An extented myGTAP model to address subsistence production and sub-national households as a module in CGEBox

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Background

Over the last years, the Joint Research Centre of the European Commission has developed a recursive-dynamic single-country CGE called DEMETRA (Dynamic Equilibrium Model for Economic development), building on the STAGE (McDonald 2007) and STAGE-DEV models (Aragie et al., 2017), specifically targeted for capacity building and subsequent support to policy design in African countries. Accordingly, DEMETRA features attributes such as multiple households, sub-national regions, segmented factor markets or specifics of home consumption and production important for developing country analysis. For a number of reasons, including an easier link to the GTAP data base, a project has recently started to implement core features of DEMETRA into CGEBox (Britz and van der Mensbrugghe 2018). CGEBox is an open source, open access flexible and modular platform for CGE modeling. Its core consists of the GTAP Standard V7 model realized in GAMS (Van der Mensbrugghe 2018). It comprises already modules which relate to features of DEMETRA such an extension to introduce multiple households and a separate account for the national government (Britz 2018, p. 92 ff), drawing on the structure of myGTAP. We present in here how additional features from DEMETRA are implemented in CGEBox such as a distinction between subsistence and commercial production and multiple household types at sub-national level. We discuss the minimal data needs to uses these extensions and show an example application where we construct a long-run baseline for an African countries based on macro-projections related to the Socio-Economic Pathways. The DEMETRA code base, specific data sampled for DEMETRA and the graphical user interface are open access and open source, please contact the authors for details.

Model and data base setup

Global instead single country based on GTAP but with agri-food detail

The existing DEMETRA model is a single country CGE, the necessary SAMs for the three (Kenya, Senegal and Ethiopia) existing case studies were developed jointly by JRC staff and contributors from Africa (see Mainar-Causape et al, 2017 for Kenya, Boulanger et al., 2017 for Senegal and Mainar – Causape et al, 2018 for a generic case). While this approach gives freedom with regard to commodity and sector detail and control over the data and quality management, it is also time consuming. Training with actual country data and policy relevant applications have to wait until at least a first version of a country SAM is constructed.

We therefore take the GTAP data base version 9 as the starting point which depicts 26 African countries as individual regions. Despite the already impressive detail for agri-food sectors in that data base (nine crop and four animal sectors, eight sectors directly linked to processing of primary agricultural outputs), specific agri-food sectors can be of high importance in African countries as a source of import revenues and related taxes. Equally, non-traded staple food such as root and tubers are often important from multiple sustainability viewpoints but aggregated into commodity groups in the GTAP data base which comprise important cash crops as well. We therefore use the FABIO data base (Bruckner and Giljum) which covers for around 190 agri-food products globally production and demand, trade matrices in values and volumes. As a MRIO, intermediate demand between the around 180 sectors is depicted at bilateral level. A ready-to-use driver program in combination with the split utility of CGEBox uses the wealth of that data base to introduce additional sectors and commodities

from FABIO into the GTAP data base. FABIO is open source and access, and a specific version is distributed along with CGEBox.

Switching to a global model drawing on the GTAP family of models is clearly mostly relevant for analysis where the international trade presentation matters. Here, CGEBox offers a number of options beyond the GTAP standard model (see Britz and van der Mensbrugghe 2018) which includes an implementation of a Krugman model with a fixed cost nests (Jafari and Britz 2018). For our test applications however, we chose the standard Armington assumption and just two regions: the country in the focus and a Rest-of-the-world aggregate[1]. These two regions differ in their representation in the model: features such as sub-national regions, multiple households and a distinction between subsistence and commercial production activities are only introduced for the country in the focus. That first reduces data needs. Second, data sampled to construct the single country SAMs for the existing case studies from DEMETRA can be used to source modules of CGEBox such as multiple household and sub-national detail in production.

Subsistence production

As one important extension captured as well in Aragie et al. 2017 we differentiate between commercial and subsistence production in agriculture and link subsistence production to a specific household type. Subsistence production involves a different technology with a lower cost share of intermediates and capital compared to commercial production. We also assume that home consumption outputs are not subject to consumption taxes and that factor use in home consumption is not taxed. We use the split-utility of CGEBox (Britz 2018, pp??) to introduce that distinction for the crop activity sectors of the GTAP data base (wht,pdr,gro,v_f,osd,ocr), based on assumptions on the output shares of the subsistence variant and differences in cost shares to the average observed production activities. Furthermore, we define the subsistence product as not tradeable internationally, an assumption entering already the split process. The resulting data base for the test cases has hence six products and activities more compared to a data base product by GTAPAgg or similar. Introducing the distinction between commercial and subsistence production for further products and sectors is straightforward.

Recursive dynamics

The current DEMETRA model is a simple recursive-dynamic model considering capital accumulation and updating population and the labour force in between simulated years. While keeping these features, we switch to G-RDEM (Britz and Roson 2018) as the recursive-dynamic driver which adds a number of other relevant features especially for long-run analysis: (1) an econometrically estimated AIDADS demand system, (2) productivity growth differentiated by broader sectors depending on the economic growth rate, (3) macro savings rates depending on the age composition of the population, income level and income growth rate, (4) cost shares depending on income levels and (5) debt serving from past foreign savings. G-RDEM can construct baselines for the five so-called Shared Social-Economic Pathways (SSPs) developed for the IPCC (Riahi et al. 2017). The SPPs provide fives narratives about global development for the next century. They have been subsequently quantified by macro-economic models e.g. by the OECD which provide key-stone results such as population and per-capita income developments for all UN countries. These peer-reviewed results are publicly

[1] CGEBox can also derive a single country model for global SAM which however implies that features such as the so-called «global bank» from the GTAP model are not longer available. We therefore stick in here to the global model layout.

available[2] and have been transformed to a directly usable format with CGEBox in which they are distributed with the code base.

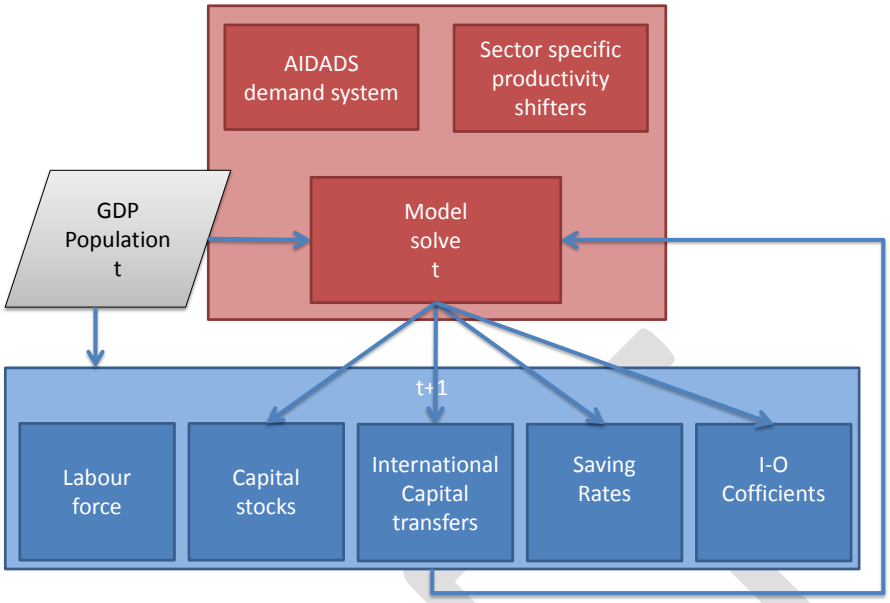

Figure 1: Overview of the recursive-dynamic modelling framework G-RDEM

A typical application of G-RDEM is a two-step exercise. First, G-RDEM is used in conjunction with macro-projections for GDP and population to construct a baseline up to the desired final year. During baseline construction, tfp-shifters adjust in interaction with the other G-RDEM features to recover the given real GDP per capita. The resulting shifters are stored. Second, these shifters are loaded and taken as exogenous in subsequent counterfactual analysis with the recursive-dynamic features active. The combination of G-RDEM and the existing SSPs projections offers unique opportunities for African to researchers for medium and long-term analysis.

Demand system and income generation

In our test applications, we introduce three household types: households involved in agricultural subsistence production, in commercial agricultural production and a residual type. These households are constructed from a number of basic assumptions, identical for all 26 countries.

Economy-wide factor endowments base are allocated to the households based on the following data (or currently assumptions): (1) the primary factors used in subsistence production are owned by the household involved in the production activity, i.e. all factor returns from subsistence production accrue to the subsistence household type, (2) the share of agricultural income from activities where no distinction between subsistence and commercial production is flowing to the two types of agricultural households, we assume shares here for testing, and (3) an assumed share of non-agricultural factor income for the two agricultural household types. Where shares are currently assumed, they need to be replaced by actual data e.g. from household surveys. These relatively simply set of assumptions allows constructing the factor income for the two agricultural households and subsequently, the factor income of the residual (urban) household type.

From the labour income (= stock), we constructed population shares and subsequently increase the share of the subsistence household by 50% and decreased the one of the residual type of 50%, which

[2] SSP data portal of IISASA, see https://tntcat.iiasa.ac.at/SspDb/dsd?Action=htmlpage&page=about

makes the latter richer on per capita basis. For the time being, savings are set proportional to factor income. As said, these assumptions are so far only introduced for testing purposes. Still, the approach underlines that data needs are limited to build a model with multiple household types. As a substitute for detailed household surveys which inform on budget share, we differentiate income dependent demand behaviour between different households by employing the econometrically estimated AIDADS demand system as part of GRDEM (Britz and Roson 2018). The income dependent (marginal) budget shares of the system are used to estimate Armington demands of the different households which are subsequently balanced to exhaust both given household income minus savings and the given aggregate Armington demand from the SAM.

We assume that agents consider commercial and subsistence variants of the same product as quality differentiated. We therefore introduce CES nests into the AIDADS demand system (or existing nests) which define a composite of the two variants (see Figure 2), and similarly, CES nests under the intermediate composite drawing on the flexible nesting approach of CGEBox (Britz 2018, p. 52 ff.). That approach is also found in Aragie et al. 2017 which however use a LES demand system and do not introduce intermediate demand nests as introduced by us.

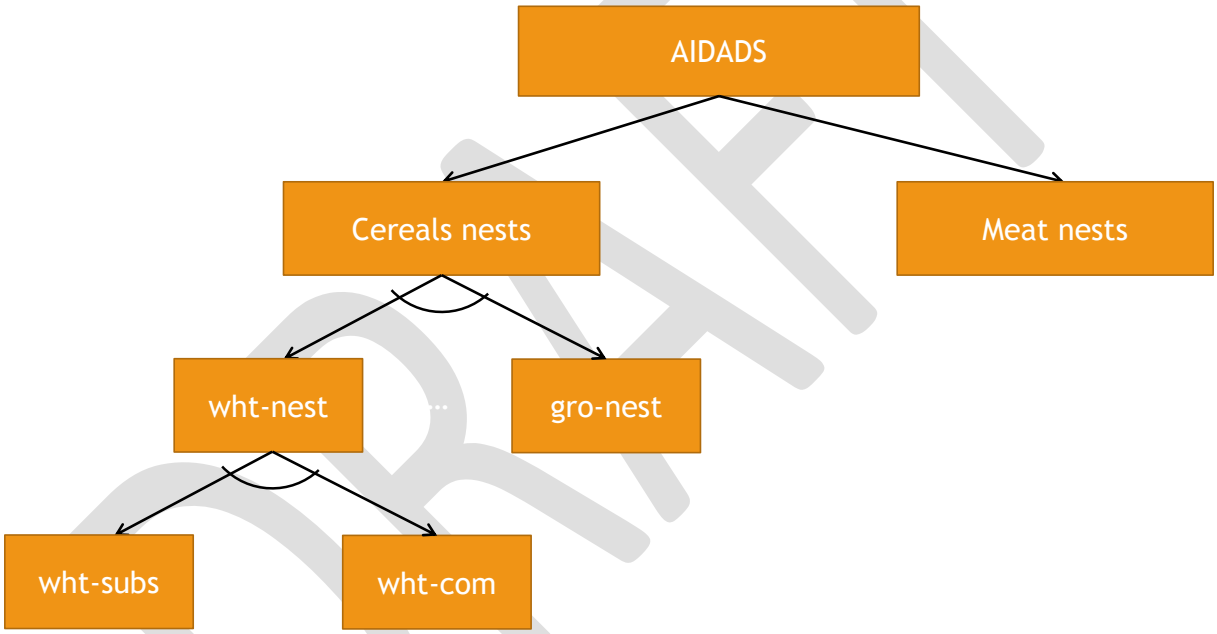

Figure 2: Multi-layered demand system

The second extension to the demand system relates to sub-national units. So far, CGEBox allows to dis-aggregating production and factor use to sub-national units (Britz 2018, p. 73), implemented for EU Member States. We now add firstly the possibility to introduce sub-national units also for non-EU countries and, secondly, to depict household demand and factor income at sub-national level. That implies adding a third origin to the top-level Armington nests for final demand by the private household. For intermediate, government and investment demand we stick to the usual representation which distinguishes between the domestic (national) and imported origins. Figure 3 depicts the basic relations. The output *xs* of product *i* in the sub-national unit *subr* covers demand in the same region *xd* or feeds into a national market pool. The household's Armington demand *xa* is covered by production from the same region *xd*, from the national pool *xn* and from imports *xm*. The third, sub-national origin is only introduced for subsistence products, for which by assumption the imported origin is always zero and only small quantities can either be marketed to other households in the same regions or sold to the national pool.

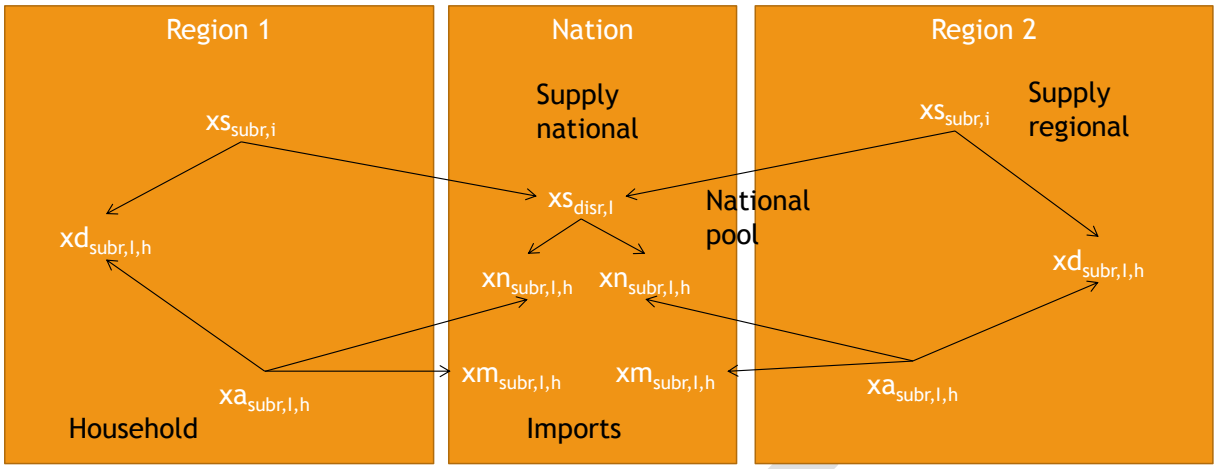

Figure 3: Distribution of sub-national supply and its relation to the demand system

The assumption of home production and other features of developing countries suggest fragmented factor markets. Accordingly, factor markets are assumed as sluggish. Households allocate their factor stocks either to production activities in the same sub-national region or to national pools (think of migrant labour or in case of capital of the national banking system financing investments in various sectors), see Figure 1. Here, *xfth* denotes the factor stock of each household, *subr* is the index for the sub-region, *h* for the household and *f* for the factor. Technically, one CET nests is used to drive the allocation. Accordingly, the factor demand of the activities, which is depicted at sub-national level, is sourced by supply of households in the same region and from the national pool.

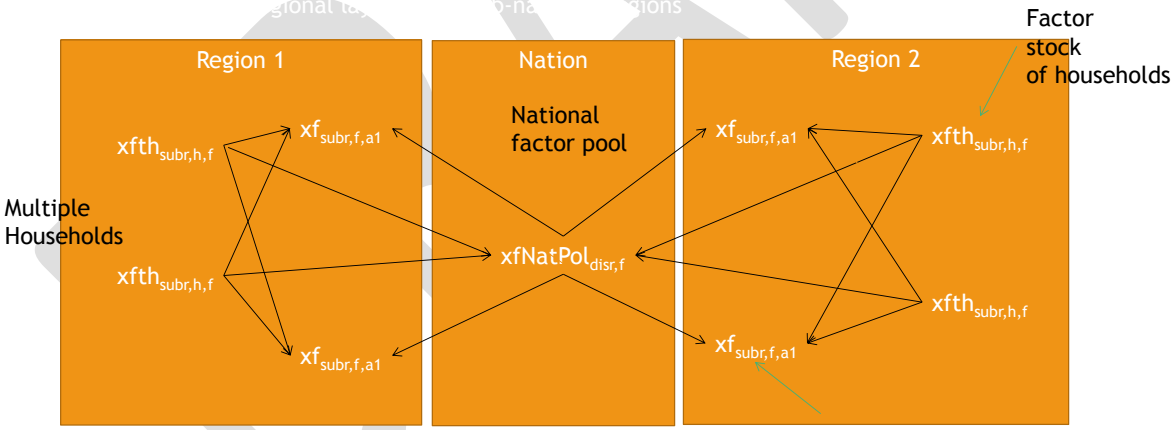

Figure 4: Factor allocation from the sub-national households

As factor income of subsistence production is not taxed by assumption, its flows fully back to the related household. Equally, intermediate input use in subsistence production is assumed as quite limited. As the output of subsistence production activities is mainly consumed by the producing household itself, we end up in an almost closed sub-economy for these sectors where factor returns cover the related consumption. Interactions with the rest of the economy are still relevant: factor use in subsistence production competes with supply to the national pool, and subsistence products compete with the internationally traded commercial variant. And clearly, in order to cover intermediate input costs of home production and products not self-produced, household firstly sell also shares of the home produced products and draw factor income of other activities.

Data processing and testing of the framework

Data base construction

In order to test our framework, we construct for each of the 26 single African countries available in GTAP 9 a separate data base, each comprising one African country and the Rest-of-the-world. We use the filter routine of the CGEBox data base driver (Britz 2018, 177ff.) to remove cost shares below 1.E-4% and subsequently apply for each country the same assumptions on the share of subsistence versus commercial production for the six crop production activities and with regard to cost share differences. In order to demonstrate the link to FABIO, we introduce additional coffee as a sector and product. As a result, we have 26 data bases with two regions and 64 sectors / products (51 unchanged GTAP sectors plus 2x6 crop sectors differentiated by commercial and subsistence plus coffee where applicable). As we do not possess data at sub-national level yet, we generated four "artificial" sub-regions in each country and use a random number generator to distribute national production into the four sub-national regions. We used the resulting factor use of land in each sub-national unit to distribute the data from the GTAP-AEZ data base. As only two countries are covered, the resulting global SAMs are quite small despite the high sector resolutions, leading to models with around 20.000 variables and equations which can be solved typically in less than 10 seconds under shocks.

Table 1 shows the configuration of CGEBox for the tests. The main aim of the testing was to exclude any run-time errors both during data base construction (especially in the split routine) and subsequent simulation runs with the model.[3]

Table 1: Configuration of CGBox for the tests

Feature/Module	
International trade	Identical bi-lateral import shares for all Armington agents (GTAP Standard), identical import / domestic shares for all production sectors
Final demand system	AIDADS for private households, otherwise as in GTAP Standard; CES nests for meats and cereals; all crops with CES nests to substitute the subsistence versus the commercial variant; private household features additionally sub-national origin as in top Armington nest for products split up in subsistence versus commercial
Recursive-dynamics	All features from G-RDEM, over 40 years in 2 year steps (tested for SSP3 for all 26 countries; all five SSPs tested for four test cases)
GTAP-AEZ	AEZ distinction at sub-national level, land supply from an empirically determined crop land buffer to economic land use, existing stock of commercial forest and agricultural land not allowed to shrink; three nests: forest against agriculture; agriculture to cropland and grazing; cropland respectively grazing to individual agricultural activities
Production function nesting	For extraction sectors: substitution between capital and natural resources; for animal sectors: substitution between feed intermediates and lands; rest of agriculture: substitution between a labour-capital-ND composite and land;

Results

Given the fact that the specific features of the data base are constructed with assumptions or even with random number generators, the results in here can only serve as a plausibility check for the overall functioning of the model. We therefore pick randomly one country and discuss selected results under SSP3 and a counterfactual against that baseline, an Intra-African full trade liberalization step-wise

[3] CGEBox is realized in GGIG (Gams Graphical User Interface Generator, Britz 2014; see also http://www.ilr.uni-bonn.de/em/staff/britz/ggig_e.htm) which supports beside the interactive model steering via the GUI also a batch processing mode. That allowed efficiently implementing the tests.

implemented over ten years. That discussion also highlights potential gaps in the current model mechanisms.

Baseline results for SSP3

Figure 5 below depicts the real per capita development for the three household types in Burkina Faso under SSP3. It firstly reveals that the data constructing introduces important differences in per capita income already at the benchmark, where the subsistence household's income being less than 20% of the residual household type. The agricultural household more targeted towards commercial production is somewhat better off. While income growth rates across the households are not much different, absolute differences increase over time. That observation serves some discussion as the differentiated productivity growth mechanism in G-RDEM should foster income growth in households which employ their factor in faster growing sectors. Here, both agriculture and services grow at a slower pace compared to manufacturing and the lower tfp growth for services might explain part of the picture.

Another point relates to the differences between the commercial and subsistence variants. Here, currently no differences in tfp assumptions are introduced. However, c.p., a lower share of intermediate input costs will lead to stronger growth if tfp increases primary factor productivity such that the subsistence variants could show a tendency to *benefit* stronger. That is a counterintuitive finding which must be checked and potentially corrected in an improved model version.

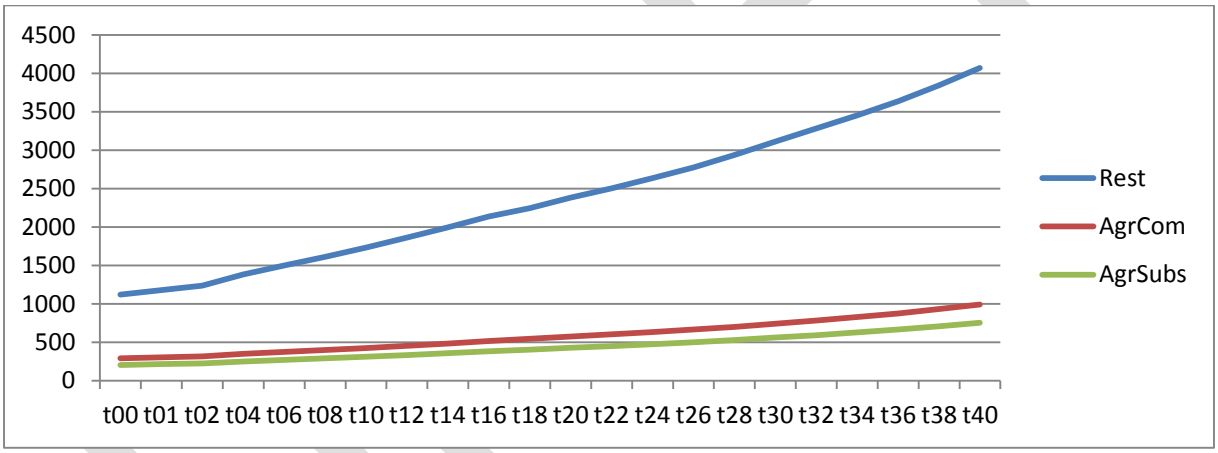

Figure 5: Real income development per capita for the household types in Burkina Faso (constructed data) under SSP3

Another interesting aspect is the development of the total (Figure 7) and final household (Figure 6) demand. The AIDADS demand system introduces considerable differences between products groups (Figure 6) with utilities and construction demand increasing by factor nine, while demand for grains and crops as well as mining and extraction only doubles. Other sectors where household demand grows stronger than the average are manufactures (Textiles and clothing Light and heavy manufacturing) followed by other services and transport and communication. Trailing are food expenditures.

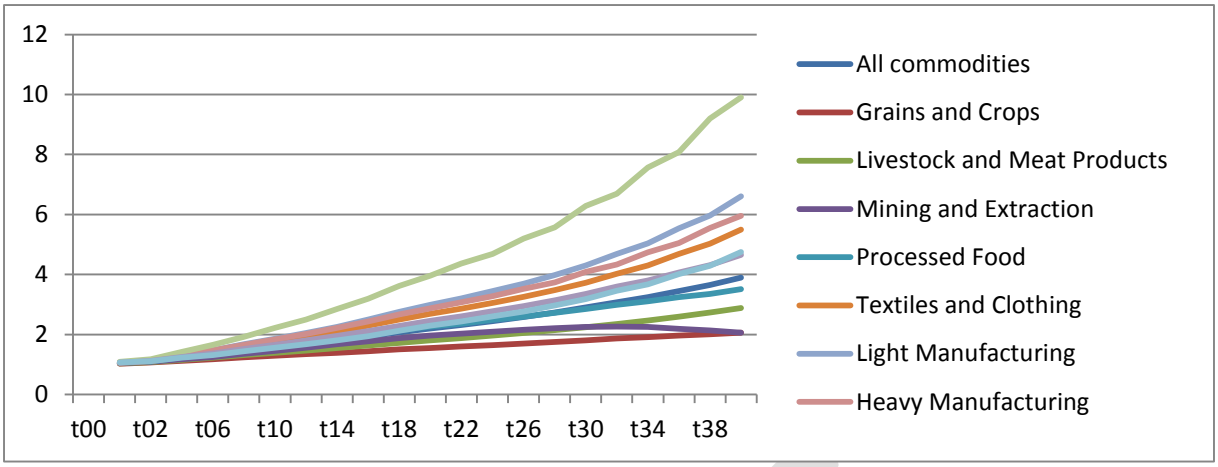

Figure 6: Relative development of household demand of aggregated commodity groups Burkina Faso under SSP3

However, taking intra-industry and other final demand into account as well (Figure 7) these differences are less pronounced.

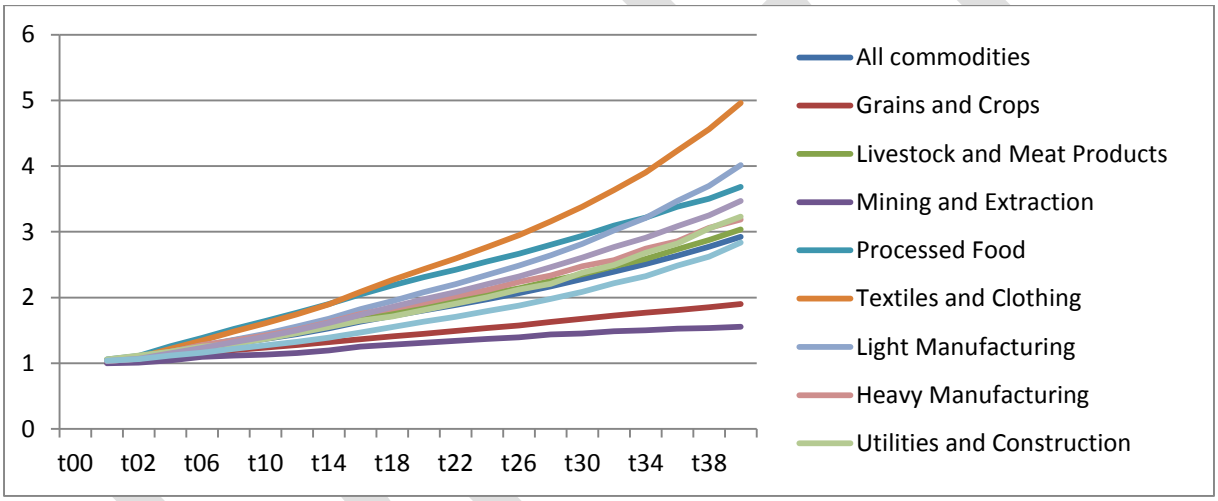

Figure 7: Relative development of total demand of aggregated commodity groups Burkina Faso under SSP3

Finally, we have a look at developments across households which reveal strong differences in the benchmark which are also carried over to the final year, reflecting the different income levels and assumption during data base construction. As the agricultural related households remains relative poor, their budget share spent on food remain high.

Table 2: Budget shares for the three different households, benchmark and last year, Burkina Faso under SSP3

	Rest		AgrCom		AgrSubs	
	t00	t40	t00	t40	t00	t40
Grains and Crops	11%	7%	31%	27%	43%	40%
Mining and Extraction	3%	3%	4%	4%	3%	3%
Processed Food	26%	18%	14%	13%	12%	11%
Textiles and Clothing	2%	2%	5%	4%	5%	4%
Light Manufacturing	3%	3%	4%	5%	5%	6%
Heavy Manufacturing	12%	12%	8%	9%	5%	6%
Utilities and Construction	2%	4%	1%	3%	2%	3%
Transport and Communication	18%	23%	6%	7%	4%	5%
Other Services	16%	26%	4%	8%	4%	8%

Note that we refrained from discussing here any sub-national results as all data in that respect are generated with a random number generator for testing.

Results from an Intra-African trade liberalization

Figure 8 below reveals that the income effect of an Intra-African trade liberalization is quite small compared to expected income changes triggered by economic growth, the change is in the range of 1%. First, the average tariff level for Burkina-Faso at the benchmark is already relatively low with in average around 6% across all commodities, and in some cases of higher rates, Intra-African trade is already taxed less (seeTable 3). Furthermore, the average import shares are around 15% in average at the benchmark and increase to around 19% in the last year of the simulation period, with large import shares observed for manufacturing, gas and electricity. For the latter two, no import taxes are reported at the benchmark. For light manufacturing, the intra-African trade is less important for Burkina-Faso which dampens the effect of removing tariff barriers. For grains and crops, imports occur for wheat and rice, both are not imported from other African countries in sizeable quantities.

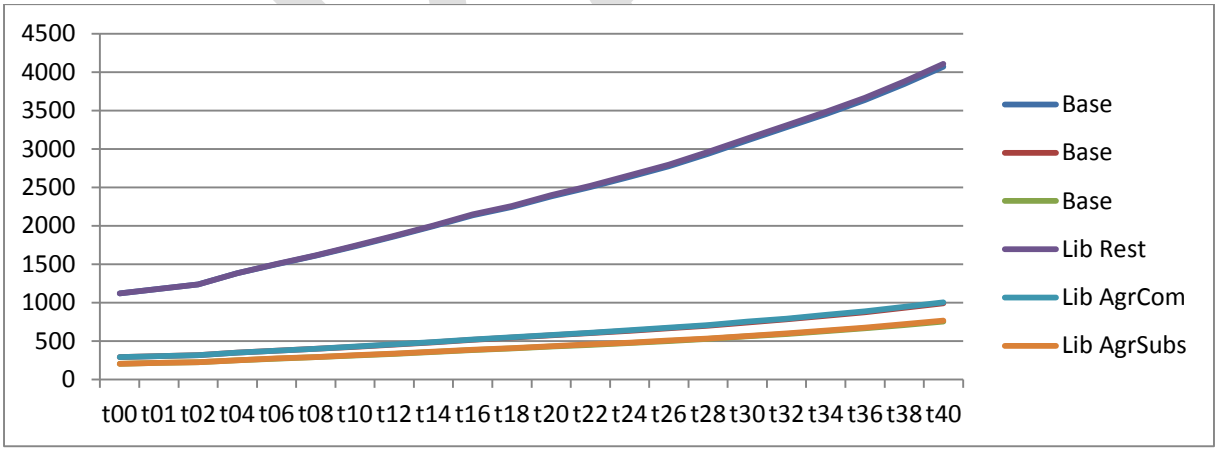

Figure 8: Real income development per capita for the household types in Burkina Faso (constructed data) under SSP3 (base) and under Intra-African trade liberalization (Lib)

Table 3: Benchmark imports tariffs of Burkina Faso

	RestOfAfrica	RestofWorld
All commodities	0.06	0.06
Grains and Crops	0.01	0.07
Wheat commercial		0.05
Paddy commercial	0	0.06
Other grains commercial	0	0.05
Veg, fruit,nuts commercial	0.01	0.16
Oilseeds commercial	0	0.08
Other crops commercial	0.03	0.06
Coffee	0.01	
Processed rice	0	0.1
Livestock and Meat Products	0.03	0.13
Cattle,sheep,goats,horses	0	0.03
Animal products nec	0.03	0.08
Meat: cattle,sheep,goats,horse		0.15
Meat products nec	0.13	0.16
Mining and Extraction	0.03	0.01
Forestry	0	0.01
Fishing	0.09	0.01
Coal	0.01	0
Oil	0.01	0.01
Gas	0.02	0.01
Minerals nec	0.05	0.05
Processed Food	0.04	0.15
Vegetable oils and fats	0	0.16
Dairy products	0.02	0.08
Sugar	0	0.2
Food products nec	0.07	0.16
Beverages and tobacco products	0.02	0.14
Textiles and Clothing	0.13	0.15
Textiles	0.13	0.14
Wearing apparel	0.16	0.19
Light Manufacturing	0.11	0.11
Leather products	0.16	0.2
Wood products	0.1	0.19
Paper products, publishing	0.04	0.1
Metal products	0.1	0.12
Motor vehicles and parts	0.14	0.11
Transport equipment nec	0.1	0.08
Manufactures nec	0.15	0.18
Heavy Manufacturing	0.07	0.08
Petroleum, coal products	0.06	0.07
Chemical,rubber,plastic prods	0.05	0.05
Mineral products nec	0.09	0.16
Ferrous metals	0.05	0.14
Metals nec	0.13	0.12
Electronic equipment	0.08	0.09
Machinery and equipment nec	0.09	0.08

Table 4: Domestic and import shares, baseline and liberalization scenario, benchmark and last year

	Base t00		Base t40		Lib t00		Lib t40	
	Domestic	Imported	Domestic	Imported	Domestic	Imported	Domestic	Imported
All commodities	**0.85**	**0.15**	**0.81**	**0.19**	**0.85**	**0.15**	**0.8**	**0.2**
Grains and Crops	**0.94**	**0.06**	**0.89**	**0.11**	**0.94**	**0.06**	**0.89**	**0.11**
Wheat subsistence	1		1		1		1	
Wheat commercial	0	1	0	1	0	1	0	1
Paddy subsistence	1		1		1		1	
Paddy commercial	0.21	0.79	0.05	0.95	0.21	0.79	0.05	0.95
Other grains subsistence	1		1		1		1	
Other grains commercial	1	0	0.99	0.01	1	0	0.99	0.01
Veg, fruit,nuts subsistence	1		1		1		1	
Veg, fruit,nuts commercial	0.8	0.2	0.53	0.47	0.8	0.2	0.53	0.47
Oilseeds subsistence	1		1		1		1	
Oilseeds commercial	0.98	0.02	0.91	0.09	0.98	0.02	0.91	0.09
Other crops subsistence	1		1		1		1	
Other crops commercial	0.78	0.22	0.69	0.31	0.78	0.22	0.69	0.31
Coffee	0.23	0.77	0.23	0.77	0.23	0.77	0.27	0.73
Sugar cane, sugar beet	1	0	1	0	1	0	1	0
Plant-based fibers	1	0	1	0	1	0	1	0
Processed rice	0.13	0.87	0.05	0.95	0.13	0.87	0.05	0.95
Livestock and Meat Products	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**
Cattle,sheep,goats,horses	1	0	1	0	1	0	1	0
Animal products nec	1	0	1	0	1	0	1	0
Raw milk	1	0	1	0	1	0	1	0
Wool, silk-worm cocoons	0.61	0.39	0.96	0.04	0.61	0.39	0.96	0.04
Meat: cattle,sheep,goats,horse	1	0	1	0	1	0	1	0
Meat products nec	0.99	0.01	0.99	0.01	0.99	0.01	0.99	0.01
Mining and Extraction	**0.99**	**0.01**	**0.97**	**0.03**	**0.99**	**0.01**	**0.97**	**0.03**
Forestry	1	0	1	0	1	0	1	0
Fishing	1	0	0.97	0.03	1	0	0.97	0.03
Coal	0.43	0.57	0.06	0.94	0.43	0.57	0.06	0.94
Oil	1	0	0.99	0.01	1	0	0.99	0.01
Gas	1	0	1	0	1	0	1	0
Minerals nec	0.97	0.03	0.98	0.02	0.97	0.03	0.98	0.02
Processed Food	**0.79**	**0.21**	**0.73**	**0.27**	**0.79**	**0.21**	**0.73**	**0.27**
Vegetable oils and fats	0.78	0.22	0.63	0.37	0.78	0.22	0.64	0.36
Dairy products	0.63	0.37	0.6	0.4	0.63	0.37	0.6	0.4
Sugar	0.58	0.42	0.56	0.44	0.58	0.42	0.58	0.42
Food products nec	0.73	0.27	0.72	0.28	0.73	0.27	0.71	0.29
Beverages and tobacco products	0.88	0.12	0.8	0.2	0.88	0.12	0.8	0.2
Textiles and Clothing	**0.82**	**0.18**	**0.89**	**0.11**	**0.82**	**0.18**	**0.86**	**0.14**
Textiles	0.69	0.31	0.79	0.21	0.69	0.31	0.75	0.25
Wearing apparel	0.92	0.08	0.95	0.05	0.92	0.08	0.93	0.07
Light Manufacturing	**0.48**	**0.52**	**0.56**	**0.44**	**0.48**	**0.52**	**0.54**	**0.46**
Leather products	0.4	0.6	0.35	0.65	0.4	0.6	0.28	0.72
Wood products	0.81	0.19	0.91	0.09	0.81	0.19	0.89	0.11
Paper products, publishing	0.41	0.59	0.55	0.45	0.41	0.59	0.54	0.46
Metal products	0.36	0.64	0.42	0.58	0.36	0.64	0.39	0.61
Motor vehicles and parts	0.43	0.57	0.51	0.49	0.43	0.57	0.51	0.49
Transport equipment nec	0.2	0.8	0.26	0.74	0.2	0.8	0.28	0.72
Manufactures nec	0.83	0.17	0.95	0.05	0.83	0.17	0.94	0.06

Heavy Manufacturing	**0.6**	**0.4**	**0.63**	**0.37**	**0.6**	**0.4**	**0.61**	**0.39**
Petroleum, coal products	0.02	0.98	0.02	0.98	0.02	0.98	0.02	0.98
Chemical,rubber,plastic prods	0.37	0.63	0.51	0.49	0.37	0.63	0.48	0.52
Mineral products nec	0.65	0.35	0.64	0.36	0.65	0.35	0.58	0.42
Ferrous metals	0.24	0.76	0.1	0.9	0.24	0.76	0.1	0.9
Metals nec	0.99	0.01	1	0	0.99	0.01	0.99	0.01
Electronic equipment	0.31	0.69	0.45	0.55	0.31	0.69	0.42	0.58
Machinery and equipment nec	0.45	0.55	0.63	0.37	0.45	0.55	0.6	0.4
Utilities and Construction	**0.94**	**0.06**	**0.93**	**0.07**	**0.94**	**0.06**	**0.93**	**0.07**
Electricity	0.88	0.12	0.8	0.2	0.88	0.12	0.81	0.19
Gas manufacture, distribution	0.98	0.02	0.97	0.03	0.98	0.02	0.97	0.03
Water	1	0	1	0	1	0	1	0
Construction	0.94	0.06	0.95	0.05	0.94	0.06	0.95	0.05
Transport and Communication	**0.94**	**0.06**	**0.92**	**0.08**	**0.94**	**0.06**	**0.92**	**0.08**
Trade	0.96	0.04	0.94	0.06	0.96	0.04	0.94	0.06
Transport nec	0.93	0.07	0.9	0.1	0.93	0.07	0.9	0.1
Sea transport	0.96	0.04	0.95	0.05	0.96	0.04	0.95	0.05
Air transport	0.51	0.49	0.41	0.59	0.51	0.49	0.42	0.58
Communication	0.99	0.01	0.97	0.03	0.99	0.01	0.97	0.03
Other Services	**0.95**	**0.05**	**0.87**	**0.13**	**0.95**	**0.05**	**0.87**	**0.13**
Financial services nec	0.95	0.05	0.86	0.14	0.95	0.05	0.86	0.14
Insurance	0.45	0.55	0.27	0.73	0.45	0.55	0.28	0.72
Business services nec	0.94	0.06	0.88	0.12	0.94	0.06	0.88	0.12
Recreation and other services	0.92	0.08	0.75	0.25	0.92	0.08	0.75	0.25
PubAdmin/Defence/Health/Educat	0.99	0.01	0.96	0.04	0.99	0.01	0.96	0.04
Dwellings	1		1		1		1	

Summary and conclusions

Our paper demonstrate how with limited data needs, the existing GTAP SAMs can be enriched with the features described above, using different African countries as examples. Next, we use G-RDEM in conjunction with macro-projections for the SSPs to generated long-term baseline for the around 25 single African countries available in the GTAP data base. We show how the features of G-RDEM in conjunction with assumption on home consumption and production lead to distinct different developments in household income and budget shares during baseline constructions. These simulations employ additional features of CGEBox, such as specific nestings in the production function for agriculture (Britz 2018, p. 92 ff.) and the GTAP-AEZ module (Britz 2018, p. 151), a split of the GTAP data base into more detail for agriculture to e.g. capture important export crops such as coffee based on the FABIO MRIO (Britz 2018,p. 222 ff).

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