OECD GLOBAL INPUT-OUTPUT DATABASES:
ICIO AND INDICATORS (TIVA -TECO2-TIM)

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OECD
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Agenda

• Introduction
  – Global models
  – OECDs databases

• ICIO
  – Estimation
  – Structure

• TiVA indicators

• TECO2 & TiM indicators

• Using the indicators
  – Exploring changes in world production and trade

• Concluding remarks
INTRODUCTION
Global Input-Output Models

- **ICIO** – Inter-Country Input-Output Database, OECD
- ECLAC - Input-Output Table for Latin America and the Caribbean
- EORA - Multi-Region Input-Output (MRIO) table of the world
- EXIOBASE - Multi-Regional Environmentally Extended Supply-Use Table (MR-SUT) and Input-Output Table (MR-IOT)
- FIGARO - EU-Inter Country Supply, Use and Input-Output Tables
- GTAP - Global Trade Analysis Project
- IDE-JETRO - International Input-Output Tables
- WIOD - World Input-Output Database
OECD Databases

• ICIO
  – Inter-Country Input-Output Tables

• TiVA
  – Trade in Value Added

• TECO2
  – CO₂ Emissions Embodied in International Trade

• TiM
  – Trade in Employment
ICIO 2018 Database

- System of National Accounts 2008 (SNA08)
- Industry list based on ISIC Rev.4
- Published for 36 industries and 64 economies + rest of the world
- ICIO estimation uses larger number of underlying industries and products (75)
- Improved estimates of “Rest of the World”, with underlying data for +130 economies
- National account benchmarked
- Trade balances (goods and services)
- International comparability (VA at basic prices)
- Direct purchases by non-residents
- International trade and transport margins
- Long term project
Starting point: ICIO structure

### Inter-country I-O at basic prices

<table>
<thead>
<tr>
<th>Cou A</th>
<th>Cou B</th>
<th>Cou C</th>
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</thead>
<tbody>
<tr>
<td>Ind 1</td>
<td>Ind 1</td>
<td>Ind 1</td>
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<tr>
<td>Ind 2</td>
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<thead>
<tr>
<th>Cou A</th>
<th>Cou B</th>
<th>Cou C</th>
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<tbody>
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<td>Ind 2</td>
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### Intermediate demand

#### Taxes less subsidies

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<th>NTZA1</th>
<th>NTZA2</th>
<th>NTZB1</th>
<th>NTZB2</th>
<th>NTZC1</th>
<th>NTZC2</th>
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</thead>
</table>

#### Value-added (VA)

<table>
<thead>
<tr>
<th>VA (A1)</th>
<th>VA (A2)</th>
<th>VA (B1)</th>
<th>VA (B2)</th>
<th>VA (C1)</th>
<th>VA (C2)</th>
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</table>

#### Output (X)

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<thead>
<tr>
<th>X (A1)</th>
<th>X (A2)</th>
<th>X (B1)</th>
<th>X (B2)</th>
<th>X (C1)</th>
<th>X (C2)</th>
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</thead>
</table>

### Final consumption and GFCF (+ changes in inventories)

#### Direct purchases by non-residents

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<th>Cou A</th>
<th>Cou B</th>
<th>Cou C</th>
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<tbody>
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<td>Cou A</td>
<td>Cou B</td>
<td>Cou C</td>
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</tbody>
</table>

### Global GDP

- Cross-border flows of intermediate goods and services
- Domestic flows of intermediate goods and services
- Cross-border flows of final goods and services
- Domestic flows of final goods and services
## Country Coverage

<table>
<thead>
<tr>
<th>Region groups</th>
<th>Country Coverage</th>
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<tbody>
<tr>
<td>OECD</td>
<td>All OECD countries</td>
</tr>
<tr>
<td>BRIICS</td>
<td>Brazil, China, India, Indonesia, Russian Federation, South Africa</td>
</tr>
<tr>
<td>Other EU28</td>
<td>Bulgaria, Croatia, Cyprus, Latvia, Lithuania, Malta, Romania</td>
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<tr>
<td>Other G20</td>
<td>Argentina, Saudi Arabia</td>
</tr>
<tr>
<td>Other South Eastern Asia</td>
<td>Brunei Darussalam, Cambodia, Malaysia, Philippines, Singapore, Thailand, Viet Nam</td>
</tr>
<tr>
<td>Other Eastern Asia</td>
<td>Chinese Taipei, Hong Kong China</td>
</tr>
<tr>
<td>Other</td>
<td>Columbia, Costa Rica, Tunisia, Kazakhstan, RoW</td>
</tr>
<tr>
<td>Region groups</td>
<td>OECD, Non-OECD, APEC, ASEAN, EasternAsia,EU28, Euro Area, North America, etc</td>
</tr>
<tr>
<td>Industry Code</td>
<td>Heading</td>
</tr>
<tr>
<td>---------------</td>
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</tr>
<tr>
<td>1 D01T03</td>
<td>Agriculture, hunting, forestry and fishing</td>
</tr>
<tr>
<td>2 D05T06</td>
<td>Mining and extraction of energy producing products</td>
</tr>
<tr>
<td>3 D07T08</td>
<td>Mining and quarrying of non-energy producing products</td>
</tr>
<tr>
<td>4 D09</td>
<td>Services to mining and quarrying</td>
</tr>
<tr>
<td>5 D10T12</td>
<td>Food products, beverages and tobacco</td>
</tr>
<tr>
<td>6 D13T15</td>
<td>Textiles, textile products, leather and footwear</td>
</tr>
<tr>
<td>7 D16</td>
<td>Wood and products of wood and cork</td>
</tr>
<tr>
<td>8 D17T18</td>
<td>Paper products and printing</td>
</tr>
<tr>
<td>9 D19</td>
<td>Coke and refined petroleum products</td>
</tr>
<tr>
<td>10 D20T21</td>
<td>Chemicals and chemical products</td>
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<tr>
<td>11 D22</td>
<td>Rubber and plastics products</td>
</tr>
<tr>
<td>12 D23</td>
<td>Other non-metallic mineral products</td>
</tr>
<tr>
<td>13 D24</td>
<td>Basic metals</td>
</tr>
<tr>
<td>14 D25</td>
<td>Fabricated metal products</td>
</tr>
<tr>
<td>15 D26</td>
<td>Computer, electronic and optical equipment</td>
</tr>
<tr>
<td>16 D27</td>
<td>Electrical machinery and apparatus, nec</td>
</tr>
<tr>
<td>17 D28</td>
<td>Machinery and equipment, nec</td>
</tr>
<tr>
<td>18 D29</td>
<td>Motor vehicles, trailers and semi-trailers</td>
</tr>
<tr>
<td>19 D30</td>
<td>Other transport equipment</td>
</tr>
<tr>
<td>20 D31T33</td>
<td>Manufacturing nec; repair of machinery and equipment</td>
</tr>
<tr>
<td>21 D35T39</td>
<td>Electricity, gas, water supply, sewerage, waste and remediation services</td>
</tr>
<tr>
<td>22 D41T43</td>
<td>Construction</td>
</tr>
<tr>
<td>23 D45T47</td>
<td>Wholesale and retail trade; repair of motor vehicles</td>
</tr>
<tr>
<td>24 D49T53</td>
<td>Transportation and storage</td>
</tr>
<tr>
<td>25 D55T56</td>
<td>Accommodation and food services</td>
</tr>
<tr>
<td>26 D58T60</td>
<td>Publishing, audiovisual and broadcasting activities</td>
</tr>
<tr>
<td>27 D61</td>
<td>Telecommunications</td>
</tr>
<tr>
<td>28 D62T63</td>
<td>IT and other information services</td>
</tr>
<tr>
<td>29 D64T66</td>
<td>Financial and insurance activities</td>
</tr>
<tr>
<td>30 D68</td>
<td>Real estate activities</td>
</tr>
<tr>
<td>31 D69T82</td>
<td>Other business sector services</td>
</tr>
<tr>
<td>32 D84</td>
<td>Public admin. and defence; compulsory social security</td>
</tr>
<tr>
<td>33 D85</td>
<td>Education</td>
</tr>
<tr>
<td>34 D86T88</td>
<td>Health and social work</td>
</tr>
<tr>
<td>35 D90T96</td>
<td>Other community, social and personal services</td>
</tr>
<tr>
<td>36 D97T98</td>
<td>Private households with employed persons</td>
</tr>
</tbody>
</table>
# TiVA 2018 Industry aggregates

<table>
<thead>
<tr>
<th>Industry Code</th>
<th>Heading</th>
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<tbody>
<tr>
<td>37</td>
<td>DTOTAL TOTAL</td>
</tr>
<tr>
<td>38</td>
<td>D05T09 Mining and quarrying</td>
</tr>
<tr>
<td>39</td>
<td>D10T33 Total Manufacturing</td>
</tr>
<tr>
<td>40</td>
<td>D16T18 Wood and paper products and printing</td>
</tr>
<tr>
<td>41</td>
<td>D19T23 Chemicals and non-metallic mineral products</td>
</tr>
<tr>
<td>42</td>
<td>D24T25 Basic metals and fabricated metal products</td>
</tr>
<tr>
<td>43</td>
<td>D26T27 Computer, electronic and electrical equipment</td>
</tr>
<tr>
<td>44</td>
<td>D29T30 Transport equipment</td>
</tr>
<tr>
<td>45</td>
<td>D45T82 Total Business Sector Services</td>
</tr>
<tr>
<td>46</td>
<td>D45T56 Distributive trade, transport, accommodation and food services</td>
</tr>
<tr>
<td>47</td>
<td>D58T63 Information services</td>
</tr>
<tr>
<td>48</td>
<td>D84T98 Public admin, education, health and other personal services</td>
</tr>
<tr>
<td>49</td>
<td>D84T88 Public admin, defence; education and health</td>
</tr>
<tr>
<td>50</td>
<td>D90T98 Other social and personal services</td>
</tr>
<tr>
<td>51</td>
<td>D05T39 Industry (Mining, Manufactures and Utilities)</td>
</tr>
<tr>
<td>52</td>
<td>D45T98 Total Services</td>
</tr>
<tr>
<td>53</td>
<td>D58T82 Information, Finance, Real Estate and other business services</td>
</tr>
<tr>
<td>54</td>
<td>D41T98 Total Services (incl. construction)</td>
</tr>
<tr>
<td>55</td>
<td>DINFO Information industries</td>
</tr>
</tbody>
</table>
- More detailed product list for better allocation of exports into importing industries and final expenditure items
- Margin industry output
  - trade
  - transport services
- Taxes and subsidies
  - Import duty
  - VAT/Consumption tax /sales tax
  - Other taxes
- Real estate: separation of *imputed rent of owner occupiers* (68A)
  - No trade
  - Approximately 20% of household final consumption
- Processing / manufacturing services (wholesale)
ICIO ESTIMATION
Brief summary of steps to build ICIO 2018

1. Create harmonized National Accounts constraints, and ..
2. ... Sectoral output, VA, exports and imports constraints
3. Balance national Supply and Use tables (SUTs)
   → generate harmonized domestic IO tables @bp (a)
3b. Manufacturing heterogeneity within a country (Mexico and China)
4. Bilateral trade in good and services by Use table harmonized products
4b. Heterogeneity split
5. Balance International Use table @pu;
   → conversion from purchasers (pu) to basic prices (bp) (b)

ICIO: combining (a) and (b)
Data sources for OECD Inter-country inter-industry model

Data sources (national / international data portals)

- National Accounts: official country data, main aggregate and satellite account
- Balance of Payments
- Supply-use and Input-Output tables (import, margins)
- Bilateral trade statistics for goods and services
- Employment
- Tourism satellite account
- Structural Business Statistics (OECD, EUROSTAT, UNIDO)
- Production and exports data from industry associations (oil, gas, steel, etc)
Intermediate analytical data products at OECD

- Harmonised SUT / symmetric Input-Output tables (OECD I-O)
- Bilateral Trade Database by Industry and by End-use for goods (OECD BTDIxE)
- Bilateral Trade in Services (OECD-WTO)
- Sectoral Value-Added, Output, Employment (OECD STAN)
- Adjusted National Accounts (currency, non-resident expenditures and re-exports)
Official NA variables to adjusted SNA constraints for ICUT/ICIO

- VA at basic prices: shift taxes on products from VA (CHN, JPN, PHL, THA, MMR)
- Output at basic prices

- SNA exports of goods = X61.DOM + RXRM 61
- SNA exports of services = X62.CB + X34.DOM + M34.RX
- SNA household consumption by non-residents (P34) = X34.DOM + M34.RX

- SNA imports of goods = M71.DOM + RXRM61+ M34.RX
- SNA imports of services = M72.CB + M33
- Retained imports (M7CB) = M71.DOM + M72.CB

where

X61.DOM is Goods exports of domestic origin products, RXRM 61 is sum of re-imports and re-exports of goods, X62.CB is cross-border services exports, X34.DOM is direct purchases by non-residents of domestic products, M34.RX is direct purchases by non-residents of imported products, M71.DOM is imports of goods consumed in domestic territory, M72.CB is imports of cross-border services and, M33 is direct purchases abroad by residents.
Trade by product (partner world)

• Priority data source: SUT / IOT
• If not available, HS 6digit → hmz product list
  – Monetary gold, printing / publishing
• TiS EBOPS 2002 / 2010 → hmz product list
  – Some items are not used to match SNA trade: FISIM (SG2), government (SL)
  – manufacturing services (SA) to wholesale (I4-46)

• Re-exports/re-imports: Comtrade, Import tables (Eurostat), comparison with reported sum values from partners
Use at purchasers’ prices

use at pu prices

= 

use import fob pu + use import fob pu

Motor vehicles WR

Wholesale

Retail

Land trp margin

Water

Air

Other trp

Import duty

Other taxes

subsidies
Margins

- **Trade**
  - Motor vehicles (I4-45)
  - Wholesale (I4-46)
  - Retail (I4-47)
- **Transport**
  - Land (I4 – 49)
  - Water (I4 – 50)
  - Air (I4 – 51)
  - Other (I4 – 52)
- **Import duty**
- **Other taxes on products (VAT, Fuel, Alcohol)**
- **Subsidies on products (agriculture, land transport)**
## Trade by product (bilateral cross border)

### Goods

<table>
<thead>
<tr>
<th>Cou A</th>
<th>HS01</th>
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<th>HS99</th>
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### Services

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<th>EB SL</th>
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### Statistics

*Goods (merchandise trade stat)*

<table>
<thead>
<tr>
<th>Cou A</th>
<th>.......</th>
<th>Cou Z</th>
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*IC UT constraints*

*Cross-border*

<table>
<thead>
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</tbody>
</table>
Trade by product (bilateral direct purchases)

**Statistics**
EBOPS2010 SDB Travel personal

**Direct Purchases**
Statistics: Tourism Satellite Account
Expenditure by inbound tourists

**World**
Cou A Hotel
Rest.
Other products

**IC UT constraints**
Direct purchases

Cou A
…
Cou Z
SDB

Cou Z
SDB

Cou A
…
Cou Z
SDB

Cou A ISICp 01
…
ISICp 96

Cou Z ISICp 01
…
ISICp 96
### International use table

<table>
<thead>
<tr>
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<th>ISIC 01</th>
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<th>NPISH</th>
<th>GGFC</th>
<th>GFCF</th>
<th>INVNT</th>
<th>DP</th>
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**BALANCE at purchasers' prices**

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## Basic Matrices in OECD’s ICIO and TiVA Indicators

<table>
<thead>
<tr>
<th>Matrix</th>
<th>Size of the matrix</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>$1 \times (N \times K)$</td>
<td>Value added, where $w_{ir}^r$ is the value added (at basic prices) by industry $i$ in country $r$ (1 to $K$) plus taxes less subsidies on intermediate products, so that total value added equals total final demand at basic prices.</td>
</tr>
<tr>
<td>X</td>
<td>$1 \times (N \times K)$</td>
<td>Gross output (at basic prices), where $x_{ir}^r$ is the gross output from industry $i$ in country $r$.</td>
</tr>
<tr>
<td>V</td>
<td>$1 \times (N \times K)$</td>
<td>Value added to output ratio, where $v_{ir}^r = w_{ir}^r / x_{ir}^r$ is the ratio of value added to gross output by industry $i$ in country $r$.</td>
</tr>
<tr>
<td>Z</td>
<td>$(N \times K) \times (N \times K)$</td>
<td>Intermediate consumption (at basic prices), where $z_{ij}^{rs}$ is the flow of goods from producing industry $i$ in country $r$ to the purchasing industry $j$ in country $s$.</td>
</tr>
<tr>
<td>Y</td>
<td>$(N \times K) \times N$</td>
<td>Final demand, where the element $y_{ij}^{rs}$ represents final demand of country $s$ for goods and services produced by industry $i$ in country $r$.</td>
</tr>
<tr>
<td>A</td>
<td>$(N \times K) \times (N \times K)$</td>
<td>Input coefficients, calculated as $a_{ij}^{rs} = z_{ij}^{rs} / x_{j}^r$.</td>
</tr>
<tr>
<td>B</td>
<td>$(N \times K) \times (N \times K)$</td>
<td>Leontief inverse, or “output multipliers”, $B = (I - A)^{-1}$, where the element $b_{ij}^{rs}$ shows the direct and indirect requirements of inputs from industry $i$ in country $r$ for the production of one unit of output for demand by industry $j$ in country $s$.</td>
</tr>
<tr>
<td>GRTR</td>
<td>$(N \times K) \times N$</td>
<td>Bilateral gross trade matrices by exporting industry/country and importing country of intermediate (INT) and final (FNL) goods $GRTR = GRTR_INT + GRTR_FNL$.</td>
</tr>
</tbody>
</table>

The matrices $W$, $X$, $V$, and $Z$ are fundamental to the input-output model and provide a comprehensive view of the economy’s production and consumption flows. The matrices $A$ and $B$ are derived from the input-output matrix to provide multipliers, which are essential for understanding the economic impact of changes in demand. The bilateral gross trade matrices $GRTR$, $GRTR\_INT$, and $GRTR\_FNL$ help in analyzing international trade patterns.
OECD’s ICIO Basic Structure
ICIO and TiVA Indicators

Obtaining the Leontief Inverse and the Value Added to Output Ratio
Bilateral Trade Flows

Obtaining the Bilateral Trade Flows

[Diagram showing intermediate consumption, gross intermediate trade flows, final demand, gross final trade flows, and gross total trade flows]
Trade Balance

- **Gross trade balance** = TiVA trade balance
- **Gross trade balance**
  - Gross Exports – Gross Imports
  - Includes intermediate and final products
- **TiVA trade balance**
  - FFD_DVA - DFD_FVA
- Reminding: Tax on intermediate inputs are included in the VA
TiVA Indicators List

- Revised and enlarged TiVA, Trade in Value Added, Indicators based on ICIO’s database
  - Total of 50+ indicators
    - Structural indicators
    - Indicators linking VA and gross exports
    - Indicators linking VA and final demand
    - Detailed indicators for gross exports, gross imports and final demand
ICIO and TiVA Indicators

- ICIO and TiVA databases can be used, e.g.:
  - By themselves, to have a better understanding about the evolution of the World trade, and how the economies of the countries and regions are linked together;
  - Combined with other databases to understand the role and the importance of other variables, like the social economic indicators presented here, to go beyond the “pure” economic dimension!
TIVA INDICATORS - METHODOLOGY
The USD million gross trade and output measures are in current prices with a basic price valuation.

Changes in inventories for a given country are allocated to the respective country total final demand.
Results from ICIO Model

- Total gross exports and imports in the ICIO, and hence TiVA, differ from official National Accounts statistics due to removal of estimates of re-exports and re-imports, conversion to a Basic Price valuation and reconciliation of bilateral asymmetries via balancing under output constraints.
Trade Discrepancies Assumptions

- Discrepancies, which are residuals from inconsistencies in global trade data, were allocated to the total final demand of the Rest of World. As a result, discrepancies are only considered in the world total, not at partner level.
For each indicator it is presented a specification of its dimension, where the abbreviations are as follow:

- **Country / Region:**
  - Prod cou = Production country
  - VA src cou = VA source country
  - Exp cou = Export country
  - Imp cou = Import country
  - FD cou = final demand / destination country
  - World = all countries includes domestic economy
TiVA Industry Definitions

• Industry:
  – Prod ind = Production source industry
  – VA src ind = VA source industry, production source industry
  – Exp ind = Export products producing industry
  – Imp ind = Import products producing industry
  – FD ind = Final demand products producing industry
  – Tot ind = Total industry

• Supply and Demand Dimensions:
  – Depending on the indicator, the supply and demand dimensions could refer to intermediate, final or total goods and services.
OECD’s TiVA Indicators can be classified into 4 subgroups according to their need of data and complexity of information:

- Structural Indicators - based on the values presented in ICIO;
- Indicators based on Value Added, Gross Exports and Imports;
- Indicators based on Value Added and Final Demand;
- Detailed Indicators, with 4 dimensions, revealing the origins of value added in gross exports, gross imports and final demand.
Treating Final Demand Matrices

### Countries Demand

<table>
<thead>
<tr>
<th>Country 1</th>
<th>Ind. 1</th>
<th>( E^{11} )</th>
<th>( \ldots )</th>
<th>( E^{1N} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ind. K</td>
<td>( \vdots )</td>
<td>( \vdots )</td>
<td>( \vdots )</td>
<td>( \vdots )</td>
</tr>
<tr>
<td>( \ldots )</td>
<td>( \vdots )</td>
<td>( \vdots )</td>
<td>( \vdots )</td>
<td>( \vdots )</td>
</tr>
<tr>
<td>Country N</td>
<td>Ind. 1</td>
<td>( E^{N1} )</td>
<td>( \ldots )</td>
<td>( E^{NN} )</td>
</tr>
<tr>
<td>Ind. K</td>
<td>( \vdots )</td>
<td>( \vdots )</td>
<td>( \vdots )</td>
<td>( \vdots )</td>
</tr>
</tbody>
</table>

### Total Demand

<table>
<thead>
<tr>
<th>Country 1</th>
<th>Ind. 1</th>
<th>Total Dem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ind. K</td>
<td>( \vdots )</td>
<td>( E^1 )</td>
</tr>
<tr>
<td>( \ldots )</td>
<td>( \vdots )</td>
<td>( \vdots )</td>
</tr>
<tr>
<td>Country N</td>
<td>Ind. 1</td>
<td>( E^N )</td>
</tr>
<tr>
<td>Ind. K</td>
<td>( \vdots )</td>
<td>( \vdots )</td>
</tr>
</tbody>
</table>
TIVA INDICATORS - UNDERSTANDING
Experienced I-O practitioners / GVC analysts
- With appropriate IT skills and software tools, carry out a wide range of GVC-related analyses. Just need the ICIO “objects” i.e. vectors and matrices (http://oecd/icio)
- Understand and discuss indicators with equations (matrix algebra etc.)
- “OECD produces too many indicators!”

Researchers and policy analysts not familiar with I-O techniques
- Demand for easy-to-use, and understand, TiVA indicators
- Require ‘simple’ explanations of indicators and their use
- “More indicators please!”

TiVA indicators: meeting various needs
Starting point: ICIO structure

### Inter-country I-O

#### at basic prices

<table>
<thead>
<tr>
<th>Cou A</th>
<th>Cou B</th>
<th>Cou C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ind 1</td>
<td>Ind 1</td>
<td>Ind 1</td>
</tr>
<tr>
<td>Ind 2</td>
<td>Ind 2</td>
<td>Ind 2</td>
</tr>
</tbody>
</table>

#### Intermediate demand

- **Cou A**
  - Ind 1
  - Ind 2
- **Cou B**
  - Ind 1
  - Ind 2
- **Cou C**
  - Ind 1
  - Ind 2

#### Taxes less subsidies...

- **Value-added (VA)**
  - VA (A1)
  - VA (A2)
  - VA (B1)
  - VA (B2)
  - VA (C1)
  - VA (C2)

#### Output (X)

- X (A1)
- X (A2)
- X (B1)
- X (B2)
- X (C1)
- X (C2)

#### Global GDP

### Final consumption and GFCF (+ changes in inventories)

- **Cou A**
  - Cou A
  - Cou B
  - Cou C

### Direct purchases by non-residents

- **Output (X)**
  - X (A1)
  - X (A2)
  - X (B1)
  - X (B2)
  - X (C1)
  - X (C2)

---

**Key:**

- **Cross-border** flows of intermediate goods and services
- **Domestic** flows of intermediate goods and services
- **Cross-border** flows of final goods and services
- **Domestic** flows of final goods and services

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---
Basic equations

\[ X = AX + Y \]

where \( A \) is the input coefficient matrix:
\[
\begin{array}{ccc}
& \pi & \pi \\
\pi & & \\
\end{array}
\]

Leontief inverse:
\[
B = (I-A)^{-1}
\]

\( b_{ij}^{rs} = \) direct and indirect inputs from industry \( i \) in country \( r \) for the production of one unit of output by industry \( j \) in country \( s \).

\[ vBe \]

\[ v_j^s = \frac{va_j^s}{x_j^s} \] i.e. VA/output ratios

\( e \) is exports, final demand etc.
Global flows of goods and services
4 perspectives, 8 dimensions

Direct flows of intermediate and final goods and services.
Note: exports of final products meet final demand in importing country

From the country and industry of value added origin, intermediate goods and services may be processed by many firms in many countries before being processed by the exporting country. Note: the exporting country is often the main origin of value added.

Intermediate goods and services processed by an importing country may pass through many countries and industries before final demand goods and services reach the ultimate destination of demand. Note: the importing country may be the country of final demand.
Many combinations

In theory, could show indicators to reveal e.g.

- value added from Chinese basic metals industry
- embodied in Japanese exports of ICT components
- imported by Mexican machinery industry
- ultimately meeting US final demand for motor vehicles

But with 64 countries and 36 industries/product groups:

\[(64 \times 36)^4\] combinations \(\approx 28,000,000,000,000\)

This is without considering regional groups, industry aggregates, splitting FD into GFCF and HHFC, splitting exports into intermediates and final goods and services etc.

Challenge: to produce easy-to-use and easy-to-understand TiVA indicators for policy analysts and researchers

(i.e. reduce 8 dimensions to 2,3 or 4)
Indicators overview (published on OECD.STAT)

Core indicators (2 or 3 dimensions)

Gross exports based:
e.g. Domestic and foreign VA content of exports (EXGR_DVA and EXGR_FVA)

Final demand based:
e.g. DVA embodied in Foreign final demand, Foreign VA in domestic demand

Four cubes with 4 dimensions (for the more adventurous)
Value added origin of gross exports, Value added origin of gross imports
Value added origin of final demand.
Value added origin of gross exports by final demand destination

All accessible from http://oe.cd/tiva

Common confusion: what does industry refer to?
Value added origin industry? exporting industry? or final demand industry/product group?
Gross trade based indicators

Gross exports, \( \text{EXGR} \)

Gross imports, \( \text{IMGR} \)

Gross trade balance, \( \text{BALGR} = \text{EXGR}_{(c,p)} - \text{IMGR}_{(c,p)} \)

Domestic Value Added content of gross exports \( \text{EXGR\_DVA} \)
Gross trade based indicators (cont)

<table>
<thead>
<tr>
<th>Direct DVA content of Gross exports</th>
<th>EXGR_DDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA origin * Exports Imports Final Demand</td>
<td></td>
</tr>
<tr>
<td>country = c Country (c)</td>
<td></td>
</tr>
<tr>
<td>industry = i Industry (i)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Indirect DVA content of Gross exports</th>
<th>EXGR_IDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA origin Exports Imports Final Demand</td>
<td></td>
</tr>
<tr>
<td>country = c Country (c)</td>
<td></td>
</tr>
<tr>
<td>∑industry ≠ i Industry (i)</td>
<td></td>
</tr>
</tbody>
</table>

* does not include DVA that has returned, via imports, after previously being exported i.e. only the VA directly generated by the domestic exporting industry

<table>
<thead>
<tr>
<th>DVA content of gross imports</th>
<th>IMGR_DVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA origin Exports Imports Final Demand</td>
<td></td>
</tr>
<tr>
<td>country = c Country (p) Country (c)</td>
<td></td>
</tr>
<tr>
<td>Industry (i)</td>
<td></td>
</tr>
</tbody>
</table>

DVA share of gross imports IMGR_DVASH = IMGR_DVA(c,i,p) / IMGR(c,i,p)
Service content of Gross exports

<table>
<thead>
<tr>
<th>VA origin *</th>
<th>Exports</th>
<th>Imports</th>
<th>Final Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>country =c</td>
<td>Country (c)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>∑ services</td>
<td>Industry (i)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VA origin *</th>
<th>Exports</th>
<th>Imports</th>
<th>Final Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>∑ country ≠ c</td>
<td>Country (c)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>∑ services</td>
<td>Industry (i)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Domestic Services VA content of Gross exports**

**EXGR_SERV_DVA**

**Foreign Services VA content of Gross exports**

**EXGR_SERV_FVA**

\[
\text{EXGR}_\text{SERV}_\text{DVASH} = \frac{\text{EXGR}_\text{SERV}_\text{DVA}(c,i)}{\text{EXGR}(c,i)}
\]

\[
\text{EXGR}_\text{SERV}_\text{FVASH} = \frac{\text{EXGR}_\text{SERV}_\text{FVA}(c,i)}{\text{EXGR}(c,i)}
\]
Using 4 dimensions

1. VA origin of gross exports
   **EXGR_BSCI**

2. VA origin of gross imports
   **IMGR_BSCI**

Gross trade-based core TiVA indicators (2, 3 dims) can be derived from these cubes:

For example, from 1. above:
- **EXGR_DVA** (*set source country* $s$ = “**DXD: Domestic**”, *source industry* $h$ = “**CTOTAL**”) hence
- **EXGR_FVA, EXGR_DVASH, EXGR_FVASH, EXGR_TFVAIND**

Also, **EXGR_SERV_DVASH** (*set source industry* = “**D41T98**”) and, **EXGR_DVAFXSH**.

Many other variations for users to play with ...
Final demand based indicators

Domestic VA embodied in foreign final demand

**FFD_DVA**

Share of Domestic VA embodied in foreign final demand

**VALU_FFDDVA** = **FFD_DVA**(c,i) / Value Added (c,i)

Foreign VA embodied in domestic final demand

**DFD_FVA**

Value added balance, **BALVAFD** = **FFD_DVA** – **DFD_FVA**

**Note:** at the total economy level **BALVAFD** = **BALGR**

i.e. Gross trade balance = VA trade balance: differences for bilateral relations
Using 4 dimensions

VA origin of
Final Demand
FDVA_BSCI

Gross exports by origin of value added and final destination
FD_EXGR_VA

Final Demand-based core TiVA indicators (2, 3 dims) can be derived from these cubes e.g. FFD_DVA and DFD_FVA but also many other variations.
Indicators for regions

- Regions = country groups e.g. EU
- For indicators such as EXGR_FVA, can include or exclude intra-region trade flows and/or VA flows.
- Including is equivalent to showing average of countries e.g. intra-region VA flows treated as FVA
- Excluding is treating the region as a single economy e.g. intra-region VA flows treated as DVA
- EXGR_FVA: excl. intra-region VA
- VA origin of EXGR (4 dims): excl. intra-region VA flows
Caveats: Average industry production functions [from vBe]

- At the detailed level of industry:
  \[ \text{DVA (FVA) share (\%) of exports} = \text{DVA (FVA) share in output for domestic consumption} \]
  \( \text{(except for China and Mexico)} \)

- Also, the same for each importing partner country
- Differences at the aggregate level (e.g. total manufactures) reflect differing industry compositions of exports to each partner
- Using a more detailed industry list would result in changes in indicators at aggregate levels (e.g. total manufactures, total services)
- Also, dividing industries to account for firm heterogeneity, e.g. exporters v. non-exporters, also changes indicators:
  
  \( \text{This is what we do for China and Mexico in the ICIO} \)
Caveats: “double counting”

• Presence of double-counting in EXGR-based indicators when comparing across countries
• Double counted value-added comes in different flavours in gross exports:
  – The foreign value-added in exports can already be regarded as ‘double counting’ because it is domestic value added in the exports of another country
    • At the world level, this is ‘double counting’
    • But not when measured for a given exporting economy
    • Also, the same FVA can be included in the gross exports of different countries
  – An additional source of double counting comes from intermediate inputs that come back to the exporting economy
    • Domestic inputs can return back home and the domestic value-added embodied in them is counted twice (as well as any foreign value-added embodied in them)
    • Foreign inputs can also return back to the exporting economy (and they have foreign value-added or domestic value-added that will also be counted several times)
    • Therefore, a full decomposition of gross exports should also include domestic double counted VA and foreign double counted VA.
• Does it matter?
  – Double counting is generally small but at the industry level and in specific countries, it is non negligible.
  – It matters when the domestic value-added has to be consistent with GDP (e.g. jobs embodied in exports).
Example of EXGR_FVASH versus EXGR_TFVAIND

EXGR_FVASH: denominator = industry exports (intensity)

EXGR_TFVAIND: denominator = total exports (magnitude)
TIVA INDICATORS - LIST
<table>
<thead>
<tr>
<th>#</th>
<th>Section</th>
<th>Indicator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.1</td>
<td>PROD</td>
<td>Production (gross output)</td>
</tr>
<tr>
<td>2</td>
<td>4.2</td>
<td>VALU</td>
<td>Value added</td>
</tr>
<tr>
<td>10</td>
<td>4.3</td>
<td>PROD_VASH</td>
<td>Value added as a % of production</td>
</tr>
<tr>
<td>3</td>
<td>4.4</td>
<td>EXGR</td>
<td>Gross exports</td>
</tr>
<tr>
<td>4</td>
<td>4.4</td>
<td>EXGR_INT</td>
<td>Gross exports of intermediate products</td>
</tr>
<tr>
<td>5</td>
<td>4.4</td>
<td>EXGR_FNL</td>
<td>Gross exports of final products</td>
</tr>
<tr>
<td>6</td>
<td>4.5</td>
<td>IMGR</td>
<td>Gross imports</td>
</tr>
<tr>
<td>7</td>
<td>4.5</td>
<td>IMGR_INT</td>
<td>Gross imports of intermediate products</td>
</tr>
<tr>
<td>8</td>
<td>4.5</td>
<td>IMGR_FNL</td>
<td>Gross imports of final products</td>
</tr>
<tr>
<td>9</td>
<td>4.6</td>
<td>BALGR</td>
<td>Gross trade balance</td>
</tr>
<tr>
<td>11</td>
<td>4.7</td>
<td>EXGRpSH</td>
<td>Gross exports, partner shares</td>
</tr>
<tr>
<td>12</td>
<td>4.7</td>
<td>IMGRpSH</td>
<td>Gross imports, partner shares</td>
</tr>
</tbody>
</table>
• Production, gross output, USD million
  – $PROD_{c,i} = X_{c,i}$
  – Prod cou | Prod ind | World

• Value added, USD million
  – $VALU_{c,i} = W_{c,i}$
  – Prod cou | Prod ind | World

• Gross exports, by industry and by partner country, USD million (f.o.b.)
  – $EXGR_{c,i} = \sum_p EXGR_{c,i,p} = \sum_p (EXGR_{INT,c,i,p} + EXGR_{FNL,c,i,p})$
  – $EXGR_{INT,c,i,p} = GRTR_{INT}\_{(c-1)*N+i,p}$
  – $EXGR_{FNL,c,p,i} = GRTR_{FNL}\_{(c-1)*N+i,p}$
  – Exp cou | Exp ind | Imp cou
Structural Indicators

- **Gross imports, by industry and by partner country, USD million (f.o.b.)**
  
  - \( IMGR_{c,i} = \sum_p IMGR_{c,p,i} \)
  
  - \( IMGR_{INT,c,i,p} = GRTR_{INT}(p-1)*N+i,c \)
  
  - \( IMGR_{FNL,c,i,p} = GRTR_{FNL}(p-1)*N+i,c \)
  
  - \( Imp\ cou \ | \ Exp\ ind \ | \ Exp\ cou \)

- **Gross trade balance, by partner country, USD million (f.o.b.)**
  
  - \( BALGR_{c,p} = EXGR_{c,p} - IMGR_{c,p} \)
  
  - \( Exp\ cou \ | \ Tot\ ind \ | \ Imp\ cou \)

- **Value added as a share of Gross Output, by industry, percentage**
  
  - \( PROD\_VASH_{c,i} = \frac{VALU_{c,i}}{PROD_{c,i}} \)
  
  - \( Prod\ cou \ | \ Prod\ ind \ | \ World \)
Structural Indicators

- Gross exports, partner shares %, by industry, percentage
  - \( EXGRpSH_{c,i,p} = \frac{EXGR_{c,i,p}}{\sum_p EXGR_{c,i,p}} \times 100 \)
  - \( Exp \ cou \mid Exp \ ind \mid Imp \ cou \)

- Gross imports, partner shares %, by industry, percentage
  - \( IMGRpSH_{c,i,p} = \frac{IMGR_{c,i,p}}{\sum_p IMGR_{c,i,p}} \times 100 \)
  - \( Imp \ cou \mid Exp \ ind \mid Exp \ cou \)
## Indicators based on Value Added, Gross Exports and Imports

<table>
<thead>
<tr>
<th>National Origin of Value Added</th>
<th>Description</th>
<th>Code</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Domestic value added content of gross exports</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 5.1</td>
<td>EXGR_DVA</td>
<td>Domestic value added content of gross exports</td>
<td></td>
</tr>
<tr>
<td>20 5.2</td>
<td>EXGR_DVASH</td>
<td>Domestic value added share of gross exports</td>
<td></td>
</tr>
<tr>
<td>29 5.3</td>
<td>EXGR_TDVAIND</td>
<td>Industry domestic value added contribution to gross exports</td>
<td></td>
</tr>
<tr>
<td>25 5.4</td>
<td>EXGR_DVApSH</td>
<td>Domestic value added in gross exports, partner shares</td>
<td></td>
</tr>
<tr>
<td><strong>Decomposition of domestic value added content of gross exports</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 5.5</td>
<td>EXGR_DDC</td>
<td>Direct domestic value added content of gross exports</td>
<td></td>
</tr>
<tr>
<td>15 5.6</td>
<td>EXGR_IDC</td>
<td>Indirect domestic value added content of gross exports</td>
<td></td>
</tr>
<tr>
<td>16 5.7</td>
<td>EXGR_RIM</td>
<td>Re-imported domestic value added content of gross exports</td>
<td></td>
</tr>
<tr>
<td><strong>Foreign value added content of gross exports (backward participation in GVCs)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 5.8</td>
<td>EXGR_FVA</td>
<td>Foreign value added content of gross exports</td>
<td></td>
</tr>
<tr>
<td>27 5.9</td>
<td>EXGR_FVASH</td>
<td>Foreign value added share of gross exports</td>
<td></td>
</tr>
<tr>
<td>30 5.10</td>
<td>EXGR_TFVAIN</td>
<td>Industry foreign value added contribution to gross exports</td>
<td></td>
</tr>
<tr>
<td>33 5.11</td>
<td>DEXFVApSH</td>
<td>Foreign value added share of gross exports, by value added origin country</td>
<td></td>
</tr>
<tr>
<td><strong>Domestic value added content of foreign gross exports (forward participation in GVCs)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 5.12</td>
<td>EXGR_DVAFXSH</td>
<td>Domestic value added embodied in foreign exports as share of gross exports</td>
<td></td>
</tr>
<tr>
<td>34 5.13</td>
<td>FEXDVApSH</td>
<td>Domestic value added in foreign exports as a share of gross exports, by foreign exporting country</td>
<td></td>
</tr>
<tr>
<td><strong>Domestic value added content of intermediate and final gross exports</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 5.14</td>
<td>EXGR_INTDVASH</td>
<td>Domestic value added in exports of intermediate products, as a share of total gross exports</td>
<td></td>
</tr>
<tr>
<td>22 5.15</td>
<td>EXGR_FNLDVASH</td>
<td>Domestic value added in exports of final products, as a share of total gross exports</td>
<td></td>
</tr>
<tr>
<td>26 5.16</td>
<td>EXGR_INTDVApSH</td>
<td>Domestic value added in exports of intermediate products, partner shares</td>
<td></td>
</tr>
<tr>
<td><strong>Services value added content of gross exports</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23 5.17</td>
<td>EXGR_SERV_DVASH</td>
<td>Domestic services value added share of gross exports</td>
<td></td>
</tr>
<tr>
<td>28 5.18</td>
<td>EXGR_SERV_FVASH</td>
<td>Foreign services value added share of gross exports</td>
<td></td>
</tr>
<tr>
<td><strong>Domestic value added in imports</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 5.19</td>
<td>IMGR_DVA</td>
<td>Domestic value added content of gross imports</td>
<td></td>
</tr>
<tr>
<td>31 5.20</td>
<td>IMGR_DVASH</td>
<td>Domestic value added share of gross imports</td>
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<tr>
<td><strong>Re-exported intermediate imports</strong></td>
<td></td>
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</tr>
<tr>
<td>19 5.21</td>
<td>REII</td>
<td>Re-exported intermediate imports</td>
<td></td>
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<tr>
<td>32 5.22</td>
<td>IMGRINT_REII</td>
<td>Re-exported intermediate imports as % of intermediate imports</td>
<td></td>
</tr>
</tbody>
</table>
Overview Indicators Estimation

IMGR_BSCI → IMGR_DVA → IMGR_DVASH

REII → IMGRINT_REII
Indicators based on Value Added, Gross Exports and Imports

- **Domestic value added embodied in gross exports, by industry and by partner country, USD million**
  - \( \text{EXGR\_DVA}_{c,i,p} = V_c B_{c,c} \text{EXGR}_{c,i,p} \)
  - \( \text{Exp cou} \mid \text{Exp ind} \mid \text{Imp cou} \)

- **Direct domestic industry value added content of gross exports, USD million**
  - \( \text{EXGR\_DDC}_c = \tilde{V}_c \text{diag} B_c \text{EXGR}_c \)
  - \( \text{Exp cou} \mid \text{Exp ind} \mid \text{World} \)

- **Indirect domestic content of gross exports (originating from domestic intermediates), USD million**
  - \( \text{EXGR\_IDC}_c = \tilde{V}_c \text{offdiag} B_c \text{EXGR}_c - \text{EXGR\_DDC}_c \)
  - \( \text{Exp cou} \mid \text{Exp ind} \mid \text{World} \)
Indicators based on Value Added, Gross Exports and Imports

• Re-imported domestic value added content of gross exports, USD million
  \[ EXGR_{RIMc} = \tilde{V}_c B_{c,c} EXGR_c - EXGR_{DDC_c} - EXGR_{IDC_c} \]
  – Exp cou | Exp ind | World

• Foreign value added content of gross exports, by industry, USD million
  \[ EXGR_{FVAc} = V_c B_c EXGR_{c,i} \]
  – Exp cou | Exp ind | World

• Domestic value added embodied in gross imports, by exporting industry and exporting country, USD million
  \[ IMGR_{DVA_{c,i,p}} = \tilde{V}_c B_{c,i,p} IMGR_{c,i,p} \]
  – Imp cou | Exp ind | Exp cou
Indicators based on Value Added, Gross Exports and Imports

• Re-exported intermediate imports, USD million
  \[ REII_{c,i} = \left( \sum_p A_{p,c} B_{c,c} EXGR_c \right)_i \]
  \[ Exp \ cou \ | \ Prod \ ind \ | \ World \]

• Domestic value added share of gross exports, percentage
  \[ EXGR_{DVASH}_{c,i} = \frac{\sum_p EXGR_{DVA_{c,i,p}}}{\sum_p EXGR_{c,i,p}} \times 100 \]
  \[ Exp \ cou \ | \ Exp \ ind \ | \ World \]

• Domestic value added in exports of intermediate products as a share of total gross exports, percentage
  \[ EXGR_{INTDVASH}_{c,i} = \frac{\sum_p EXGR_{INTDVA_{c,i,p}}}{\sum_p EXGR_{c,i,p}} \times 100 \]
  \[ Exp \ cou \ | \ Exp \ ind \ | \ World \]
Indicators based on Value Added, Gross Exports and Imports

- **Domestic value added in exports of final products as a share of total gross exports, percentage**
  
  \[ EXGR\_FNLDVASH_{c,i} = \frac{\sum_p EXGR\_FNLDVA_{c,i,p}}{\sum_p EXGR_{c,i,p}} \times 100 \]
  
  - Exp cou | Exp ind | World

- **Domestic services value added share in gross exports, percentage**
  
  \[ EXGR\_SERV\_DVASH_{c,i} = \frac{EXGR\_SERV\_DVA_{c,i}}{EXGR_{c,i}} \times 100 \]
  
  - where: \[ EXGR\_SERV\_DVA_{c,i} = \sum_{j \in S} \overline{V}_{c,j} (B_{c,c})_{ji} EXGR_{c,i} \]
  
  - Exp cou | Exp ind | World

- **Domestic value added embodied in foreign exports as share of gross exports, percentage**
  
  \[ EXGR\_DVAFXSH_{c,i} = \frac{\sum_p EXGR\_BSCI_{c,i,p}}{EXGR_{c}} \times 100 \]
  
  - VA src cou | Exp ind | World
Indicators based on Value Added, Gross Exports and Imports

- Domestic value added in gross exports, partner shares, percentage
  \[ EXGR_{DVApSH}_{c,i,p} = \frac{EXGR_{DVA}_{c,i,p}}{\sum_p EXGR_{DVA}_{c,i,p}} \times 100 \]
  \[ Exp \ cou \mid Exp \ ind \mid Imp \ cou \]

- Domestic value added in exports of intermediate products, partner shares, percentage
  \[ EXGR_{INTDVApSH}_{c,i,p} = \frac{EXGR_{INTDVA}_{c,i,p}}{\sum_p EXGR_{INTDVA}_{c,i,p}} \times 100 \]
  \[ Exp \ cou \mid Exp \ ind \mid Imp \ cou \]

- Foreign value added share of gross exports, percentage
  \[ EXGR_{FVASH}_{c,i} = \frac{\sum_p EXGR_{FVA}_{c,i,p}}{\sum_p EXGR_{c,i,p}} \times 100 \]
  \[ Exp \ cou \mid Exp \ ind \mid World \]
Indicators based on Value Added, Gross Exports and Imports

- Foreign services value added share in gross exports, percentage
  \[
  EXGR\_SERV\_FVASH_{c,i} = \frac{EXGR\_SERV\_FVA_{c,i}}{EXGR_{c,i}} \times 100
  \]
  where: \( EXGR\_SERV\_FVA_{c,i} = \sum_p \sum_{j \in S} V_{p,j} (B_{p,c})_{j,i} EXGR_{c,i,p} \)
  - Exp cou | Exp ind | World

- Industry domestic value added contribution to gross exports, as a percentage of total gross exports
  \[
  EXGR\_TDVAIND_{c,i} = \frac{\sum_p EXGR\_DVA_{c,i,p}}{\sum_p EXGR_{c,i,p}} \times 100
  \]
  - Exp cou | Exp ind | World

- Industry foreign value added contribution to gross exports, as a percentage of total gross exports
  \[
  EXGR\_TFVAIND_{c,i} = \frac{\sum_p EXGR\_FVA_{c,i,p}}{\sum_p EXGR_{c,i,p}} \times 100
  \]
  - Exp cou | Exp ind | World
Indicators based on Value Added, Gross Exports and Imports

- **Domestic value added share of gross imports, percentage**
  \[
  IMGR_{DVASH_{c,i,p}} = \frac{IMGR_{DVA_{c,i,p}}}{\sum_p IMGR_{c,i,p}} \times 100
  \]
  - Imp cou | Exp ind | Exp cou

- **Re-exported intermediate imports as a % of total intermediate imports, percentage**
  \[
  IMGRINT_{REII_{c,i}} = \frac{REII_{c,i}}{\sum_p IMGR\_INT_{c,i,p}}
  \]
  - Exp cou | Prod ind | World

- **Backward participation in GVCs, percentage**
  \[
  DEXFVApSH_{c,p} = \frac{EXGR_{BSCI_{c,p}}}{EXGR_c} \times 100
  \]
  - Exp cou | Tot ind | VA src cou
Indicators based on Value Added, Gross Exports and Imports

- Forward participation in GVCs, percentage
  - \( FEXDVApSH_{cp} = \frac{EXGR_{BSCI_{cp}}}{EXGR_c} \times 100 \)
  - VA src cou | Tot ind | Exp cou
## Indicators based on Value Added and Final Demand

<table>
<thead>
<tr>
<th>Indicator Code</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>6.1</td>
<td>FFD_DVA Domestic value added embodied in foreign final demand</td>
</tr>
<tr>
<td>44</td>
<td>6.2</td>
<td>FFD_DVApSH Domestic value added in foreign final demand, partner shares</td>
</tr>
<tr>
<td>46</td>
<td>6.3</td>
<td>VALU_FFDDVA Share of domestic value added embodied in foreign final demand</td>
</tr>
<tr>
<td>39</td>
<td>6.4</td>
<td>DFD_FVA Foreign value added embodied in domestic final demand</td>
</tr>
<tr>
<td>45</td>
<td>6.5</td>
<td>DFD_FVApSH Foreign value added in domestic final demand, partner shares</td>
</tr>
<tr>
<td>40</td>
<td>6.6</td>
<td>BALVAFD Value added embodied in final demand, balance</td>
</tr>
</tbody>
</table>

### Sources of value added in final demand

<table>
<thead>
<tr>
<th>Indicator Code</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>6.7</td>
<td>FD_VA Value added content of final demand, by source country and industry</td>
</tr>
<tr>
<td>36</td>
<td>6.7</td>
<td>CONS_VA Value added content of total consumption, by source country and industry</td>
</tr>
<tr>
<td>37</td>
<td>6.7</td>
<td>GFCF_VA Value added content of gross fixed capital formation, by source country and industry</td>
</tr>
<tr>
<td>41</td>
<td>6.8</td>
<td>FD_VASH Value added share of total final demand, by source country and industry</td>
</tr>
<tr>
<td>42</td>
<td>6.8</td>
<td>CONS_VASH Value added share of total consumption, by source country and industry</td>
</tr>
<tr>
<td>43</td>
<td>6.8</td>
<td>GFCF_VASH Value added share of gross fixed capital formation, by source country and industry</td>
</tr>
</tbody>
</table>
Overview Indicators Estimation
Indicators based on Value Added and Final Demand

- Value added embodied in final demand, consumption and GFCF, USD million
  - $FD_{VA_{c,p}} = (\widehat{V} B FD)_{p,c}$
  - $CONS_{VA_{c,p}} = (\widehat{V} B CONS)_{p,c}$
  - $GFCF_{VA_{c,p}} = (\widehat{V} B GFCF)_{p,c}$
  - $FD$ cou | $VA$ src ind | $VA$ src cou

- Domestic value added embodied in foreign final demand, USD million
  - $FFD_{DVA_{c,p}} = (\widehat{V} B FD)_{c,p}$
  - $VA$ src cou | $VA$ src ind | $Dem$ cou

- Foreign value added embodied in domestic final demand, USD million
  - $DFD_{FVA_{c,p}} = (\widehat{V} B FD)_{p,c}$
  - $FD$ cou | $VA$ src ind | $VA$ src cou
Indicators based on Value Added and Final Demand

- **Value added embodied in final demand, balance, USD million**
  - \( BALVAFD_{c,i,p} = FFD_{DVA_{c,i,p}} - DFD_{FVA_{c,i,p}} \)
  - VA src cou | VA src ind | FD cou

- **Value added shares in final demand, consumption and GFCF, by source country and industry, percentage**
  - \( FD\_VASH_{c,i,p} = \frac{FD_{VA_{c,i,p}}}{\sum_p FD_{VA_{c,i,p}}} \times 100 \)
  - \( CONS\_VASH_{c,i,p} = \frac{CONS_{VA_{c,i,p}}}{\sum_p CONS_{VA_{c,i,p}}} \times 100 \)
  - \( GFCF\_VASH_{c,i,p} = \frac{GFCF_{VA_{c,i,p}}}{\sum_p GFCF_{VA_{c,i,p}}} \times 100 \)
  - FD cou | VA src ind | VA src cou
Indicators based on Value Added and Final Demand

- Domestic value added embodied in foreign final demand, partner shares, percentage
  
  \[ FF_DVApSH_{c,i,p} = \frac{FFD_{DVA_{c,i,p}}}{\sum_p FFD_{DVA_{c,i,p}}} \times 100 \]

- Foreign value added embodied in domestic final demand, partner shares, percentage
  
  \[ DFD_{FVApSH_{c,i,p}} = \frac{DFD_{FVA_{c,i,p}}}{\sum_p DFD_{FVA_{c,i,p}}} \times 100 \]

- Domestic value added embodied in foreign final demand as a % of total value added, percentage
  
  \[ VALUX_{FFDDVA_{c,i}} = \frac{\sum_p FFD_{DVA_{c,i,p}}}{VALUX_{c,i}} \times 100 \]
## Indicators with four dimensions

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<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Origins of value added By Source Country and Industry (BSCI)</strong></td>
</tr>
<tr>
<td>47</td>
<td>7.1</td>
<td>EXGR_BSCI Origin of value added in gross exports</td>
</tr>
<tr>
<td>48</td>
<td>7.2</td>
<td>IMGR_BSCI Origin of value added in gross imports</td>
</tr>
<tr>
<td>49</td>
<td>7.3</td>
<td>FDVA_BSCI Origin of value added in final demand</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Gross exports with 3 country dimensions: exporter, value added origin and final destination</strong></td>
</tr>
<tr>
<td>50</td>
<td>7.4</td>
<td>FD_EXGRINT_VA Gross exports of intermediate products by origin of value added and final destination</td>
</tr>
<tr>
<td>51</td>
<td>7.4</td>
<td>FD_EXGRFNLS_VA Gross exports of final products by origin of value added and final destination</td>
</tr>
<tr>
<td>52</td>
<td>7.4</td>
<td>FD_EXGR_VA Gross exports by origin of value added and final destination</td>
</tr>
</tbody>
</table>
Indicators with four dimensions

• Origin of value added in gross exports, USD million
  – \( EXGR_{BSCI}^{p,h,c,i} = (\hat{V}B \ EXGR_{c,i})^{p,h} \)
  – VA src ind | VA src ind | Exp cou | Exp ind

• Origin of value added in gross imports, USD million
  – \( IMGR_{BSCI}^{p,c,i,s} = \hat{V}BIMGR_{p,c} \)
  – Imp cou | VA src cou | Exp ind | Exp cou

• Origin of value added in final demand, USD million
  – \( FDVA_{BSCI}^{c,i,p,h} = (\hat{V}B \ FD_{p,h})^{c,i} \)
  – VA src cou | VA src ind | FD cou | FD ind
Indicators with four dimensions

• Value added embodied in intermediate products exports by final destination, USD million
  \[ FD_{EXGRINT\_VA_{s,c,i,p}} = V_{s,j} \times B_{s,j,c,i} \times F_{c,i,p} \]
  – Where: \( F = \text{diag}([\gamma \circ A \times \text{diag}(B \times FD)] \times i) \)
  – VA src cou | Exp cou | Exp ind | FD cou

• Value added embodied in final products exports by final destination, USD million
  \[ FD_{EXGRFNL\_VA_{s,c,i,p}} = V_{s,j} \times B_{s,j,c,i} \times \text{EXGR\_FNL}_{c,i,p} \]
  – VA src cou | Exp cou | Exp ind | FD cou

• Value added embodied in total gross exports by final destination, USD million
  \[ FD_{EXGR\_VA_{s,c,i,p}} = FD_{EXGRINT\_VA_{s,j,c,i}} + FD_{EXGRFNL\_VA_{c,i,p}} \]
  – VA src cou | Exp cou | Exp ind | FD cou
TECO2 AND TIM INDICATORS
TECO\textsubscript{2} and TiM Indicators

- TECO\textsubscript{2} and TiM indicators are estimated according to the methodology presented for the estimation of the TiVA indicators.
- They make use of CO\textsubscript{2} emissions and employment coefficients in the place of value added coefficients.
- The discussion of the coefficients estimation of these databases is presented in the respective working papers published by OECD and on the dedicated internet webpages (http://oe.cd/io-co2 and http://oe.cd/io-emp)
EXPLORING CHANGES IN WORLD PRODUCTION AND TRADE

INSIGHTS FROM THE 2018 UPDATE OF OECD’S ICIO/TIVA DATABASE
• Has the structure of world production and trade really changed from 2005 to 2015?
• If so, how do these changes affect (and are affected by) changes in the structure of value added, employment, and emissions generation?
• Who are the main players?
• A portrait by OECD’s ICIO and TiVA!

• For a Brazilian perspective using OECD databases:
De-globalisation?

- For major blocs of countries, in recent years, the general trend in foreign contents of exports has been downward.
- The notable exception is South and Central America.
- At the country level the patterns of change can be very different within the same trading bloc.
Foreign value added shares of total exports, 2010 = 1.00

*Source:* Estimation based on OECD’s Inter-Country Input-Output (ICIO) Database, 2018
Globalisation or regionalisation?

• Inter x Intra regional trade
• Main trading blocs: North America, European Union (EU28), East and Southeast (E&SE) Asia
• Overall increase in the trade of manufactured goods, in value added terms, from 2005 to 2015, especially for E&SE Asia
• As a whole, there are declines in intra-regional trade in North America and EU28, while for E&SE Asia there is an clear increase in the intra-regional trade, in great part due to China.
Inter- and Intra-regional demand for manufactured goods

Globalisation or regionalisation?

- Analysis of the final destination of intermediate exports, for select countries, shows where these goods actually end up.
  - For USA and, to a lesser extent, for China, there is a return of exports to meet demand in the originating countries;
  - For the selected Asian countries (Japan, Korea, China) around one-third of the intra-regional exports are subsequently embodied in exports to the rest of the world.

- The increased dependence and integration among E&SE Asian economies is a result of organisation within the region to produce goods and services to fulfil the growing extra-regional demand and Chinese domestic demand.
Final destination of intermediate exports by final demand region, 2015

Source: Estimation based on OECD’s Inter-Country Input-Output (ICIO) Database, 2018
Industry perspective

Four highly fragmented sectors are:

• Textiles and apparel;
• Chemicals and pharmaceuticals;
• Computer, electronic and optical products (or “ICT and electronics”); and,
• Motor vehicles

OECD countries are more integrated in production chains of ICT and electronics and motor vehicles
Foreign value added embodied in domestic final demand by sector, global average, 2015

As a percentage of total domestic demand

Industry perspective

Origin of value added in US imports of “electronics, machinery and transport equipment” from Mexico, 2005-2015:
while US value added content fell (22% to 18%), China’s increased from 5% to 12% and Mexico’s from 46% to 50%
US imports of “electronics, machinery and transport equipment” from Mexico, 2005 to 2015
by country or region of value added origin

For most OECD and G20 countries, the total service value added content of manufactured exports ranges between 25% and 40%, with many experiencing an increase over the period from 2005 to 2015. There is a wide variation in the mix of domestic and foreign contributions.

Splitting foreign services content of manufactured exports into intra-regional and extra-regional origin, reveals that in the European Union, on average, about 58% of the foreign value added is intra-regional.
Services value added embodied in manufactured exports, by domestic and foreign origin, 2015

as a percentage of total manufacturing exports

Spending on final goods and services by non-resident households (e.g. accommodation and food services) has a notable indirect impact on the activities of upstream suppliers. **On average, indirect domestic value added content accounted for about a third of spending by non-resident households in 2015**
Non-resident household expenditure and tourism

In OECD ICIO tables: cross-border trade and non-resident household expenditure are separated → insights into international tourism and GVCs

Contribution of non-resident household expenditure to total exports, 2015, %

Insights into origin of value added in non-resident household purchases of final goods and services e.g. How much comes from upstream (indirect) domestic sources and foreign sources?

Relative to GDP:
- Greece and Iceland > 5%
- Chile, Finland, Japan and Korea < 0.75%
- Canada and USA ≈ 1%

OECD Tourism working paper: “Providing new OECD evidence on tourism trade in value added” (2019)
Using the OECD ICIO tables, it is possible to estimate employment and labour compensation sustained by foreign final demand, disaggregated by region of demand.

On average in OECD countries, there was an increase in business sector employment sustained by foreign final demand between 2005 and 2015.

There are some important variations by country with Chile and China reducing their external dependence while for most European Union (EU28) countries and the United States, the dependence increased, although not dramatically (1-3 percentage points in most cases).
Employment in the business sector sustained by foreign demand, by region of demand, 2015

*as a percentage of total business sector employment*

The OECD ICIO tables can also be used to provide insights into environmental impacts of global production networks; e.g. going beyond the origin of CO2 emissions to estimate emissions embodied in final demand.

The difference between production-based and demand-based carbon emissions is highlighted by comparing the OECD and non-OECD groups.

In total, the OECD is a net-importer of embodied carbon while non-OECD economies, as a whole, are net-exporters. Net-imports by the OECD countries have gradually been falling since 2005.
CO2 emissions from fuel combustion (OECD and non-OECD countries), demand-based and production-based

Source: Estimation based on OECD’s Inter-Country Input-Output (ICIO) Database (2018) and IEA (2018)
CO₂ emissions

• Not all OECD countries are net-importers of carbon and similarly, not all non-OECD countries are net-exporters.

• Among OECD and G20 countries, the average of the three countries with highest per capita demand-based emissions (Australia, Saudi Arabia and United States, 18.3 tonnes CO₂) is nearly ten times higher than that of the three countries with lowest per capita emissions (Brazil, Indonesia and India, 1.9)
Per capita CO₂ emissions from fuel combustion demand-based and production-based

Source: Estimation based on OECD’s Inter-Country Input-Output (ICIO) Database (2018), IEA (2018), and UN (2017)
• **Developed nations**: a) are emitting less; b) have high intensity of emissions per-capita; and c) are net importers of emissions.

• **Developing nations**: a) are emitting more; b) have low intensity of emissions per-capita; and c) are net-exporters of emissions.

• **Challenge 1**: Better quality of life in developing countries with less emissions.

• **Challenge 2**: Political willingness of the nations to effectively engage in the decarbonisation process, as Nordhaus (2015) pointed out, when he introduces the notion of “Climate Clubs”.

CO₂ emissions
Evidence of recent falls in the foreign value added (FVA) content of exports in many economies

Regional integration remains strong. Especially in East and Southeast Asia—where there is significant growth in intra-regional flows (a large share of production being directed to exports ending up to meet Chinese and extra-regional demand)

Using ICIO, it is possible to reveal the importance of international trade (cross-border and non-resident purchases) for the generation of value added and employment in non-exporting service industries

OECD’s ICIO and TiVA infrastructure has proved to be an important tool for revealing new insights into the role of the international trade and GVCs as a source of growth and development for the world economies
FINAL COMMENTS
OECD’s ICIO and Indicators

• The OECD estimation of a time series of ICIO tables and related indicators - TiVA, TECO₂, TiM, etc. – provide an important source of information for academics, researchers and policy makers.

• These databases are regularly updated and freely available in the internet.

• It is a continuous work which aims not only on the update of the information, but also on bringing novelties in terms of indicators and methodological estimation.
ICIO tables and TiVA indicators – next release

• Estimates up to 2018 + earlier years (1995 to 2000)
• Expected release: Q4 2020 (other indicator sets thereafter)
• 2020 and beyond
  – More countries (subject to sufficient coverage and quality of national statistics and resources) i.e. Africa, South and central Asia and, Central and South America
  – Improved metadata and documentation + new online visualisation tools to help users.
  – New ICIO extensions and indicator collections
REFERENCES
References


THANK YOU

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More information at
http://oe.cd/icio
http://oe.cd/tiva
http://oe.cd/io-co2
http://oe.cd/io-emp