Improving Trade in Value Added (TiVA) Approach in Global Value Chain Analysis

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The views expressed here are solely those of the presenter. This presentation is not meant to represent the views of the USITC or any of its Commissioners.

Agenda

- Trade in Value Added (TiVA) Approach in GVC Analysis
- USITC and Regional TiVA Initiatives
- APEC TiVA Experience: Two-Stage Balancing Trade under the Supply-Use Framework
- Improve TiVA Approach in GVC Analysis
- Q & A

Trade in Value Added (TiVA) Approach in GVCs Analysis

- Trade in Value added (TiVA):
  - It is a statistical approach to measure global value chains (GVCs) by estimating the sources of the value added (by country and industry) in producing goods and services for final consumption (OECD).
  - *Inter-country input-output (ICIO) tables* are the underpinnings of TiVA databases.
  - It is the most feasible approach to develop comprehensive and consistent measure for trade in value added that goes beyond case studies of individual products (such as the iPod).

Inter-Country Input-Output Table (ICIOT)

			USE								Total Use
			Intermediate Use				Final Use				
			Ctr 1	Ctr 2	Ctr 3	Row	Ctr 1	Ctr 2	Ctr 3	RoW	
			1……n	1……n	1……n	1……n	1…e	1…e	1…e	1…e	
Supply	Ctr 1	1 . . . n	$ID^{1}_{i,j}$	$IM^{1,2}_{i,j}$	$IM^{1,3}_{i,j}$	$IM^{1,row}_{i,j}$	FD^{1}_{i}	$FM^{1,2}_{i}$	$FM^{1,3}_{i}$	$FM^{1,row}_{i}$	O^{1}_{i}
	Ctr 2	1 . . . n	$IM^{2,1}_{i,j}$	$ID^{2}_{i,j}$	$IM^{2,3}_{i,j}$	$IM^{2,row}_{i,j}$	$FM^{2,1}_{i}$	FD^{2}_{i}	$FM^{2,3}_{i}$	$FM^{2,row}_{i}$	O^{2}_{i}
	Ctr 3	1 . . . n	$IM^{3,1}_{i,j}$	$IM^{3,2}_{i,j}$	$ID^{3}_{i,j}$	$IM^{3,row}_{i,j}$	$FM^{3,1}_{i}$	$FM^{3,2}_{i}$	FD^{3}_{i}	$FM^{3,row}_{i}$	O^{3}_{i}
	RoW	1 . . . n	$IM^{row,1}_{i,j}$	$IM^{row,2}_{i,j}$	$IM^{row,3}_{i,j}$	$ID^{row}_{i,j}$	$FM^{row,1}_{i}$	$FM^{row,2}_{i}$	$FM^{row,3}_{i}$	FD^{row}_{i}	O^{row}_{i}
Value-added			V^{1}_{j}	V^{2}_{j}	V^{3}_{j}	V^{row}_{j}					
Total supply			O^{1}_{j}	O^{2}_{j}	O^{3}_{j}	O^{row}_{j}	Source: author's modification from Nadim Ahmad's "Creating Global Input-output tables," 2017				

An ICIOT consists of four major matrices:
intermediate use, final use, direct value added, output.

Leontief Input-Output Model

			USE								Total Use
			Intermediate Use				Final Use				
			Econ 1	Econ 2	Econ 3	RoW	Econ 1	Econ 2	Econ 3	RoW	
			1…… n	1…… n	1…… n	1…… n	1…e	1…e	1…e	1…e	
Supply	Econ 1	1 . . . n	$ID^{1}_{i,j}$	$IM^{1,2}_{i,j}$	$IM^{1,3}_{i,j}$	$IM^{1,row}_{i,j}$	FD^{1}_{i}	$FM^{1,2}_{i}$	$FM^{1,3}_{i}$	$FM^{1,row}_{i}$	O^{1}_{i}
	Econ 2	1 . . . n	$IM^{2,1}_{i,j}$	$ID^{2}_{i,j}$	$IM^{2,3}_{i,j}$	$IM^{2,row}_{i,j}$	$FM^{2,1}_{i}$	FD^{2}_{i}	$FM^{2,3}_{i}$	$FM^{2,row}_{i}$	O^{2}_{i}
	Econ 3	1 . . . n	$IM^{3,1}_{i,j}$	$IM^{3,2}_{i,j}$	$ID^{3}_{i,j}$	$IM^{3,row}_{i,j}$	$FM^{3,1}_{i}$	$FM^{3,2}_{i}$	FD^{3}_{i}	$FM^{3,row}_{i}$	O^{3}_{i}
	RoW	1 . . . n	$IM^{row,1}_{i,j}$	$IM^{row,2}_{i,j}$	$IM^{row,3}_{i,j}$	$ID^{row}_{i,j}$	$FM^{row,1}_{i}$	$FM^{row,2}_{i}$	$FM^{row,3}_{i}$	FD^{row}_{i}	O^{row}_{i}
Value-added			V^{1}_{j}	V^{2}_{j}	V^{3}_{j}	V^{row}_{j}					
Total supply			O^{1}_{j}	O^{2}_{j}	O^{3}_{j}	O^{row}_{j}	Source: author's modification from Nadim Ahmad's "Creating Global Input-output tables," 2017				

A

Y

X

V

$$X = (I - A)^{-1}Y = BY$$

$$v_i = \hat{V}X_i = \hat{V}BY_i$$

A: Direct input coefficient matrix
B: the Leontief inverse matrix
X: industry gross output
Y: final products
V: direct industry value added
$\hat{V}$: diagonal industry value added matrix

Major ICIO/TiVA Databases

- GTAP database (GTAP)
  - Developed and maintained by the Center of Global Trade Analysis at Purdue University.
  - 65 sectors; 141 countries and regions; 2004, 2007, 2011, and 2014.
- The World Input-Output database (WIOD)
  - Developed by a consortium of eleven European research institutions.
  - Two releases:
    - 2016 release: 56 sectors; 43 countries; 2000–14.
    - 2013 release: 35 sectors; 40 countries; 1995–2011.
- The OECD-WTO TiVA database (OECD)
  - Launched by OECD and WTO in 2013.
  - Released four editions: 2013, 2016, 2018, and 2021
  - 2021 edition: 45 sectors; 66 economies; 1995–2018.

"*The Similarities and Differences among Three Major Inter-country Input-output Databases and their Implications for Trade in Value-added Estimates*," C. Degain, L. Jones, Z. Wang and X. Li (2014).

USITC and Two Regional TiVA Initiatives

- APEC TiVA Initiative:
  - Initiated in Spring 2014 under APEC GVC Work Stream 2: "APEC GVCs and TiVA Measurement"
  - Co-led by the United States (USTR, USITC, BEA) and China (MOFCOM, SIC)
  - Major outputs:
    - ✓ 2005 and 2012 APEC TiVA databases; 34 sectors; 23 economies.
    - ✓ Two APEC TiVA technical reports (2019 and 2021).
    - ✓ Four APEC capacity building workshops.

- North America (NA) TiVA Initiative:
  - Initiated in Fall 2014 to synergize the APEC TiVA effort
  - Joint effort by USITC, BEA, Census, INEGI, Statistics Canada
  - Major outputs:
    - ✓ 2012 the NA TiVA database; 100 sectors; 4 economies.
    - ✓ Two NA TiVA White Papers (2018, 2022).
    - ✓ A Proof of Concept: Estimating Extended Supply-Use Tables in Basic Prices with Firm Heterogeneity for the United States (2018).

Trade in a Single-Country Supply Table

		Ind 1	Ind 2	Ind 3	……	Ind n	Total domestic supply	Imports (c.i.f.)	Total supply at basic price	Margins and net taxes	Total supply at purchaser's price
Supply	Prd 1	$O_{1,1}$	$O_{2,1}$	$O_{3,1}$		$O_{n,1}$	O_1	IM_1	$S_{1(b)}$		$S_{1(p)}$
	Prd 2	$O_{1,2}$	$O_{2,2}$	$O_{3,2}$		$O_{n,2}$	O_2	IM_2	$S_{2(b)}$		$S_{2(p)}$
	Prd 3	$O_{1,3}$	$O_{2,3}$	$O_{3,3}$		$O_{n,3}$	O_3	IM_3	$S_{3(b)}$		$S_{3(p)}$
	. .										
	Prd m	$O_{1,m}$	$O_{2,m}$	$O_{3,m}$		$O_{n,m}$	O_m	IM_m	$S_{m(b)}$		$S_{m(p)}$
	TIO	O_1	O_2	O_3		O_n					

In a single-country supply table, the import vector presents a country's total imports from the world by product.

Trade in a Single-Country Use Table

	Use								
	Ind 1	Ind 2	Ind 3	……	Ind N	Total Intermediate use	Final Use (Cons, Cap, Inv)	Exports	Total use
Prd 1	$INT_{1,1}$	$INT_{2,1}$	$INT_{3,1}$		$INT_{n,1}$	INT_1	FIN_1	EX_1	$U_{1(b\ or\ p)}$
Prd 2	$INT_{1,2}$	$INT_{2,2}$	$INT_{3,2}$		$INT_{n,2}$	INT_2	FIN_2	EX_2	$U_{2(b\ or\ p)}$
Prd 3	$INT_{1,3}$	$INT_{2,3}$	$INT_{3,3}$		$INT_{n,3}$	INT_3	FIN_3	EX_3	$U_{3(b\ or\ p)}$
. .									
Prd m	$INT_{1,m}$	$INT_{2,m}$	$INT_{3,m}$		$INT_{n,m}$	INT_m	FIN_m	EX_m	$U_{m(b\ or\ p)}$
TVA	V_1	V_2	V_3		V_n				
TIO	O_1	O_2	O_3		O_n				

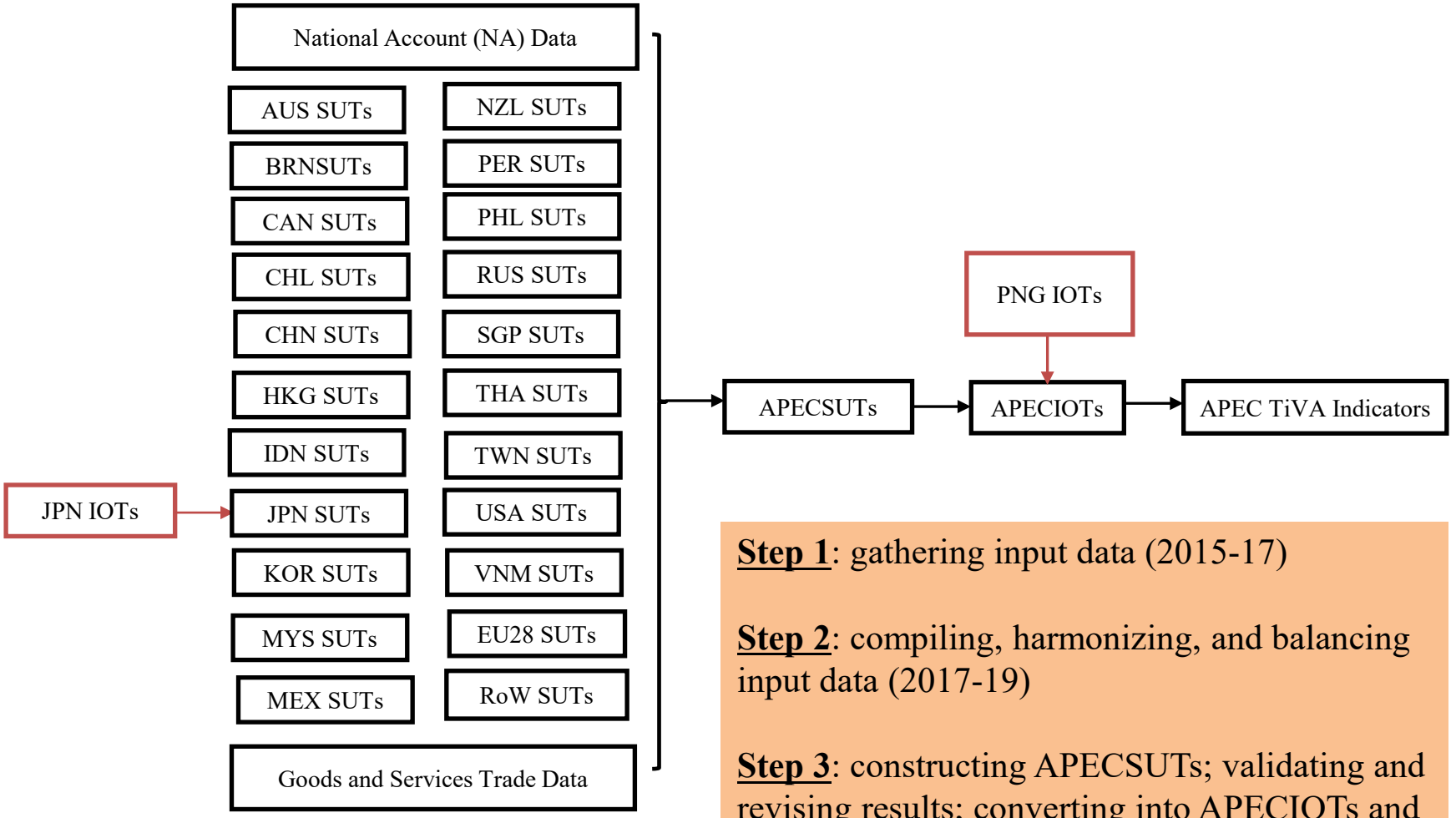
In a single-country use table, the export vector presents a country's total exports to the world by product.

Trade in an ICIOT

			USE								Total Use
			Intermediate Use				Final Use				
			Ctr 1	Ctr 2	Ctr n	RoW	Ctr 1	Ctr 2	Ctr n	RoW	
			1……n	1……n	1……n	1……n	1…e	1…e	1…e	1…e	
Supply	Ctr 1	1 . . . n	$ID^{1}_{i,j}$	$IM^{1,2}_{i,j}$	$IM^{1,3}_{i,j}$	$IM^{1,row}_{i,j}$	FD^{1}_{i}	$FM^{1,2}_{i}$	$FM^{1,3}_{i}$	$FM^{1,row}_{i}$	O^{1}_{i}
	Ctr 2	1 . . . n	$IM^{2,1}_{i,j}$	$ID^{2}_{i,j}$	$IM^{2,3}_{i,j}$	$IM^{2,row}_{i,j}$	$FM^{2,1,c}_{i}$	FD^{2}_{i}	$FM^{2,3}_{i}$	$FM^{2,row}_{i}$	O^{2}_{i0-}
	Ctr n	1 . . . n	$IM^{3,1}_{i,j}$	$IM^{3,2}_{i,j}$	$ID^{3}_{i,j}$	$IM^{3,row}_{i,j}$	$FM^{3,1}_{i}$	$FM^{3,2}_{i}$	FD^{3}_{i}	$FM^{3,row}_{i}$	O^{3}_{i}
	RoW	1 . . . n	$IM^{row,1}_{i,j}$	$IM^{row,2}_{i,j}$	$IM^{row,3}_{i,j}$	$ID^{row}_{i,j}$	$FM^{row,1}_{i}$	$FM^{row,2}_{i}$	$FM^{row,3}_{i}$	FD^{row}_{i}	O^{row}_{i}
Value-added			V^{1}_{j}	V^{2}_{j}	V^{3}_{j}	V^{row}_{j}					
Total supply			O^{1}_{j}	O^{2}_{j}	O^{3}_{j}	O^{row}_{j}	Source: author's modification from Nadim Ahmad's "Creating Global Input-output tables," 2017				

In an ICIOT, cross-border transactions, or inter-economy trade, is balanced at global, bilateral, and sectoral levels by end use.

The APEC TiVA Database Compilation Process



Step 1: gathering input data (2015-17)

Step 2: compiling, harmonizing, and balancing input data (2017-19)

Step 3: constructing APECSUTs; validating and revising results; converting into APECIOTs and computing TiVA indicators (2019-21)

APEC TiVA Compilation Methodology

- Constructing a complete set of bilateral merchandise and services trade statistics
- Disaggregating trade vectors in SUTs by trading partners and end use
- Adjusting for special trade items
  - Residents' purchases abroad
  - Non-residents' domestic purchases
- Balancing global export supply and import demand, bilateral trade by sector and end use, and total supply and use under the APECSUT framework

APEC Two-Stage Trade Balancing Approach

- Stage One: Stage one is balancing international trade statistics at bilateral and sectoral level by end use.
- Stage two is rebalancing trade at global, bilateral, and sectoral levels under the APECSUT framework.
- The principle of the APEC balancing approach: to preserve the official data to the extent possible
  - Adopting the optimization process
  - Dictating a set of balancing conditions that results should meet
  - Applying the official national account data (e.g., GDP by industries and by major expenditure category) as controls and only relaxing them in an optimization loop gradutely when there is no solution can be found
  - Constraining the solutions within the upper and lower bounds based on official statistics from different sources

Stage One: Balancing International Trade Statistics at Bilateral and Sector Levels

- Merchandise trade statistics:
  - FOB vs. CIF adjustment
  - Re-export adjustment
- Services trade statistics
  - Pulling data from available official sources (APEC direct submission, OECD, WTO, IMF)
  - Using a top-down approach to fill in missing data points
  - 49 EBOPS categories (12 major categories and 37 sub-categories)
- Estimating international transport margin services
  - Air, sea and other transport for freight; and freight insurance
  - Demand: merchandise trade statistics and OECD CIF estimates
  - Supply: services trade statistics + residuals
  - CIFs as part of the intermediate input of final APECIOTs

Stage Two: Rebalancing Trade at Global, Bilateral, and Sectoral Levels under the APECSUT Framework

- Stage two used three models to achieve the final balancing:
  - Model 1: Balancing global export supply and import demand

$$\sum IMP_{c.i.f.} = \sum EXP_{f.o.b.} + \sum CIFmargin$$

  - Model 2: Rebalancing APECSUTs with results from Model 1
    - $\sum_i (ID^k_{i,j} + IM^k_{i,j}) + V^k_j = O^k_j$
    - $\sum_j ID^k_{i,j} + FD^k_i + ED^k_i = O^k_i$
    - $\sum_i FM^k_i + \sum_j IM^k_{i,j} + \sum_i RE_{i,fob} - \sum_i RE_{mark\text{-}up} = \sum_{world} M^k_{i,cif}$
    - $\sum_i ED^k_{i,\,fob} + \sum_i RE_{i,fob} = \sum_i E^k_{i,\,fob}$
    - $\sum_i FCE^k_i = \sum_i FD^k_i + \sum_i FM^k_i + \sum_i MG^k_i + \sum_i NTAX^k_i$
  - Model 3: Applying results from stage one and model 1 and 2 to construct bilateral trade matrices that meet all balancing conditions

Improving TiVA Approach in GVC Analysis

- Having high-quality TiVA data is critical for systematic GVC analysis that goes beyond product/industry case studies.
- Improving the underlying input data
  - Increasing the adoptions of SUTs; improving services trade statistics; reducing bilateral trade discrepancies
  - Building statistical capacity; collaborating with national statistical agencies
- Improving TiVA compilation methodologies
  - Sharing detailed technical documentation and best practices
  - Developing methodologies to treat special trade items and incorporate firm heterogeneity
- Improving global TiVA governance
  - Providing transparency and harmonizing compilation methodologies via international collaboration.

For more information:

USITC TiVA Portal

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