

Export:

```
vxwd(r,rr,g) = VXWD(r,rr,g);
```

where VXWD is export of n from r to rr comes from GTAP10_SAMAC_5_17_8_1_recycle/vxwd;

```
vxwd(r,rr,m) = export(r,rr,m);
```

where ***export*** is export value of m from r to rr from regional SUT/IOTs.

Consumption of domestic commodities by private sector:

```
vdpm (n,r) = vom(n,r)+sum(rr,vxwd-vxmd(n,r,rr)) * sh_dcons_p(n,r);
```

where ***sh_dcons_p*** is share of consumption of m by private sector

```
sh_dcons_p (g,r) =vdpm(g,r)/ [sum(gg,vdam(g,gg,r)) +vdpm(g,r)
+vdgm(g,r) +vdim(g,r) +sum(rr,vxwd(g,r,rr))];

sh_dcons_p (m,r) =priv_dcons(m,r)/ [sum(mm,act_dcons(m,mm,r))
+priv_dcons(m,r)+gov_dcons(m,r) +inv_dcons(m,r)
+sum(rr,exp_d(m,r,rr))];
```

Consumption data for m set of subsectors comes directly from raw IOT/SUTs; see details in GTAP10_SAMAC_5_17_8_1_disagg/cons

Consumption of domestic commodities by government:

```
vdgm (n,r) = vom(n,r)+sum(rr,vxwd-vxmd(n,r,rr)) * sh_dcons_g(n,r);
```

where ***sh_dcons_g*** is share of consumption of m by government

```
sh_dcons_g (g,r) =vdgm(g,r)/ [sum(gg,vdam(g,gg,r)) +vdpm(g,r)
+vdgm(g,r) +vdim(g,r) +sum(rr,vxwd(g,r,rr))];

sh_dcons_p (m,r) =gov_dcons(m,r)/ [sum(mm,act_dcons(m,mm,r))
+priv_dcons(m,r)+gov_dcons(m,r) +inv_dcons(m,r)
+sum(rr,exp_d(m,r,rr))];
```

Consumption data for m set of subsectors comes directly from raw IOT/SUTs; see details in GTAP10_SAMAC_5_17_8_1_disagg/cons

Consumption of domestic commodities by investment sector:

```
vdim (n,r) = vom(n,r)+sum(rr,vxwd-vxmd(n,r,rr)) * sh_dcons_i(n,r);
```

where ***sh_dcons_i*** is share of consumption of m by investment sector

```
sh_dcons_i (g,r) =vdim(g,r)/ [sum(gg,vdam(g,gg,r)) +vdpm(g,r)
+vdgm(g,r) +vdim(g,r) +sum(rr,vxwd(g,r,rr))];

sh_dcons_i (m,r) =inv_dcons(m,r)/ [sum(mm,act_dcons(m,mm,r))
+priv_dcons(m,r)+gov_dcons(m,r) +inv_dcons(m,r)
+sum(rr,exp_d(m,r,rr))];
```

Consumption data for m set of subsectors comes directly from raw IOT/SUTs; see details in GTAP10_SAMAC_5_17_8_1_disagg/cons

Imports:

```
viws-vtwr(r,rr,n) = transpose[export(r,rr,n)];
```

where ***export*** is export of n from r to rr (see details in …/vxwd)

Transport Services:

```
vtwr(r,g,rr) = VTWR(r,g,rr);
```

where VTWR is transport of n from r to rr comes from GTAP10_SAMAC_5_17_8_1_recycle/vtwr;

*International transport of **mt** is calculated as:*

```
vtwr(r,mt,rr) = viws-vtwr(r,tex,rr)*trans_mrgn(r,mt,rr);
```

Assumption: transport margin is proportional to the size of mt being transported to r from origin rr:

```
trans_mrgn(r,mt,rr)= viws_vtwr(r,mt,rr)/sum(mt,viws_vtwr(r,mt,rr));
```

*Export tax in **subset mw of wap** and **subset ml of lea** are calculated in similar fashion:*

```
vtwr(r,mw,rr) = viws-vtwr(r,wap,rr)*trans_mrgn(r,mw,rr);

trans_mrgn(r,mw,rr)= viws_vtwr(r,mw,rr)/sum(mw,viws_vtwr(r,mw,rr));

vtwr(r,ml,rr) = viws-vtwr(r,lea,rr)*trans_mrgn(r,ml,rr);

trans_mrgn(r,ml,rr)= viws_vtwr(r,ml,rr)/sum(ml,viws_vtwr(r,ml,rr));
```

Import Tariffs:

```
vims-viws(r,g,rr) = VIMS-VIWS(r,g,rr);
```

where VIMS-VIWS is import tariff on g of r origin to rr destination comes from GTAP10_SAMAC_5_17_8_1_recycle/vims_viws;

*Import Tariff on **subset mt** is calculated as:*

```
vims-viws(r,rr,mt) = vims_viws(r,rr,tex)*sh_vims_viws(r,rr,mt);

sh_vims_viws(r,rr,mt) = viws-vtwr(r,rr,mt)*sum(mt, viws-
vtwr(r,rr,mt));
```

where sh_vims_viws(r,rr,mt) is the share of import of mt relative to import of tex from r to rr

***Assumption**: import tariff applied on a commodity mt is proportional to the import size of mt relative to size of tex*

*Import tariff on **mw of wap** and on **ml of lea** are calculated in similar fashion:*

```
vims-viws(r,rr,mw) = vims_viws(r,rr,wap)*sh_vims_viws(r,rr,mw);

sh_vims_viws(r,rr,mw) = viws-vtwr(r,rr,mw)*sum(mw, viws-
vtwr(r,rr,mw));

vims-viws(r,rr,ml) = vims_viws(r,rr,lea)*sh_vims_viws(r,rr,ml);

sh_vims_viws(r,rr,ml) = viws-vtwr(r,rr,ml)*sum(ml, viws-
vtwr(r,rr,ml));
```

Consumption of imported commodities by private sector:

```
vipm (j,r) = [sum(rr,(vims-viws(r,rr,n))+vtwr(r,rr,n)+(viws-
vtwr(r,rr,n))) - sum(nn,viam(r,n,nn))]*sh_mcons_p (n,r) ;
```

where ***sh_mcons_p*** is share of consumption of m by private sector

```
sh_mcons_p (g,r) =vipm(g,r)/ [sum(gg, vipm(r,g) -vigm(r,g) -
viim(r,g)];

sh_mcons_p (m,r) =priv_mcons(m,r)/ [priv_mcons(m,r)+gov_mcons(m,r)
+inv_mcons(m,r) ];
```

Consumption data for imported m set of subsectors comes directly from raw IOT/SUTs; see details in GTAP10_SAMAC_5_17_8_1_disagg/cons

Consumption of imported commodities by government:

```
vigm (j,r) = [sum(rr,(vims-viws(r,rr,n))+vtwr(r,rr,n)+(viws-
vtwr(r,rr,n))) - sum(nn,viam(r,n,nn))]*sh_mcons_g (n,r) ;
```

where ***sh_mcons_g*** is share of consumption of m by government

```
sh_mcons_g (g,r) =vigm(g,r)/ [sum(gg, vipm(r,g) -vigm(r,g) -
viim(r,g)];

sh_mcons_g (m,r) =gov_mcons(m,r)/ [priv_mcons(m,r)+gov_mcons(m,r)
+inv_mcons(m,r) ];
```

Consumption data for imported m set of subsectors comes directly from raw IOT/SUTs; see details in GTAP10_SAMAC_5_17_8_1_disagg/cons

Consumption of imported commodities by investment sector:

```
viim (j,r) = [sum(rr,(vims-viws(r,rr,n))+vtwr(r,rr,n)+(viws-
vtwr(r,rr,n))) - sum(nn,viam(r,n,nn))]*sh_mcons_i (n,r) ;
```

where ***sh_mcons_i*** is share of consumption of m by investment sector

```
sh_mcons_i (g,r) =viim(g,r)/ [sum(gg, vipm(r,g) -vigm(r,g) -
viim(r,g)];

sh_mcons_i (m,r) =inv_mcons(m,r)/ [priv_mcons(m,r)+gov_mcons(m,r)
+inv_mcons(m,r) ];
```

Consumption data for imported m set of subsectors comes directly from raw IOT/SUTs; see details in GTAP10_SAMAC_5_17_8_1_disagg/cons

Disposable Income

```
evoa-vdep(f,r) = sum(c,vfm(f,c,r)) - (ptaxfact(f,r)+vdep(f,r));
```

where **evoa-vdep** is total factor income minus capital depreciation and income tax revenue of f in each r;

Income Tax

```
ptaxfact(f,r) = PTAXFACT(f,r);
```

where PTAXFACT is income tax applied on f of r file comes from GTAP10_SAMAC_5_17_8_1_recycle/ptaxfact

Capital Depreciation

```
vdep(f,r) = VDEP(f,r);
```

where VDEP is transfers to capital accumulation funds in each r; file comes from GTAP10_SAMAC_5_17_8_1_recycle/ptaxfact

Regional income of households

```
yh (r) = sum(f, evoa-vdep (f,r)) + sum(n, tmtax (n,r)) +sum(n ,
tetax(n,r)) +sum(n , istax(n,r) +dstax(n,r)) +sum(f, ftax(f,r))
+ptax(r) +dtax(r) - yg(r) -save(r)
```

where **yh** is total income including earnings and tax/tariff revenues from all sources minus government purchases and transfers to regional savings fund

Regional government's income

```
yg (r) = YG(r)
```

where YG is part of regional income used by government of each r; file comes from GTAP10_SAMAC_5_17_8_1_recycle/yg

Regional savings

```
save (r) = SAVE(r)
```

where SAVE is a part of regional income saved by each r; file comes from GTAP10_SAMAC_5_17_8_1_recycle/save

Import Tariff Revenue

```
tmtax (r,rr) = sum(n,viws-vims(r,rr,n))
```

where **tmtax** is total amount of import tariff over all n collected by r and applied on rr;

Export Tax Revenue

```
tetax (r,rr) = sum(n,vxwd-vxmd(r,rr,n))
```

where **tetax** is total amount of export tax collected by r applied on exports to rr;

Imported Commodity Sales Tax Revenue

```
istax (r,n) =vipa_vipm(r,n)+viga_vigm(r,n)+viia_viim(r,n)+
sum(n,viaa_viam(r,n,nn))
```

where **istax** is total amount of sales tax collected in r from sales of imported n ;

Domestic Commodity Sales Tax Revenue

```
dstax (r,n) =vdpa_vdpm(r,n)+vdga_vdgm(r,n)+vdia_vdim(r,n)+
sum(n,vdaa_vdam(r,n,nn))
```

where **dstax** is total amount of sales tax collected in r from sales of domestic n ;

Factor Use Tax Revenue

```
ftax (f,r) = sum(n,evfa-vfm(f,n,r));
```

where **ftax** is total amount of tax collected from use of f in production in r ;

Production Tax Revenue

```
ptax (r) = sum(n,prodtax(r,n));
```

where **ptax** is total amount of production tax collected in r ;

Production Tax Revenue

```
ptax (r) = sum(n,prodtax(r,n));
```

where **ptax** is total amount of production tax collected in r ;

Sales Tax on Imported Goods Consumption by Private sector

```
vipa-vipm (g, r) = VIPA-VIPM (g,r);
```

where VIPA-VIPM is sales tax on finished imported goods consumed by private sector in r; file comes from GTAP10_SAMAC_5_17_8_1_recycle/vipa_vipm

```
vipa-vipm (mt, r) = vipm(tex,r)* sh_istax_prate(mt,r);
```

where sh_istax_prate is the share of tax for ***mt*** in r is equal to

```
sh_istax_prate(mt,r) = vipm(mt,r) / sum(mt,vipm(mt,r));
```

Assumption: rate of sales tax on finished imported ***mt*** is proportional to the size of ***mt*** in ***tex***

Sales tax on imported ***mw*** and ***ml*** subsets are calculated in similar fashion

```
vipa-vipm (mw, r) = vipm(wap,r)* sh_istax_prate(mw,r);

sh_istax_prate(mw,r) = vipm(mw,r) / sum(mw,vipm(mw,r));

vipa-vipm (ml, r) = vipm(lea,r)* sh_istax_prate(ml,r);

sh_istax_prate(ml,r) = vipm(ml,r) / sum(ml,vipm(ml,r));
```

Sales Tax on Domestic Goods Consumption by Private sector

```
vdpa-vdpm (g, r) = VDPA-VDPM (g,r);
```

where VDPA-VDPM is sales tax on finished domestic goods consumed by private sector in r; file comes from GTAP10_SAMAC_5_17_8_1_recycle/vdpa_vdpm

```
vdpa-vdpm (mt, r) = vdpm(tex,r)* sh_dstax_prate(mt,r);
```

where sh_dstax_prate is the share of tax for ***mt*** in r is equal to

```
sh_dstax_prate(mt,r) = vdpm(mt,r) / sum(mt,vdpm(mt,r));
```

Assumption: rate of sales tax on finished domestic ***mt*** is proportional to the size of ***mt*** in ***tex***

Sales tax on domestic ***mw*** and ***ml*** subsets are calculated in similar fashion

```
vdpa-vdpm (mw, r) = vdpm(wap,r)* sh_dstax_prate(mw,r);

sh_dstax_prate(mw,r) = vdpm(mw,r) / sum(mw,vdpm(mw,r));

vdpa-vdpm (ml, r) = vdpm(lea,r)* sh_dstax_prate(ml,r);

sh_dstax_prate(ml,r) = vdpm(ml,r) / sum(ml,vdpm(ml,r));
```

Sales Tax on Imported Goods Consumption by Government

```
viga-vigm (g, r) = VIGA-VIGM (g,r);
```

where VIGA-VIGM is sales tax on finished imported goods consumed by government in r; file comes from GTAP10_SAMAC_5_17_8_1_recycle/viga_vigm

```
viga-vigm (mt, r) = vigm(tex,r)* sh_istax_grate(mt,r);
```

where sh_istax_grate is the share of tax for ***mt*** in r is equal to

```
sh_istax_grate(mt,r) = vigm(mt,r) / sum(mt,vigm(mt,r));
```

Assumption: rate of sales tax on finished imported ***mt*** is proportional to the size of ***mt*** in ***tex***

Sales tax on imported ***mw*** and ***ml*** subsets are calculated in similar fashion

```
viga-vigm (mw, r) = vigm(wap,r)* sh_istax_grate(mw,r);

sh_istax_grate(mw,r) = vigm(mw,r) / sum(mw,vigm(mw,r));

viga-vigm (ml, r) = vigm(lea,r)* sh_istax_grate(ml,r);

sh_istax_grate(ml,r) = vigm(ml,r) / sum(ml,vigm(ml,r));
```

Sales Tax on Domestic Goods Consumption by Government

```
vdga-vdgm (g, r) = VDGA-VDGM (g,r);
```

where VDGA-VDGM is sales tax on finished domestic goods consumed by government in r; file comes from GTAP10_SAMAC_5_17_8_1_recycle/vdga_vdgm

```
vdga-vdgm (mt, r) = vdgm(tex,r)* sh_dstax_grate(mt,r);
```

where sh_dstax_grate is the share of tax for ***mt*** in r is equal to

```
sh_dstax_grate(mt,r) = vdgm(mt,r) / sum(mt,vdgm(mt,r));
```

Assumption: rate of sales tax on finished domestic ***mt*** is proportional to the size of ***mt*** in ***tex***

Sales tax on domestic ***mw*** and ***ml*** subsets are calculated in similar fashion

```
vdga-vdgm (mw, r) = vdgm(wap,r)* sh_dstax_grate(mw,r);

sh_dstax_grate(mw,r) = vdgm(mw,r) / sum(mw,vdgm(mw,r));

vdga-vdgm (ml, r) = vdgm(lea,r)* sh_dstax_grate(ml,r);
```

```
sh_dstax_grate(ml,r) = vdgm(ml,r) / sum(ml,vdgm(ml,r));
```

Sales Tax on Imported Goods Consumption by Investment sector

```
viia-viim (g, r) = VIIA-VIIM (g,r);
```

where VIIA-VIIM is sales tax on finished imported goods consumed by investment sector of r; file comes from GTAP10_SAMAC_5_17_8_1_recycle/vila_vilm

```
viia-viim (mt, r) = viim(tex,r)* sh_istax_irate(mt,r);
```

where sh_istax_irate is the share of tax for ***mt*** in r is equal to

```
sh_istax_irate(mt,r) = viim(mt,r) / sum(mt,viim(mt,r));
```

Assumption: rate of sales tax on finished imported ***mt*** is proportional to the size of ***mt*** in ***tex***

Sales tax on imported ***mw*** and ***ml*** subsets are calculated in similar fashion

```
viia-viim (mw, r) = viim(wap,r)* sh_istax_irate(mw,r);

sh_istax_irate(mw,r) = viim(mw,r) / sum(mw,viim(mw,r));

viia-viim (ml, r) = viim(lea,r)* sh_istax_irate(ml,r);

sh_istax_irate(ml,r) = viim(ml,r) / sum(ml,viim(ml,r));
```

Sales Tax on Domestic Goods Consumption by Investment sector

```
vdia-vdim (g, r) = VDIA-VDIM (g,r);
```

where VDIA-VDIM is sales tax on finished domestic goods consumed by investment sector in r; file comes from GTAP10_SAMAC_5_17_8_1_recycle/vdia_vdim

```
vdia-vdim (mt, r) = vdim(tex,r)* sh_dstax_irate(mt,r);
```

where sh_dstax_irate is the share of tax for ***mt*** in r is equal to

```
sh_dstax_irate(mt,r) = vdim(mt,r) / sum(mt,vdim(mt,r));
```

Assumption: rate of sales tax on finished domestic ***mt*** is proportional to the size of ***mt*** in ***tex***

Sales tax on domestic ***mw*** and ***ml*** subsets are calculated in similar fashion

```
vdia-vdim (mw, r) = vdim(wap,r)* sh_dstax_irate(mw,r);

sh_dstax_irate(mw,r) = vdim(mw,r) / sum(mw,vdim(mw,r));
```

```
vdia-vdim (ml, r) = vdim(lea,r)* sh_dstax_irate(ml,r);

sh_dstax_irate(ml,r) = vdim(ml,r) / sum(ml,vdim(ml,r));
```

Trade balance in Investment goods market

```
ptaxinv (r) = PTAXINV (r);
```

where PTAXINV from file GTAPDATA header "PTAXINV", account to balance investment goods market in r;

Trade balance in transport services market

```
vtwr-vst (r) = vtwr2(r)-VST (r);
```

where vtwr2 is international transport service for each region

Trade Balance for Goods Market

```
viws-vtwr-vxmd (r, rr) = sum(c, viws-vtwr (c, r)) - sum(c, vxmd (c, r))
```

where **viws-vtwr-vxmd** is net difference between imports and exports for finished goods market in r;

International Transport Services

```
vtwr2 (r, rr) = sum(c, vtwr (c, r,rr))
```

where **vtwr2** (r, rr) is international transport service provided by r for goods transport from rr

Sector 4: Adding Gender and Employment Satellites

Data File: An excel file named "**GTAP10_SAMAC_5_17_8_1_gender.xls**" contains the satellite gender and employment data. There are five separate satellite data for each five regional SAMs (sheet names are **"chn-rac", "ind-rac", "usa-rac", "eur-rac"**, and **"row-rac"**).

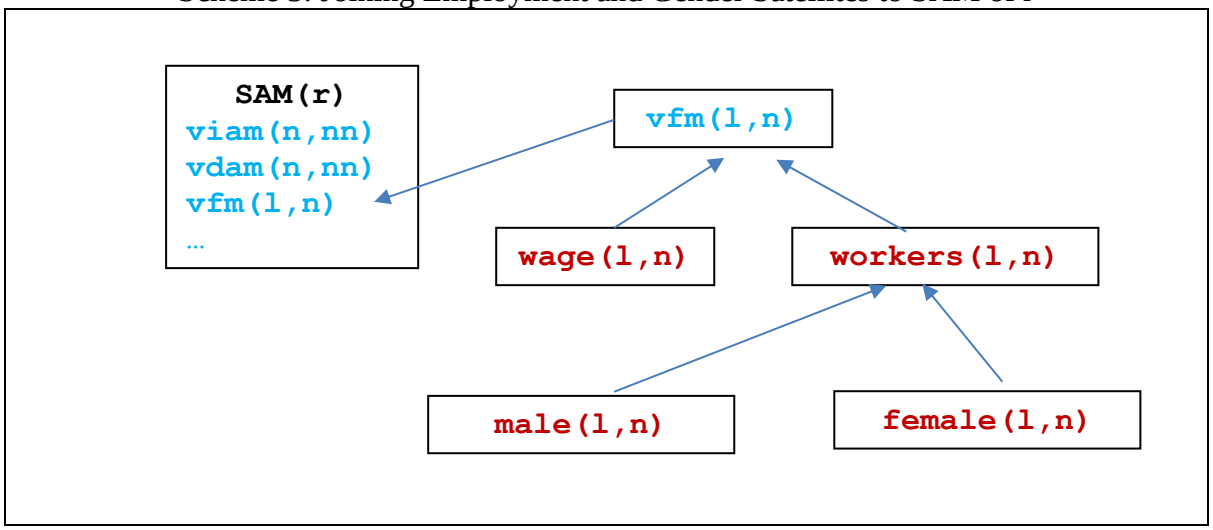
Data Dimensions: After the disaggregation process, final five SAMs have 27 sectors, 5 regions and 8 factors of production. Following notations is used to represent each set/subset:

```
n (nn) - set of sectors;
r (rr) - set of regions;
f (ff) - set of factors;
     nl (nll) - subset of 3 non-labour factors;
     l (ll) - subset of 5 labour factors;
          lf (lff) - subsubset of female labour only;
          lm (lmm) - subsubset of male labour only;
```

Sheet named "**dim**" of the file provide the full list of regions, sectors and factors in use.

Ad-hoc Satellites: The logic is that the satellite gender and employment data is then joined to the existing SAM in ad-hoc fashion without disturbing balanced among accounts. This is represented in Scheme 3 below. SAM contains a number of accounts. Labour related account is vfm(f,n) = vfm(nl,n)+vfm(l,n), where **vfm(l,n)** is labour ***l*** type use in sector ***n*** production in region ***r***. Since vfm(l,n) is in other words the *value* added table given in nominal terms, it should be a product of average weighted **wage** by total employment (i.e. **workers**). Total number of workers is a combination of **male** and **female** workers.

Scheme 3: Joining Employment and Gender Satellites to SAM of r



Data Sources: The source is International Labour Organisation's (ILO) employment datasets. There are two files we use; one provides number of employees by labour category (occupations) and gender for each region (sheet "**ilo(sec)**"), and the other file provides

number of employees by sector and gender (sheet "**ilo(lab)**"). See Table below providing the labour categories (occupations)

Table: Occupations in ILO matched with SAM labour categories

SAM labor categories			ILO occupations	
No	Code	Description		
1	lnd	Land		
2	clk	Clerks	4. Clerical support workers	
3	shw	Service/Shop workers	5. Service and sales workers	7. Craft and related trades workers
4	tch	Technicians/AssocProfessional	2. Professionals	3. Technicians and associate professionals
5	mng	Officials and Managers	1. Managers	
6	agw	Agricultural and Unskilled	8. Plant and machine operators, and assemblers	96. Elementary occupations and skilled agricultural, forestry and fishery workers
7	capital	Capital		
8	nrs	Natural Resources		

RAC-method: First, we standardise employment data (to be consistent with labour categories in SAM) and separate male from female workers. Next, we obtain employment table with total number of workers by labour category and by sector (this is necessary dimension as vfm(l,n) also comes in such dimension). Unfortunately, ILO files provide number of workers by either labour category or by sectors, not both at once. Thus, a method called **RAC** (shortened from balancing matrixes by **R**ows **A**nd then by **C**olumns) is used to form the employment tables with both dimensions. This is an iterative method to adjust numbers in each element of a matrix to satisfy total values by rows and by columns (see for instance Fofana, Lemelin and Cockburn (2005) paper[6] which explains the RAC methodology in greater detail). Using RAC, female and male employment tables are obtained and merged to form total employment tables. Details are in sheets named **"chn-rac", "ind-rac", "usa-rac", "eur-rac"**, and **"row-rac"**).

Conclusion

In real life we observe that not all the goods come to the end of their life after its first use. This is especially true to fashion goods which are recycled, upcycled, or downcycled. Most of fashion products through end up in landfills. Developing SAMs that takes into count such elements for CGE work requires a large amount of data and consistency. Building a SAM from GTAP datasets is not as trivial job as it they look from Section 1, however, developing economic cycles (Section 2) and decomposing some sectors (Section 3) is not a straightforward job as it may look. There are challenges arise related to data quality/shape/coverage if any type of data is available. If it is not, then this is up to accuracy of methods/assumptions/techniques employed to generate necessary data. Either way recorded or generate data should then go though some adjustments to *fit* the bigger picture and comply with necessary balances in the SAMs. This document provides technical details of how circular fashion data (SAMs for the CGE model) are formed and put together. It can be treated as an instruction to the excel data files. However, it explains the type of methodology, data sources, and assumptions used to form the SAMs. Finally, this document signifies the end of the data related work. Next is the modelling stage.

[6] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2439868

Appendix

This report provides technical details of constructed datasets for the project. The following four excel files are included as appendixes this report.

1) **GTAP10_SAMAC_5_17_8_1.xls**
2) **GTAP10_SAMAC_5_17_8_1_recycle.xls**
3) **GTAP10_SAMAC_5_17_8_1_disagg.xls**
4) **GTAP10_SAMAC_5_17_8_1_gender.xls**