Compilation and Structure of the ADB Multiregional Input-Output Table

CAREC Workshop

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Multiregional Input-Output Framework

- Traditional input-output framework analyzes the **interdependence of industries** in an economy by looking at the goods and services they produce (**outputs**) and consume (**inputs**) in the process of producing each of their own output

- Multiregional Input-Output Framework extends this analysis to many countries

2

Why compile MRIOTs?
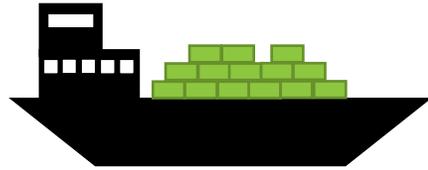
1	2	3
INTERNATIONAL TRADE	**ENVIRONMENT & ECONOMY**	**LABOR MARKETS & GLOBALIZATION**

- *Trade in value-added*
- *Global value chains*
- *Bilateral trade balances*

- *Environmental accounts*
- *Regulation and taxation*
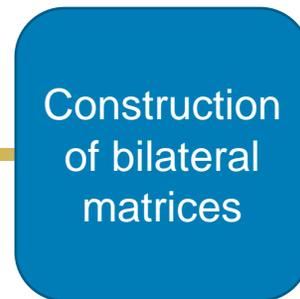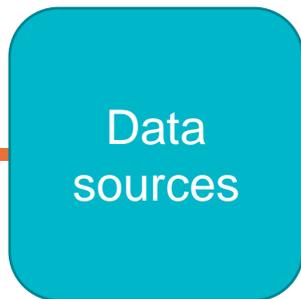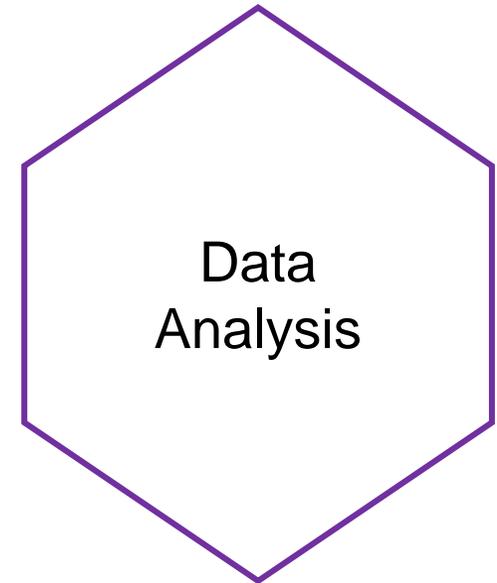- *Footprint of productive activities*

- *Analysis of labor markets and productivity*
- *Income distribution*
- *Globalization*

ISSUES

Harmonization of product and industry classification	Use of standard bridge tables; Disaggregation using alternative sources
Availability of national data (SUTs)	Non-survey methods; Extrapolation / interpolation techniques
Bilateral trade matrices and trade asymmetries	Dual approach; Alternative sources / data confrontation
Proportionality assumption	'Import use' ratios; BEC classification; Modelled estimates from other sources
Reconciliation and balancing	Investigative approach; Automated balancing for final round-up

SOLUTIONS

CAREC INSTITUTE   ADB

Data Collection
Coverage and Structure
Data Sources

Data Collection

Coverage and structure

Data source

Main features of various databases

DATABASE	COUNTRIES	PRODUCTS AND INDUSTRIES	YEARS
AIIOT (IDE-JETRO) (ide.go.jp)	10 (8 for 1975 table)	75 products (56 for 1975 table, 77 for 1985 table)	1975, 1985, 1990, 1995, 2000, 2005
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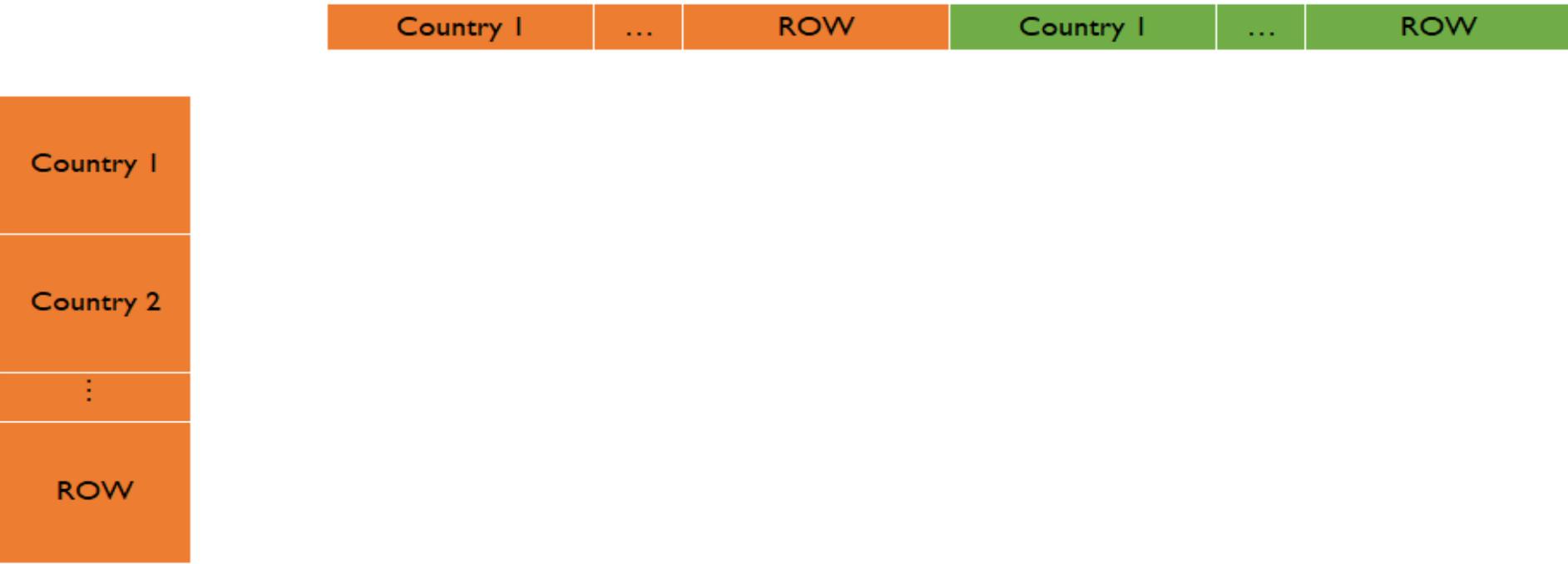| DATABASE	COUNTRIES	PRODUCTS AND INDUSTRIES	YEARS
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Schematic of MRIOTs

Country 1	...	ROW	Country 1	...	ROW

Country 1
Country 2
⋮
ROW

Schematic of MRIOTs

		Country 1	...		ROW		Country 1	...		ROW	
		c1	...	c35	c1	...	c35	f1	...	f5	f1	...	f5
Country 1	c1										
	...										
	c35										
Country 2	c1										
	...										
	c35										
⋮											
ROW	c1										
	...										
	c35										

Intermediate Consumption and Final Demand Matrices

Intermediate Use

Final Demand

Intermediate Inputs

Total Sector Output

Intraregional Transactions

Interregional Transactions

		Intermediate Use						Final Demand						Total
		Country 1			...	ROW		Country 1			...	ROW		
		c1	...	c35		c1	...	c35	f1	...	f5	f1	...	f5	
Country 1	c1				Intermediate sales from Country 1 to Country 2 and ROW							Final sales from Country 1 to Country 2 and ROW			
	...														
	c35														
Country 2	c1	Intermediate sales from Country 2 to Country 1				Intermediate sales from Country 2 to ROW			Final sales from Country 2 to ROW			Final sales from Country 2 to ROW			X
	...														
	c35														
:															
ROW	c1	Intermediate sales from ROW to Country 1 and Country 2							Final sales from ROW to Country 1 and Country 2						
	...														
	c35														
Intermediate input total															

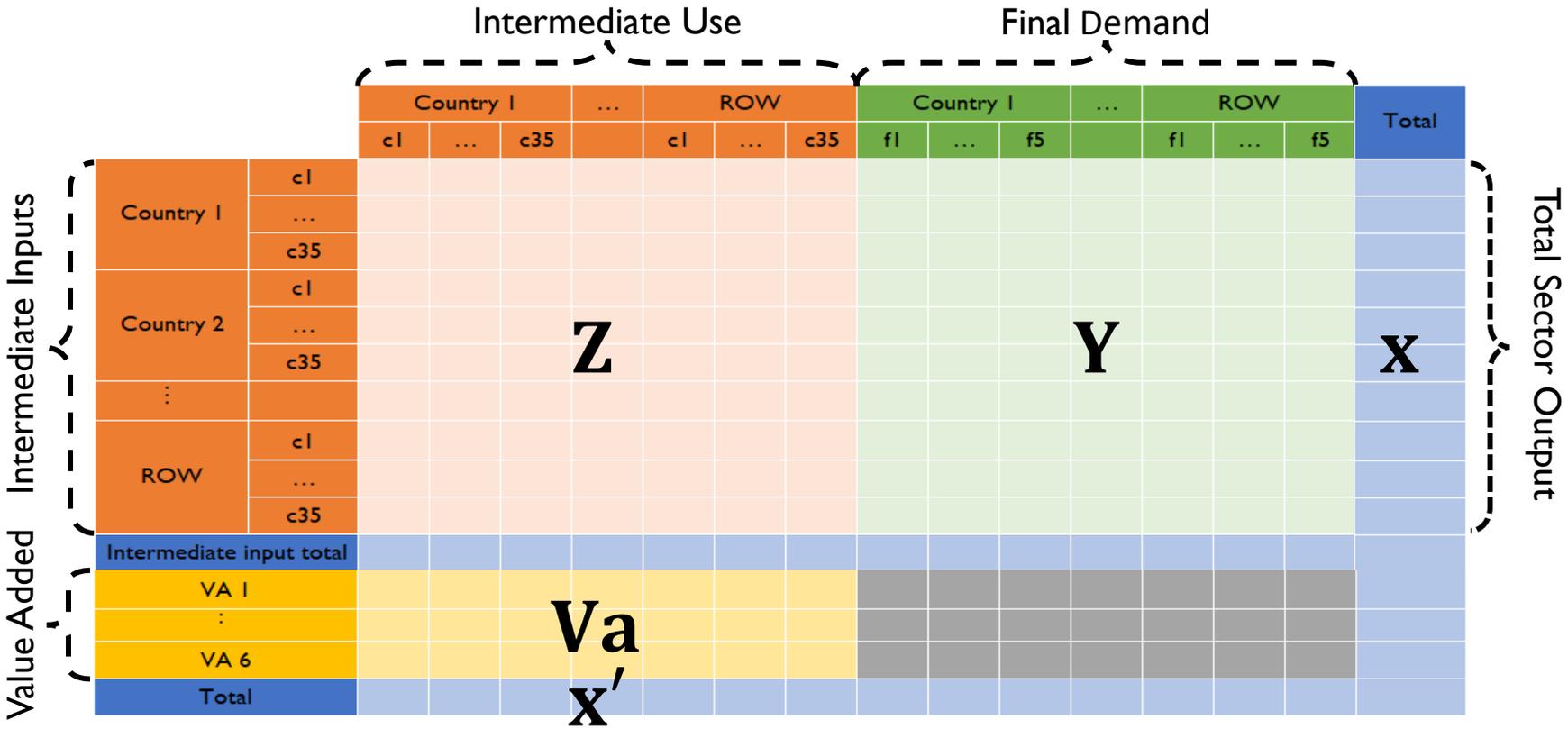Intermediate Inputs

Total Sector Output

Value-Added Matrix

The ADB MRIOT

Economies: 63 (G) ; 43 from WIOD and 19 ADB member countries

Sectors: 35 (c) ; based on ISIC Rev. 3

Final demand: 5 components (f)

Value added: 6 components (Va)

Units: Million USD, in current basic prices

Years: 2000, 2007-2020

The ADB MRIOT Economies

From WIOD (43)			From ADB (19)
Australia	France	Malta	Bangladesh
Austria	United Kingdom	Netherlands	Malaysia
Belgium	Greece	Norway	Philippines
Bulgaria	Croatia	Poland	Thailand
Brazil	Hungary	Portugal	Viet Nam
Canada	Indonesia	Romania	Kazakhstan
Switzerland	India	Russia	Mongolia
People's Republic of China	Ireland	Slovak Republic	Sri Lanka
Cyprus	Italy	Slovenia	Pakistan
Czech Republic	Japan	Sweden	Fiji
Germany	Republic of Korea	Turkey	Lao People's Democratic Republic
Denmark	Lithuania	Taipei,China	Brunei Darussalam
Spain	Luxembourg	United States	Bhutan
Estonia	Latvia	Rest of the World (RoW)	Kyrgyz Republic
Finland	Mexico		Cambodia
			Maldives
			Nepal
			Singapore
			Hong Kong, China

The ADB MRIOT Sectors

	Sectors (35)		
c1	Agriculture, Hunting, Forestry, and Fishing	c19	Sale, Maintenance, and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel
c2	Mining and Quarrying	c20	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles
c3	Food, Beverages, and Tobacco	c21	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods
c4	Textiles and Textile Products	c22	Hotels and Restaurants
c5	Leather, Leather Products, and Footwear	c23	Inland Transport
c6	Wood and Products of Wood and Cork	c24	Water Transport
c7	Pulp, Paper, Paper Products, Printing, and Publishing	c25	Air Transport
c8	Coke, Refined Petroleum, and Nuclear Fuel	c26	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies
c9	Chemicals and Chemical Products	c27	Post and Telecommunications
c10	Rubber and Plastics	c28	Financial Intermediation
c11	Other Nonmetallic Minerals	c29	Real Estate Activities
c12	Basic Metals and Fabricated Metal	c30	Renting of M&Eq and Other Business Activities
c13	Machinery, Nec	c31	Public Administration and Defense; Compulsory Social Security
c14	Electrical and Optical Equipment	c32	Education
c15	Transport Equipment	c33	Health and Social Work
c16	Manufacturing, Nec; Recycling	c34	Other Community, Social, and Personal Services
c17	Electricity, Gas, and Water Supply	c35	Private Households with Employed Persons
c18	Construction		

The ADB MRIOT Final Demand and Value-Added Components

Final Demand (5)		Value-Added (6)	
f1	Final consumption expenditure by households	va1	Taxes less subsidies on products
f2	Final consumption expenditure by non-profit organisations serving households (NPISH)	va2	CIF / FOB adjustments on exports
f3	Final consumption expenditure by government	va3	Direct purchases abroad by residents
f4	Gross fixed capital formation	va4	Purchases on the domestic territory by non-residents
f5	Changes in inventories and valuables	va5	Value added at basic prices
		va6	International Transport Margins

Data Partners and Stakeholders

Extended core

Direct-core

Core
WIOD and Country national accounts

Country data sources

Users of direct data sources

Internationally comparable sources / databases

Users of comparative database

Complementary country sources

Complementary international databases

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Bilateral trade matrices and trade asymmetries

Proportionality assumption

Reconciliation and balancing

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Investigative approach; Automated balancing for final round-up

Harmonization of Classifications

- Objective: **augment** existing world input-output tables (Timmer et al., 2015) by expanding to include **19** participating economies under ADB's regional capacity development technical assistance project 8838
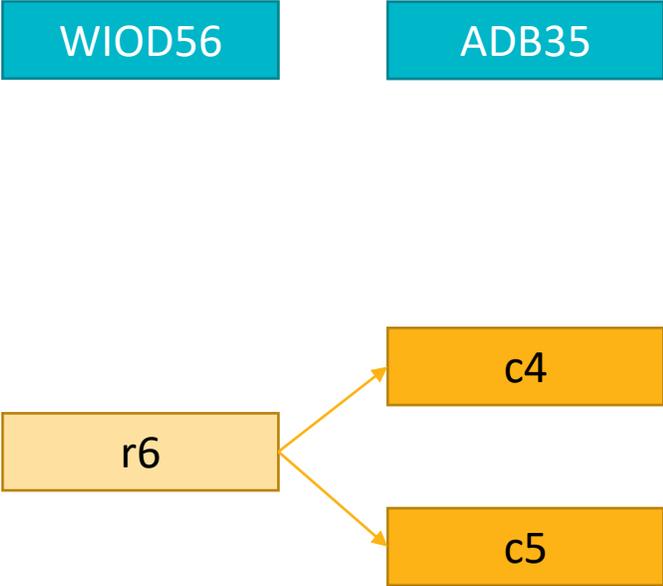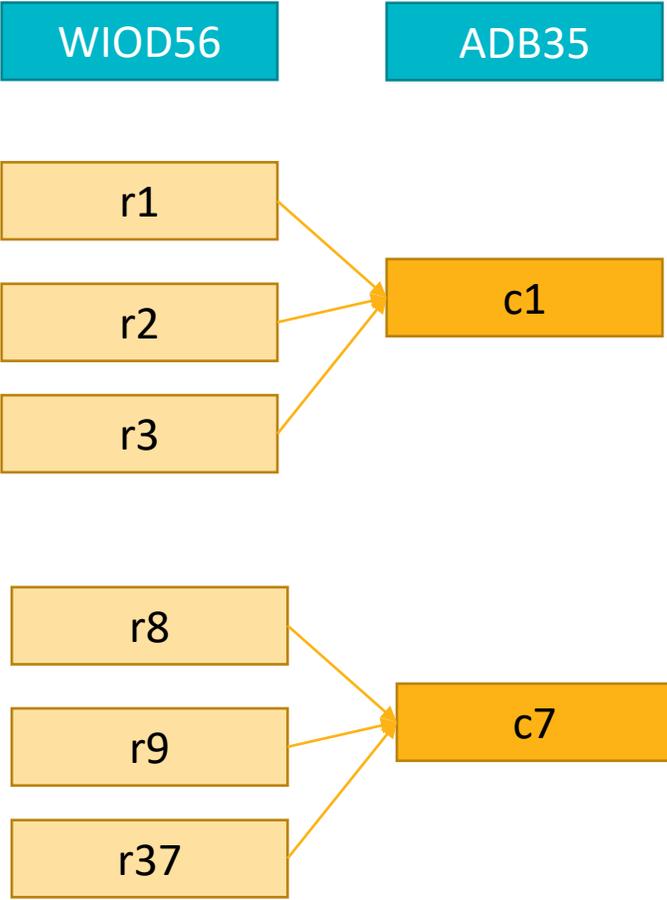- Key publication: Compendium of Supply and Use Tables for Selected Economies in Asia and the Pacific (2017)

Source: United Nations Statistics Division

Aggregations and Disaggregations

WIOD56	ADB35

r1
r2
r3

c1

r8
r9
r37

c7

WIOD56	ADB35

r6

c4

c5

Aggregations and Disaggregations

Official statistics

Analytical database

Indirect estimation approaches

Indicators (less robust)

HIGH

Administrative sources
(e.g. turnover data, merchandise trade, employment)

MED-LOW

Partner country statistics
(e.g. use of 'similar' country structure, esp. when there is presence of regional firms)

MED-HI

Similar intercountry input-output databases
(e.g. use of OECD ICIOT 2015 / 2018 versions)

LOW

Modelled estimates
(e.g. use of varied research publications [UN, WB, industry reports] for indicators; most useful on the expenditure side)

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Availability of national data (SUTs and IOTs)
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Availability of annual national data

What if there are no annual supply and use tables or input-output tables?

- Option 1: **Trends and extrapolation** anchored on annual national accounts statistics, direct input coefficients of benchmark year; normalized such that each element adds up to control figures (see for instance Timmer et al, 2013; Eurostat 2008); Back casting techniques using 'balanced' bilateral trade database of BACI

- Option 2: **Marginal inputs coefficients** (Miller & Blair, 2009) relate the *change* (from year $t - r$ to year t) in the amount of input i purchased by industry j to the *change* (over the same period) in the total amount of j produced.

Marginal changes

$$a_{ij}^*(t) = \frac{z_{ij}(t) - z_{ij}(t - r)}{x_j(t) - x_j(t - r)} = \frac{\Delta z_{ij}}{\Delta x_j}$$

- Option 3: G-RAS (Temurshoev 2013) and M-RAS algorithm (Paelinck and Waelbroeck 1963)

Availability of annual national data

- **Moving towards dual approach** (export / import) of the OECD Regional-Global TiVA Expert Group

- Important data sources:

  Priority scale

  1) UN Comtrade (by trade partner; HS-6 digit) and expanded balance of payment statistics (EBOPS);
  2) Data published by national statistics agencies (for missing years / countries (e.g. for splitting BEL-LUX economic union; Taipei,China));
  3) International Monetary Fund Direction of Trade Statistics (IMF-DOTS);
  4) OECD-World Trade Organization Balanced Trade in Services;
  5) Other MRIOs;
  6) Observatory of Economic Complexity (OEC-MIT)

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Construction of bilateral trade matrices

1

2

Import matrix

Intermediate uses   Final consumption   Capital goods

| Goods Import vector *(cif)* | Goods import vector *(fob)* |
| Services import vector | Services import vector |

I_i^M F_i^M G_i^M

I_i^M F_i^M G_i^M

$M_{i,j}$

3

$I_{i,j}^M$ $F_{i,j}^M$ $G_{i,j}^M$

$I_{i,j}^M$ $F_{i,j}^M$ $G_{i,j}^M$

$$= \boldsymbol{M_i} \ \forall \boldsymbol{i}$$
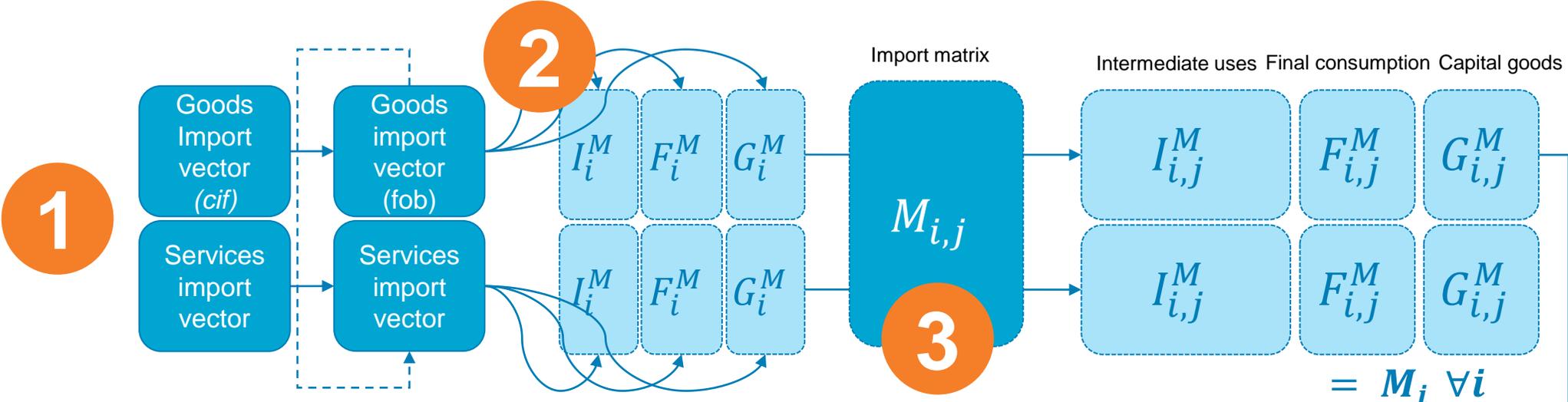
Available from Balance of Payments;
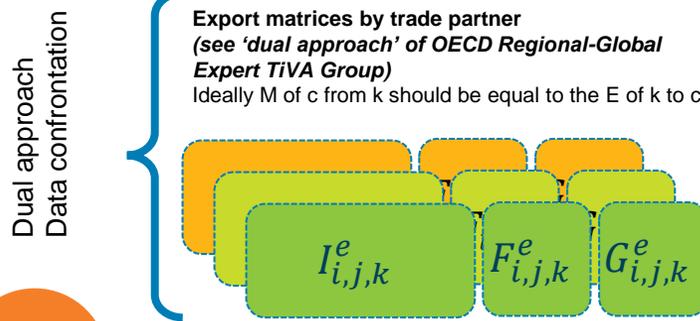*Estimates from partner countries fob exports;*
CIF-FOB bilateral margins

Various databases
BEC classification

Published by NSO;
Import matrix from SUT to
IOT transformation; or
EORA structure

Proportionality assumption (if no data);
Import use intensity from benchmark year t, e.g. :

$$I(t)_{i,j}^M \ / \ I(t)_{i,j}^U \ * \ I(t+r)_{i,j}^M$$

(and then normalized such that imported use of industries i… j…to n
is equal to total imported intermediate goods and services)

4

Partner country A		
Partner country B		
Partner country C $I_{i,j,k}^M$	$F_{i,j,k}^M$	$G_{i,j,k}^M$
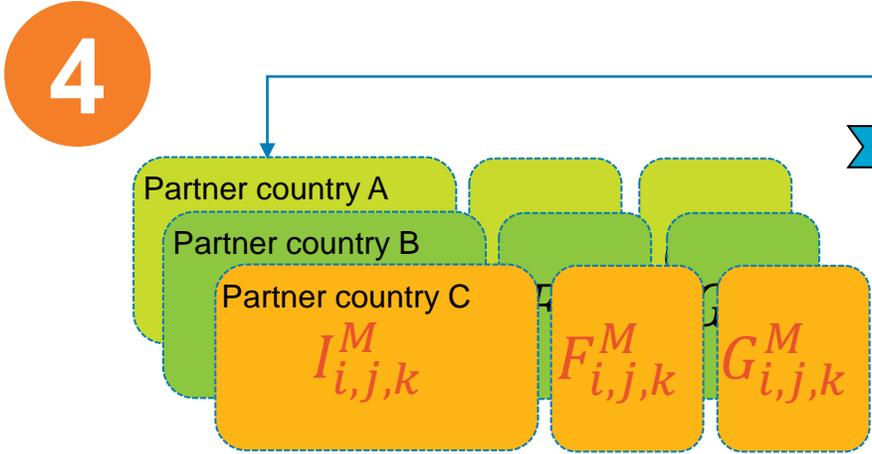
By trade partner
UN Comtrade
IMF-DOTS
OECD-WTO BaTIS

By product *i*
UN Comtrade;
UN EBOPS
Proportionality assumption

By industry *j*
Eora MRIO;
OECD ICIOT

Dual approach
Data confrontation

Export matrices by trade partner
(see 'dual approach' of OECD Regional-Global
Expert TiVA Group)
Ideally M of c from k should be equal to the E of k to c

$I_{i,j,k}^e$ $F_{i,j,k}^e$ $G_{i,j,k}^e$

5

CAREC INSTITUTE   ADB

Construction of bilateral trade matrices

SOME INVESTIGATIVE APPROACHES:

▪ **Which trade flow? Imports** are usually recorded with more accuracy than exports because imports generally generate tariff revenues while exports don't *(Based on World Integrated Trade Solution, echoed by Timmer et al 2012)*

▪ **Which reporter? Reliability indicators** (Guo, Webb, and Yamano (2009) and Gehlhar, Wang and Yao (2008), and more recently <u>Fortanier & Sarrazin</u> (2016; 2017) suggest indicators for reporter reliability based on discrepancies at the commodity-partner level. E.g. reported exports and imports are then reconciled using a "symmetry index" that gives more weight to those countries whose data more often agree with those of their trading partner

$$SI_{ikt}^{x} = \sum_{j} \frac{X_{ijkt}^{r}}{X_{ijkt}} \quad and \quad SI_{ikt}^{m} = \sum_{j} \frac{M_{ijkt}^{r}}{M_{ijkt}}$$

Where X^r and M^r reflect retained exports and retained imports, i.e. those bilateral flows that meet certain criterion (e.g. 30% in the case of <u>OECD BATiS</u>).

• **Top-down approach** is also used which checks highest levels of aggregation before looking at subcomponents; enables compiler to flag misdirected and misclassified trade.

ISSUES

| SOLUTIONS |

Harmonization of product and industry classification

Use of standard bridge tables; Disaggregation using alternative sources

Availability of national data (SUTs and IOTs)

Non-survey methods; Extrapolation / interpolation techniques

Bilateral trade matrices and trade asymmetries

Dual approach; Alternative sources / data confrontation

Proportionality assumption

'Import use' ratios; BEC classification; Modelled estimates from other sources

Reconciliation and balancing

Investigative approach; Automated balancing for final round-up

Reconciliation and balancing

- Manual balancing: 35 sectors, 63 "economies", 2000-2019*
  - Evaluation of underlying sources
  - Before and after comparison
  - Commodity flow approach for 'rest of the world'
  - Timeseries analysis (checks for outliers)
- **Modified RAS approach** (separately for domestic and external trade matrices)

1. Country-compilation (SUT, NA, Trade)
2. Consolidation (bilateral) (Export, Import)
3. Manual / automated balancing (MRIO)

Examples of plausibility checks
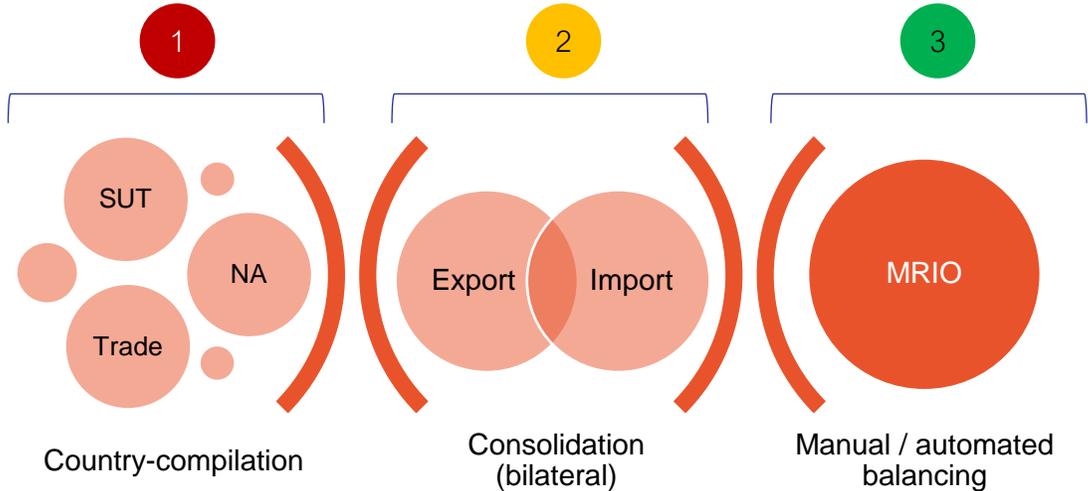
| Examples of plausibility checks |
| --- |
| Gross value-added to output ratios |
| Changes in gross value-added weights |
| Changes in intermediate consumption and intermediate use ratios (consumption vs. use) |
| Changes in export-to-output ratios |
| Changes in import intensity |
| Movement of stocks / inventories |
| Fluctuations in exchange rates |
| Changes in final demand categories' composition |

Applications of MRIO analysis
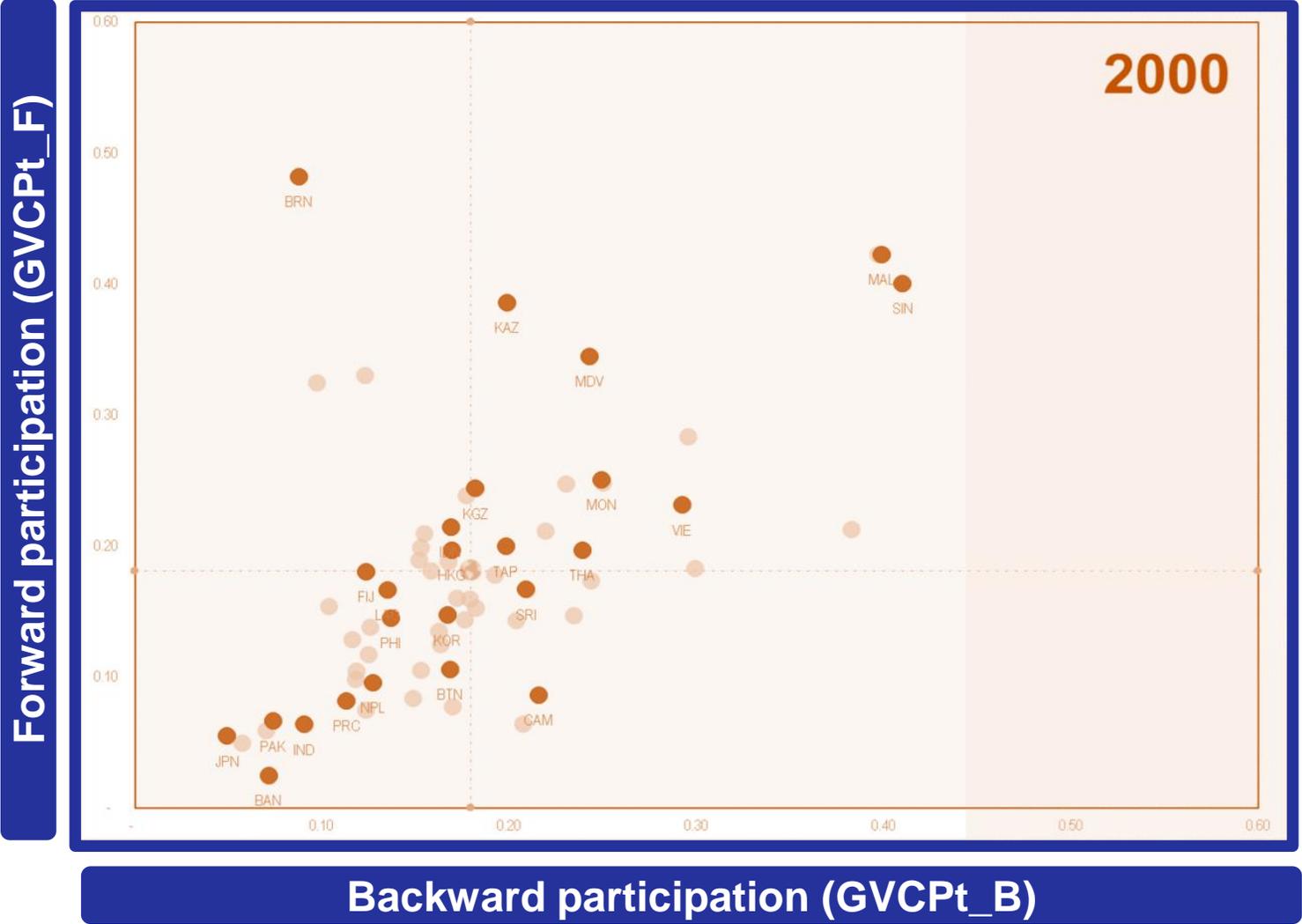
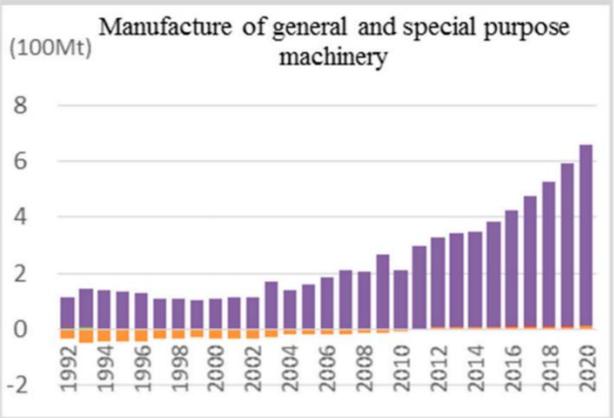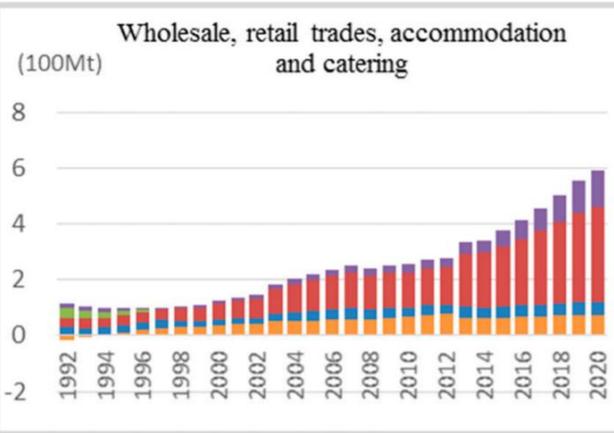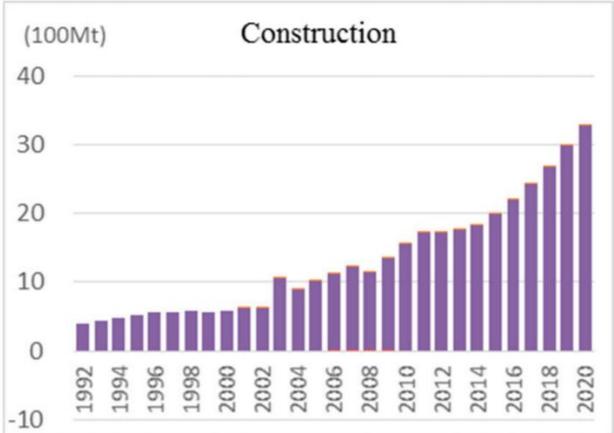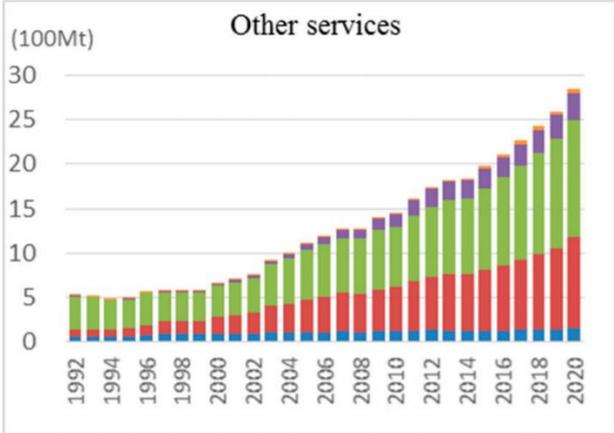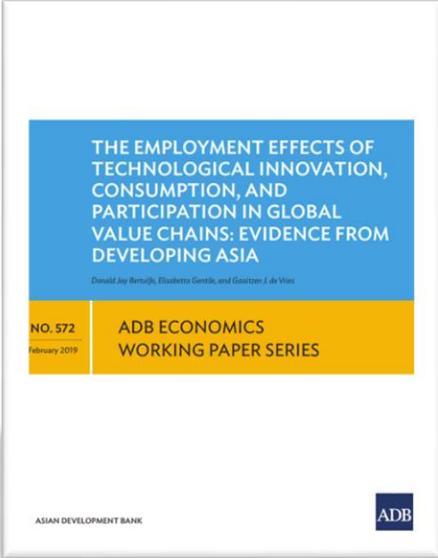# Applications of MRIO analysis
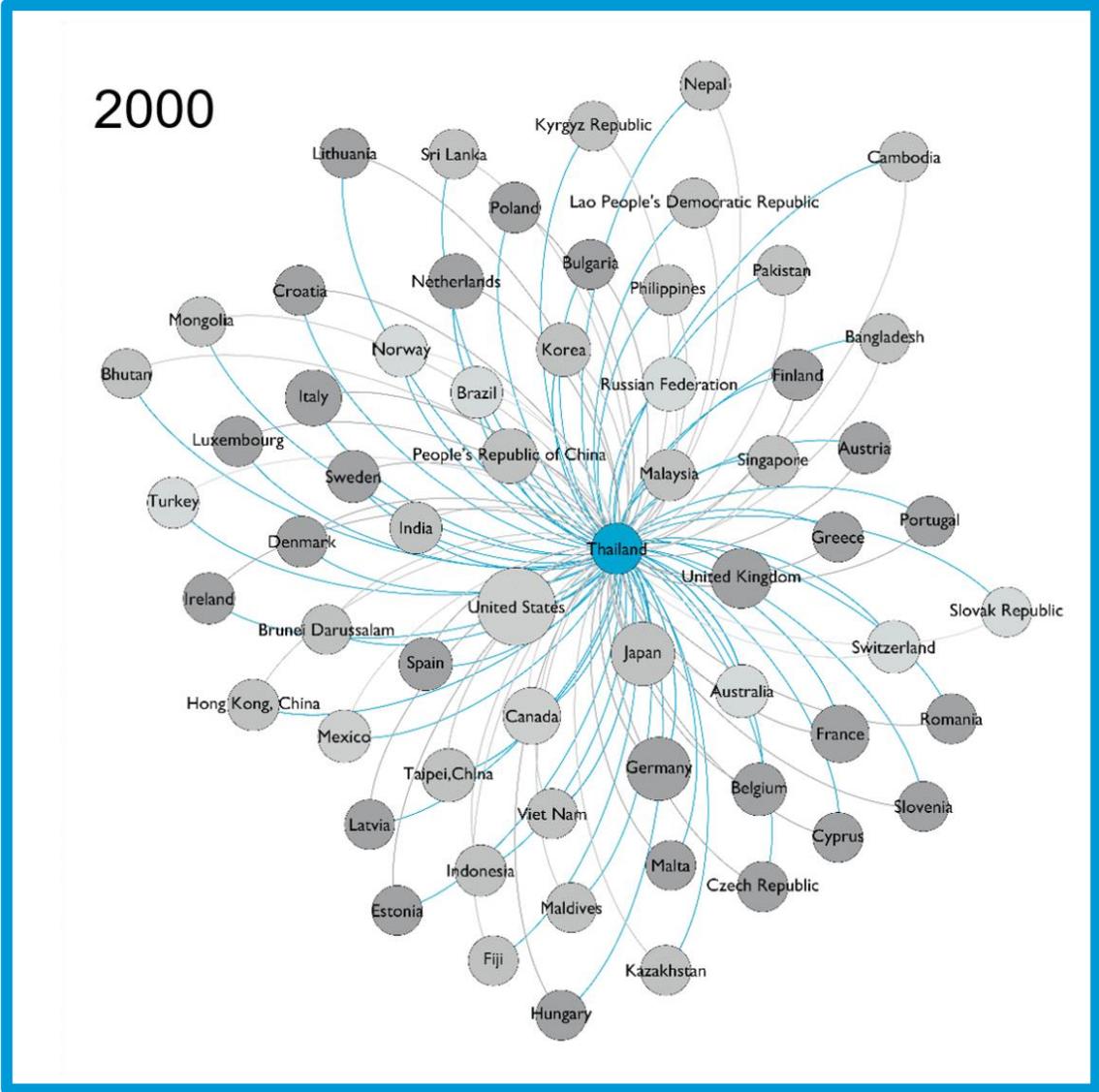
Applications of MRIO analysis

Total embodied carbon emissions by type of final demand of six industries from 1992 to 2020 in PRC (Zheng, Wang, Wang, and Ren, 2017)
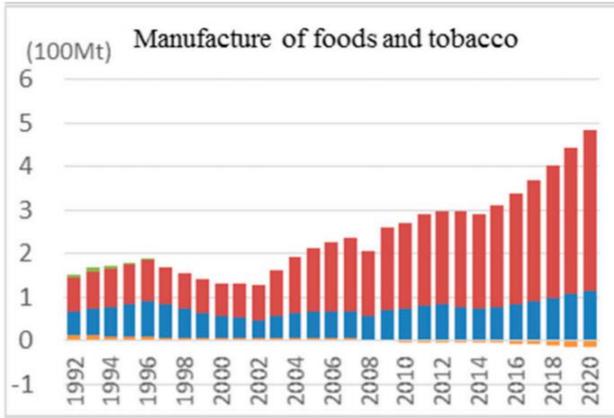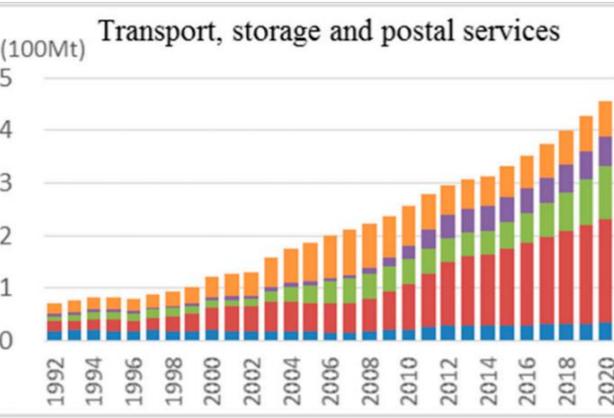
Legend: ■ Rural   ■ Urban   ■ Government   ■ Capital   ■ Net export

Applications of MRIO analysis

Changes in number of jobs induced by foreign and domestic demand, 2005-2015

THE EMPLOYMENT EFFECTS OF TECHNOLOGICAL INNOVATION, CONSUMPTION, AND PARTICIPATION IN GLOBAL VALUE CHAINS: EVIDENCE FROM DEVELOPING ASIA

Donald Jay Bertulfo, Elisabetta Gentile, and Gaaitzen J. de Vries

NO. 572
February 2019

ADB ECONOMICS
WORKING PAPER SERIES

ASIAN DEVELOPMENT BANK

Source: The Employment Effects of Technological Innovation, Consumption, and Participation in Global Value Chains: Evidence from Developing Asia (2019)

using ADB MRIOTs

■ Domestic final demand   ■ Foreign final demand (rest of the world)   ■ Foreign final demand (advanced)
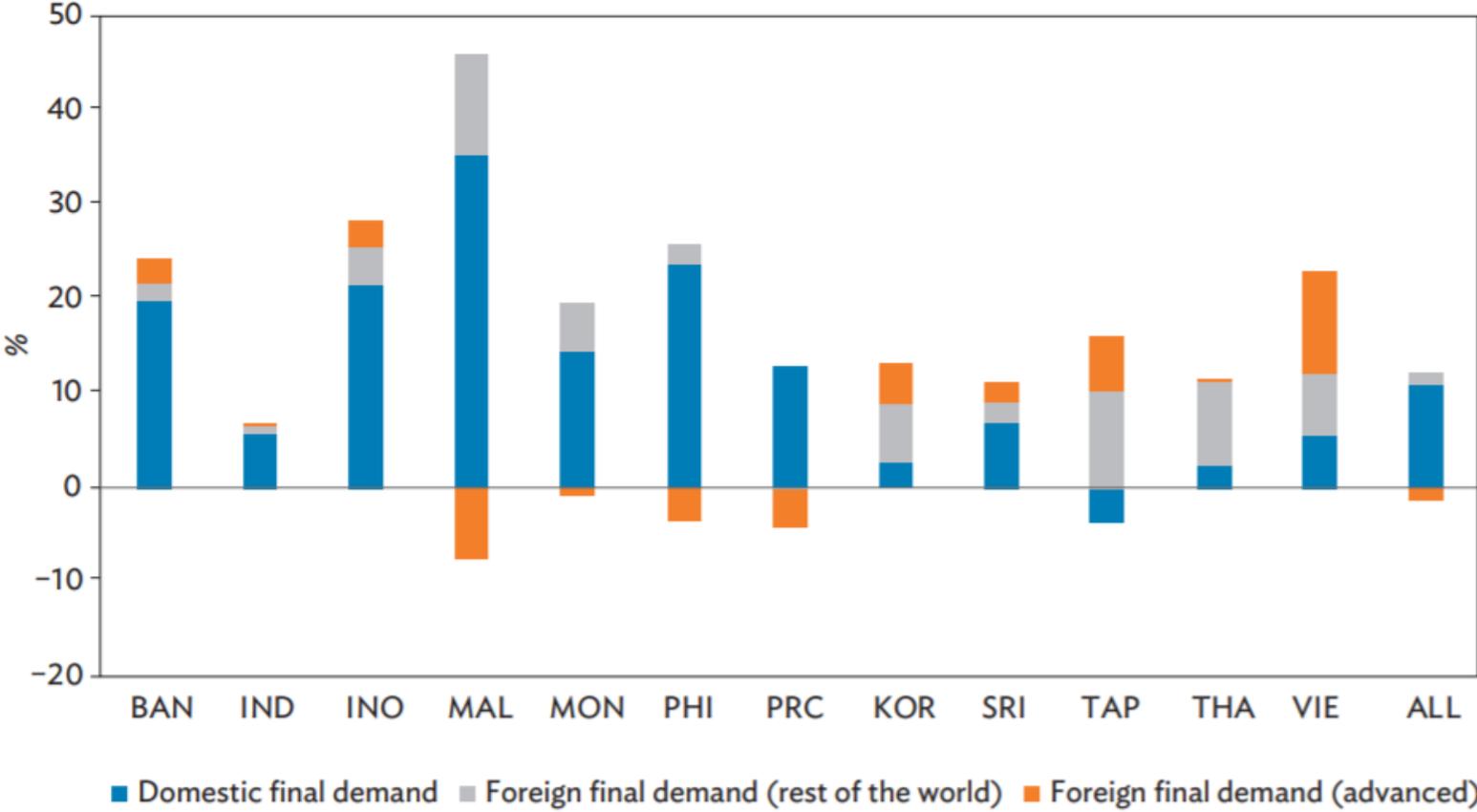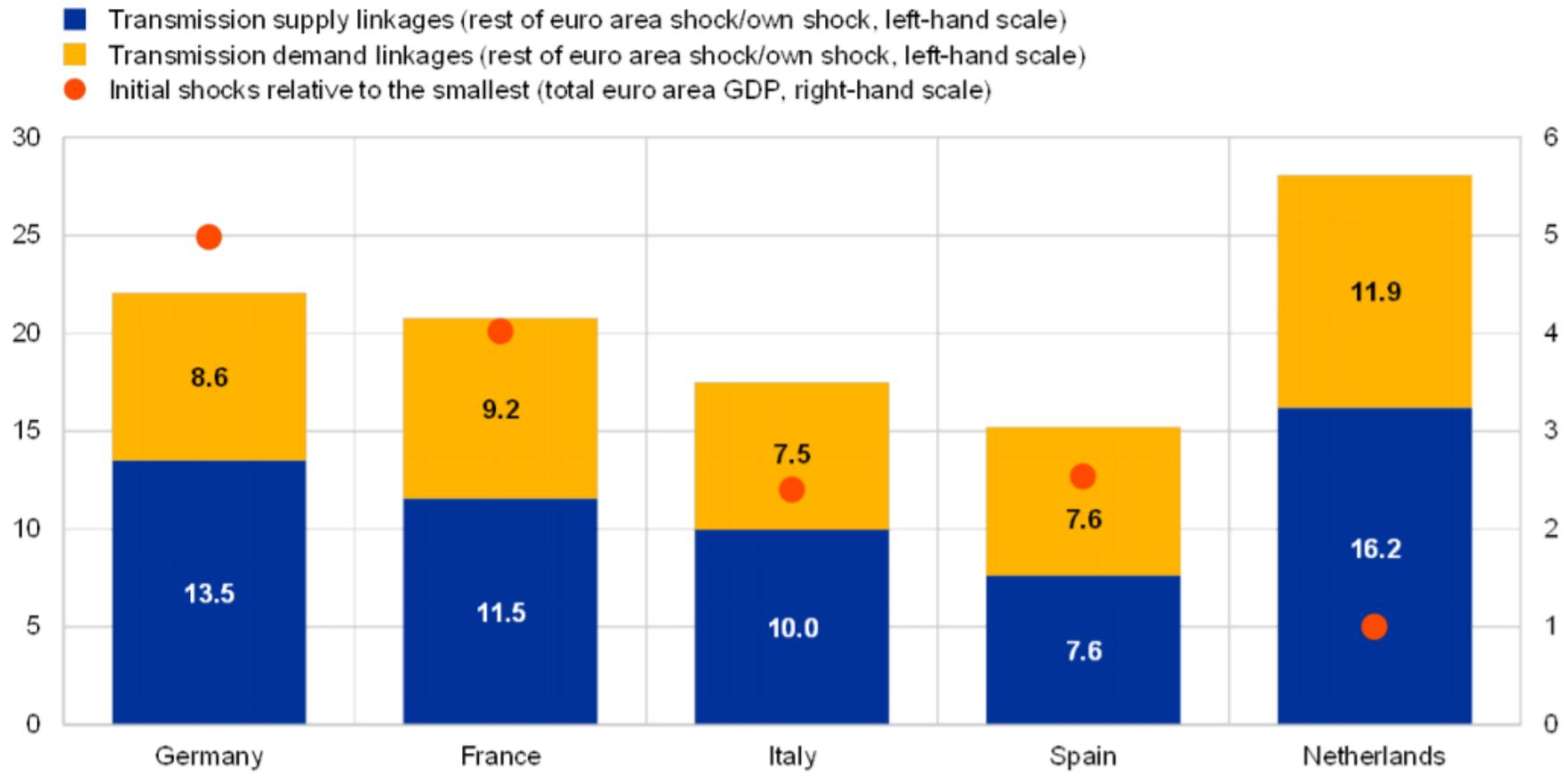
BAN = Bangladesh; IND = India; INO = Indonesia; KOR = Republic of Korea; MAL = Malaysia; MON = Mongolia; PRC = People's Republic of China; PHI = Philippines; SRI = Sri Lanka; TAP = Taipei,China; THA = Thailand; VIE = Viet Nam; ALL = 12 developing Asian economies.

Source: ADB estimates using data from ADB Multiregional Input–Output Database (accessed 20 November 2017), Labor Force Surveys, and Socioeconomic Accounts of the World Input–Output Database (accessed 30 August 2017).

Applications of MRIO analysis

Transmission of single-country shocks to the five largest euro area economies through supply and demand linkages

■ Transmission supply linkages (rest of euro area shock/own shock, left-hand scale)
■ Transmission demand linkages (rest of euro area shock/own shock, left-hand scale)
● Initial shocks relative to the smallest (total euro area GDP, right-hand scale)

Source: Di Nino and Veltri (2020) using WIOD, ADB MRIO database, ECB staff calculations
Notes: Shocks are indexed to the smallest shock in terms of euro area GDP (the Netherlands), which is set to 1; the other aggregate shocks are multiples of it. For instance, the initial shock to Germany takes on the value of five because it has five times more weighting in euro area GDP
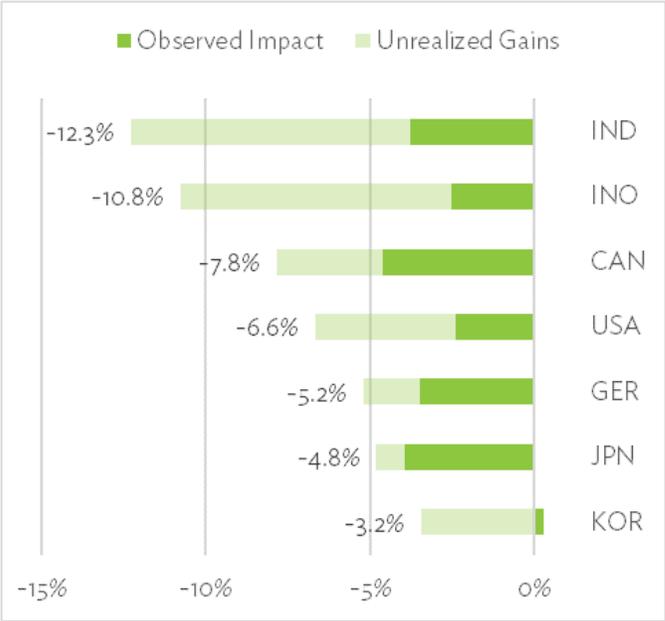
Applications of MRIO analysis

Impact of the COVID-19 pandemic on output, value-added, and employment from 2019 to 2020
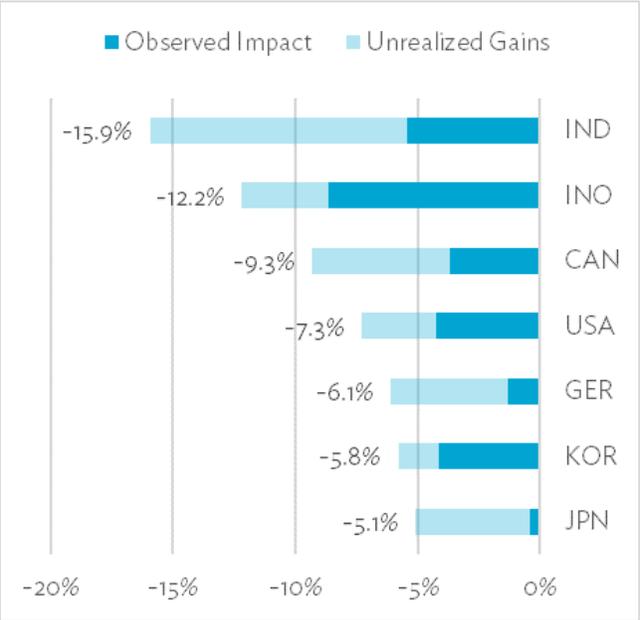
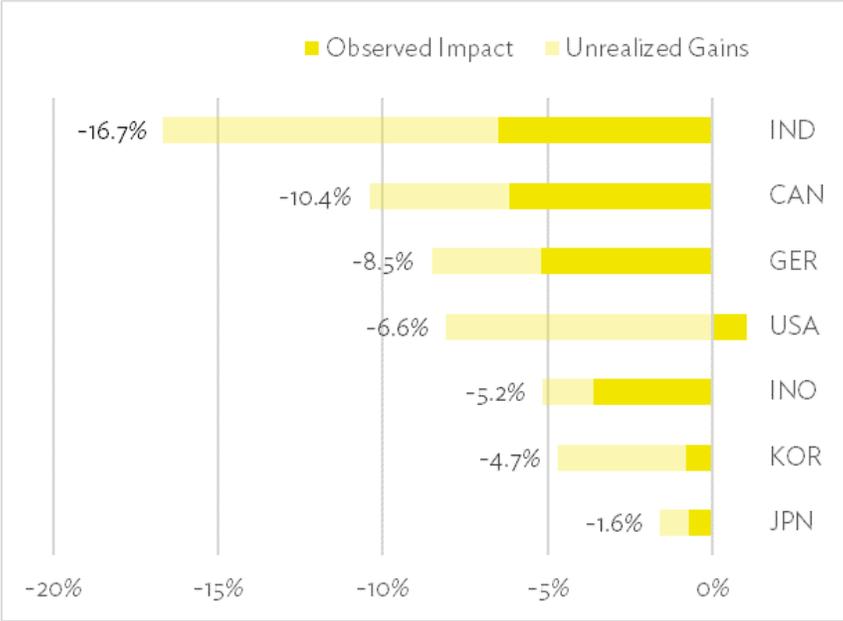**Gross Output** · **Value-Added** · **Employment**

CAN = Canada; GER = Germany; IND = India; INO = Indonesia; JPN = Japan; KOR = Republic of Korea; USA = United States
Note: Percentage impact in terms of 2019 levels.
Source: Calculations using ADB Multiregional Input-Output Tables for 2019 and 2020 (accessed July 2021)

Source: Alvarez, Bernabe, Jola, and Mores (forthcoming) using ADB MRIOT

Applications of MRIO analysis

Accounting for the size of PRC's real estate activities in 2017 through production linkages

Finance & economics
Nov 27th 2021 edition ›

Free exchange
Measuring the universe's most important sector

Is property really 29% of China's GDP?

The team estimated the value-added contributed by the real estate sector, including the value-added contributed by the construction sector in providing services to the real estate sector.

The size of the real estate activities, including real estate-related construction activities, for **15.4% of PRC's total GDP in 2017. Less imports, 13.8%.**

Source: The Economist
Calculations by Bernabe, Jabagat, Mariasingham, and Mores (2021), using the ADB MRIOT

Applications of MRIO analysis

Identifying digitally-enabled sectors in select economies in 2020
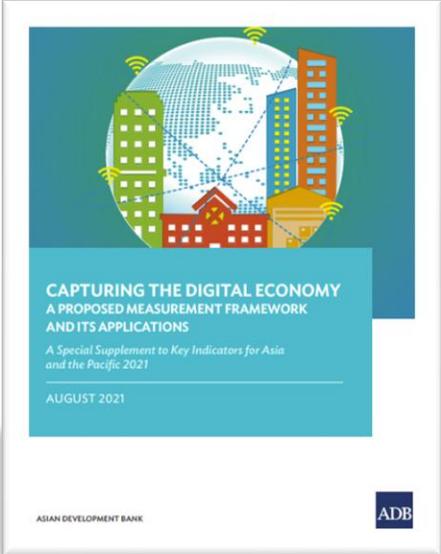
Industry	AUS	CAN	DEN	FIJ	GER	IND	INO	JPN	KAZ	KOR	MAL	PRC	SIN	TAP	THA	USA
Agriculture, hunting, forestry, and fishing				5.5												5.7
Air transport				8.4			2.1						1.3			
Architectural and engineering activities			3.2			0.9			3.0		0.5	2.6				
Construction	6.5	3.7	2.5	8.1		2.5	11.9	1.7	1.0	2.2	0.9	12.3	0.7	0.6		
Education	4.4		3.1	4.8			4.7		2.8	3.9	1.6	2.1	0.7	0.7	1.9	
Electronic, electrical, and optical equipment						3.2	1.9			4.6	9.6	15.3	1.6	0.6	19.4	1.6
Financial intermediation	19.2	9.1	3.2	7.9	3.8		1.8	4.9		5.0	4.4		2.1			1.6
Food, beverages, and tobacco				10.0		2.1	3.6	1.3			1.8					
Furniture						1.6										
Health and social work	5.9	1.9	5.5		3.7			4.1		1.9		2.0		0.8		2.4
Hotels and restaurants				18.0	3.5			2.6		2.2	0.5			1.4	1.8	
Information services					4.9											
Inland transport						2.2			1.7							
Leather, leather products, and footwear															1.4	
Machinery, nec						4.1	1.7		1.2			5.1		0.7		
Manufacturing, nec; recycling															0.7	
Mining and quarrying									3.6							
Other community, social, and personal services									0.8		1.8					2.6
Other supporting and auxiliary transport activities; activities of travel agencies				11.4												
Pharmaceuticals			3.7													
Post and telecommunications										2.9						
Public administration and defense; compulsory social security	15.5	12.3	11.3	9.6	5.8		3.5	5.5	7.2	4.6	4.6	5.8	3.5	1.9		6.0
Real estate activities	5.2	2.1	4.9					1.5	0.7							
Renting of M&Eq and other business activities	3.8										1.1		1.1		3.8	
Research and development					3.4			4.2		3.1						
Textiles and textile products						2.3	1.7									
Transport equipment					5.0	1.6				2.4		2.6				6.4
Water transport													0.6			
Wholesale and retail trade	17.5		15.8	30.9	9.3		3.4	11.7	4.7	11.2	3.2		4.9	2.1	2.4	2.5
Wood and products of wood and cork																2.9

Source: Capturing the Digital Economy: A Proposed Measurement Framework and its Applications (2021) using ADB MRIOTs

Applications of MRIO analysis

Forward and backward agglomeration indices across economies, 2000, 2010, 2020
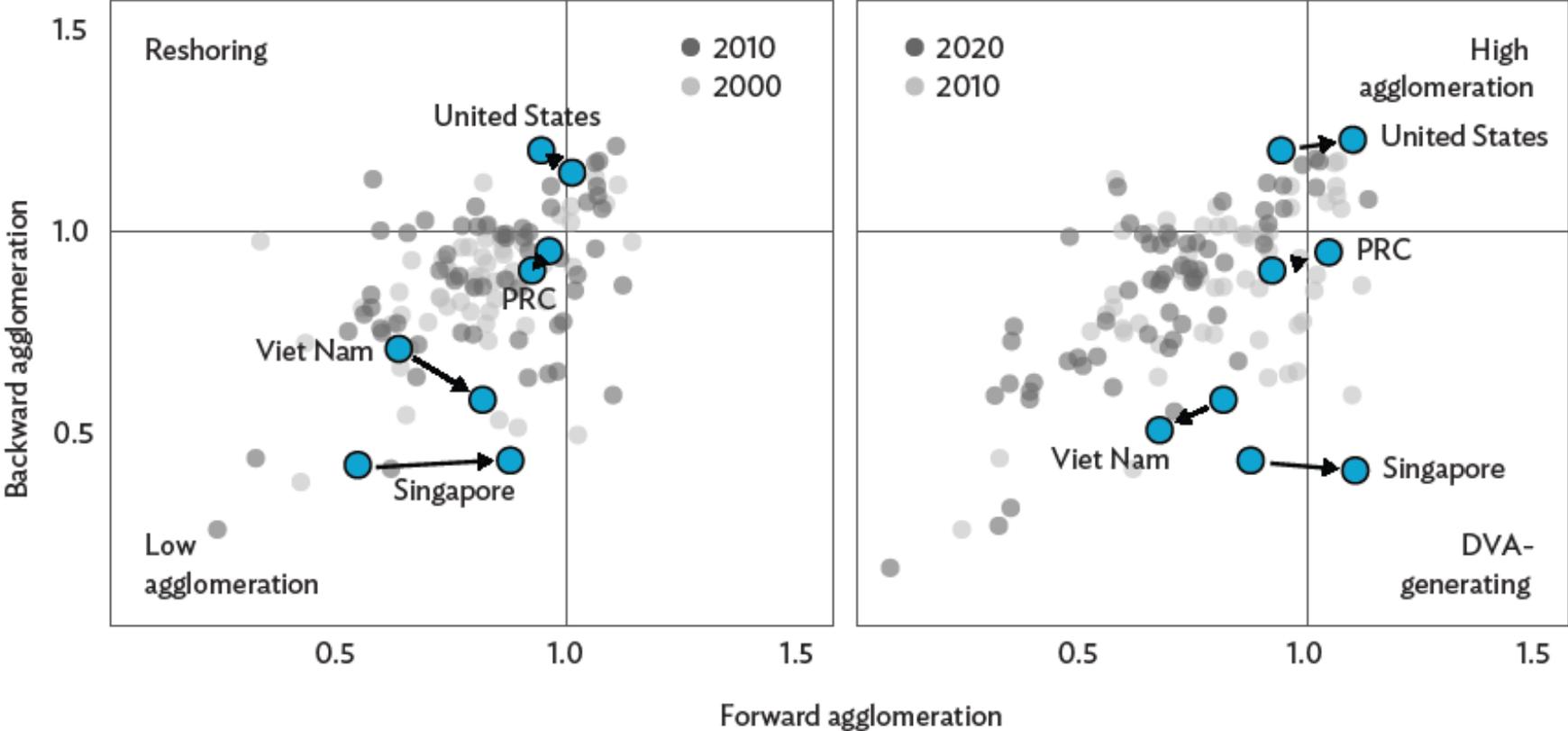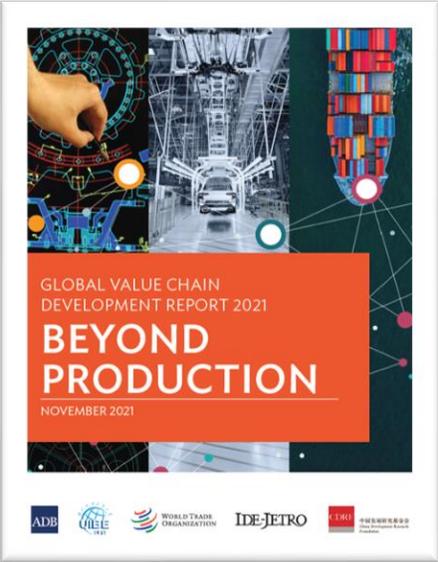
Source: Global Value Chain Development Report 2021: Beyond Production (2021)
using ADB MRIOTs
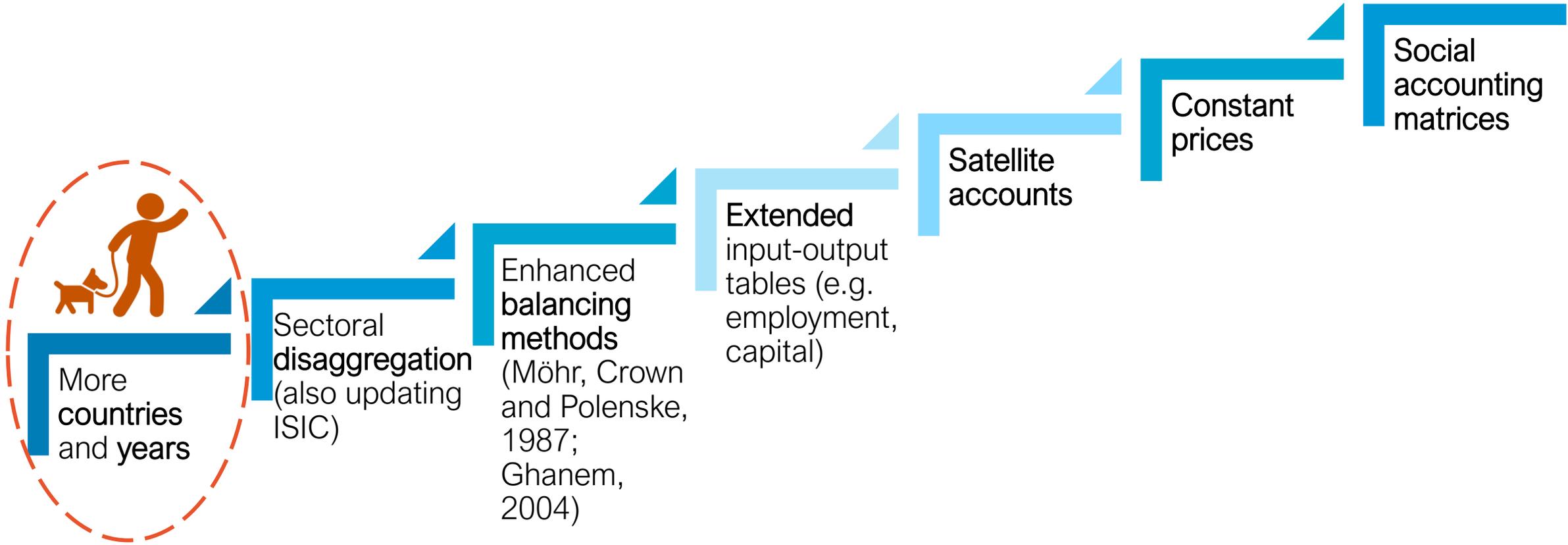
Applications of MRIO analysis

WIOD	ADB	LAC
ADB	ADB	LAC
LAC	LAC	LAC

2007, 2011, 2017
LAC = Latin American Countries

71 economies
Rest of Latin American
Countries (ROLAC)
Rest of the World (RoW)

35 sectors
38 sectors (pending)

Extensions and ways forward

More **countries** and **years**

Sectoral **disaggregation** (also updating ISIC)

Enhanced **balancing methods** (Möhr, Crown and Polenske, 1987; Ghanem, 2004)

Extended input-output tables (e.g. employment, capital)

Satellite accounts

Constant prices

Social accounting matrices

Thank you.

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Emores.consultant@adb.org