Workshop on Impact Analysis Toolkit

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Session 5 : Introduction to key data inputs for global CGE modeling

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Outline of the presentation

I. GTAP database

1. Overview of the GTAP database
2. GTAP database to be used primarily as Global SAM for CGE models

II. MAcMap-HS6 database

1. Overview of the MAcMap-HS6 database
2. Protection measurements
3. Aggregating tariffs for trade policy analysis and CGE modeling

I. GTAP database

1. **Overview of the GTAP database**

2. GTAP database to be used primarily as Global SAM for CGE models

1. Overview of the GTAP database

➢ What is the GTAP database about?

- Sectoral and geographic coverage of the GTAP database

1. GTAP database: What is it about?

What is GTAP?

- The Global Trade Analysis Project (GTAP) is a global network of researchers and policy makers conducting quantitative assessments of policy reforms (GTAP acronym created in 1991)

- GTAP is coordinated by the Center for Global Trade Analysis from the Department of Agricultural Economics at Purdue University (based in West Lafayette, State of Indiana, USA)

- GTAP organizes:
  - (since 1993) Annual Courses on the use of the GTAP CGE models (several versions: standard static, standard dynamic, GTAP-E [to look at energy and environment issues], GTAP-W [to capture water use in agriculture], etc.)
  - (Since 1998) Annual Conferences on Global Economic Analysis

1. GTAP database: What is it about?

❑ Rational behind the GTAP database and evolution

- GTAP CGE model (like other CGE models) requires considerable amount of data; leading to the creation of the GTAP database (the first GTAP model and the first GTAP database were both released in 1993)

- GTAP database is now used as the main data input to most CGE models

- Between early 90s and 2015, 9 versions of the GTAP database have been developed and released:
  - From a database made up 15 countries/regions and 37 sectors (GTAP1)
  - To a database with 140 countries/regions and 57 sectors (GTAP 9)
  - *Soon a database with likely 141 countries/regions and 67 sectors (GTAP 10)*

1. GTAP database: What is it about?

What does the GTAP database contain?

- GTAP database provides data on:
  - Consumption of intermediate as well as final goods and services
  - Bilateral trade flows (for both merchandises and services)
  - Use of factors of productions (i.e. labor [skilled vs. unskilled], capital, natural resources and land)
  - Transport, Taxes and subsidies, Bilateral protection on goods, etc.
  - Plus a number of satellite datasets in new areas (such as energy volumes, land use, CO2 emissions and international migrations)

- GTAP database version 9 provides such data for:
  - Three reference years: 2004, 2007, 2011 (providing a picture of the world economy for a particular year); *version 10 will provide data for year 2014*
  - As many as 57 sectors and 140 countries/regions

1. Overview of the GTAP database

- What is the GTAP database about?

➢ **Sectoral and geographic coverage of the GTAP database**

1. GTAP database (v.9): Sectors

	GTAP label
20 sectors for Agriculture and Food products	Paddy rice
	Wheat
	Cereal grains nec
	Vegetables, fruit, nuts
	Oil seeds
	Sugar cane, sugar beet
	Plant-based fibers
	Crops nec
	Bovine cattle, sheep and goats, horses
	Animal products nec
	Raw milk
	Wool, silk-worm cocoons
	Bovine meat products
	Meat products nec
	Vegetable oils and fats
	Dairy products
	Processed rice
	Sugar
	Food products nec
	Beverages and tobacco products
4 sectors for Primary products	Coal
	Oil
	Gas
	Minerals nec
13 sectors for Services	Water transport
	Air transport
	Communication
	Financial services nec
	Insurance

	GTAP label
20 sectors for Industry	Forestry
	Fishing
	Textiles
	Wearing apparel
	Leather products
	Wood products
	Paper products, publishing
	Petroleum, coal products
	Chemical, rubber, plastic products
	Mineral products nec
	Ferrous metals
	Metals nec
	Metal products
	Motor vehicles and parts
	Transport equipment nec
	Electronic equipment
	Machinery and equipment nec
	Manufactures nec
	Electricity
	Gas manufacture, distribution
	Water
	Construction
	Trade
	Transport nec
	Business services nec
	Recreational and other services
	Public Administration, Defense, Education, Health
	Dwellings

- Further breakdown within sectors available at: https://www.gtap.agecon.purdue.edu/databases/contribute/detailedsector.asp

1. GTAP database (v.9): Regions

	GTAP label		GTAP label		GTAP label		GTAP label
4 countries/ regions for North America	Canada	54 countries/regions for Europe, Central and Western Asia	Germany		Bahrain		Sri Lanka
	United States of America		Greece		Iran Islamic Republic of		***Rest of South Asia***
	Mexico		Hungary		Israel	32 countries/regions for Africa	Ethiopia
	Rest of North America		Ireland		Jordan		Kenya
23 countries/regions for the Caribbean, Central and South America	Argentina		Italy		Kuwait		Madagascar
	Bolivia		Latvia		Oman		Malawi
	Brazil		Lithuania		Qatar		Mauritius
	Chile		Luxembourg		Saudi Arabia		Mozambique
	Colombia		Malta		Turkey		Rwanda
	Ecuador		Netherlands		United Arab Emirates		Tanzania United Republic of
	Paraguay		Poland		***Rest of Western Asia***		Uganda
	Peru		Portugal	26 countries/regions for the rest of Asia and the Pacific	Australia		Zambia
	Uruguay		Slovakia		New Zealand		Zimbabwe
	Venezuela		Slovenia		***Rest of Oceania***		***Rest of Eastern Africa***
	Rest of South America		Spain		China		Benin
	Costa Rica		Sweden		Hong Kong		Burkina Faso
	Guatemala		United Kingdom		Japan		Cameroon
	Honduras		Switzerland		Korea Republic of		Cote d'Ivoire
	Nicaragua		Norway		Mongolia		Ghana
	Panama		***Rest of EFTA***		Taiwan		Guinea
	El Salvador		Albania		***Rest of East Asia***		Nigeria
	Rest of Central America		Bulgaria		Brunei Darussalam		Senegal
	Dominican Republic		Belarus		Cambodia		Togo
	Jamaica		Croatia		Indonesia		***Rest of Western Africa***
	Puerto Rico		Romania		Lao People's Democratic Republ		Egypt
	Trinidad and Tobago		Russian Federation		Malaysia		Morocco
	Rest of Caribbean		Ukraine		Philippines		Tunisia
	Austria		***Rest of Eastern Europe***		Singapore		***Rest of North Africa***
	Belgium		***Rest of Europe***		Thailand		***Central Africa***
	Cyprus		Kazakhstan		Viet Nam		***South Central Africa***
	Czech Republic		Kyrgyzstan		***Rest of Southeast Asia***		Botswana
	Denmark		***Rest of Former Soviet Uni***		Bangladesh		Namibia
	Estonia		Armenia		India		South Africa
	Finland		Azerbaijan		Nepal		***Rest of SACU***
	France		Georgia		Pakistan		***Rest of the World***

- Further breakdown within regions available at: https://www.gtap.agecon.purdue.edu/databases/contribute/iotables.asp?Version=9.211

1. GTAP database (v.9): Regions

- **18 ESCWA members** and **22 LAS members** *(including Syria-suspended)* split into:
  - **10** individual countries + **4** regions

GTAP label	GTAP label
Bahrain*	***Rest of Eastern Africa***
Jordan*	*Burundi*
Kuwait*	***Comoros****
Oman*	***Djibouti****
Qatar*	*Eritrea*
Saudi Arabia*	*Mayotte*
United Arab Emirates*	*Seychelles*
Rest of Western Asia	***Somalia****
Iraq*	***Sudan****
Lebanon*	***Rest of Western Africa***
Palestine*	*Cape Verde*
Syrian Arab Republic*	*Gambia*
Yemen*	*Guinea-Bissau*
Egypt*	*Liberia*
Morocco*	*Mali*
Tunisia*	***Mauritania****
Rest of North Africa	*Niger*
Algeria*	*Saint Helena*
Libya*	*Sierra Leone*
Western Sahara	

* ESCWAand LAS members
* LAS members only

- Looking forward, need to expend country coverage so that trade policy analysis using the GTAP database can be improved further

I. GTAP database

1. Overview of the GTAP database

2. **GTAP database to be used primarily as Global SAM for CGE models**

2. GTAP database to be used primarily as Global SAM for CGE models

- **What is a SAM?** ***(seen in session 3)***

- Basic structure of the GTAP database

2. GTAP database as global SAM for CGE models: What is a SAM?

- **Social Accounting Matrix (SAM):**
  - Provides a snapshot of an economy for a particular year
    - Describing flows of all economic transactions taking place within an economy (i.e. national accounting) and with outside (i.e. foreign transaction accounts)
  - Used as key data input for CGE modeling
    - A SAM provides-along with parameter estimates (e.g. elasticities)- the benchmark dataset for calibration of CGE models in a particular year (i.e. required data to allow the model to reach its equilibrium in that year)

2. GTAP database as global SAM for CGE models: What is a SAM?

❑ Structure of a SAM:

- Strictly depends on the study underlined
- Main common elements:
  - Production (factors, activities, products)
  - Institutions (households, firms, government, ROW)

Basic structure of a SAM

		Production			Institutions				Total
		Factors	Activities	Products	HH	Firms	Gov.	ROW	
Production	Factors		X					X	A
	Activities			X	X				B
	Products		X	X	X		X	X	C
Institutions	HH	X			X	X	X	X	D
	Firms	X					X	X	E
	Gov.	X	X	X	X	X		X	F
	ROW	X		X		X	X		G
Total		A	B	C	D	E	F	G	H

2. GTAP database as global SAM for CGE models: What is a SAM?

❑ Key principles of a SAM:

- Square matrix (each account is found in row and in column)
- Row ↔ Incomes from sales (e.g. incomes from the sale of labor factor to the metallurgic activity)
- Column ↔ Expenditures from purchases
  - i.e.: payment made from the account of a column to the account of a row (e.g. expenditure from purchase by the metallurgic industry to the labor factor)
- Row total = Column Total (for each account)

Basic structure of a SAM

		Production			Institutions				Total
		Factors	Activities	Products	HH	Firms	Gov.	ROW	
Production	Factors		X					X	A
	Activities			X	X				B
	Products		X	X	X		X	X	C
Institutions	HH	X			X	X	X	X	D
	Firms	X					X	X	E
	Gov.	X	X	X	X	X		X	F
	ROW	X		X		X	X		G
Total		A	B	C	D	E	F	G	H

2. GTAP database as global SAM for CGE models: What is a SAM?

❑ Example of a detailed SAM - A SAM must be strictly balanced!

		Production			Institutions				Investment	Total
		Factors	Activities	Products	HH	Firms	Gov.	ROW		
Production	Factors		value-added					factor income from ROW		**factor income**
	Activities			marketed outputs	home-consumed outputs					**activity income (gross output)**
	Products		intermediate inputs	transactions costs	private consumption		government consumption	exports	Investment	**demand**
Institutions	HH	factor income households			inter-households transfers	surplus to households	transfers to households	transfers to households from ROW		**household income**
	Firms	factor income to enterprises					transfers to enterprises	transfers to enterprises from ROW		**enterprises income**
	Gov.	factor income to government, factor taxes	producer taxes, value-added tax	sales taxes, tariffs, export taxes	transfers to government, direct household taxes	surplus to government, direct enterprise taxes		transfers to government from ROW		**government income**
	ROW	factor income to ROW		imports		surplus to ROW	government transfers to ROW			**foreign exchange outflow**
Savings					household savings	enterprise savings	government savings	foreign savings		**savings**
Total		**factor expenditures**	**activity expenditures**	**supply**	**household expenditures**	**enterprise expenditures**	**government expenditures**	**foreign exchange inflow**	**investment**	

Source: SAM Development and Economy-wide Analysis at IFPRI

Total Incomes = Total Expenditures

Savings = Investment

Demand = Supply

Foreign exchange outflows = Foreign exchange Inflows

2. GTAP database to be used primarily as Global SAM for CGE models

- What is a SAM?

➢ **Basic structure of the GTAP database**

2. GTAP database as global SAM for CGE models: Structure of the GTAP database

❑ A global SAM for CGE models

- A global SAM links input-output (I/O) tables of different economies/countries describing all economic transactions within and between the different countries for a particular year
- For multi-country multi-sector CGE models (such as the GTAP model), a global SAM (to represent the world economy) is required
- GTAP database does provide such extensive information
- Unfortunately, GTAP database is not free (although contributors to the database can get the version they contributed to for free)
- However, older versions of GTAP database provided for free; currently version 7 (with 2004 data) available after registration on GTAP website: https://www.gtap.agecon.purdue.edu/databases/archives.asp

2. GTAP database as global SAM for CGE models: Structure of the GTAP database

- **Simplified view of the GTAP database structure** (excluding commodity taxes)

	Domestic activities (57)	Other countries (129)	Global Transport (1)	Investment (cgds) (1)	Private Consumption (1)	Government (1)
Domestic Commodities (57)	VDFM	VXMD	VST	VDFM	VDPM	VDGM
Imported Commodities (57)	VIFM			VIFM	VIPM	VIGM
Factors (5)	VFM					

Source: Walmsley T., Aguiar A. and Narayanan B. GTAP Working Paper No. 67 (2012)

- **V** stands for Value; **D** (Domestic) and **I** (Imports); **P** (Private), **G** (Government), **F** (Firm/intermediate) and **X** (Exports); **M** for Market prices (as opposed to **A** for Agent prices (i.e. including of commodity taxes)); **VST** = Value of sales of transport; **D** (Destination) in VXMD.

2. GTAP database as global SAM for CGE models: Structure of the GTAP database

- **Concrete illustration** *(here using GTAP 7)*
  - Possible to answer questions such as:

1) What is the market price value (with 3 decimals) of capital purchased by all firms engaged in the textile industry ("tex") in Tunisia ("Tun")?

VFM ("capital","tex","Tun") = USD 237.517 million

2) What is the total value (with 4 decimals) of imported bovine meat products ("cmt") purchased by households from the rest of Western Asia region ("Xws"), at market price?

VIPM ("cmt","Xws") = USD 696.8441 million

2. GTAP database as global SAM for CGE models: Structure of the GTAP database

- **In addition to I/O tables and taxes, the GTAP database provides information for other variables, such as:**
  - Capital stock (VKB)
  - Capital depreciation (VDEP)
  - Population (POP), etc.

- **As well as satellite databases:**
  - Historic annual bilateral trade data (file tstrade.har)
  - Energy volumes (file gsdvole.har)
  - CO2 emissions (not available in GTAP 7), etc.

II. MAcMap-HS6 database

1. **Overview of the MAcMap-HS6 database**

2. Protection measurements

3. Aggregating tariffs for trade policy analysis and CGE modeling

1. Overview of the MAcMap-HS6 database

- **What is the MAcMap-HS6 database about?**

- What information does it contain?

1. MAcMap-HS6 database: What is it about?

- The Market Access Map (MAcMap) database provides detailed bilateral protection information at a very disaggregated level of tariff lines (up to the Harmonized System at 6-digit (HS6) level)
  - Thus the name of MAcMap-HS6 (to distinguish with MAcMap from ITC; http://www.macmap.org/)

- MAcMap was created by the *Centre d'Etudes Prospectives et d'Informations Internationales* (CEPII) based in Paris, France; with contributions from ITC, WTO and more recently IFPRI

- Requests to obtain and use MAcMap database should be made to CEPII (after registering to MAcMap on ITC website):
  - Unfortunately, not very friendly to use and requires costly software
  - But it now exists a free tool to extract data from MAcMap: the Tariff Analytical and Simulation Tool for Economists (TASTE)

Version with 2004 data can be downloaded from: http://www.copsmodels.com/taste.htm; for 2007 data: can be requested to GTAP (https://www.gtap.agecon.purdue.edu/resources/taste/taste.asp); for 2011 data: only given to GTAP Board members

1. Overview of the MAcMap-HS6 database

- What is the MAcMap-HS6 database about?

➢ **What information does it contain?**

1. MAcMap-HS6 database: What's in it?

- Bilateral tariff barriers to trade in goods for:
  - About 240 exporters and 190 importers countries
  - More than 5000 product lines (HS6-2002)
  - In years 2001, 2004, 2007 and 2011 (matching the GTAP database years availability; as they are both complementary and key inputs to CGE modeling)
- Information provided for the whole structure of tariffs:
  - Bound, MFN applied and preferential tariffs
- And by tariff types:
  - Ad-valorem, specific, compound and mixed tariffs
- Also includes information on quotas and bilateral trade

II. MAcMap-HS6 database

1. Overview of the MAcMap-HS6 database

2. **Protection measurements**

3. Aggregating tariffs for trade policy analysis and CGE modeling

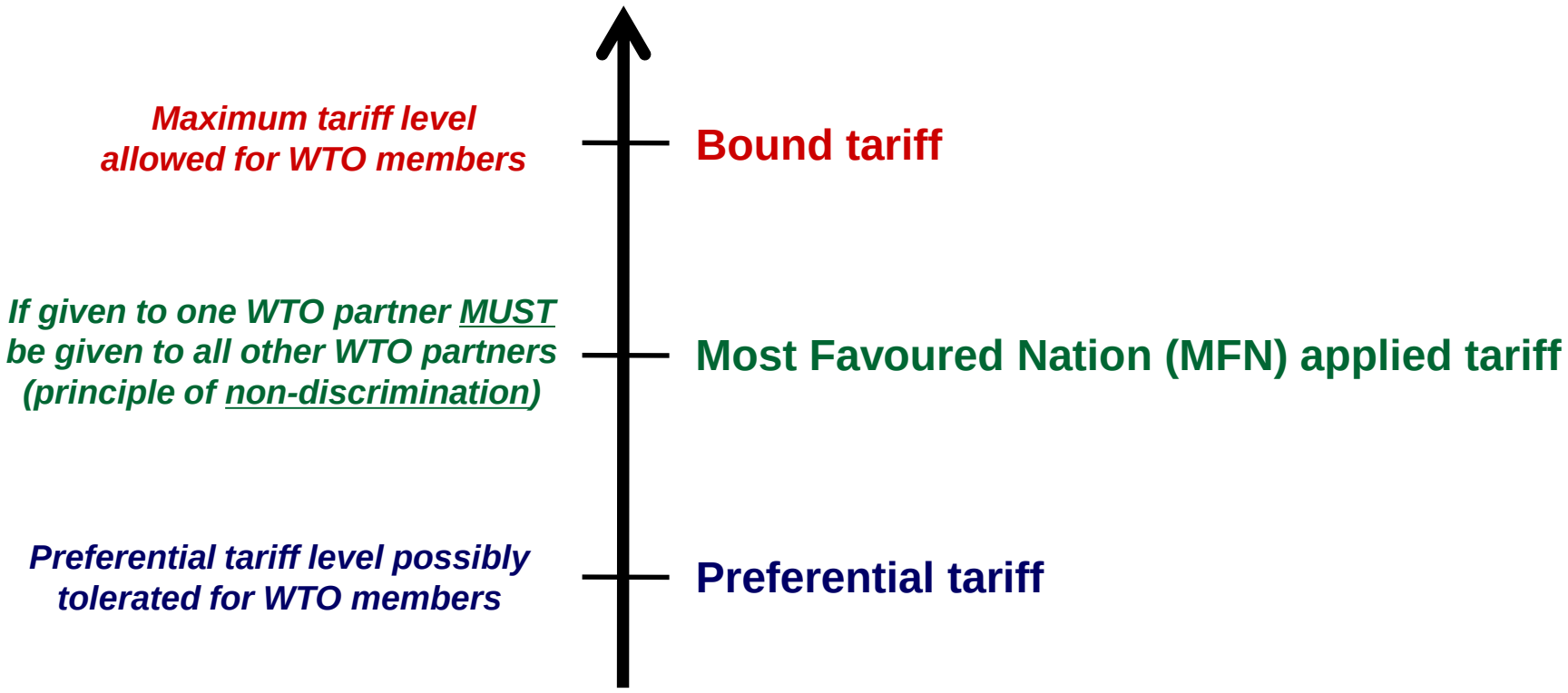
2. Protection measurements

➢ Structure of tariffs

- Types of tariffs

2. Protection measurement: Structure of tariffs

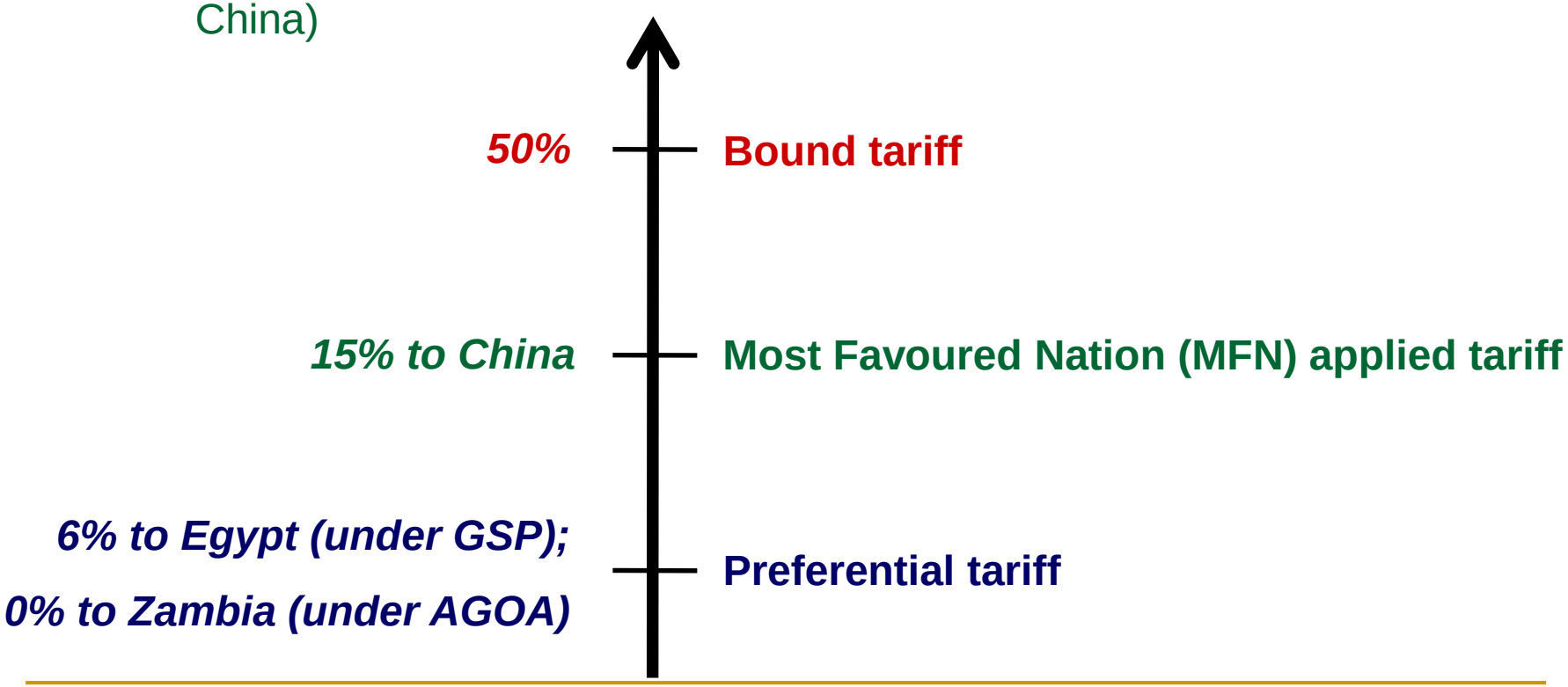
- 3 levels of tariffs (or duties) by tariff line such as:



Bound tariff >= MFN applied tariff >= Preferential tariff

2. Protection measurement: Structure of tariffs

- **Example:**
  - Let us assume that a country A (e.g. United States) imposes the following tariff structure on its imports of product i (e.g. honey) from country B (e.g. Zambia), country C (e.g. Egypt) and country D (e.g. China)

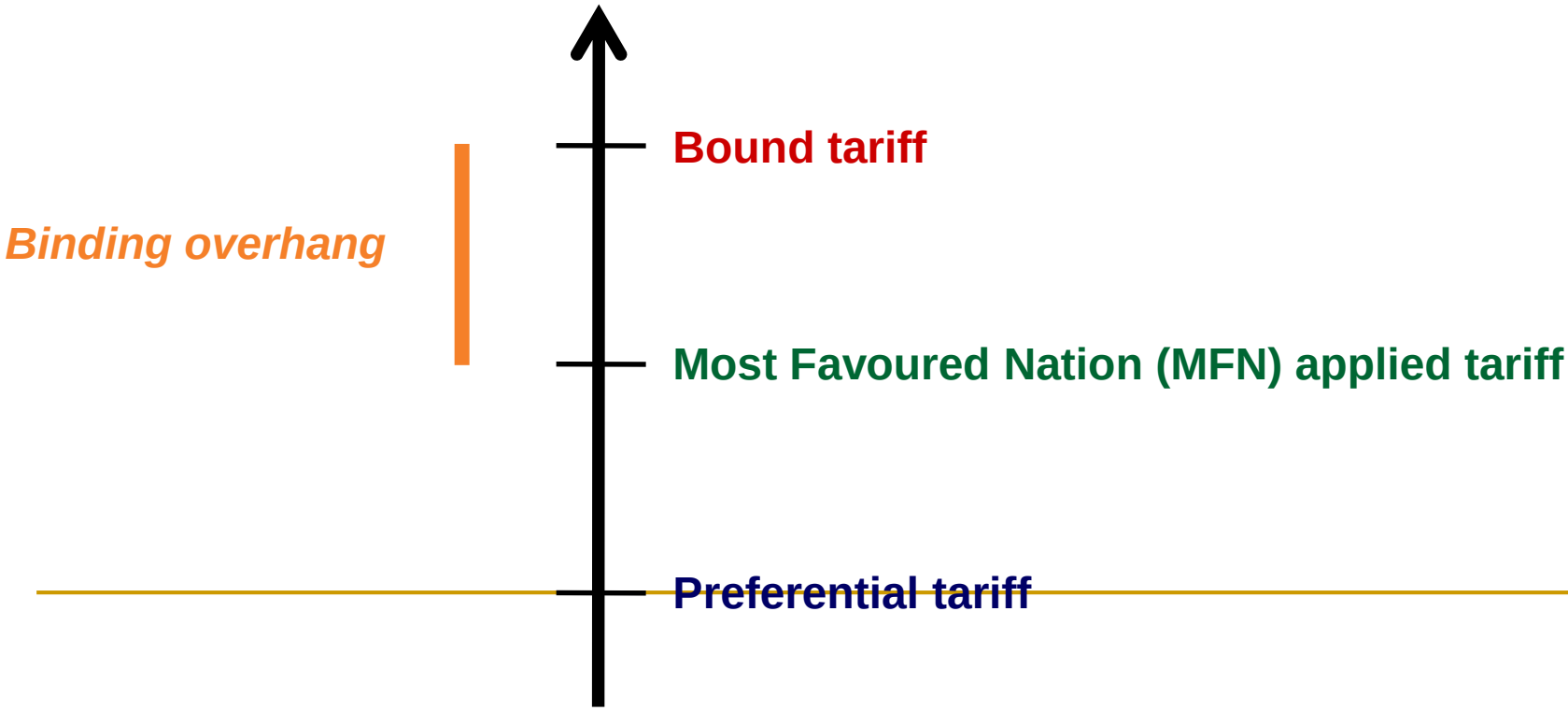


2. Protection measurement: Structure of tariffs

- **2 important concepts**

1) Binding overhang = Bound tariff – MFN applied tariff

- Margin that a country has within its WTO obligations; MFN applied can always be increased up to the bound; negotiations in WTO are about bound tariffs

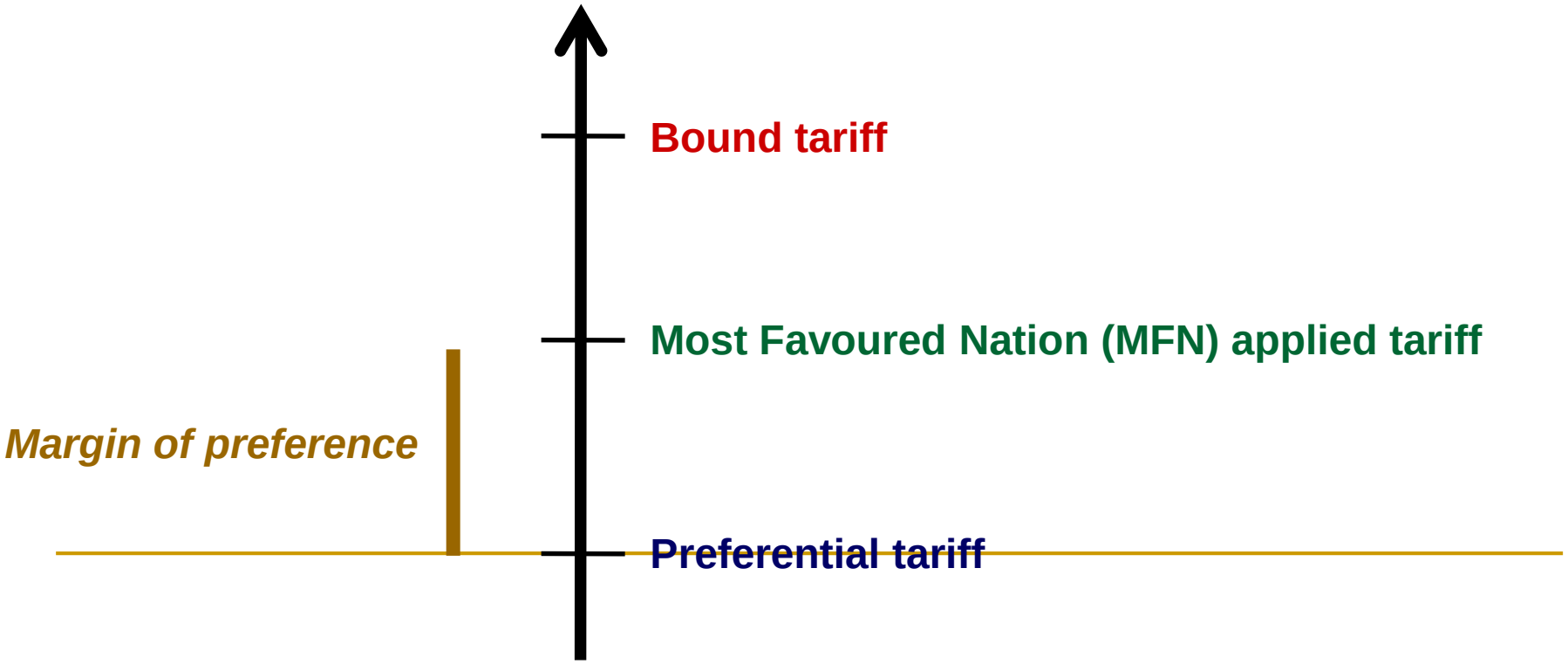


2. Protection measurement: Structure of tariffs

- **2 important concepts:**

2) Margin of preference = MFN applied tariff – Preferential tariff

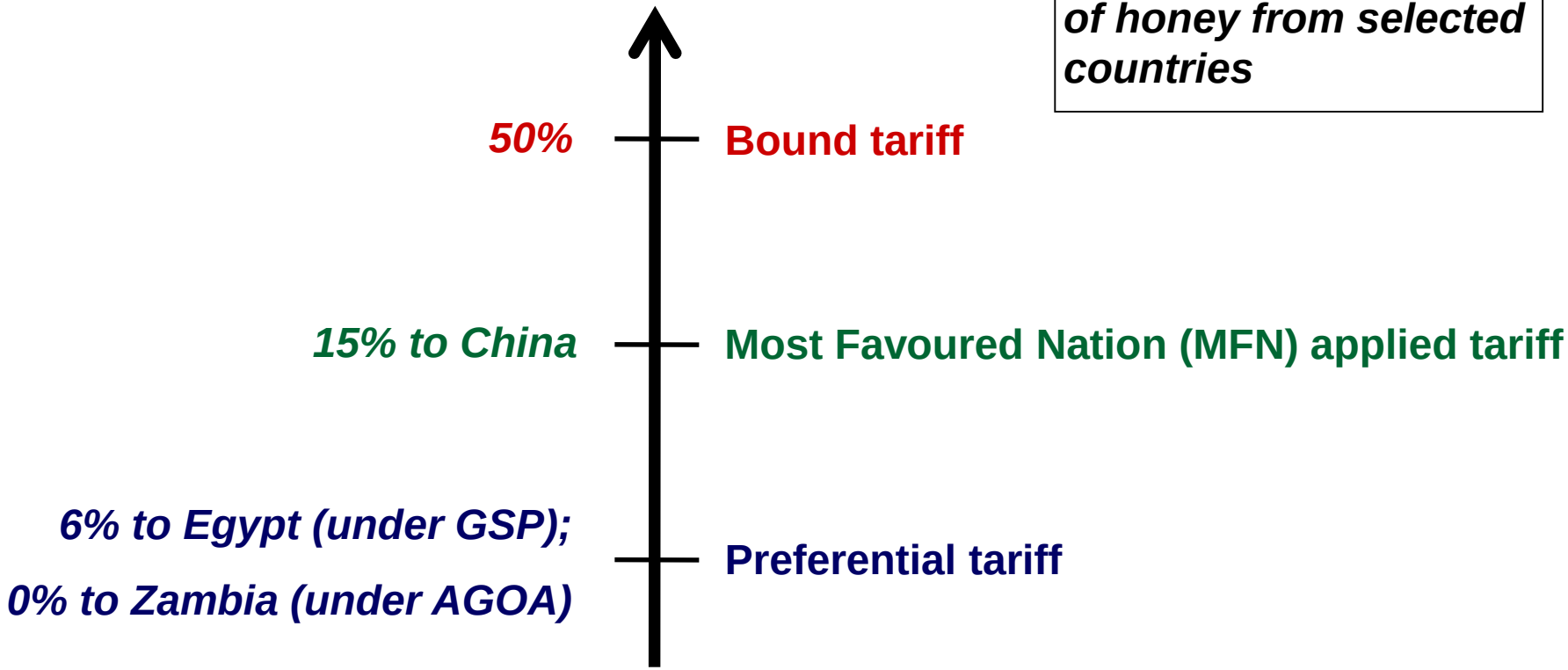
- Margin that a country grants to a specific partner in agreement with WTO



2. Protection measurement: Structure of tariffs

❑ **Illustration based on previous example:**

US structure of tariffs imposed on its imports of honey from selected countries



➢ **What is the binding overhang in honey for the US?** 35%

➢ **What is the margin of preference granted to Egypt?** **To Zambia?**

9% to Egypt 15% to Zambia

2. Tariff protection measurements

- Structure of tariffs

➢ **Types of tariffs**

2. Protection measurement: Types of tariffs

- **Each product line can have a combination of different tariffs types:**
  - **Ad valorem equivalent tariffs**: percentage
    - Example: 7%
  - **Specific tariffs**: monetary value by physical unit
    - Example: $100/ton
  - **Compound tariffs**: combination of ad valorem and specific tariff
    - Example: 12% + $2/kg
  - **Mixed tariff**: choice of either ad valorem or specific tariff depending on the condition attached
    - Example: 5% or 0.5$/kg, whichever is less

2. Protection measurement: Types of tariffs

- **Computing a single ad valorem equivalent (AVE) tariff by product line (using the unit value method)**:

  - **Example:** Let us assume that, in 2017, Qatar imported 10,000 liters of olive oil from Lebanon for a total value of $80,000.

    - Knowing that the specific tariff imposed by Qatar on its imports of olive oil from Lebanon is set to 4% + $0.5/liter, what is the corresponding AVE tariff?

2. Protection measurement: Types of tariffs

- **Computing a single ad valorem equivalent (AVE) tariff by product line (using the unit value method):**

  - **Solution for the example from previous slide:**

    - Formula:

      AVE of Specific Tariff in % = Specific Tariff / Unit Value * 100

      with, Unit Value = Value imported / Quantity imported

    - In our example:

      AVE of Specific Tariff in %

      = 0.5 / (80,000/10,000) * 100 = 6.25

    AVE imposed by Qatar on its imports of olive oil from Lebanon

    = 4% + 6.25% = **10.25%**

II. MAcMap-HS6 database

1. Overview of the MAcMap-HS6 database

2. Protection measurements

3. **Aggregating tariffs for trade policy analysis and CGE modeling**

3. Aggregating tariffs for trade policy analysis and CGE modeling

- **Aggregation methods**

- Illustration

3. Aggregating tariffs: Methods

- **Tariff aggregation methods:**
  - **Simple average**
    - Tariffs are aggregated using only tariff information available for each product line
  - **Import-weighted**
    - Tariffs are aggregated using both tariff and bilateral import value of each product line
  - **"Reference group" weighted (specific to MAcMap)**
    - Tariffs are aggregated using tariff information and bilateral import value from a group of countries called "reference group" for each product line
      - 5 "Reference groups" defined by a clustering procedure combining two criteria: GDP per capita and openness

3. Aggregating tariffs: Methods

❑ **Comparison of tariff aggregation methods using specific example**

	HS6 code	HS6 label	Importer	Exporter	AVE (%)	Trade value (USD million)	RG trade value (USD million)
	560890	Knottd nettg of twite/cordage/rope nes and made up nets of oth tex mat	Sudan	Lesotho	15.0	699	7749
	560900	Articles of yarn, strip, twine, cordage, rope and cable, nes	Sudan	Lesotho	20.0	276	12767
	570110	Carpets of wool or fine animal hair, knotted	Sudan	Lesotho	30.0	18	7776
Simple average	560890+ 560900+ 570110	Aggregated textile products	Sudan	Lesotho	21.7	993	28292
Import-weighted	560890+ 560900+ 570110	Aggregated textile products	Sudan	Lesotho	16.7	993	28292
Reference group-weighted	560890+ 560900+ 570110	Aggregated textile products	Sudan	Lesotho	21.4	993	28292

Simple average

= (15+20+30) / 3 = **21.7 %**

Import-weighted

= ((15*699)+(20*276)+(30*18)) / (699+276+18) = **16.7 %**

Reference group-weighted

= ((15*7749)+(20*12767)+(30*7776)) / (7749+12767+7776) = **21.4 %**

3. Aggregating tariffs: Methods

❑ Tariff aggregation method: Which one to pick?

➢ Simple average:

- Does not take into account any elements related to trade or economy size for the bilateral relationships

➢ Import-weighted:

- Satisfactory to reflect quality specialization of a bilateral relationship *[if no mistake on the trade value]* but serious endogeneity bias *[for a specific line: when tariff is very high and that import flow is very low, then aggregating this tariff line with another traded line (with relatively low tariff) will result in low aggregated tariff; in other words: a line with prohibitive tariff and no trade will have no weight associated to it, which is highly unsatisfactory as a prohibitive tariff does matter in economic terms]* – Tends to underestimate protection

➢ Reference group-weighted:

- Limit endogeneity bias between trade and protection as well as measurement errors

3. Aggregating tariffs for trade policy analysis and CGE modeling

- Aggregation methods

➢ **Illustration**

3. Aggregating tariffs: Illustration

- MAcMap-HS6 database which allows for both import-weight and reference group weight aggregation methods is increasingly used for trade policy analysis; allowing to:

  - **Aggregate tariff information** (across countries and/or products) **and therefore providing fine description of tariff barriers to trade worldwide at one point of the time**

    - For example:

      - What is the average applied protection imposed/faced by the League of Arab States on their imports/exports from/to the World?
      - What is the average protection imposed by Morocco on its imports of metals from India?, etc.

  - **Design scenarios of trade liberalization** to be implemented and simulated with multi-sector multi-region Computable General Equilibrium (CGE) models

3. Aggregating tariffs: Illustration

- **How to compute such aggregated tariffs?**

  - Until recently, it was requiring:
    - Strong programming skills
    - Powerful computers (size of the full MAcMap-HS6 database is about 8 gigabytes; running tariff aggregation programs could take hours)
    - Use of **S**tatistical **A**nalysis **S**oftware (SAS) – Costly!

  - Now, utilization of a free software with user friendly interface: the **T**ariff **A**nalytical and **S**imulation **T**ool for **E**conomists (**TASTE)**

3. Aggregating tariffs: Illustration

- **Example:**
  - *Using the TASTE software:*
    - *Compute the average protection imposed by Palestine on its imports of meat from Ethiopia*
      - *Using "Reference group" weight and GTAP scaling for the computations*
  - With TASTE version 8.1, we get: **52%**

Thank you very much for your kind attention!

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