Microfoundation of Inter-Country Input-Output Tables through Firm-Level Data: enhancing Global Value Chain participation and positioning indicators

Luca Salvatici
(Università Roma Tre– Centro Rossi-Doria)

Based on a work with
Fusacchia I., Giunta A., Mantuano M., Marvasi E., Nenci S., Sallusti F., Agbekponou

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It feels like yesterday…

SEMINARIO DE INVESTIGACION

MIERCOLES 24 DE JULIO 2019 (Aula 412)

Luca Salvatici

Global Value Chain Analysis: forgotten costs and counterfactual gains of the international trading system

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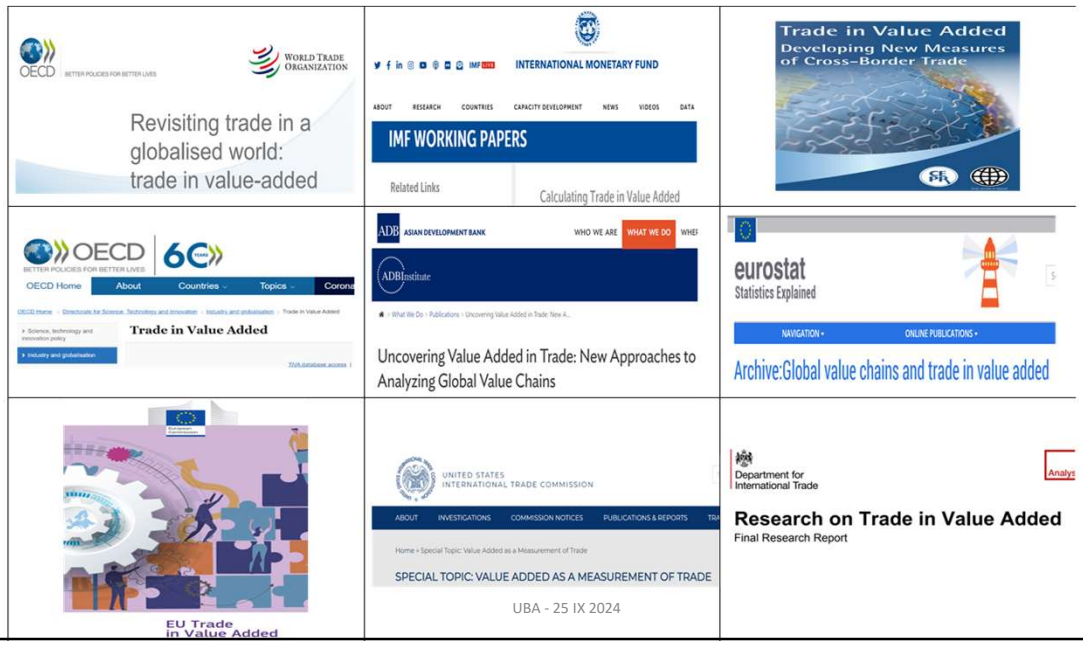
A (still) relevant analytical paradigm



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About our research activity in BATMODEL

GOAL

→ To enhance the **quality** of data used for the computation of Trade in Value Added (TVA) and Global Value Chains (GVCs) indicators.

→ To capture the **heterogeneity** in sourcing patterns of intermediate imports across different sectors

HOW

◊ We provide and apply a **micro-foundation** in the construction of a global Inter-Country Input-Output (ICIO) accounting framework, commonly used in macro analysis of GVC.

◊ We use Italian **firm-level data** to directly inform and refine the attribution of bilateral sector-to-sector trade by agent within the **GTAP** Data Base.

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About our research activity in BATMODEL

WHAT WE GET

- An integrated database to get better estimates and compute improved **GVC-related indicators**
- WP Dipartimento Economia Roma Tre
- Revise and resubmit at *Economic Systems Research*

Ongoing work

- Extends this **methodological improvement** to **French data** and provides **a comparison of GVC indicators** computed for Italy and France

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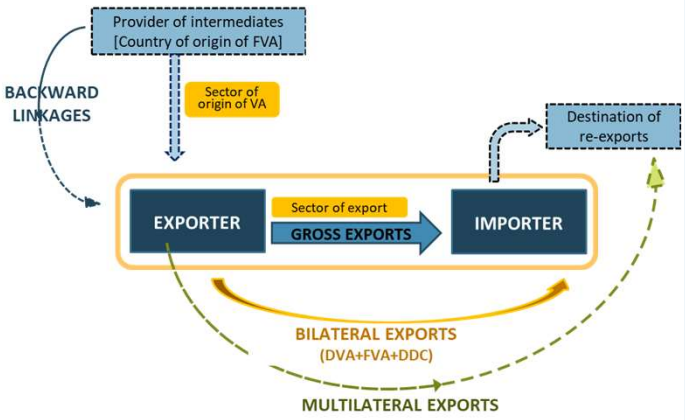
Value-added decomposition (very useful!)



Four main concepts of trade in value added (TVA):

1. **Domestic VA (DVA)**: value originated in all sectors of the exporting country which is embedded in a domestic sector's exports (Direct vs. Indirect exports).
   - A measure of the real contribution a given export makes to an economy's income.
2. **Foreign VA (FVA)**: value of imported intermediate inputs embodied in a country's exports
   - import content of exports, or backward linkages in GVCs.
3. **Multilateral DVA (DVAM)**: DVA contained in intermediate goods and services that is exported to a partner country which then re-exports it to the final market, embodied in other goods or services.
   - DVAM provides a measure of the forward linkages a country has in selling in GVCs.
4. **Double counting (DDC)**

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Motivation

- The quality of indicators measuring GVC integration finally depends on the quality of the underlying global ICIO which, in turn, depends on the quality and availability of national statistics and the balancing and estimation techniques used in the harmonization procedure.
- In an ideal world, GVCs would be measured directly on the universe of firm-to-firm trade flows, however, there remain significant hurdles to linking micro datasets across countries (e.g., accessibility of data, confidentiality of firm, etc.)
- Still, improvements are feasible in individual countries and can be extended simultaneously to more countries.

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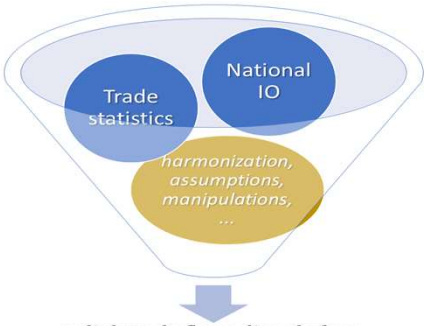
The ICIO tables

- Much of the work on developing measures of trade in VA has focused on the use of **global inter-country, input-output** (ICIO) tables
- The ICIO table is a map of world economies, compactly depicting all the flows of goods and services for a given year using recorded transaction values between countries and industries.



to link trade flows directly from producers in each region to importing firms and consumers in all other regions.

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Data: main global ICIO tables

	Geographical coverage	*Sector breakdown*	*Time span*	*Methodological reference*
GTAP (and GTAP-MRIO Database) [Ver. 11] https://www.gtap.agecon.purdue.edu/databases/v11/	158 regions	65 sectors	2004, 2007, 2011, 2014 2017	Aguiar, A., Chepeliev, M., Corong, E., & van der Mensbrugghe, D. (2023). The Global Trade Analysis Project (GTAP) Data Base: Version 11. Journal of Global Economic Analysis, 7(2). https://doi.org/10.21642/JGEA.070201AF (Original work published December 19, 2022) Carrico et al. (2020) "The GTAP version 10A Multi-Region Input Output (MRIO) Data Base", Research Memorandum, 34.
World Input-Output Database (WIOD) [Rel. 2016] http://www.wiod.org/home	43 countries + RoW	56 sectors	2000 - 2014	Timmer et al. (2015) "An Illustrated User Guide to the World Input–Output Database: the Case of Global Automotive Production", *Review of International Economics*, 23: 575–605. Timmer et al. (2016), "An Anatomy of the Global Trade Slowdown based on the WIOD 2016 Release", GGDC research memorandum number 162, University of Groningen.
OECD Input-Output Tables and **OECD/WTO TiVA Database** [Ed. 2021] https://www.oecd.org/tiva.htm	66 countries	45 sectors	1995-2018	OECD-WTO (2012) "Trade in Value Added: Concepts, Methodologies and Challenges", Joint OECD-WTO concept note.
Eora MRIO Database [Eora26] https://worldmrio.com/	190 countries	26 sectors	1990-2015	Lenzen et al. (2012) "Mapping the structure of the world economy", *Environmental Science & Technology*, 46(15): 8374–8381. Lenzen et al. (2013) "Building Eora: A Global Multi-Regional Input-Output Database at High Country and Sector Resolution", *Economic Systems Research*, 25(1): 20-49.

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OECD Input-Output Tables and **OECD/WTO TiVA Database** [Ed. 2021] https://www.oecd.org/tiva.htm	66 countries	45 sectors	1995-2018
Eora MRIO Database [Eora26] https://worldmrio.com/	190 countries	26 sectors	1990-2015

WHY ARE THEY DIFFERENT?

- ✓Different sectoral classifications.
- ✓Different regional aggregations: National IOTs/SUTs vary widely in their level of detail and scope
- ✓Different construction methodologies adopted (e.g., re-exports).
- ✓Harmonization procedures vary (e.g., GTAP is benchmarked mainly against trade statistics, while TiVA and WIOD prioritize supply-use data).

Value added: GTAP<TiVA

Intermediate total trade: GTAP>>TiVA

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Global ICIO tables construction: challenges

- The construction of ICIO tables is **complex** and requires the application of **specific compilation methods** and **assumptions** to reconcile data from different sources and cope with **data availability** or **reliability issues**.
- Significant variations in the figures depicted by different databases.
- Two possible ways out:
  1) More efforts in the direction of a **commonly agreed methodology** to meet the statistical challenges in measuring the GVC-related trade.
  2) To provide a **micro-foundation** in the construction of global ICIOs (e.g., by using firm level data to directly inform the firm-to-firm trade)

To solve the estimation bias: data are observed

To overcome the assumptions needed for an ICIO (e.g. proportionality; firm homogeneity)

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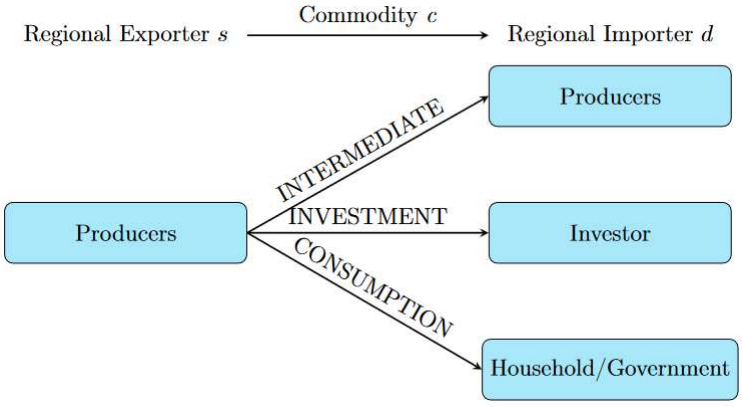
Trade and Tariff Flows by End-users (proportionality assumption)



Source: Carrico, C., E. Corong, D. van der Mensbrugghe (2020). The GTAP version 10A Multi-Region Input Output Data Base. GTAP Research Memorandum 34, Center for Global Trade Analysis, Purdue University.

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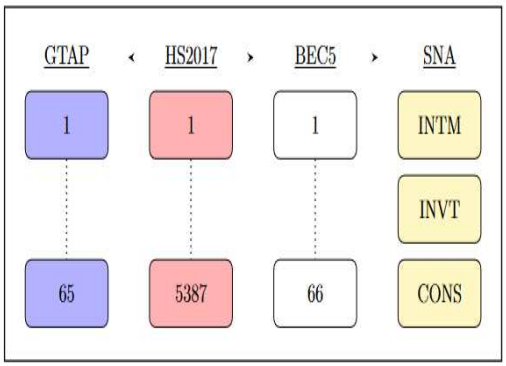
GTAP-MRIO Database (BEC classification)

- **Extends the standard GTAP Data Base**
  - Bilateral trade and tariff flows by end-users: firms, private household, government and investors
- **HS to BEC to SNA**
  - United Nations Statistics Division (UNSD) 6-digit HS to Broad Economic Categories concordances (BEC5) to System of National Accounts (SNA) end-use framework
- **Disaggregate Trade and tariff flows**
  - Disaggregate trade and tariff flows information from MAcMap by source and end-user using HS to BEC to SNA concordances



Source: E. Corong, D. van der Mensbrugghe (forthcoming). The GTAP version 11 Multi-Region Input Output Data Base. Center for Global Trade Analysis, Purdue University.

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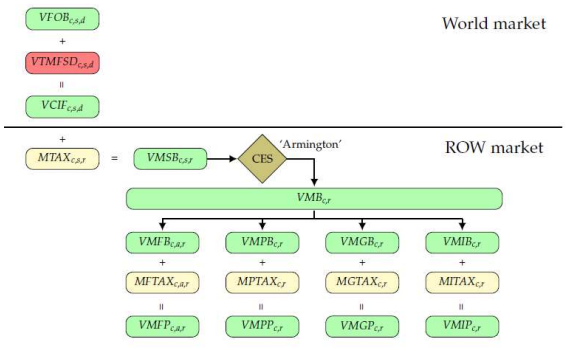
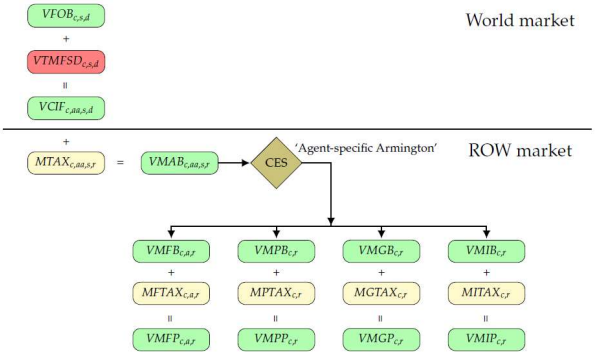
Standard GTAP vs. GTAP-MRIO Model

Standard GTAP



GTAP-MRIO



Where: a - activities or industries; c - commodities; s - source region; d – destination region; aa – agents; F - Firms; P - Private household; G – government; I – Investment

Sources: Corong, E. (2020). "The GTAP-MRIO Model". Center for Global Trade Analysis, Purdue University.
Corong, E., T.W. Hertel, R. McDougall, M. Tsigas and D. van der Mensbrugghe (2017). "The Standard GTAP Model, Version 7". Journal of Global Economic Analysis 2:1

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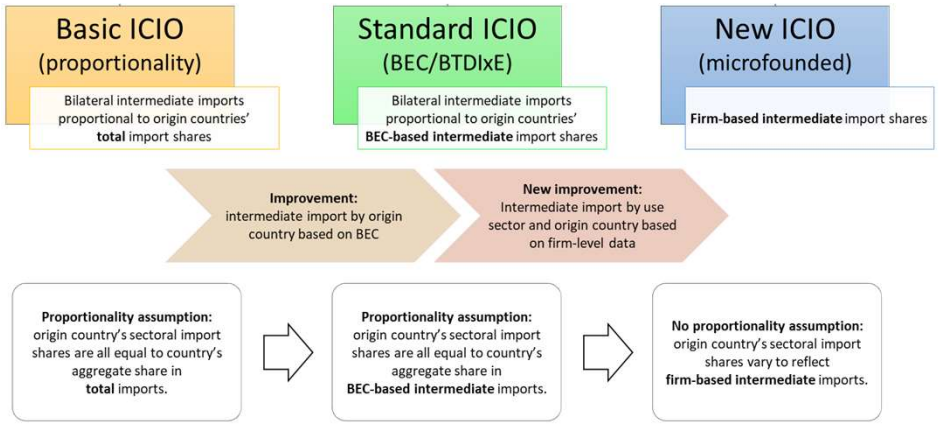
Main approaches for allocating bilateral sector-to-sector trade



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Does it make the difference?

Italy's imports of Computer, electronic and optical products (USD million, 2014)

Total imports	Final use	Intermediate use
30,444	12,639	17,806

1st layer

	Total imtermediates		
Top 4 exporters:	Bilateral trade/proportionality	BEC attribution	Micro-based attribution
China	22%	29%	14%
Germany	18%	21%	17%
France	7%	7%	10%
Netherlands	6%	5%	9%

2nd layer

Using sectors:	*Machinery and equipment*		*Business services*		*Manufactures nec*	
Top 4 exporters:	BEC attribution	Micro-based attribution	BEC attribution	Micro-based attribution	BEC attribution	Micro-based attribution
China	29%	15%	29%	13%	29%	7%
Germany	21%	25%	21%	13%	21%	15%
France	7%	7%	7%	10%	7%	15%
Netherlands	5%	4%	5%	10%	5%	12%

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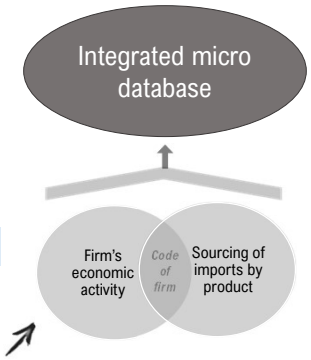
Work on data: main steps

I STEP



Structural Business Statistics (Frame SBS)
Statistical register on economic accounts of Italian enterprises, covering ~ 4,3 million firms.
Firms are categorized using the Ateco 2007 classification of economic activities (i.e., the Italian version of the European nomenclature, Nace Rev. 2).

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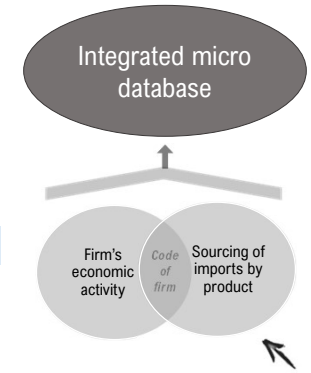
Work on data: main steps

I STEP



Foreign Trade Survey (COE)
Italian National Institute for Statistics (ISTAT)'s external trade register.
Firm-level data on exports and imports (including type of goods at CN8, country of origin or destination of the goods) for about 190,000 Italian firms.

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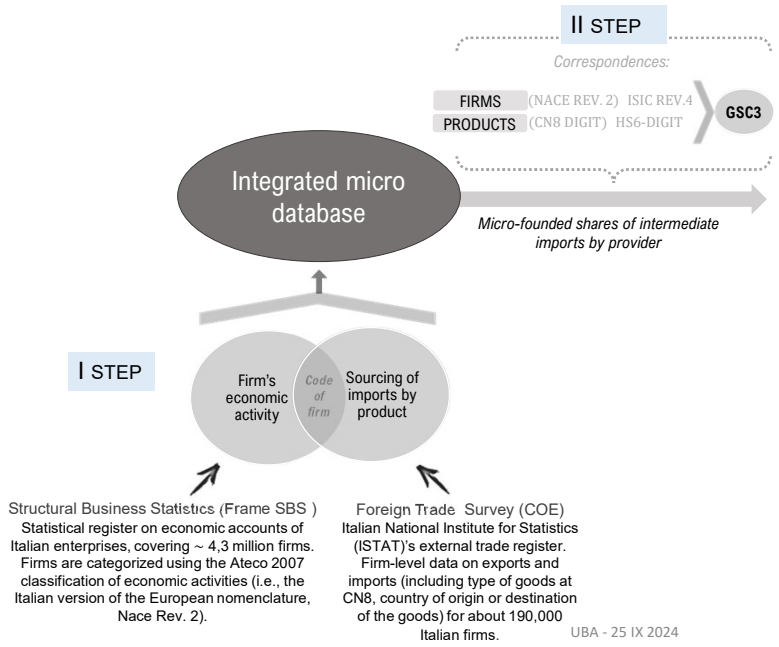
Work on data: main steps



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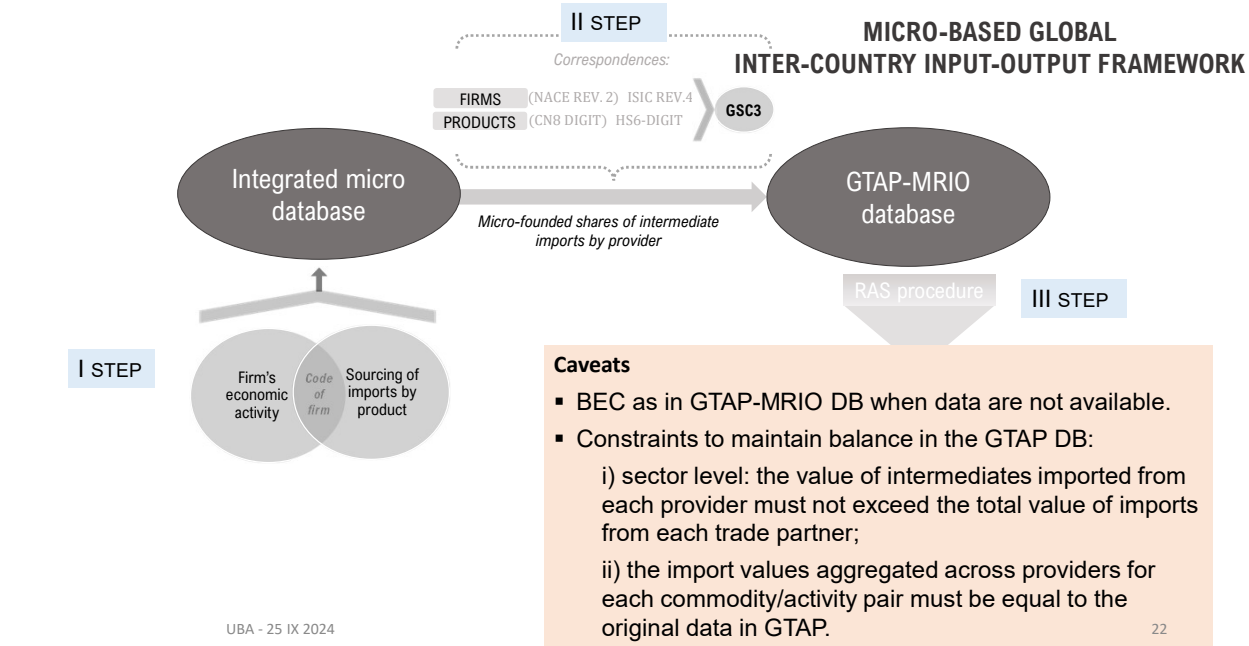
Work on data: main steps



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Sectoral coverage of Italian micro data

	pdr	wht	gro	v_f	osd	c_b	pfb	ocr	ctl	oap	rmk	wol	frs	fsh	cmt	omt	vol	mil	pcr	sgr	ofd	b_t
Sector of imports	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x
Sectors of firms										x				x		x	x	x		x	x	x

	coa	oil	gas	oxt	tex	wap	lea	lum	ppp	p_c	chm	bph	rpp	nmm	i_s	nfm	fmp	ele	eeq	ome	mvh	otn	omf
Sector of imports	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sectors of firms	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

	ely	gdt	wtr	cns	trd	afs	otp	wtp	atp	whs	cmn	ofi	ins	rsa	obs	ros	osg	edu	hht	dwe
Sector of imports		x																		
Sectors of firms	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	

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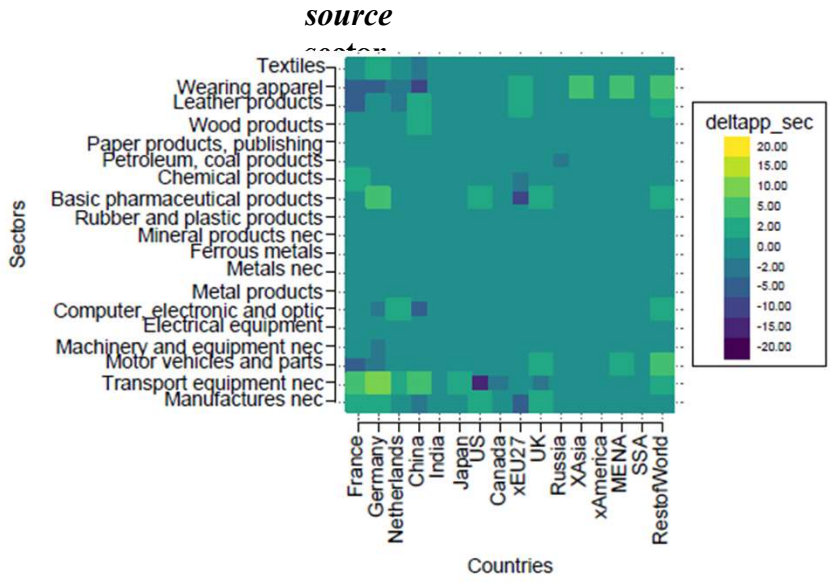
Heatmap of country import share reallocations for Italian manufacturing



- *Source* sector: out of 304 possible country-sector pixels, 49 display import share differences above 1 p.p. (about 16% of cases) and four are above 5 p.p. (in absolute value).

Note: Pixels are colored according to the percentage point difference between country shares in GTAP-Micro and GTAP-MRIO by sector. Country share differences sum to zero for each sector.

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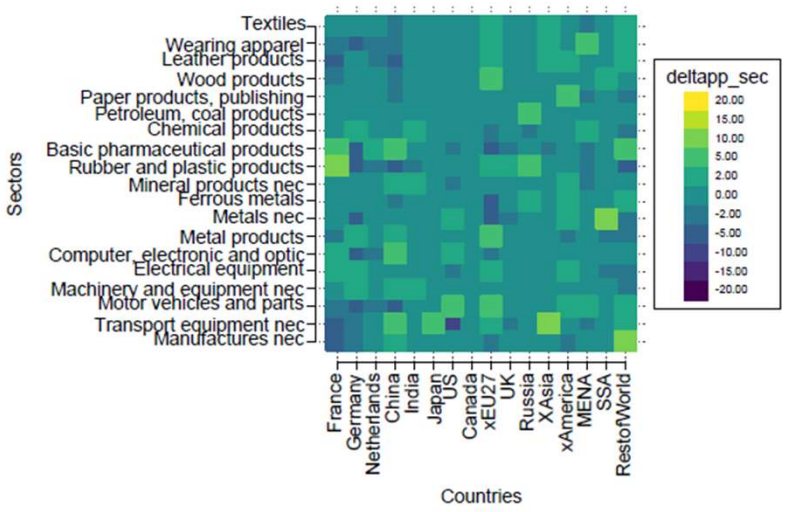
Heatmap of country import share reallocations for Italian manufacturing

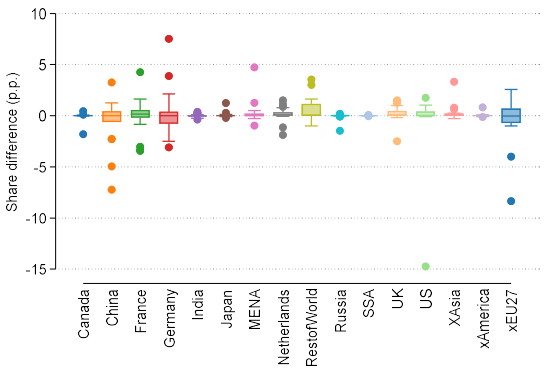
***use* sector**



- *Use* sector: the micro-foundation introduces more heterogeneity, with the number of import share differences above 1 p.p. being 121 (about 40% of all pixels) and eleven above 5 p.p. (in absolute value).
- Relevant changes are concentrated on few countries (e.g., China and the US) and sectors.

Country share reallocations

manufacturing *source* sectors

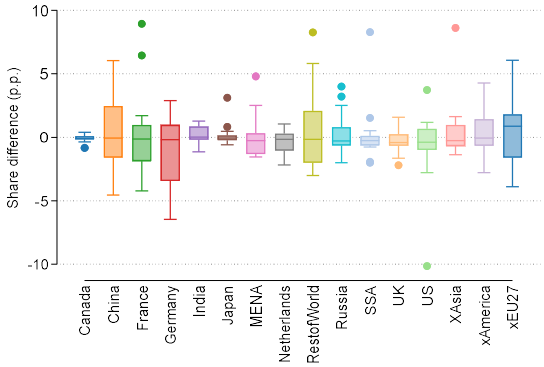


Note: source sector countries are those that provide the manufacturing inputs to the Italian firms operating in all sectors, manufacturing or not (source sectors identify the imported goods).

Germany gains up to about 7.5 p.p., and the US loses almost 15 p.p.

Note: use sector countries are those that provide manufacturing or non-manufacturing good inputs to Italian manufacturing firms (use sectors identify the Italian firms).

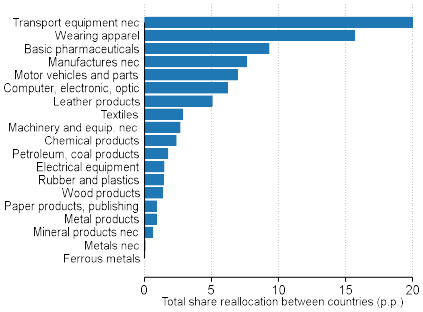
manufacturing *use* sectors



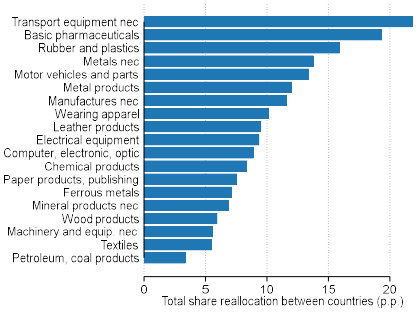
Discrepancies up to 8-9 p.p. for France, Sub-Saharan Africa, the rest of Asia, and the rest of the world – while the US loses up to 10 p.p.

Total import share reallocations for Italian manufacturing

***source* sector**



***use* sector**



Note: the bars indicate the total import shares reallocated between countries by sector between GTAP-Micro and GTAP-MRIO, calculated as the sum of positive share differences (or equivalently sum of negative share differences in absolute value).

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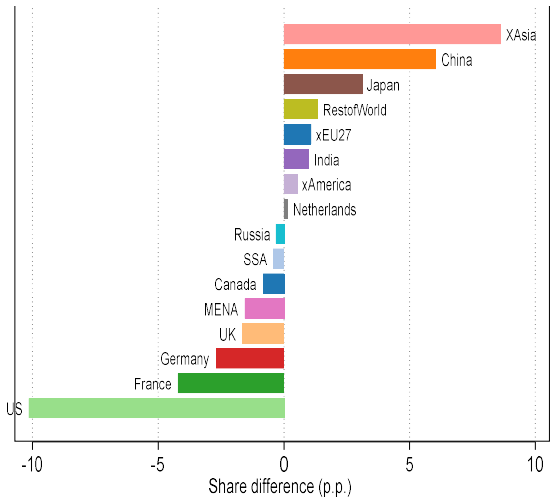
Country import share reallocations in "Transport equipment" (*use* sector)



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Data used

For **Italy**:

- The same data already illustrated above

For **France**:

- Firm-level data from the French Institute of Statistics and Fiscal Services (FARE), provided by INSEE and DG-FIP:
  - **Accounting data** for French firms and information on total sales, employment, added value and the five-digit NACE sector code. Each firm is identified by a unique SIREN number.
  - French **customs data**, supplied by the customs services, with information on the final destination country for exports from each French firm and the origin country for imports. Products are detailed at the 8-digit level.
- The resulting dataset for each country is then integrated into the IO framework alongside trade data from the **Global Trade Analysis Project** (GTAP) database (Aguiar et al. 2019) in its **MRIO version** (Carrico et al. 2020).
- The dataset encompasses the year 2014, the latest available for the GTAP-MRIO database.

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Descriptive analysis

The VA composition of Italian and French exports, by sector ($ million at FOB prices and shares), 2014

- Approximately 70% of France and Italy's gross exports are **domestic value-added**
- Italy's key export sectors (***services, machinery, motor vehicles***) incorporate around 30% **foreign value-added**.
- France's major export sectors (***services, transport equipment, chemicals***) - except for services- show **higher foreign input** reliance (50% and 36,5%)
- **Domestic value-added** is notably high in the **agri-food sector** for both countries (around 79%).

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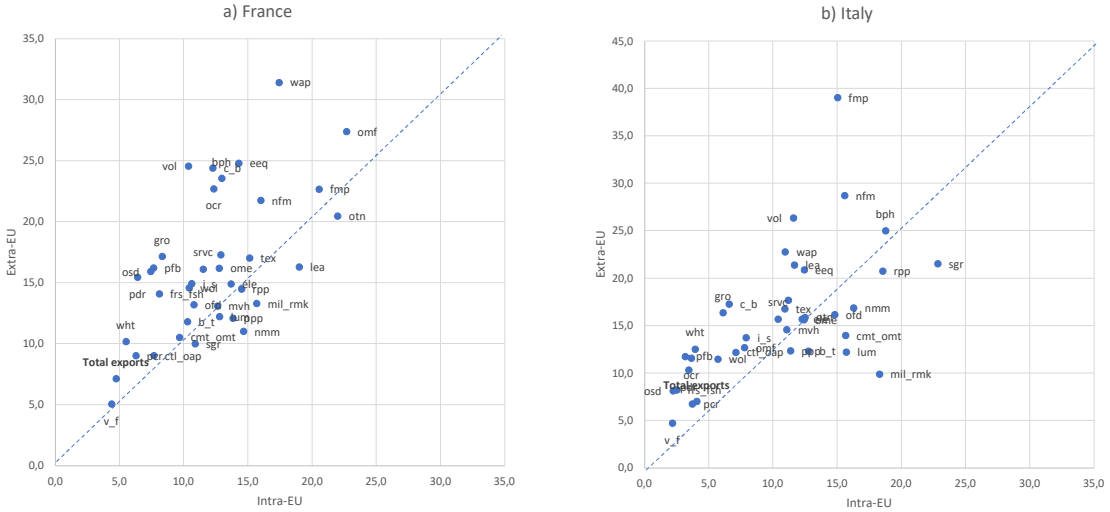
Results: GVC *backward* participation

Figure 1. Intra and extra-regional GVC *backward* participation of France and Italy at the sectoral level in 2014

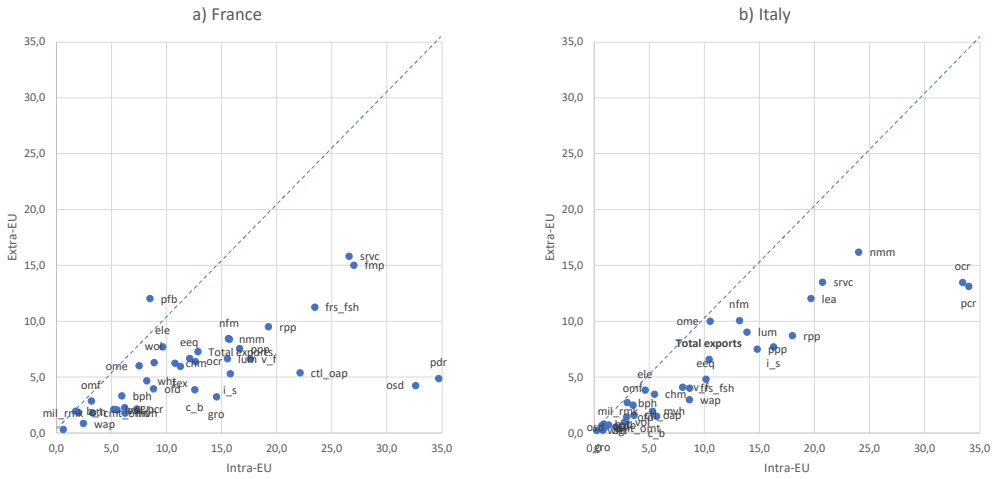


Although significant heterogeneity at the sector level, both France and Italy **rely** more on **non-EU sources for intermediate** imports (extra-EU backward participation)

Note: The GVC backward participation index measures the regional import content of exports from an EU member and non-regional providers.

Results: GVC *forward* participation

Figure 2. Intra and extra-regional sectoral GVC *forward* participation of France and Italy in 2014

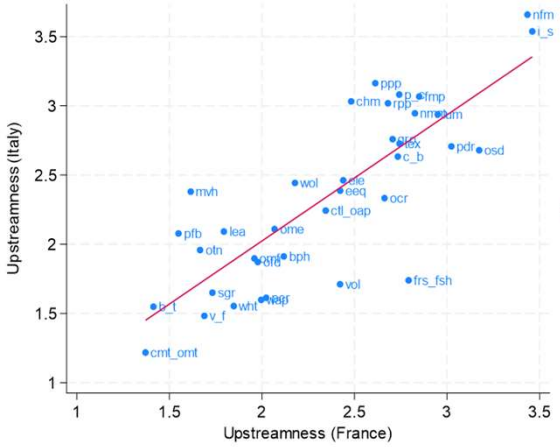


But **EU regional partners** play a **prominent role** in vehiculating French and Italian domestic value added to other destinations

Note: the GVC forward participation index is the country's value-added exports re-exported by regional partners (intra-EU) or non-regional partners (extra-EU).

Results: GVC *positioning*

Correlation of industry *upstreamness* between Italy and France



- Italy seems relatively *more upstream* in *processing raw materials (*basic metals, rubber, and petroleum products) and in *manufacturing* (motor vehicles and parts, paper products, chemical products, and leather products)
- France is relatively more upstream in most *agricultural and food industries* (forestry and fishing, raw milk, vegetable oils and fats, oil seeds, processed rice, crops, paddy rice and wheat)

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Conclusions

This work's contributions are threefold:

1. We contribute to the applied ICIO and GVC literature by proposing a new way to micro-found the available databases by integrating firm-level information on international IO linkages to refine proportionality weights in constructing global ICIO tables.
2. Our framework allows us to add details and refine the information even for a single country while preserving the global ICIO internal consistency:
   - Easily applicable to other ICIO tables and countries
   - Readily applicable to calculate value-added based GVC indicators and for model simulations
3. Practical implications for future research: our approach is adaptable and reproducible by other researchers having access to suitable microdata from different countries, thus stimulating further analyses and international collaborations.

❖Potentiality of such integrated datasets: to assess competitiveness, product quality, vulnerability to macroeconomic shocks, diversification, + satellite data to assess environmental issues (climate change, embedded emissions, water content,...)

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Muchas Gracias!

luca.salvatici@uniroma3.it

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