Constructing input-output tables and a CGE database for Afghanistan

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Outline

Basic Introduction too Key terms

- **Supply table** shows the supply of goods and services, distinguishing between supply of domestic industries and imports.
- **Use table** provide information on the intermediate and final consumptions of different product.
- **Valuation matrices** comprising information on taxes less subsidies on product, trade margins and transport margins.
- **Input-Output Tables** (IOTs) describe the sale and purchase relationship between producers and consumers within an economy.
- **Social accounting matrix** (SAM) is a comprehensive, and economy-wide database recording data about all transactions between economic agents in a specific economy, for a specific period of time.

Research problem

- **Creating a database consistent** with GTAP and to be functional as a CGE database is problematic and requires a considerable amount of information and a number of data manipulation steps. Therefore very few articles provide details about the database creation process.
- For **Developing countries such as Afghanistan** it is important to construct a dataset so it can facilitate policy analysis within CGE framework

Objective:

- **Constructing a SAM** for a single country (i.e. developing) consistent with the required structure of the GTAP Data Base.
  1. Conversion method
  2. Projection method

Contributions

- **Construction of the first Afghan IOTs** (65 sectors, several years) using advanced balancing procedure that admits arbitrary equality constraints, and subsequently the first Afghan SAMs
- **Backward projection of the SAM** in order to obtain the SAM for the remaining GTAP reference years.
- **Integrate Afghanistan into the GTAP** (worldwide) GE database
- **Documenting data compilation** such that our approach can be applied to create other countries or regions

Methods

- **In order to obtain the objective** the paper introduce two methods:
  1. Conversion method
  2. Projection method

- **Conversion:** The conversion method convert the 2017 Afghanistan Supply and Use table into Social Accounting matrix
- **Projection** the projection method project the Social Accounting Matrix from 2016 and 2019 backward to estimate the SAM for the remaining GTAP reference years (204, 2011, 2007, 2004)

Structure of the CGE region

			Absorption Matrix					
			1	2	3	4	5	6
			Producer	Investors	Household	Export	government	Change in Inventories
		Size	← I →	← I →	← I →	← I →	← I →	← I →
1	Basic Flows	C X S	V1BAS	V2BAS	V3BAS	V4BAS	V5BAS	V6BAS
2	Margins	C X S X M	V1MAR	V2MAR	V3MAR	V4MAR	V5MAR	n/a
3	Taxes	C X S	V1TAX	V2TAX	V3TAX	V4TAX	V5TAX	n/a
4	Labour	OCC	V1LAB					
5	Capital	1	V1CAP					
6	Land	1	V1LAND					
7	Production Tax	1	V1PTX					

C = 65 Commodities

I = 65 Industries

M = commodities used as margins

S = 2 Sources (Domestic, Imported)

OCC = 5 Occupation types

Data collected from domestic organizations, these include:

- National Statistics and Information Authority of Afghanistan **(NSIA)**
- Ministry of Agriculture, Irrigation, and Livestock **(MAIL)**
- Ministry of Commerce and Industries of Afghanistan **(MOCI)**
- Ministry of Energy and Water **(MEW)**
- Ministry of Mines, and Petroleum **(MOMP)**
- Da Afghanistan Brishna Shirkat **(DABS)**
- Afghanistan Living Condition Survey **(ALCS)**

Data collected from International organizations, these include:

- World Bank
- International Labor Organization **(ILO)**
- International Monetary Fund **(IMF)**
- Food and Agriculture Organization **(FAO)**

The conversion method consist of 26 steps grouped into ten stages

- Conversion **Use** table
- Conversion **Supply** table
- Compilation of **IOT** and split the **Use** matrix
- Construction of **labour compensation** matrix
- Estimation of compensation to **land and natural** resources
- Estimation of compensation to **capital**
- Allocation of taxes on **product**
- Allocation of **income and factor taxes**
- Construction of **trade and transport** margins
- **Trade-link** of international trade

Supply and Use Tables (SUT)

- The SUTs contain 267 commodities and 22 industries
- **Supply table:**
  1. Domestic outputs
  2. Imports
  3. valuation matrices
- **Use table:**
  1. Intermediate consumption
  2. Final consumption
  3. Value-added

Intermediate Consumption Matrix

- The **intermediate consumption** data is available at the aggregate economic activity level (22 Afghan's sector), and 267 commodities

Conversion

- **conversion of 22 industries** into 65 GTAP sectors and **conversion of 267 commodities** into 65 GTAP sectors deal with those situations where the correspondence between rows and columns in the old and new classification implies the following cases:
  1. One-to-one case
  2. Many-to-one case
  3. One-to-many case

Conversion:

The conversion method transform the Supply and Use table from the old industry and product classification to new ones through **bridge matrices**:

$$\underset{(65\times267)}{\mathbf{R}} \times \underset{(267\times22)}{\mathbf{A}} \times \underset{(22\times65)}{\mathbf{C}} = \underset{(65\times65)}{\mathbf{G}} \tag{1}$$

Where:

- **R** and **C** are bridge matrices
- Matrix **A** is the initial matrix of value (intermediate use matrix)
- 267 is the number of **product** in the old classification
- 22 is the number of **industry** in the old classification
- 65 is the number of industry and product in the **new classification**
- Matrix **G** is the the target matrix with different dimensions and in the new classification

Conversion Supply table:

- The **columns in the supply** table are converted from the **old commodity** classifications into the new product classification
- The conversion is a reallocation of values to a new classification.

Compilation of input-output table and import and domestic use tables:

- The supply table has diagonal entries, indicating that the Use table is equivalent to an IO table.
- To meet **GTAP's requirements**, we **split the use matrix** into domestic and imported use matrices, which distinguish between intermediate and final uses by activities in the IOTs.

Construction of employment and compensation matrices

: calculate labor compensation across 65 GTAP sectors, split into five occupation level

- **Impute missing wage** by occupation for the year 2017
- **Generates the employment** matrix with ILO occupations in rows and GTAP sectors in columns.
- Calculate the **labor compensation**
- **Normalize labour compensation** to the labour income share in Gross value-added
- **Map labor by occupation** (sub-major-groups) and GTAP sectors to the GTAP occupations.
- The resulting matrix has the GTAP occupations level in rows and GTAP sectors in columns

Compensation for Land and natural resources

- calculate the **compensation to land and natural resources**, we rely on the methodology developed by (Hertel et al.,2020)

Compensation to capital

- **Adjustment of labour income share**
  1. Measure net domestic product, which is equal to GDP less depreciation,
  2. Obtain net labour share
- **Calculate compensation to capital**
  1. Matrix of value-added **disaggregated into net labor share**, compensation to land and other natural resources and capital depreciation
  2. **Add together** all the percentage shares, and normalize them to one
  3. **Normalise the compensation to labor** such the total is equal to the gross labor share
  4. Calculate and normalize **non-labour value-added**

Taxes on products

- **Taxes on products** include general taxes on goods and services and excise taxes
- Allocate **general taxes on products** to the relevant entries of the use table (intermediate use and final uses)
- Allocate the **excise taxes** to the final use categories (private households and capital formation)
- To obtain a **valuation matrix** for taxes on products, we add together the general taxes on goods and service matrices
- Proportionally adjust the **value-added matrix**, for sector-specific taxes
- Proportionally adjust the **intermediate and final use** tables for taxes on final use categories

Income and Factor Taxes

To distribute **income and factor taxes**, we follow GTAP methodology, and we allocate them proportionally

- **Income, payroll, and social security** taxes to five labor occupations
- **Corporate income and property** taxes to natural resources and capital
- **Other income taxes** to all the primary factors with a similar procedure

Valuation matrices (Trade and Transport margins)

- `Convert the trade and transportation` margin vectors into matrices
- **Identify flows** that do not require any margins (mainly for inventories) And set the values equal to zero
- **Map the trade and transportation margin** vectors into 22 intermediate consumption and final demand matrices.
- Use the **adjusted conversion coefficient matrix** C^{adj} to convert the 22 intermediate industries into 65 GTAP sectors.

Trade-link: imports

Using international import, statistics, we disaggregate the import use table into bilateral import use tables

- **Remove** any duties and import commodity taxes
- **Calculate** import ratios for each trading partner
- **Apply** the ratios to calculate bilateral import use matrices.
- The import use table of the **rest of world** is calculated as residuals.

Trade-link: exports

Using international statistics to split the export column vector into bilateral export vectors.

- **Construct** the export matrix with the GTAP classification in rows and bilateral export partners in the columns.
- Using trade data obtained from several sources introduces **inconsistencies**.
- Apply the **KRAS method** to balance the export matrix

Creation of initial estimate

With respect to the remaining **reference years** 2014, 2011, 2007 and 2004 (GTAP years), we project the **SAM from 2017 backwards** using the **compound annual growth rate**.

$$CAGR_{ij} = \left(\frac{a_{ij}^{2019}}{a_{ij}^{2016}}\right)^{\frac{1}{3}} - 1 \tag{1}$$

where a_{ij}^{2019} and a_{ij}^{2016} are the values of technical coefficients

Technical coefficients for the years backwards

The **technical coefficients** for the year 2014 a_{ij}^{2014}can be calculated as follow:

$$\begin{aligned} CAGR_{ij} &= \left(\frac{a_{ij}^{2016}}{a_{ij}^{2014}}\right)^{\frac{1}{2}} - 1 \\ a_{ij}^{2014} &= \frac{a_{ij}^{2016}}{\left(CAGR_{ij} + 1\right)^2} \end{aligned} \tag{2}$$

Technical coefficients for the year 2014

Once we have the matrix for the year 2014(a_{ij}^{2014}), we can calculate the **amount of commodity** i used by sector j (u_{ij})

$$u_{ij\,domestic}^{2014} = u_{ij}^{2016} * a_{ij}^{2014} \tag{3}$$

Imports as input

Assuming similar cost structure for the domestic and import input, we can calculate the **import use table** using the technical coefficient matrix

$$u_{ij\,import}^{2014} = u_{ij}^{2016} * a_{ij}^{2014} \tag{4}$$

Imposing External Constrains:

Once the initial SAM is estimated

- **Additional** data is imposed as external constraints
- **Constraints** are constructed from all available data
- Main idea is to leave fewer data to be **estimated** mathematically

Different types of constraints:

1. **Row and column constraint**
2. constraints on an arbitrary **subset of matrix elements** = Constraints on the aggregates of the cells (sub-matrix)
3. Constraints on a **specific cell**
4. **Zero as constraint**

Performing the balancing

Once we imposed all the above mentioned constraints, the KRAS balancing is performed, and consists of the following steps

- Calculate the **scaling factor** r for each constraint j.
- **scaling factor** is calculated using the 8 equation in Lenzen et al. (2009)
- The scaling factors are used to **update the elements** in the vectorized form of the initial matrix.
- The algorithm checks the constraints and if they are fulfilled, **calculates the information** loss and breaks the loop.
- The information loss is calculated using the objective function in equation (3) of Junius and Oosterhaven (2003).

Conclusion

- This paper describe the **process of constructing the first IOTs** and SAMS for Afghanistan that allow us to insert this country in the GTAP multi-country, multi-sector CGE model (releases for 2004, 2007, 2011, 2014, 2017)
- We **calculate the use tables** and compile the IOTs for the years 2016–2019
- To **obtain IOTs in previous years**, the technical coefficients of the IOTs are calculated using their compound growth rates for 2019–2016 and KRAS-balancing subject to equality restrictions sequentially
- **Projection and balancing** method developed in this paper can be easily used for other regions
- We **decompose gross value-added** and calculate valuation matrices
- We **document the data gathering** and mapping for each of the sub-matrices of the SAM for each year

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Use table

	Agriculture (A)			GTAP(Agriculture)													
	%	mill. Afs	USD_77,74	pdr	wht	gro	v_f	osd	c_b	pfb	ocr	ctl	oap	rmk	wol	frs	fsh
Paddy	5,00	856	11.017.352	11.017.352	0	0	0	0	0	0	0	0	0	0	0	0	0
Wheat	5,00	6.783	87.250.411	0	69.800.329	0	0	0	0	0	0	16.839.329	122.151	0	0	0	488.602
			5.716.272	0	0	4.573.017	0	0	0	0	0	1.103.240	8.003	0	0	0	32.011
Barley	5,00	175	2.249.556	0	0	1.799.645	0	0	0	0	0	434.164	3.149	0	0	0	12.598
Maize	5,00	250	3.221.841	0	0	2.577.473	0	0	0	0	0	621.815	4.511	0	0	0	18.042
Millet	5,00	19	244.874	0	0	195.899	0	0	0	0	0	47.261	343	0	0	0	1.371
			14.970.389	0	0	1.229.297	13.226.175	0	0	0	0	496.895	3.604	0	0	0	14.418
Beans	3,00	142	1.822.704	0	0	0	1.822.704	0	0	0	0	0	0	0	0	0	0
Peas	3,00	73	943.180	0	0	0	943.180	0	0	0	0	0	0	0	0	0	0
Oth-	3,00	530	6.815.191					6.815.191									
Oth-Cer	3,00	119	1.536.622			1.229.297	0	0	0	0	0	296.568	2.151	0	0	0	8.605
Potatoes	3,00	161	2.075.923	0	0	0	1.868.331	0	0	0	0	200.327	1.453	0	0	0	5.813
Eggplants	3,00	25	323.865	0	0	0	323.865	0	0	0	0	0	0	0	0	0	0
Cabbage	3,00	1	14.160	0	0	0	14.160	0	0	0	0	0	0	0	0	0	0
Cucumber	3,00	167	2.152.567	0	0	0	2.152.567	0	0	0	0	0	0	0	0	0	0
Onions	3,00	173	2.222.931	0	0	0	2.222.931	0	0	0	0	0	0	0	0	0	0
Tomatoes	3,00	232	2.986.377	0	0	0	2.986.377	0	0	0	0	0	0	0	0	0	0
Carrottes	3,00	44	562.432	0	0	0	562.432	0	0	0	0	0	0	0	0	0	0
Spinach	3,00	7	88.356	0	0	0	88.356	0	0	0	0	0	0	0	0	0	0
Leek	3,00	10	130.616	0	0	0	130.616	0	0	0	0	0	0	0	0	0	0
Celery	3,00	1	17.134	0	0	0	17.134	0	0	0	0	0	0	0	0	0	0
Squash	3,00	4	54.401	0	0	0	54.401	0	0	0	0	0	0	0	0	0	0
Mushroo	3,00	2	22.382	0	0	0	22.382	0	0	0	0	0	0	0	0	0	0
Radish	3,00	1	16.738	0	0	0	16.738	0	0	0	0	0	0	0	0	0	0
vegO		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Watermel	3,00	368	4.728.184	0	0	0	4.728.184	0	0	0	0	0	0	0	0	0	0
Cantaloup	3,00	297	3.824.138	0	0	0	3.824.138	0	0	0	0	0	0	0	0	0	0
vega	3,00	305	3.926.122	0	0	0	3.926.122	0	0	0	0	0	0	0	0	0	0