OECD's Inter-Country Input-Output (ICIO) tables

Overview of development and applications

OECD Directorate for Science, Technology, and Innovation

ICIO tables provide an international statistical infrastructure that maps flows of production, consumption, investment within countries and flows of international trade in goods and services between countries, broken down by economic activity and by country, globally and in a consistent manner and for a time period that makes such data fit for analytical purposes.

Background

1.   For several decades, globalisation has shaped the world's economic landscape. Global value chains (GVCs) emerged, reflecting the increasing division of labour between countries and industries in the production of goods and services. Merchandise and services trade flows saw a steady upward trend, along with significant foreign direct investment.

2.   Even if, in the face of geopolitical tensions, the trend towards more globalisation has slowed, understanding regional and global value chains remains more important than ever: the pandemic showed how supply chains can be fragile, leading to questions about their resilience; concerns about climate change have made apparent the need to estimate greenhouse gas emissions that are embodied in internationally traded goods; international political tensions require good evidence on trade dependence, for example for energy products and there is a long-standing question about how much value-added (wages, salaries, profits, taxes) each country generates through participation in global value chains.

3.   A statistical infrastructure is essential to provide key answers to these questions, by mapping flows of production, consumption, investment within countries and flows of international trade between countries, broken down by economic activity and by country, globally and in a consistent manner and for a period that makes such data fit for analytical purposes. The OECD Inter-country Input Output (ICIO) database purports to do exactly this.

4.   Work on input-output tables at the OECD started in the 1990s, triggered by the need to measure international technology spillovers. After the global financial crisis of 2009, the ICIO emerged to meet demands from policy analysts for a better understanding of the mechanisms behind the collapse in international trade worldwide. Specifically, tools were required to provide insights into the role of global value chains for trade, unattainable from "traditional" trade statistics, in particular the origins of value added in exports or in domestic final demand and soon, further applications developed (see below). While earlier work focused on the benefits of integration into GVCs, more recently (due to the COVID-19 crisis and the Russian invasion of Ukraine[1]) attention has shifted towards dependencies and potential risks in regional and global supply chains and the utility of ICIO tables to provide insights in discussions on resilience in GVCs.

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[1] Both Ukraine and Belarus were added to the ICIO database in 2022 to enable analyses of effects of the war in Ukraine.

5.   The first version of TiVA indicators was released in early 2013, covering 40 countries, 18 industries and just three years (2005, 2008 and 2009). However, the underlying ICIO tables used to generate the first editions of the TiVA database covered 36 industries based on ISIC Rev.3 (Yamano *et al*. 2012).

6.   Since then, the published tables, through a number of editions have undergone a significant expansion so that the current version covers 76 countries (plus "Rest of the world"), 45 industries[2] and 26 years (1995-2020) – see Annexes 1 and 2. This note summarises the basic data work required to build the ICIO infrastructure, along with international partnerships in its development; it describes some of the analytical applications to date, and then turns to the challenges faced in updating, quality-ensuring, and expanding the tool. Question to the Committee complete the document.

From national to international data – the many ingredients to the ICIO

7.   The **target structure** of the ICIO is readily explained – at least **in concept** (see Figure 1). The principal elements are (i) a matrix of industry-to-industry flows of intermediate inputs covering both flows of goods and services between domestic industries within each country and the international deliveries between industries of different countries; (ii) a matrix of deliveries of each industry to final demand components (such as consumption or investment). In addition, separate information is needed on taxes less subsidies on intermediate and final products so that all estimates are valued consistently (at basic prices). A unique feature of OECD ICIO tables (compared to other multi-regional input-output tables) is the identification of direct purchases abroad by residents, separated from cross-border trade.

Figure 1. Target structure of OECD ICIO tables

A simple 3-country, 2-industry example
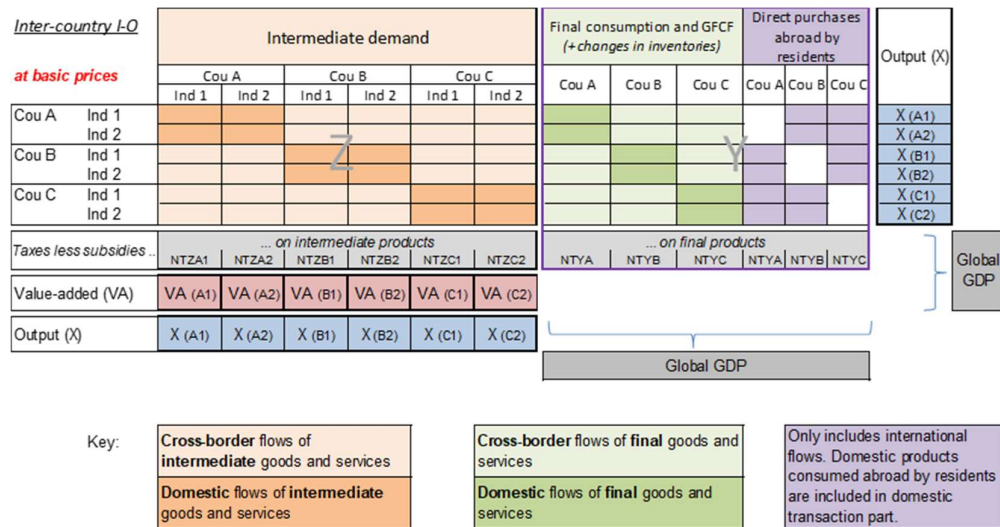
8.   **In practice**, constructing ICIO tables is a **complex, data intensive and time-consuming task**, requiring a multitude of sources. These include national Supply and Use Tables (SUTs) and/or Input-Output Tables (IOTs) to gauge deliveries between industries within countries, data on international trade in goods and services by product to capture deliveries between countries and national accounts statistics to benchmark estimates against countries' most recent main aggregates time-series (GDP, final demand, exports and imports) and output and value added by industry. The main steps in the ICIO complication

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[2] On a full count, and prior to treatment, the underlying working-level ICIO framework covers 198 countries and 75 industries.

procedure along with a detailed methodological description for recent editions can be found in Yamano et al. (2022a) and Yamano et al. (2022b).

9.   Much of the **OECD's value-added** occurs by bringing together the various sources of available statistics to construct a globally consistent set of ICIO tables. This implies:

- *Compiling and understanding national statistics*. Despite international statistical standards, there are differences in implementation between countries, and within countries across time, and practices need to be understood for informed use.
- *Addressing differences between the 2008 System of National Accounts (2008 SNA) and the previous version (1993 SNA)*. The latter is still used by some non-OECD countries and is the format of vintage data for many others
- Unlike for national accounts aggregates, very *few countries publish historical revisions of SUTs* based on the latest standards (2008 SNA). Thus, earlier published SUTs and IOTs may not be consistent with latest reported SNA time series. Also, the format of a country's SUTs may change over time, i.e. how certain elements are reported.
- *Differences in valuation* (basic prices, purchasers' prices, producers' prices) need addressing.
- *Mapping national classifications* into a standard industry list.
- *Addressing industry / product coverage* that varies across countries and over time.
- *Differences between Balance of Payments* statistics and trade reported in *SNA* expenditure accounts.
- Dealing with widespread *asymmetries in reported bilateral trade statistics*, both goods and services, i.e. exports reported by country A to country B do not match, and can be significantly different from, imports reported by country B from country A. For goods, reasons include significant re-exporting activities, designations of partner country (e.g. country-of-origin versus country of consignment), product code changes, confidentiality, misreporting.
- Dealing with missing and confidential data.

TiVA and beyond – the ICIO as a versatile tool

10.   While the key motivation to embark on the development of ICIO tables was to produce TiVA indicators to inform trade policy discussions, they are widely used, often in conjunction with other statistics, to produce indicators to address a wide range of policy areas, conducted under the auspices of various OECD Committees.

11.   One of the most widely noted applications is Carbon dioxide (CO_2) emissions embodied in international trade. In fact, at OECD, the first estimates of trade in embodied CO_2 based on ICIO tables (in 2011), preceded the development of TiVA indicators. CO_2 emitted in the production of a product that is subsequently exported (and possibly further transformed into other, final products) is allocated to the country where final consumption or investment occurs, thus painting a consumption-based profile of national emissions as opposed to production-based profiles. There is significant interest in such 'carbon footprints', given their relevance for climate change policy, including measurement of embodied carbon taxes and indirect impacts of border adjustments. OECD's International Programme for Action on Climate and the IMF's Climate Change Dashboard[3] draw on indicators of embodied carbon. Figure 2 demonstrates that differences between production and consumption-based CO_2 can be large.

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[3] Chapter 2 of the recent IMF publication Data for a Greener World showcases work based on the OECD's embodied carbon indicators.

Figure 2. Total production and consumption-based CO2 emissions by top 6 emitters
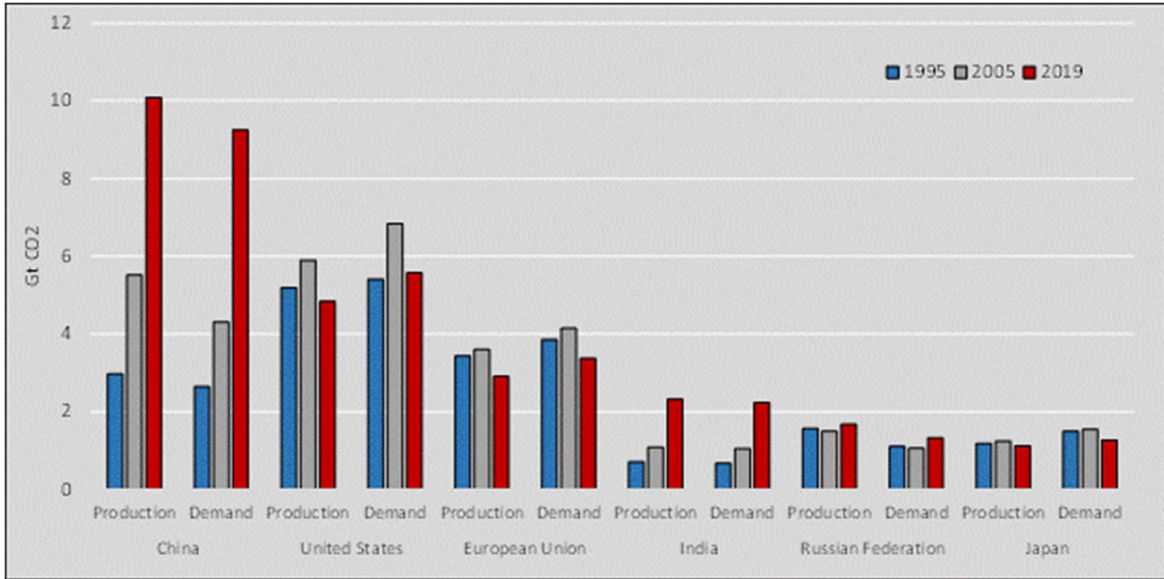
Source: OECD (2022), Secretariat estimates based on a preliminary update of the Trade in Embodied CO_2 database, http://oe.cd/io-co2

12.   A full description of other applications is beyond the scope of the present note, but the following list indicates that breadth of potential applications. Work on Trade in Employment uses the ICIO statistical infrastructure to compute the impact of foreign demand on domestic labour markets. Linking ICIO data with the OECD's database on Activities of Multinational Enterprises has enabled analysis of MNE activities in GVCs. The ICIO is also instrumental in addressing gender-related questions such as the impact of trade on male and female employment, social issues such as work on Child and Forced Labour in GVCs and sector-specific topics such as Tourism and GVCs. Other applications include indicators on the role of SMEs in global value chains.

Box 1. Recent partnerships and global outreach

The construction of ICIO tables is co-ordinated with work in other international bodies through the Regional-Global TiVA Initiatives, organised by the OECD since 2017. Partners include Eurostat, the Joint Research Centre of the European Commission, UNECLAC, the Asian Development Bank (ADB), and the IMF. The initiative aims at co-operating on the construction of multi-country Input-Output Tables by sharing base data and following common methodologies.

A three-year "Africa TiVA" project with WTO and the United Nations Economic Commission for Africa (UNECA) to include five more African countries in the TIVA database.

A project under Pillar 1 of OECD's Egypt Country Programme has resulted in Egypt's inclusion in ICIO and TiVA database.

A recent joint project with UNIDO allowed Jordan to be included in ICIO and TiVA database.

Collaboration with ADB resulted in the inclusion of Bangladesh and Pakistan.

Looking ahead – challenges and opportunities

13.   As stated above, there is increasing demand for the analytical use of ICIO in a rising number of subject matters. There is also strong demand for **greater geographical coverage** with regions or countries of interest explicitly recognised in the published global databases, rather than being hidden in the 'Rest of the World". Box 1 outlines key initiatives in this respect, such as bringing more African countries into the ICIO, further to OECD Country Programmes (as, for instance, with Egypt) or as part of broader development dialogues for example with Africa.

14.   Extending the geographical scope to the developing word exacerbates statistical challenges, making it difficult to estimate the desired industry/product detail in line with the requirements on methodology and quality to use the data confidently. Targeted country programmes to **build statistical capacity**, especially **in developing and emerging economies** are of fundamental importance.

15.   **Support by National Statistics Institutes (NSIs).** The single most significant support for the development of ICIO Tables **for international and national use** comes from NSIs themselves. The greater the possibility to provide national statistics of similar level of detail, timeliness and scope, the less need for estimates at the international level. Key areas include:

- *Greater industry and product detail in IOTs/SUTs*. For instance, for its SUT database, the OECD collects SUTs from countries in line with a common format such as a target industry/product breakdown of 88 industries (i.e. 2-digit ISIC Rev.4 / NACE Rev.2), separate reporting of domestic

and import use tables, different price bases etc. The more NSIs can provide such data at the full level of detail, the richer and more reliable the information base, including for national purposes.[4]

- *Time series of SUTs/IOTs consistent with latest 2008 SNA.* Some countries have developed such time-consistent series, for example the United States. Needless to underline that this is tremendously useful and raises data quality and comparability.

- *Continued efforts to reduce inconsistencies in bilateral trade data.* An informal group of the OECD Working Party on Trade in Goods and Services Statistics — is deriving Balanced Trade Statistics by initiating discussions between those countries with the biggest bilateral asymmetries. Much can be achieved in this group and NSOs are invited to actively participate in identifying reasons for asymmetries and remediating them.

- *Bilateral trade in services data also often lack product detail and good partner coverage.* With the steadily increasing importance of trade in services, many analytical insights can be gained – above and beyond from the ICIO tables – by expanding product detail of services trade data. Naturally, this is a longer-term project.

In conclusion

16.   ICIO tables are a prime example for a statistical product that can only reasonably be developed internationally. Mapping the world's production and trade flows consistently in space, by industry and over time constitutes a fundamental international statistical asset and infrastructure. The ICIO tables are also an example of a very versatile tool, adaptable to myriad analytical questions and indicators. Constructing ICIO tables is a complex and time-consuming process requiring a range of national and international statistics as inputs along with tools to fill numerous data gaps and to quality assure data to the extent possible.

17.   While an international statistical product, ICIO tables have proven useful for both international and national analyses. The importance of support by NSIs through targeted development of underlying statistics, for example by developing full details in SUTs cannot be overstated. Such longer-term investments in statistical infrastructure has wide-ranging benefits, well beyond improved ICIO tables.

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[4] For example, it is particularly important to provide a 2-digit breakdown of Mining sector industries and products. Given the great interest in understanding energy dependencies, separating oil and gas, coal, metal mining and quarrying is of the essence.

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Yamano, Guilhoto, Alsamawi, Webb, Horvat, Zürcher, Cimper, and Han (2022b) OECD ICIO 2021 edition

Annex 1. Geographical coverage in published ICIO tables and TiVA database

N.	Code	Country		N.	Code	Country
1	AUS	Australia		39	ARG	Argentina
2	AUT	Austria		40	BGD	Bangladesh
3	BEL	Belgium		41	BLR	Belarus
4	CAN	Canada		42	BRA	Brazil
5	CHL	Chile		43	BRN	Brunei Darussalam
6	COL	Colombia		44	BGR	Bulgaria
7	CRI	Costa Rica		45	KHM	Cambodia
8	CZE	Czechia		46	CMR	Cameroon
9	DNK	Denmark		47	CHN	China (People's Republic of)
10	EST	Estonia		48	CIV	Côte d'Ivoire
11	FIN	Finland		49	HRV	Croatia
12	FRA	France		50	CYP	Cyprus[2]
13	DEU	Germany		51	EGY	Egypt
14	GRC	Greece		52	HKG	Hong Kong, China
15	HUN	Hungary		53	IND	India
16	ISL	Iceland		54	IDN	Indonesia
17	IRL	Ireland		55	JOR	Jordan
18	ISR	Israel[1]		56	KAZ	Kazakhstan
19	ITA	Italy		57	LAO	Lao (People's Democratic Rep.)
20	JPN	Japan		58	MYS	Malaysia
21	KOR	Korea		59	MLT	Malta
22	LVA	Latvia		60	MAR	Morocco
23	LTU	Lithuania		61	MMR	Myanmar
24	LUX	Luxembourg		62	NGA	Nigeria
25	MEX	Mexico		63	PAK	Pakistan
26	NLD	Netherlands		64	PER	Peru
27	NZL	New Zealand		65	PHL	Philippines
28	NOR	Norway		66	ROU	Romania
29	POL	Poland		67	RUS	Russian Federation
30	PRT	Portugal		68	SAU	Saudi Arabia
31	SVK	Slovakia		69	SEN	Senegal
32	SVN	Slovenia		70	SGP	Singapore
33	ESP	Spain		71	ZAF	South Africa
34	SWE	Sweden		72	TWN	Chinese Taipei
35	CHE	Switzerland		73	THA	Thailand
36	TUR	Türkiye		74	TUN	Tunisia
37	GBR	United Kingdom		75	UKR	Ukraine
38	USA	United States		76	VNM	Viet Nam
				77	ROW	Rest of the World

OECD countries (as of 25 May 2021)   Countries added in 2022

Notes:

1. The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities or third party. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

2. **Footnote by Türkiye**: The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Türkiye recognizes the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Türkiye shall preserve its position concerning the "Cyprus issue". **Footnote by all the European Union Member States of the OECD and the European Union**: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Türkiye. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

Annex 2. Industry coverage in published ICIO tables and TiVA database

N.		Industry	ISIC Rev.4 Divisions	ISIC Rev.4 Sections
1	A01_02	Agriculture, hunting, forestry	01, 02	A
2	A03	Fishing and aquaculture	03	
3	B05_06	Mining and quarrying, energy producing products	05, 06	B
4	B07_08	Mining and quarrying, non-energy producing products	07, 08	
5	B09	Mining support service activities	09	
6	C10T12	Food products, beverages and tobacco	10, 11, 12	C
7	C13T15	Textiles, textile products, leather and footwear	13, 14, 15	
8	C16	Wood and products of wood and cork	16	
9	C17_18	Paper products and printing	17, 18	
10	C19	Coke and refined petroleum products	19	
11	C20	Chemical and chemical products	20	
12	C21	Pharmaceuticals, medicinal chemical and botanical products	21	
13	C22	Rubber and plastics products	22	
14	C23	Other non-metallic mineral products	23	
15	C24	Basic metals	24	
16	C25	Fabricated metal products	25	
17	C26	Computer, electronic and optical equipment	26	
18	C27	Electrical equipment	27	
19	C28	Machinery and equipment, nec	28	
20	C29	Motor vehicles, trailers and semi-trailers	29	
21	C30	Other transport equipment	30	
22	C31T33	Manufacturing nec; repair and installation of machinery and equipment	31, 32, 33	
23	D	Electricity, gas, steam and air conditioning supply	35	D
24	E	Water supply; sewerage, waste management and remediation activities	36, 37, 38, 39	E
25	F	Construction	41, 42, 43	F
26	G	Wholesale and retail trade; repair of motor vehicles	45, 46, 47	G
27	H49	Land transport and transport via pipelines	49	H
28	H50	Water transport	50	
29	H51	Air transport	51	
30	H52	Warehousing and support activities for transportation	52	
31	H53	Postal and courier activities	53	
32	I	Accommodation and food service activities	55, 56	I
33	J58T60	Publishing, audiovisual and broadcasting activities	58, 59, 60	J
34	J61	Telecommunications	61	
35	J62_63	IT and other information services	62, 63	
36	K	Financial and insurance activities	64, 65, 66	K
37	L	Real estate activities	68	L
38	M	Professional, scientific and technical activities	69 to 75	M
39	N	Administrative and support services	77 to 82	N
40	O	Public administration and defence; compulsory social security	84	O
41	P	Education	85	P
42	Q	Human health and social work activities	86, 87, 88	Q
43	R	Arts, entertainment and recreation	90, 91, 92, 93	R
44	S	Other service activities	94, 95, 96	S
45	T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	97, 98	T