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Fit2GTAP: Replacing country data in the GTAP data base

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Abstract

This paper shows how to incorporate (new) regional information in the existing GTAP database using a program called Fit2GTAP. This can be especially useful, if one has to report figures that are completely consistent with the original data for the replaced regional GTAP data.

1 Introduction

GTAP provides researchers around the world with a fully documented, publicly available, global data base.[1] The current release is GTAP 7 with base year 2004. The database combines country input-output tables, bilateral trade, transport and protection data. It contains information on production and trade for 112 regions or countries, 57 sectors and 5 primary factors.[2].

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[1] For more information on GTAP see https://www.gtap.agecon.purdue.edu/.

[2] A list with regions, sectors and factors can be found in the Appendix

GTAP emphasizes that the GTAP data base is not a repository of Input-Output tables.[3] The data used to construct the data base not only comes from regional IOTs but also from other sources like trade databases. Many IOTs do not have the same sectoral detail or are based on another year as the actual GTAP database.

For achieving overall regional consistency, the original data is usually further disaggregated using information from other regions, missing data is filled in and part of the data is replaced.[4] In this process performed by GTAP it can happen that entries of the original IOT are replaced by more reliable data or data consistent with other information. If the original data is based on a prior year the data is scaled using macro figures. At the end of this process the whole data set is adjusted using an algorithm that ensures consistency of the whole data set.

Switzerland might be a good example for the necessary adjustments: The sectoral disaggregation of the original data is 22 instead of 57 sectors, there is no distinction between imports and domestic demand, no disaggregation of the value added, and the base year of the data is 2005 instead of 2004. One can imagine that this together with the replacement of the trade and tariff data and the consistency adjustments will lead to data for Switzerland that deviate from the original IOT.

The discrepancy between the original regional data and the final GTAP data can be a problem in regional policy analysis. Not only the reported figures like sectoral value added and intermediate demand might differ from the official figures but also the sector specific effects of the policy itself might give different results, because the level of taxes in the GTAP data base differ from the values of the original IOT. It can also happen that the researcher wants to use a more actual IOT than the one used in the GTAP data base.

In this paper we describe a program for replacing the regional information for a specific country or region in the GTAP 7 data base by original regional data (for example the IOT). Note that we do not say that the GTAP data is wrong and the original IOT data is better. In the case of Switzerland the IOT is not based on surveys but on foreign IOTs and macro figures for Switzerland, which means that the IOT itself will certainly not reflect the "real" data properly. The program to replace the regional data by the original data is developed out of the necessity to present figures that are consistent with the national statistics.

We also like to stress that this program will hardly keep researchers from providing GTAP with new IOTs for their region. Researchers who will use the program have to prepare their original IOT in such a way that they will only be a small step away from the GTAP requirements for providing a regional IOT. This also means that other researchers will have to do some coding before they can

[3] See Narayanan and Walmsley (2008).

[4] See Narayanan and Walmsley (2008) for a description of the procedures used to adjust the data.

use the program (especially the part of preparing the original data).

The main idea of the program is to replace the original data for a specific region from GTAP 7 with the original regional data, fix the replaced data and adjust all other data for the other countries using a simple least square procedure. The package has been tested for Switzerland with GTAP 7.1. The Swiss IOT used is a symmetric version of the 2005 IOT with additional matrices for the taxes on a good by good basis. The package is written in GAMS.[5] It requires a license for the GTAP7 data base and GAMS with a NLP solver (for example PathNLP, Minos or Conopt). The program code will be available to interested researchers.

The program consists of several steps (see figure 1):

1: Get the GTAP data and the regional IOT and aggregate: In a first step, the original GTAP data is transferred from the HAR-file to a Gams readable GDX-file. The aggregated GTAP data set is stored in header-array files identified by the suffix ".har". The tools developed by Horridge and Rutherford allow us to translate the har-files directly to the GAMS data exchange format. Read the regional IOT that will be replaced with the corresponding GTAP-data. This data is usually available in Excel-Format (see for example the IOTs provided by OECD or EUROSTAT) The researcher will have to define a consistent mapping between the IOT and the GTAP sectors. Note that the final version of the database will be in this aggregation and not in the original GTAP sectoral disaggregation.

2: Build symmetric GTAP-IOT: The original IOT data is than prepared in such a way that it is consistent with the GTAP database data. This will allow us to compare the original data with the GTAP data. A report is written on the main differences between the original data and the GTAP data. This allows the researcher to decide if a replacement of the GTAP data is really necessary.

3: Replace data: he GTAP data for the region is replaced by the original data.

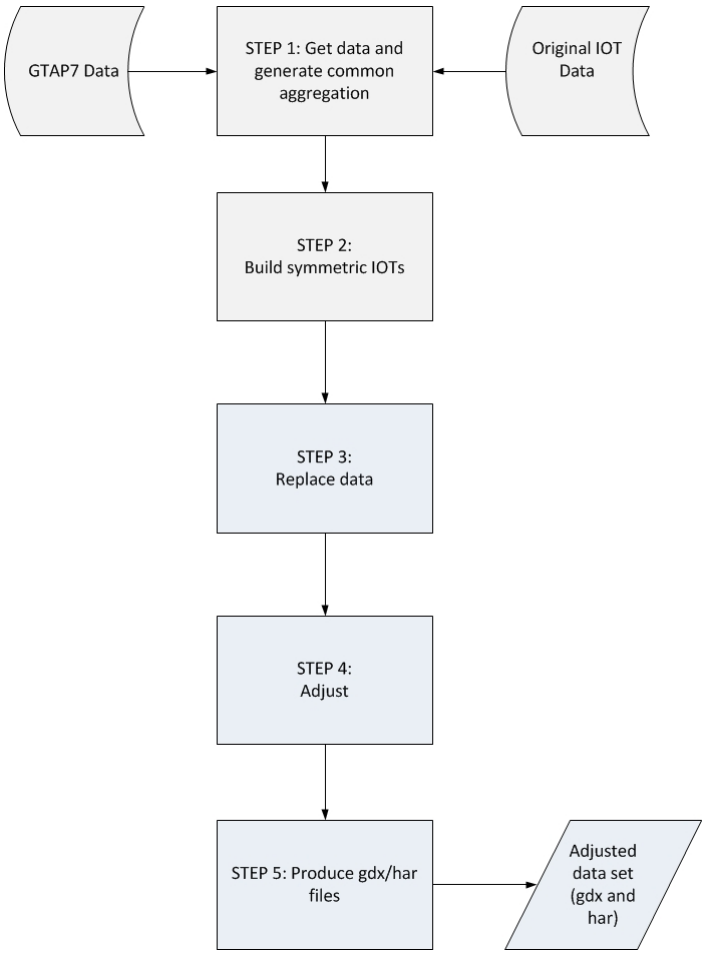
4: Consistency of the new database: An optimization program is used to achieve consistency. The replaced data is fixed and all other entries are free to change. In the new data set the small subset of replaced data will be unchanged and all other data entries will differ. The changes will depend on the relative size of the replaced data. A report is written on the changes in the original GTAP data.

[5] We use GAMS. GAMS is an acronym for General Algebraic Modeling System and is a high-level modeling system for mathematical programming and optimization. It consists of a language compiler and a stable of integrated high-performance solvers. GAMS is tailored for complex, large scale modeling applications, and allows you to build large maintainable models that can be adapted quickly to new situations. For further information see www.gams.com.

5: Produce gdx and har files with the new data: In the final step, the data will be written back to a HAR-file, so it can be used for simulations with GEMPACK (this will be part of the final version of the paper).

Note that the final data will in most cases not be in the full GTAP disaggregation. The level of aggregation depends on the mapping between the original IOT and the GTAP sectors. The final data will be available for the researcher in GTAP-format (HAR-Files) or GAMS-Format (GDX-files).

Figure 1 – Work flow: Steps of the Fit2GTAP procedure



We will to keep the program up-to-date with newer releases of the GTAP data base. The program itself does not run with the previous versions of GTAP, but a good GAMS programmer could adjust the code accordingly. One drawback is that the program code is written in GAMS. We hope that somebody with GEMPACK skills can translate the program, so it also can be used by researchers who solely work with RUNGtap.

The structure of this paper is as follows: Chapter 2 introduces the Fit2GTAP program and shows its use with the example of the Swiss IOT. Chapter 3 concludes with conclusions and further research. The appendix contains information tables with the GTAP factors, sectors and regions as well as the Swiss IOT sectors. In the final version of the paper it will also contain the program code.

We will explain the procedure with the example of the Swiss IOT as described above and an aggregation of two regions (Switzerland and the rest of the world (ROW)). If researchers want to use the code for another region, they should adjust the code accordingly. The final version of the code will allow disaggregations into more regions and a simple switch for choosing the region with the original data.

2 The fit2gtap procedure

2.1 Step 1: Get the GTAP data and the regional IOT and aggregate

Before we can replace the regional data in the GTAP data base with our own regional data, we have to prepare the data of both sources. This means that we have to aggregate the GTAP data and the original IOT data to a common aggregation level.

There are two ways to aggregate the GTAP database: Either we read the full GTAP database into GAMS and use GAMS to aggregate the data, or we use the FlexAgg or GTAPagg tools from GTAP (See for FlexAgg McDougall (2008) and for GTAPagg Horridge (2008).

For the GTAP data we use flexagg, the aggregation utility that comes with the GTAP database. To test the Fit2GTAP package it is easier to aggregate the data to two regions: the home country/region and the rest of the world (ROW). If this runs fine, one can take a more detailed regional aggregation. The aggregated database is saved under the name BaseData and stored in the file BaseData.har. The FlexAgg program produces a zip file with several har (header array) files. We will only use the file BaseData.har.

The aggregated GTAP data set is stored in header-array files identified by the suffix ".har". The tools developed by Horridge and Rutherford[6] allow us to translate the har-files directly to the GAMS data exchange format. This can be done with the following GAMS code under the assumption that the (aggregated) GTAP data set with the har-file "BaseData.har" resides in the subdirectory "data". In the case of Switzerland, the IOT is stored in a simple excel sheet and can be easily imported into Gams.

The Swiss symmetric IOT for the year 2005 (Nathani et al., 2008), which was used for the GTAP 7 Database counts 54 sectors (see table 8 in the Appendix).[7] Unfortunately, the common aggregation level between the GTAP data and the Swiss IOT only counts 22 sectors and one factor (see Table 1 and 2).

For the regional data, we have written a Gams aggregation procedure. This procedure depends

[6] For a description of the tools see Horridge and Rutherford (2003)

[7] A description of the Swiss IOT for the GTAP 7 Database can be found in Nathani et al. (2008).

Table 1 – Mapping from the aggregated Swiss IOT to the aggregated GTAP sectors

Nr	Swiss IOT Sector	Swiss Sector	GTAP sector
1	agr	01, 02, 05	pdr, wht, gro, v_f, osd, c_b, pfb, ocr, ctl, oap, rmk, wol, frs, fsh
2	coa	14	coa, oil, gas, omn
3	nah	15, 16	cmt,omt, vol, mil, pcr, sgr, ofd, b_t
4	tex	17	tex
5	kle	18	wap
6	lea	19	lea
7	pap	21, 22	ppp
8	che	23,24,25	p_c, crp
9	nme	26	nmm
10	met	27, 28	i_s, nfm, fmp
11	mch	20, 29, 30, 31, 32, 33, 36	lum, ele, ome, omf
12	fah	34, 35	mvh, otn
13	ene	40, 41	gdt, ely, wtr
14	bau	45	cns
15	han	37, 50, 51, 52, 55	trd
16	trp	60-63	otp, wtp, atp
17	com	64	cmn
18	fin	65, 66	ofi,isr
19	imo	70	dwe
20	con	71, 72, 73, 74	obs
21	sta	75, 80, 85, 90	osg
21	rdl	91, 92, 93, 95	rdl

Table 2 – Value added mapping

Swiss IOT	GTAP	Description
va	land	Land
va	sklab	Skilled labor
va	unsklab	Unskilled labor
va	capital	Capital
va	natlres	Natural resources

on the form and the aggregation in which the local IOT is available and should be adjusted for use with other regional IOTs.

2.2 Step 3: Build symmetric IOT and report on differences

The GTAP database does not have the structure of a collection of symmetric IOTs. If we want to compare the data of the original IOT with the regional GTAP IOT we therefore first write the GTAP regional tables in the form of regional symmetric IOTs. Usually, the GTAP database contains more detailed information. For example, the Swiss IOT only has information on total use (domestic and imported demand).

The construction of the symmetric IOT for every region in the GTAP database is done with the following equations, where the variable $iot_{*,*,r}$ contains the symmetric IOT for region r.

Factor demands in the IOT are given by:[8]

$$iot_{f,i,r} = vfm_{f,i,r} \tag{1}$$

Imports in the IOT are the sum of the imported intermediate goods ($vifm_{i,j,r}$), the imported private consumption ($vipm_{i,r}$) and the imported governmental consumption ($vigm_{i,r}$):

$$iot_{imp,i,r} = \sum_j (vifm_{i,j,r}) + vipm_{i,r} + vigm_{i,r} \tag{2}$$

Demand for intermediates is given by the total of domestic demand ($vdfm_{i,j,r}$) and imported ($vifm_{i,j,r}$) :

$$iot_{i,j,r} = vdfm_{i,j,r} + vifm_{i,j,r} \tag{3}$$

The same kind of equation is used for the investments:

$$iot_{i,cgd,r} = vdfm_{i,cgds,r} + vifm_{i,cgds,r} \tag{4}$$

The demand of the private households consists also of domestic ($vdpm_{i,r}$) and imported demand ($vipm_{i,r}$):

$$iot_{i,c,r} = vdpm_{i,r} + vipm_{i,r} \tag{5}$$

The demand of the government has the same form:

$$iot_{i,g,r} = vdgm_{i,r} + vigm_{i,r} \tag{6}$$

[8] All definitions of GTAP variables are taken from Hertel (1997, Appendix C Derivatives of the Base Data).

where $vdgm_{i,r}$ is domestic and $vigm_{i,r}$ is imported demand.

In the GTAP database the variable $vst_{i,CHE}$ are subtracted from the original exports at market prices. For Switzerland this means that the exports from the sector "transportation" (trp) are adjusted. Therefore, The exports inclusive of transport costs are given by:

$$iot_{i,exp,r} = \sum_{s} vxmd_{i,r,s} + vst_{i,r} \tag{7}$$

where $vxmd_{i,r,s}$ are the exports valuated at market prices and $vst_{i,r}$ are the transport costs.

Aggregated factor taxes in the symmetric IOT are defined as:

$$iot_{tf,i,r} = \sum_{f} \left(evfa_{f,i,r} - vfm_{f,i,r} \right), \tag{8}$$

where $evfa_{f,i,r}$ and $vfm_{f,i,r}$ is the input of factor f at agent and market prices.

Domestic taxes on intermediate demand and investment, private and governmental demand can be calculated by taking the difference between the value at agent minus the value at market prices:

$$iot_{td,j,r} = \sum_{i} \left(vdfa_{i,j,r} - vdfm_{i,j,r} \right) \tag{9}$$

$$iot_{td,c,r} = \sum_{i} \left(vdpa_{i,r} - vdpm_{i,r} \right) \tag{10}$$

$$iot_{td,g,r} = \sum_{i} \left(vdga_{i,r} - vdgm_{i,r} \right) \tag{11}$$

Import taxes on intermediate demand and investments, private and governmental demand is given by the difference between imports at agent and market prices:

$$iot_{ti,j,r} = \sum_{i} \left(vifa_{i,j,r} - vifm_{i,j,r} \right) \tag{12}$$

$$iot_{ti,c,r} = \sum_{i} \left(vipa_{i,r} - vipm_{i,r} \right) \tag{13}$$

$$iot_{ti,g,r} = \sum_{i} \left(viga_{i,r} - vigm_{i,r} \right) \tag{14}$$

Taxes on output are given by:

$$iot_{to,i,r} = vom_{i,r} - voa_{i,r} \tag{15}$$

where $voa_{i,r}$ is the value of non-savings commodity i output or supplied in region r evaluated at agents' prices and $voa_{i,r}$ the same variable evaluated at market prices:

$$\begin{aligned} voa_{i,r} &= \sum_f evfa_{f,i,r} + \sum_j (vdfa_{j,i,r} + vifa_{i,j,r}) && (16)\\ vdm_{i,r} &= vdpm_{i,r} + vdgm_{i,r} + \sum_j vdfm_{i,j,r} && (17)\\ vom_{i,r} &= vdm_{i,r} + \sum_s vxmd_{i,r,s} + vst_{i,r} && (18)\\ vom_{cgds,r} &= voa_{cgds,r}, && (19) \end{aligned}$$

where $vdm_{i,r}$ is the value of domestic sales of commodity i in region r evaluated at market prices.

Table 3 – Symmetric IOT with GTAP Variables

	Goods	Private Consumption	Government	Investment	Exports
Goods	$vdfm_{i,j,r}$ + $vifm_{i,j,r}$	$vdpm_{i,r}$ + $vipm_{i,r}$	$vdgm_{i,r}$ + $vigm_{i,r}$	$vdfm_{i,cgds,r}$ + $vifm_{i,cgds,r}$	$\sum_s vxmd_{i,r,s}$+ $vst_{i,r}$
Value Added	$vfm_{f,i,r}$				
Factor taxes	$\sum_f(evfa_{f,i,r}$ $-vfm_{f,i,r})$				
Domestic taxes	$\sum_i(vdfa_{i,j,r}$ $-vdfm_{i,j,r})$	$\sum_i(vdpa_{i,r}$ $-vdpm_{i,r})$	$\sum_i(vdga_{i,r}$ $-vdgm_{i,r})$	$\sum_i(vdfa_{i,cgds,r}$ $-vdfm_{i,cgds,r})$	
Output taxes	$vom_{i,r}-$ $voa_{i,r}$				
Tariffs	$\sum_i(vifa_{i,j,r}$ $-vifm_{i,j,r})$	$\sum_i(vipa_{i,r}$ $-vipm_{i,r})$	$\sum_i(viga_{i,r}$ $-vigm_{i,r})$	$\sum_i(vifa_{i,cgds,r}$ $-vifm_{i,cgds,r})$	
Imports	$\sum_j(vifm_{i,j,r})$ $+vipm_{i,r}$ + $vigm_{i,r}$				

The following two tables show the sectoral aggregated symmetric IOT for Switzerland according to the GTAP 7 database (Table 4) and the official Swiss IOT 2005 (Table 5. Because the GTAP data has 2004 as base year and is reported in dollars, we scaled the Swiss data by assuming a scaling

factor equal to the total of sectoral output according to GTAP divided by the same figure from the original Swiss IOT.

Table 4 – Symmetric IOT with GTAP data

	Goods (j)	Private Consumption (c)	Government (g)	Investment ($cgds$)	Exports (exp)	Total
Goods (i)	223'569	205'545	41'594	72'218	166'459	709'385
Value Added (f)	289'075					289'075
Factor taxes (tf)	51'197					51'197
Domestic taxes (td)	1'717	4'881	701	1'849		9'148
Output taxes (to)	-250					-250
Tariffs (ti)	1'226	3'797	10	522		5'554
Imports (imp)	142'851					142'851
Total	709'385	214'222	42'305	74'589	166'459	

Table 5 – Original Symmetric Swiss IOT

	Goods (j)	Private Consumption (c)	Government (g)	Investment ($cgds$)	Exports (exp)	Total
Goods (i)	234'258	197'639	39'117	71'916	166'455	709'385
Value Added (f)	323'268					323'268
Factor taxes (tf)	0					0
Domestic taxes (td)	3'785	6'846	689	2'102		13'422
Output taxes (to)	185					185
Tariffs (ti)	2'586	1'540		69		4'195
Imports (imp)	145'304					145'304
Total	709'385	206'025	39'806	74'088	166'455	0

Table 6 shows the differences between the Swiss GTAP and the original IOT. The differences for the main aggregates (with the exception of taxes) are not big (a maximum of 6% for governmental consumption). The differences for the aggregates of the taxes, however, differ extremely.

Table 6 – Percentage difference between GTAP and Swiss original data

	Goods (j)	Private Consumption (c)	Government (g)	Investment ($cgds$)	Exports (exp)	Total
Goods (i)	4.8%	-3.8%	-6.0%	-0.4%	0.0%	0.0%
Value Added (f)	-5.0%*					11.8%
Factor taxes (tf)	n.a.					
Domestic taxes (td)	120.4%	40.3%	-1.8%	13.7%		46.7%
Output taxes (to)	-174.1%					-174.1%
Tariffs (ti)	110.9%	-59.4%	n.a.	-86.8%		-24.5%
Imports (imp)	1.7%					1.7%
Total	0.0%	-3.8%	-5.9%	-0.7%	0.0%	0.0%

* Sum of value added and factor taxes

An analysis of the sectoral differences, which will not be discussed here, show very high discrepancies for some of the sectors.[9] The differences in aggregates and sectoral figures clearly show the

[9] At the time of writing there is discussion going on with GTAP on why these differences are so big.

problems, when the Swiss researcher wants to report absolute figures in a study: the GTAP figures are not equal to the Swiss figures reported by the Swiss Federal Office of Statistics. Here we repeat, that this does not mean that the GTAP figures are wrong. In the case of Switzerland the IOT is not based on surveys but on foreign IOTs and macro figures for Switzerland for the year 2005, which means that the IOT itself will certainly not reflect the "real" data properly.

2.3 Step 4: Replace data

After building symmetric IOTs for every region, we have to replace the GTAP data for Switzerland (Table 4 at the sectoral level) by the original symmetric IOT (Table 5, also at the sectoral level).

2.4 Step 5: Consistency of the new database

If the symmetric IOT with the original data is consistent with the GTAP formulation of all the data, we can proceed to the next step, which is getting the data consistent.

Although we replaced in the previous step all the GTAP data for Switzerland, the trade data between Switzerland and the ROW is the only part that matters. All other data from the original IOT are domestic data and have no relation to data from the ROW.

The trade data in GTAP is saved in several variables [10]:

- $vxmd_{i,r,s}$: value of exports of commodity i from source r to destination s valued at (exporter's) market prices,
- $vxwd_{i,r,s}$: value of exports of commodity i from source r to destination s evaluated at world (fob) prices,
- $vims_{i,r,s}$: value of imports of commodity i from source r to destination s valued at importer's market prices,
- $viws_{i,r,s}$: value of import of commodity i from source r to destination s evaluated at world (cif) prices,
- $vtwr_{i,r,s}$: value of transportation services associated with the shipment of commodity i form source r to destination s (*fob* - *cif* margin)
- $vst_{i,s}$: value of sales of commodity i to the international transport sector in region r evaluated at market prices.

[10] The acronyms use the following system: v stands for value, x and i for export and import, m and w for domestic market and world market price and d and s for demand and supply

The tariffs and taxes on the commodities are calculated by taking differences of two variables. The tariffs for imported goods i from Switzerland are given by:

$$t_i^{imp} = vims_{i,ROW,CHE} - viws_{i,ROW,CHE}, \tag{20}$$

and the taxes on exports from Switzerland to the ROW by:

$$t_i^{exp} = vxwd_{i,CHE,ROW} - viws_{i,CHE,ROW} \tag{21}$$

The total trade margins for international transportation at world prices of good i from region r to s is given by the sum over j of the trade margins at world market prices $wtwr_{i,j,r,s}$:

$$vst_{i,r} = \sum_{r,j} vtwr_{i,j,s,r}. \tag{22}$$

The relations between the variables are given in table 7. The first column is Switzerland and the first vertical line is the border with the surrounding countries. In this column all prices are domestic prices. This is also true for the last column with ROW. In between is the transportation area, where the goods are shipped from Switzerland to the ROW and vice versa and goods are valued in world market prices.

The first block shows the relations between Swiss imports from the rest of the world and the second block the Swiss exports to the ROW (the main difference is the order of the indices). Note that the transport costs are paid by the importing country. The variables in read are taken from the original data and are fixed; the other variables are taken from the GTAP data base and have to be adjusted to reach consistency.

Table 7 – Exports and imports from Switzerland to and from ROW (first column data from the original IOT; all other data from GTAP)

IOT	GTAP-Data			
CHE imports	transportation			ROW exports
$vims_{i,ROW,CHE} + t_i^{imp}$	$= viws_{i,ROW,CHE}$ $\downarrow$ $viws_{i,ROW,CHE}$	$+ \quad vst_{i,CHE}$	$= vxwd_{i,ROW,CHE}$ $\downarrow$ $vxwd_{i,ROW,CHE}$	$+ \quad t_i^{exp} = vxmd_{i,ROW,CHE}$
CHE exports	transportation			ROW imports
$vxmd_{i,CHE,ROW} + t_i^{exp}$	$= vxwd_{i,CHE,ROW}$ $\downarrow$ $vxwd_{i,CHE,ROW}$	$+ \quad vst_{i,ROW}$	$= viws_{i,CHE,ROW}$ $\downarrow$ $viws_{i,CHE,ROW}$	$= vims_{i,CHE,ROW} + t_i^{imp}$

From this table we can see which restrictions have to be imposed on the GTAP data with regard to the trade data:

$$vims_{i,ROW,CHE} + t_i^{imp} = viws_{i,ROW,CHE} \tag{23}$$

$$vxmd_{i,CHE,ROW} + t_i^{exp} = avxwd_{i,CHE,ROW}. \tag{24}$$

The left hand side of these restrictions have variables with original Swiss data, which will be fixed:

$$iot_{i,imp} + t_i^{imp} = viws_{i,ROW,CHE} \tag{25}$$

$$iot_{i,exp} + t_i^{exp} = vxwd_{i,CHE,ROW}. \tag{26}$$

The variables on the right hand side are not fixed and will adjust. Note that in the case of a more detailed disaggregation with more regions, we have to replace the restrictions (25) and (26) by

$$iot_{i,imp} + t_i^{imp} = \sum_s viws_{i,s,CHE} \tag{27}$$

$$iot_{i,exp} + t_i^{exp} = \sum_s vxwd_{i,CHE,s}, \tag{28}$$

because in the Swiss case, we do not have information on the disaggregation of the imports and exports according to source and destination respectively.

We have to make an assumption on the transport costs by Switzerland (these are the variables $vst_{i,CHE}$ and $vtwr_{i,j,ROW,CHE}$). This data is not available from the original IOT. In the GTAP database the variable $vst_{i,CHE}$ are subtracted from the original exports at market prices. For Switzerland this means that the exports from the sector "transportation" (trp) are adjusted. As the original IOT does not contain information on transportation services, we leave this GTAP data unchanged (and fix it).

$$iot_{i,exp,CHE} - vst_{i,CHE} = vxmd_{i,CHE,ROW} \tag{29}$$

Besides the trade restrictions we have two equations that assure consistency. The first imposes that for every good from the IOT of the ROW the column total is equal to the row total.

$$\begin{aligned}
&\sum_j (vdfm_{j,i,r} + vifm_{j,i,r}) + \sum_f vfm_{f,i,r} + vom_{i,r} - voa_{i,r} \\
&+ \sum_f (evfa_{f,i,r} - vfm_{f,i,r}) + \sum_j (vdfa_{j,i,r} - vdfm_{j,i,r}) \\
&+ \sum_s vims_{i,s,r} + \sum_j, (vifa_{j,i,r} - vifm_{j,i,r}) \\
&= \\
&\sum_j (vdfm_{i,j,r} + vifm_{i,j,r}) + vdpm_{i,r} + vipm_{i,r} \\
&+ vdgm_{i,r} + vigm_{i,r} + \sum_s vxmd_{i,r,s} + vst_{i,r}
\end{aligned} \tag{30}$$

The second equation is a budget balance restriction saying that the total of consumption by the households and the government, the investments and exports should be equal to the total of value added and taxes:

$$\begin{aligned}
&\sum_i (vdpa_{i,r} + vipa_{i,r} + vdga_{i,r} + viga_{i,r} + vdfa_{i,"CGDS",r} \\
&+ vifa_{i,"CGDS",r} + vst_{i,r}) \sum_{i,s} + vxmd_{i,r,s} \\
&= \\
&\sum_{i,f} evfa_{f,i,r} + \sum_{i,j} (vifa_{j,i,r} - vifm_{j,i,r}) + \sum_i (vipa_{i,r} - vipm_{i,r}) \\
&+ \sum_i (viga_{i,r} - vigm_{i,r}) + \sum_{i,j} vifm_{j,i,r} + \sum_i (vipm_{i,r} + vigm_{i,r}) \\
&+ \sum_{i,j} (vdfa_{i,j,r} - vdfm_{i,j,r}) + \sum_i (vdpa_{i,r} - vdpm_{i,r}) \\
&+ \sum_i (vdga_{i,r} - vdgm_{i,r}) + \sum_i (vom_{i,r} - voa_{i,r})
\end{aligned} \tag{31}$$

We use the equations (23)-(26), (29), (30) and (31) to solve an adjusted minimum least-square program, where we minimize the square of the relative changes of the variables. The program can be solved with a non-linear solve like PATH or CONOPT (Ferris and Munson (2010) or Drud (2010)).

3 Conclusions and Further Research

This paper shows how to incorporate (new) regional information in the existing GTAP database using a program called Fit2GTAP. This can be especially useful, if one has to report figures that

are completely consistent with the original data for the replaced regional GTAP data. Fit2GTAP is written in GAMS and is still in the testing phase. Apart from a thorough check of the program code, the following points are still part of the research agenda:

- Program code for using GAMS for aggregating the GTAP data
- Check of data for other IOTs: Fit2GTAP was tested with the Swiss symmetric IOT for the year 2005. We would like to conduct tests of the program with other regional IOTs. We would be grateful if other researchers could provide us with a regional IOT which is consistent with the GTAP data base.
- The resulting new database is still in GAMS format and could be used in a multi-region CGE model. Step 6, which still has to be properly implemented, allows to rebuild the GTAP database with the incorporated data and export it to gdx and har format. This will allow further checks of the consistency using tools from GTAP.
- The program code will have to be more user-friendly allowing the researcher a minimum of own coding.
- A homepage with documentation and the program will be available as soon as possible.
- The reporting should be extended, especially for analyzing the differences between the data as delivered to GTAP and the final data in the GTAP database. This could be very helpful for improving the quality of future GTAP databases.

I am grateful for any reports on bugs fixes or suggestions for clarification of the documentation which may be offered by users of these tools.

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A Description of Factors, Sectors and Regions

Table 8 – GTAP sectors

Number	Code	Description
1	pdr	Paddy Rice: rice, husked and unhusked
2	wht	Wheat: wheat and meslin
3	gro	Other Grains: maize (corn), barley, rye, oats, other cereals
4	v_f	Veg & Fruit: vegetables, fruitvegetables, fruit and nuts, potatoes, cassava, truffles,
5	osd	Oil Seeds: oil seeds and oleaginous fruit; soy beans, copra
6	c_b	Cane & Beet: sugar cane and sugar beet
7	pfb	Plant Fibres: cotton, flax, hemp, sisal and other raw vegetable materials used in textiles
8	ocr	Other Crops: live plants; cut flowers and flower buds; flower seeds and fruit seeds; vegetable seeds, beverage and spice crops, unmanufactured tobacco, cereal straw and husks, unprepared, whether or not chopped, ground, pressed or in the form of pellets; swedes, mangolds, fodder roots, hay, lucerne (alfalfa), clover, sainfoin, forage kale, lupines, vetches and similar forage products, whether or not in the form of pellets, plants and parts of plants used primarily in perfumery, in pharmacy, or for insecticidal, fungicidal or similar purposes, sugar beet seed and seeds of forage plants, other raw vegetable materials
9	ctl	Cattle: cattle, sheep, goats, horses, asses, mules, and hinnies; and semen thereof
10	oap	Other Animal Products: swine, poultry and other live animals; eggs, in shell (fresh or cooked), natural honey, snails (fresh or preserved) except sea snails; frogs' legs, edible products of animal origin n.e.c., hides, skins and furskins, raw , insect waxes and spermaceti, whether or not refined or coloured
11	rmk	Raw milk
12	wol	Wool: wool, silk, and other raw animal materials used in textile
13	frs	Forestry: forestry, logging and related service activities
14	fsh	Fishing: hunting, trapping and game propagation including related service activities, fishing, fish farms; service activities incidental to fishing
15	col	Coal: mining and agglomeration of hard coal, lignite and peat
16	oil	Oil: extraction of crude petroleum and natural gas (part), service activities incidental to oil and gas extraction excluding surveying (part)
17	gas	Gas: extraction of crude petroleum and natural gas (part), service activities incidental to oil and gas extraction excluding surveying (part)
18	omn	Other Mining: mining of metal ores, uranium, gems. other mining and quarrying
19	cmt	Cattle Meat: fresh or chilled meat and edible offal of cattle, sheep, goats, horses, asses, mules, and hinnies. raw fats or grease from any animal or bird.

(GTAP sectors table continued from previous page)

Number	Code	Description
20	omt	Other Meat: pig meat and offal. preserves and preparations of meat, meat offal or blood, flours, meals and pellets of meat or inedible meat offal; greaves
21	vol	Vegetable Oils: crude and refined oils of soya-bean, maize (corn),olive, sesame, groundnut, olive, sunflower-seed, safflower, cotton-seed, rape, colza and canola, mustard, coconut palm, palm kernel, castor, tung jojoba, babassu and linseed, perhaps partly or wholly hydrogenated,inter-esterified, re-esterified or elaidinised. Also margarine and similar preparations, animal or vegetable waxes, fats and oils and their fractions, cotton linters, oil-cake and other solid residues resulting from the extraction of vegetable fats or oils; flours and meals of oil seeds or oleaginous fruits, except those of mustard; degras and other residues resulting from the treatment of fatty substances or animal or vegetable waxes.
22	mil	Milk: dairy products
23	pcr	Processed Rice: rice, semi- or wholly milled
24	sgr	Sugar
25	ofd	Other Food: prepared and preserved fish or vegetables, fruit juices and vegetable juices, prepared and preserved fruit and nuts, all cereal flours, groats, meal and pellets of wheat, cereal groats, meal and pellets n.e.c., other cereal grain products (including corn flakes), other vegetable flours and meals, mixes and doughs for the preparation of bakers' wares, starches and starch products; sugars and sugar syrups n.e.c., preparations used in animal feeding, bakery products, cocoa, chocolate and sugar confectionery, macaroni, noodles, couscous and similar farinaceous products, food products n.e.c.
26	b_t	Beverages and Tobacco products
27	tex	Textiles: textiles and man-made fibres
28	wap	Wearing Apparel: Clothing, dressing and dyeing of fur
29	lea	Leather: tanning and dressing of leather; luggage, handbags, saddlery, harness and footwear
30	lum	Lumber: wood and products of wood and cork, except furniture; articles of straw and plaiting materials
31	ppp	Paper & Paper Products: includes publishing, printing and reproduction of recorded media
32	p_c	Petroleum & Coke: coke oven products, refined petroleum products, processing of nuclear fuel
33	crp	Chemical Rubber Products: basic chemicals, other chemical products, rubber and plastics products
34	nmm	Non-Metallic Minerals: cement, plaster, lime, gravel, concrete
35	i_s	Iron & Steel: basic production and casting
36	nfm	Non-Ferrous Metals: production and casting of copper, aluminium, zinc, lead, gold, and silver

(GTAP sectors table continued from previous page)

Number	Code	Description
37	fmp	Fabricated Metal Products: Sheet metal products, but not machinery and equipment
38	mvh	Motor Vehicles: cars, lorries, trailers and semi-trailers
39	otn	Other Transport Equipment: Manufacture of other transport equipment
40	ele	Electronic Equipment: office, accounting and computing machinery, radio, television and communication equipment and apparatus
41	ome	Other Machinery & Equipment: electrical machinery and apparatus n.e.c., medical, precision and optical instruments, watches and clocks
42	omf	Other Manufacturing: includes recycling
43	ely	Electricity: production, collection and distribution
44	gdt	Gas Distribution: distribution of gaseous fuels through mains; steam and hot water supply
45	wtr	Water: collection, purification and distribution
46	cns	Construction: building houses factories offices and roads
47	trd	Trade: all retail sales; wholesale trade and commission trade; hotels and restaurants; repairs of motor vehicles and personal and household goods; retail sale of automotive fuel
48	otp	Other Transport: road, rail ; pipelines, auxiliary transport activities; travel agencies
49	wtp	Water transport
50	atp	Air transport
51	cmn	Communications: post and telecommunications
52	ofi	Other Financial Intermediation: includes auxiliary activities but not insurance and pension funding (see next)
53	isr	Insurance: includes pension funding, except compulsory social security
54	obs	Other Business Services: real estate, renting and business activities
55	ros	Recreation & Other Services: recreational, cultural and sporting activities, other service activities; private households with employed persons (servants)
56	osg	Other Services (Government): public administration and defense; compulsory social security, education, health and social work, sewage and refuse disposal, sanitation and similar activities, activities of membership organizations n.e.c., extra-territorial organizations and bodies
57	dwe	Dwellings: ownership of dwellings (imputed rents of houses occupied by owners)

Table 9 – Swiss IOT 2005: Sectoral disaggregation

Id	Description of sector
S01	Agriculture, hunting and related service activities
S02	Forestry, logging and related service activities
S05	Fishing, fish farming and related service activities

(Swiss IOT sectors table continued from previous page)

Id	Description of sector
S14	Mining and quarrying (includes also NOGA 10-13)
S15	Manufacture of food products and beverages
S16	Manufacture of tobacco products
S17	Manufacture of textiles
S18	Manufacture of wearing apparel; dressing and dyeing of fur
S19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
S20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
S21	Manufacture of pulp, paper and paper products
S22	Publishing, printing and reproduction of recorded media
S23	Manufacture of coke, refined petroleum products and nuclear fuel
S24	Manufacture of chemicals and chemical products
S25	Manufacture of rubber and plastic products
S26	Manufacture of other non-metallic mineral products
S27	Manufacture of basic metals
S28	Manufacture of fabricated metal products, except machinery and equipment
S29	Manufacture of machinery and equipment n.e.c.
S30	Manufacture of office machinery and computers
S31	Manufacture of electrical machinery and apparatus n.e.c.
S32	Manufacture of radio, television and communication equipment and apparatus
S33	Manufacture of medical, precision and optical instruments, watches and clocks
S34	Manufacture of motor vehicles, trailers and semi-trailers
S35	Manufacture of other transport equipment
S36	Manufacture of furniture; manufacturing n.e.c.
S37	Recycling
S40	Electricity, gas, steam and hot water supply
S41	Collection, purification and distribution of water
S45	Construction
S50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel
S51	Wholesale trade and commission trade, except of motor vehicles and motorcycles
S52	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods
S55	Hotels and restaurants
S60	Land transport; transport via pipelines

(Swiss IOT sectors table continued from previous page)

Id	Description of sector
S61	Water transport
S62	Air transport
S63	Supporting and auxiliary transport activities; activities of travel agencies
S64	Post and telecommunications
S65	Financial intermediation, except insurance and pension funding (includes also part of NOGA 67)
S66	Insurance and pension funding, except compulsory social security (includes also part of NOGA 67)
S70	Real estate activities (including NOGA 97)
S71	Renting of machinery and equipment without operator and of personal and household goods
S72	Computer and related activities
S73	Research and development
S74	Other business activities
S75	Public administration and defence; compulsory social security
S80	Education
S85	Health and social work
S90	Sewage and refuse disposal, sanitation and similar activities
S91	Activities of membership organizations n.e.c.
S92	Recreational, cultural and sporting activities
S93	Other service activities
S95	Activities of households as employers of domestic staff

Table 10 – GTAP Regions

Number	Code	Description	Number	Code	Description
1	AUS	Australia	64	POL	Poland
2	NZL	New Zealand	65	PRT	Portugal
3	XOC	Rest of Oceania	66	SVK	Slovakia
		- American Samoa	67	SVN	Slovenia
		- Cook Islands	68	ESP	Spain
		- Fiji	69	SWE	Sweden
		- French Polynesia	70	GBR	United Kingdom
		- Guam	71	CHE	Switzerland
		- Island of Wallis and Futuna	72	NOR	Norway
		- Kiribati	73	XEF	Rest of EFTA
		- Marshall Islands			- Iceland
		- Micronesia, Federated States of			- Liechtenstein
		- Nauru			
		- New Caledonia	74	ALB	Albania
		- Niue	75	BGR	Bulgaria
		- Norfolk Island	76	BLR	Belarus
		- Northern Mariana Islands	77	HRV	Croatia
		- Palau	78	ROU	Romania
		- Papua New Guinea	79	RUS	Russian Federation
		- Samoa	80	UKR	Ukraine
		- Solomon Islands	81	XEE	Rest of Eastern Europe
		- Tokelau			- Moldova, Republic of
		- Tonga			
		- Tuvalu	82	XER	Rest of Europe
		- Vanuatu			- Andorra
					- Bosnia and Herzegovina
4	CHN	China			- Faroe Islands
5	HKG	Hong Kong			- Gibraltar
6	JPN	Japan			- Macedonia, the former Yugoslav Republic of
7	KOR	Korea			- Monaco
8	TWN	Taiwan			- San Marino
9	XEA	Rest of East Asia			- Serbia and Montenegro
		- Korea, Democratic Republic of			
		- Macau	83	KAZ	Kazakhstan
		- Mongolia	84	KGZ	Kyrgyzstan
			85	XSU	Rest of Former Soviet Union
10	KHM	Cambodia			- Tajikistan
11	IDN	Indonesia			- Turkmenistan
12	LAO	Lao People's Democratic Republic			- Uzbekistan
13	MMR	Myanmar			
14	MYS	Malaysia	86	ARM	Armenia
15	PHL	Philippines	87	AZE	Azerbaijan
16	SGP	Singapore	88	GEO	Georgia
17	THA	Thailand	89	IRN	Iran, Islamic Republic of
18	VNM	Vietnam	90	TUR	Turkey
19	XSE	Rest of Southeast Asia	91	XWS	Rest of Western Asia
		- Brunei Darussalamă			- Bahrain
		- Timor-Leste			- Iraq
					- Israel
20	BGD	Bangladesh			- Jordan
21	IND	India			- Kuwait
22	PAK	Pakistan			- Lebanon
23	LKA	Sri Lanka			- Oman
24	XSA	Rest of South Asia			- Palestinian Territory, Occupied
		- Afghanistan			- Qatar
		- Bhutan			- Saudi Arabia
		- Maldives			- Syrian Arab Republic
		- Nepal			- United Arab Emirates
					- Yemen
25	CAN	Canada			
26	USA	United States of America	92	EGY	Egypt
27	MEX	Mexico	93	MAR	Morocco

Table 11 – GTAP Regions (continued)

Number	Code	Description	Number	Code	Description
28	XNA	Rest of North America	94	TUN	Tunisia
		- Bermuda	95	XNF	Rest of North Africa
		- Greenland			- Algeria
		- Saint Pierre and Miquelon			- Libyan Arab Jamahiriya
29	ARG	Argentina	96	NGA	Nigeria
30	BOL	Bolivia	97	SEN	Senegal
31	BRA	Brazil	98	XWF	Rest of Western Africa
32	CHL	Chile			- Benin
33	COL	Colombia			- Burkina Faso
34	ECU	Ecuador			- Cape Verde
35	PRY	Paraguay			- Cote d'Ivoire
36	PER	Peru			- Gambia
37	URY	Uruguay			- Ghana
38	VEN	Venezuela			- Guinea
39	XSM	Rest of South America			- Guinea-Bissau
40	CRI	Costa Rica			- Liberia
41	GTM	Guatemala			- Mali
42	NIC	Nicaragua			- Mauritania
43	PAN	Panama			- Niger
44	XCA	Rest of Central America			- Saint Helena
45	XCB	ăCaribbean			- Sierra Leone
		- Anguilla			- Togo
		- Antigua & Barbuda			
		- Aruba	99	XCF	Rest of Central Africa
		- Bahamas			- Cameroon
		- Barbados			- Central African Republic
		- Cayman Islands			- Chad
		- Cuba			- Congo
		- Dominica			- Equatorial Guinea
		- Dominican Republic			- Gabon
		- Grenada			- Sao Tome and Principe
		- Guadeloupe			
		- Haiti	100	XAC	Rest of South Central Africa
		- Jamaica			- Angola
		- Martinique			- Congo, Democratic Republic of the
		- Montserrat			
		- Netherlands Antilles	101	ETH	Ethiopia
		- Puerto Rico	102	MDG	Madagascar
		- Saint Kitts and Nevis	103	MWI	Malawi
		- Saint Lucia	104	MUS	Mauritius
		- Saint Vincent and the Grenadines	105	MOZ	Mozambique
		- Trinidad and Tobago	106	TZA	Tanzania
		- Turks and Caicos	107	UGA	Uganda
		- Virgin Islands, British	108	ZMB	Zambia
		- Virgin Islands, U.S.	109	ZWE	Zimbabwe
			110	XEC	Rest of Eastern Africa
45	XCB	ăCaribbean			- Burundi
46	AUT	Austria			- Comoros
47	BEL	Belgium			- Djibouti
48	CYP	Cyprus			- Eritrea
49	CZE	Czech Republic			- Kenya
50	DNK	Denmark			- Mayotte
51	EST	Estonia			- Reunion
52	FIN	Finland			- Rwanda
53	FRA	France			- Seychelles
54	DEU	Germany			- Somalia
55	GRC	Greece			- Sudan
56	HUN	Hungary			
57	IRL	Ireland	111	BWA	Botswana
58	ITA	Italy	112	ZAF	South Africa
59	LVA	Latvia	113	XSC	Rest of South African Customs Union
60	LTU	Lithuania			- Lesotho
61	LUX	Luxembourg			- Namibia
62	MLT	Malta			- Swaziland
63	NLD	Netherlands			

B Gams code

To be added to the final version of the paper