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Microfoundation of ICIO Tables through Firm-Level Data: Enhancing GVC Participation and Positioning Indicators

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Abstract This paper provides a methodological contribution to reconciling and integrating the Inter-Country Input-Output accounting framework, commonly used for country-industry Global Value Chain (GVC) analysis, with firm-level data. The goal is to establish robust micro-founded indicators of GVC participation and positioning. Firm-level data on production, and exported and imported (narrowly defined) products are used to more precisely measure bilateral trade flows by intermediate or final use within the Global Trade Analysis Project (GTAP). This integration enhances the accuracy of estimating the sourcing and allocation of imported inputs across sectors, thereby improving the quality of data for calculating trade in value-added indicators. The resulting integrated database is used to compute improved GVC-related indicators, providing insights into the participation and positioning of Italian firms.

Keywords: Global Value Chains; Inter-Country Input-Output tables; Firm-level data; GTAP.
JEL Codes: C670, C810, E010

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1. Introduction

With the growth and spread of international linkages, production processes have become fragmented and dispersed among various locations in different countries. More than 50% of trade in goods occurs with intermediate products. This implies that traditional trade statistics based on gross flows do not provide reliable information on the production patterns behind world trade and the formation of value-added. Due to production fragmentation, a country's gross exports do not coincide with domestically generated value-added. This discrepancy arises because, through imported inputs and intermediate goods, exports also incorporate foreign value-added. Similarly, imports may contain a domestic content stemming from intermediate goods exported by domestic firms, which are then processed abroad, and further directly or indirectly imported back. As a result, gross trade flows, which do not reflect the actual production structure underlying international trade, do not allow the retrieval of accurate measures of backward/forward linkages.

Accordingly, there is widespread recognition that fragmentation of global production requires measurement of trade in Value Added (VA), which accounts for how slices of value embedded in goods or services are added at each step of increasingly international manufacturing processes within Global Value Chains (GVCs). The current standard for GVC analysis at the macro level relies on the global Inter-Country Input-Output (ICIO) accounting. An ICIO table harmonizes national Input-Output (IO) tables for multiple regions and links trade flows directly from producers in each region to importing firms and consumers in all other regions. Since the early 2000s, various research initiatives have developed different ICIO databases in response to policy needs and scientific aims (e.g., TiVA, WIOD, EORA, GTAP, and GTAP-MRIO).

Although the use of statistics based on an ICIO accounting has become more routine for analyzing key areas of global governance (e.g., international trade and governance, the link between the environment and the economy; the impact of globalization on labor markets, Tukker and Dietzenbacher, 2013), there is no harmonization among different global databases (Jones et al., 2014). The construction of a global ICIO requires a huge amount of data, often suffering from time lag, and above all, it requires a high level of harmonization, consolidation and adaptation of different data sources. Specific analytical purposes guiding the development of global ICIOs, data sources, the country coverage, the period of the data available, the level of detail for industries and products and the methodological choices in the compilation process, are the reasons that have led to the development of different ICIO systems, constructed by various approaches.

The literature outlines large differences in the figures depicted by different databases, both at the country and sector levels (see, for example, Jones et al., 2014; Fusacchia et al., 2022; Kutlina-Dimitrova et al., 2022). This suggests that more efforts would be required in the direction of a commonly agreed methodology to meet the statistical challenges in measuring the GVC-related trade. In this vein, efforts to provide a micro-foundation in the construction of global ICIO (e.g., by using firm-level data to directly inform and refine the construction of the proportionality weights) would likely benefit researchers in this field. Although these improvements are unlikely to be feasible at the world level as there remain significant obstacles to linking micro-data across countries, they are feasible for individual countries (Antràs and Chor, 2021).

Importantly, the use of microdata allows advancements with respect to one of the main assumptions in the conventional ICIO system, namely that imported inputs are usually allocated across sectors in the same proportion as domestic goods, and the proportionality assumption is naturally applied to total imports, so inputs from all bilateral trade partners are treated in the same way (the so-called, "import comparability", Johnson, 2017). Indeed, empirical evidence shows that internationalization activities

and GVC participation patterns are strongly related to specific firm characteristics, which are, in turn, sources of technological differences in production processes.

In this context, this work makes a significant methodological contribution to enhancing ICIO data based on the Global Trade Analysis Project (GTAP) Data Base (Aguiar et al., 2019). We achieve this by disaggregating IO tables specifically for Italy, thus tracking GVC linkages at higher resolution. To accomplish this, we combine export, import, and production firm-level databases to improve estimates of the sourcing and allocation of imported inputs across sectors thus enhancing the quality of data used for the estimation of trade in VA indicators. The resulting integrated database is used to compute improved GVC-related indicators. Our focus is on Italy, where we present an overview of its GVC involvement using these refined indicators mostly looking at the agricultural and food sectors, exploiting the relatively high resolution of the GTAP Data Base. It is worth noting, however, that the developed framework can be applied to other countries with available microdata. We believe this aspect adds significant value to our work and proves highly beneficial for other scholars in the field.

This contribution is articulated as follows. The next section describes the data sources and the data construction process. Then a characterization of the Italian positioning and participation within global production networks is provided. Finally, are discussed the differences between sourcing patterns based on standard and micro-founded ICIO.

2. Micro-based ICIO framework for the GTAP Data Base: sources and data construction

To construct a micro-founded ICIO for Italy, we integrate different datasets. First, firm-level data from Frame SBS (Structural Business Statistics, data transmitted annually to Eurostat by the EU Member States on the basis of a legal obligation), which is the statistical register on economic accounts of Italian enterprises in the Industry and Services sectors[1], developed by the Italian National Institute of Statistics (ISTAT). It provides annual estimates of the main variables of the economic accounts based on massive use of microdata coming from integrated administrative sources, complemented by sampling survey on enterprises, namely the survey on enterprise accounting system (SCI, total survey on legal units with 250 and more employees) and the survey on the small and medium enterprise including professional and artistic activities (SME, sample survey on legal units with less than 250 employees)[2]. We gathered data, for the period 2013-2018, for around 4,3 million of firms[3] on selected variables, namely: the value of production, cost of labour, turnover, purchases of goods and services, value/quantity of exports and value/quantity of imports. Firms are categorized using the Ateco 2007 classification of economic activities, the Italian version - comparable up to a 4-digit level - of the European nomenclature, Nace Rev. 2.

Second, we use statistics from the survey on foreign trade (COE)[4]. ISTAT's external trade register COE provides data on Italy's international trade in goods of both intra- and extra-EU trade flows (Dispatch/arrival of goods with EU Countries -Intrastat System- and Special trade extra EU import-export, respectively) for about 215,000 Italian firms and foreign trade operators. The dataset includes information concerning the type of goods, the statistical partner country of origin or destination of the goods, for the period of interest 2013-2018. Trade of goods is classified by country of origin for imports and country of destination for exports (defined according to the geo-nomenclature). Traded goods are classified on the basis of the Combined Nomenclature (CN) at 8-digit, and economic activities are

[1] Except Financial services.
[2] The threshold of 250 persons employed is used since 2017; it was of 100 persons employed until 2016.
[3] Until 2016 the Frame-SBS database was made up of enterprises active for at least 6 months during the years. This time threshold is no longer valid as of 2017.
[4] International Trade in Goods Statistics (ITGS) is the Eurostat-level equivalent.

categorized using the Ateco 2007. The two datasets are combined through the common reference to the Statistical Register of Italian Active Enterprises (acronym ASIA). The resulting dataset for 2014 – our reference year – consists of more than 32 million external trade transactions made by about 190,000 firms and relating to about 9,000 different CN8 products. The integrated dataset provides a comprehensive framework describing the cost and the selling structure of firms. In this development, we focus on the production side and, particularly, on the sourcing of intermediate inputs from abroad for which granular data are used to improve the attribution of bilateral trade at the agent level within the GTAP Data Base.

A three-step processing procedure is followed. First, the integrated dataset is collapsed to the GTAP sector level using several concordances. Specifically, we group firms according to their prevalent activities and apply different correspondences to map from the Ateco/Nace to the International Standard Industrial Classification (ISIC Rev.4) and then to the GTAP sectors/activities version 3 (GSC3). As for traded goods and services, we aggregate sectors from the 8-digit of the CN to the 6-digit of the Harmonized System (HS) to the GSC3.

The second step is to use the new dataset to compute micro-founded shares of production, cost structure, and imports of intermediate goods by provider consequently applied to the GTAP Data Base (version 10A). In Table A1 in the Appendix the sectoral coverage of Italian micro-data is reported. Activities/sectors for which microdata are not available are reallocated to providers according to the Broad Economic Categories (BEC) classification as in the already available MRIO version of the GTAP-database (Carrico et al., 2020).

Finally, a rebalancing procedure is applied to ensure consistency with the entire GTAP Data Base and maintain the original GTAP bilateral and agent-specific trade data. Specifically, a RAS procedure has been applied to adjust the micro-based matrix for intermediate flows based on two constraints:

i) at the sector level, the value of intermediate goods imported from each provider must not exceed the total value of imports from each trading partner;

ii) the import values aggregated across providers for each commodity/activity pair must equal the original data in GTAP.

These developments allow the production of the global ICIO framework underlying the macro-economic analysis of value chains, mapping the full set of upstream and downstream, backward and forward links in the global value chain based on firm-level data.

3. GVC indicators: the case of Italy

To get a comprehensive picture of a country's (or sector) involvement in GVCs based on the use of trade in VA statistics, a set of indicators has been recently developed by the empirical literature. The two most common GVC measures are the GVC participation index (see, among others, Hummels et al., 2001; Johnson and Noguera, 2012; Koopman et al., 2014; Borin et al., 2021) and the GVC positioning index (see Fally, 2012; Antràs et al., 2012; Antràs and Chor, 2013; Fally and Hillberry, 2015; Miller and Temurshoev, 2017; Wang et al., 2017; Alfaro et al., 2019).

The GVC participation index is given by the sum of a 'backward' component (the value of imported intermediate inputs in exports) and a 'forward' component (the value of intermediate exports sent indirectly through third countries to final destinations). By combining the two components, one can have a comprehensive assessment of a country's participation in GVCs, both as a user of foreign inputs and supplier of intermediates used in other countries' exports. The larger the indicator, the higher the intensity of involvement of a particular country (or sector) in GVCs.

To measure the positioning of a particular country (or sector) in GVCs, two indicators of GVC positioning are very popular in the literature: a measure of distance or upstreamness of a production sector from final demand (Fally, 2012; Antràs et al., 2012; and Antràs and Chor, 2019) and a measure of the distance or downstreamness of a given sector from the economy's primary factors of production (Fally, 2012).

The upstreamness index measures how many stages of production are left before the goods or services produced by an industry reach final consumers. It takes as a point of reference the sources of final demand at the end of each production chain and computes the upstreamness of the country-industry relative to final use. Larger values are associated with relatively higher levels of upstreamness of the output originating from one sector.

The downstreamness index captures the distance of each country-industry from where production processes commence, namely from sources of value-added to primary factors. In other terms, it measures the distance of a given sector from the economy's primary factors of production (or sources of value-added). Larger values are associated with relatively higher levels of downstreamness of an industry.

To analyze the GVC involvement of the Italian industries in GVCs, we compute both the GVC participation and positioning indicators. Concerning the latter, both the upstreamness and the downstreamness measures provide similar characterization of where countries are positioned; in this work, we focus on the upstreamness measure, the most relevant measure in the case of agriculture (Antràs et al., 2012).

In presenting and characterizing the participation and positioning of Italian firms in global networks, we aggregate the micro-based GTAP database, keeping sectors at a high resolution while reflecting the main trade partners for Italy in the regional aggregation choice. Details on the aggregation are reported in Table A2 in the Appendix. The analysis is based on 2014, the last year available for the GTAP-MRIO Data Base.

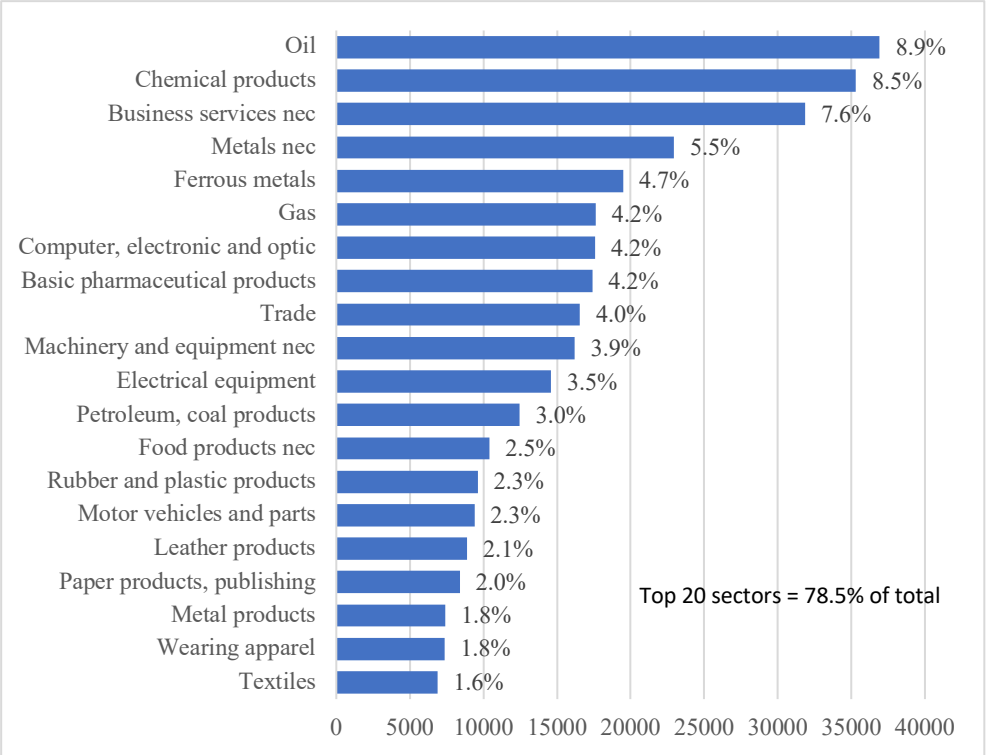
3.1 Participation in GVC: Backward and forward linkages

a) Backward participation

Thanks to the inclusion of micro-data into the GTAP database, we can improve the measurement of imports and, in particular, the division between intermediate and final and their sources. This, in turn, refines the calculation of GVC participation indicators, especially the backward component.

Italian intermediate imports amount to 417 billion dollars. These imported goods are used across several downstream industries for domestic production and exports, and clearly, some inputs are broadly used in the economy. Intermediate imports are quite concentrated across sectors, with the top 20 sectors accounting for 78.5% of the total. Oil, Chemical products and Business services are the top 3 sectors, all above 7.5%; Other Metals ("Metals nec") account for 5.5%; other sectors are all below 5% (Figure 1).

Figure 1. Italian intermediate imports (million USD and percent of total intermediate imports; top 20 sectors).

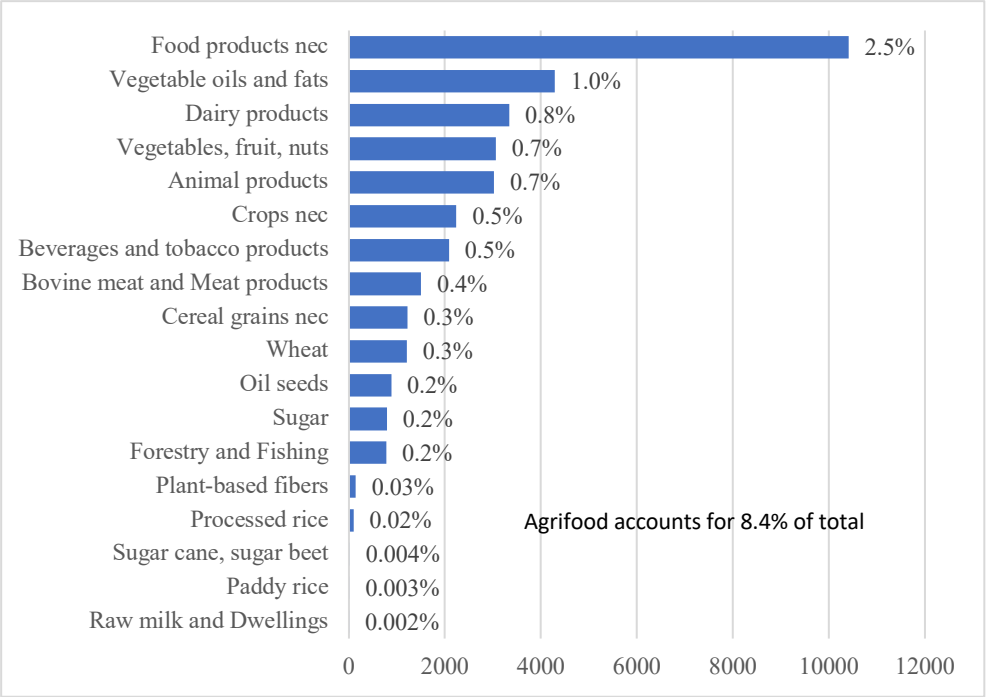


Source: Authors' computations based on the micro-founded GTAP Data Base.

Agrifood intermediate imports are relatively small: on aggregate, they account for 8.4% of total intermediate imports. Figure 2 reports the agrifood sectors ranked by intermediate imports. With a share of 2.5%, the largest agrifood intermediate import sector is Other Food Products ("Food producs nec"), which accounts for almost 1/3 of agrifood intermediate imports and it is the only one appearing among the top 20 sectors.[5]

Figure 2. Italian intermediate import of agrifood products (million USD and percent of total intermediate imports).

[5] This figure also partly reflects the level of aggregation of the sectors of the available classifications, as some sectors tend to have a broader coverage, while others include a relatively narrower range of products.



Source: Authors' computations based on the micro-founded GTAP Data Base.

When looking at intermediate imports, we considered the type of goods imported. Imported intermediate goods are then used across several downstream industries. Through imports, foreign value-added (FVA) contributes to national production and exports. FVA is imported and incorporated into exports through direct sectoral intermediate imports and indirectly through other products and sectors.

Before considering how FVA contributes to sectoral exports (backward GVC participation), it is worth considering the main export sectors. The top Italian exporting sector is Machinery and equipment nec, with a share of 14.8% of total exports (about $87 billion); the aggregate Agrifood sector is the second one, accounting for 7.9% of total exports (about $46 billion of the total $585 billion). Focusing on agrifood products, the ones with the greatest weight in total agrifood exports are Food products nec (36.1%), Beverages and Tobacco products (21,0%), Vegetables, fruits, nuts (11.8%) (Table 1). These three sectors account for two-thirds of the entire agrifood exports.

Table 1. Italian exports by sector ($million at FOB prices and shares).

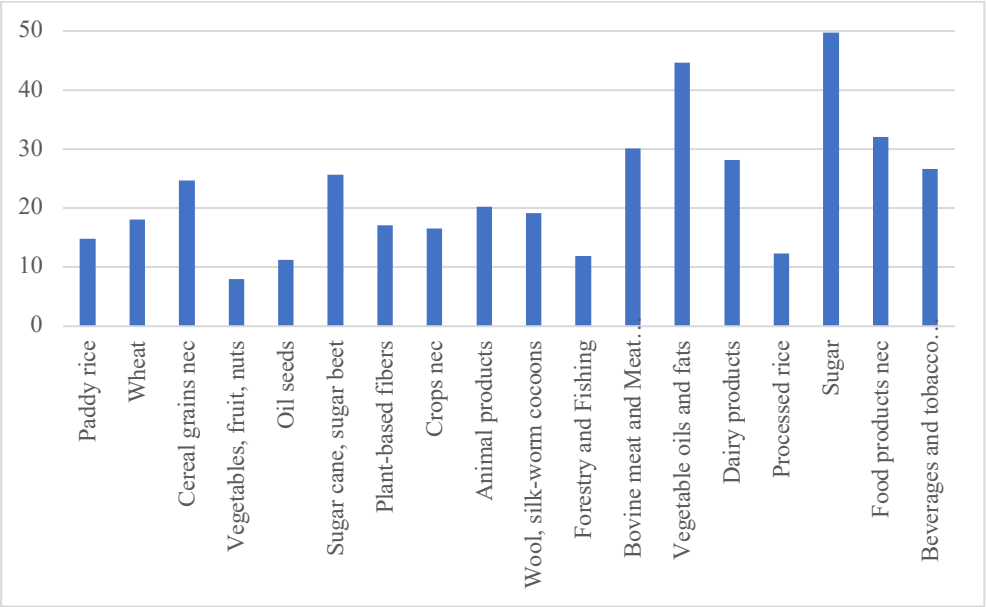
	Exports (mln USD)	Share (%)	Cum.share (%)
Machinery and equipment nec	86880	14.8	14.8
Agrifood	46085	7.9	22.7
of which			
Food products nec	*16649*	*36.1*	*36.1*
Beverages and tobacco products	*9662*	*21.0*	*57.1*
Vegetables, fruit, nuts	*5424*	*11.8*	*68.9*

Dairy products	*3586*	*7.8*	*76.6*
Bovine meat and Meat products	*3469*	*7.5*	*84.2*
Vegetable oils and fats	*2690*	*5.8*	*90.0*
Wool, silk-worm cocoons	*1216*	*2.6*	*92.6*
Crops nec	*1156*	*2.5*	*95.2*
Processed rice	*673*	*1.5*	*96.6*
Other agrifood products	*1560*	*3.4*	*100*
TOTAL Agrifood	*46085*	*100*	
Motor vehicles and parts	39981	6.8	29.6
Chemical products	33076	5.7	35.2
Electrical equipment	29111	5.0	40.2
Manufactures nec	27522	4.7	44.9
Leather products	26244	4.5	49.4
Basic pharmaceutical products	24641	4.2	53.6
Wearing apparel	23764	4.1	57.7
Other sectors	247774	42.3	100
TOTAL	585078	100	

Source: Authors' computations based on the micro-founded GTAP Data Base.

Figure 3 reports backward GVC participation of agrifood productions, calculated as the FVA share of sectoral exports for each sector. Sugar, Vegetables oils and fats, and Other Food products ("Food products nec") are the agrifood sectors with the highest backward participation, all above 30%. Italian exports of these sectors thus strongly depend on foreign value-added.

Figure 3. Backward participation of Italian agrifood sectors (FVA as percent of sectoral exports).



Source: Authors' computations based on the micro-founded GTAP Data Base.

b) Forward participation

Results regarding forward participation of Italian agrifood sectors are reported in Table 2. The indicator used reports the Italian domestic value-added originated within the agrifood sectors, which is exported and further incorporated into foreign exports expressed as a share of the sectoral Italian exports. Because the value originated within a given sector (the numerator) can be higher than the value in the sector's exports (the denominator), at the sector level, the forward participation index used can be higher than 100%. This is the case of paddy rice, which is, by far, the agrifood sector showing the highest forward GVC participation for Italy: sectoral VA exported and further incorporated into foreign exports accounts for 159.6% of sectoral Italian.

Table 2. Forward participation (% of sectoral exports)

Paddy rice	159,6
Wheat	14,5
Cereal grains nec	34,9
Vegetables, fruit, nuts	7,8
Oil seeds	50,0
Sugar cane, sugar beet	17,3
Plant-based fibers	13,8
Crops nec	24,7
Animal products	23,0
Wool, silk-worm cocoons	15,5
Forestry and Fishing	38,1
Bovine meat and Meat products	1,8
Vegetable oils and fats	1,2
Dairy products	4,0
Processed rice	3,6
Sugar	5,9
Food products nec	3,9
Beverages and tobacco products	2,3

Source: Authors' computations based on the micro-founded GTAP Data Base

The geographical composition of Italian forward participation highlights that, with 14% of Italian domestic value added (DVA) exported, Germany is the main destination and exporter of Italian value-added (the second one being France). In other words, Germany is an implicit export platform for Italian value-added. Table 3 shows that 57% of Italian agrifood value-added exported by Germany ends up within the EU (including 8% to Italy itself), while 8% goes to the UK, 7% to the US, 4% to China and 3% to Russia (the remaining 21% goes elsewhere).

Table 3. VA in Italian agrifood sectors forwarded through Germany

EU27	57%
of which reflected back to Italy	8%
UK	8%
US	7%
China	4%
Russia	3%

Source: Authors' computations based on the micro-founded GTAP Data Base

3.2 GVC positioning

To compute the upstreamness of specific industries and countries, a common approach is to consider the extent to which a country-industry pair sells intermediate inputs to other producing sectors worldwide. A sector that sells little to final consumers is more likely to be upstream in value chains.

Following this approach, we have computed a measure of the distance or upstreamness of a production sector from final demand, which was developed by Fally (2012), Antràs et al. (2012) and Antràs and Chor (2013). Specifically, we adhered to the methodological steps outlined in Mancini et al. (2023). Fally's model, as well as the variation proposed by Antràs and others (2012), captures the average number of production stages by pegging the endpoint of the sequence at final consumption, which enables us to measure the distance to the final demand of a sector along the production chains. More specifically, this measure aggregates information on the extent to which industry in a given country produces goods that are sold directly to final consumers or that are sold to other sectors that themselves sell disproportionately to final consumers. A relatively upstream sector is thus one that sells a small share of its output to final consumers and instead sells disproportionately to other sectors that themselves sell relatively little to final consumers (Antràs and Chor, 2019). Building on these ideas, final goods can be considered one step away from demand, inputs directly used to produce final goods are two steps away from demand, inputs used to produce inputs are three steps away from demand, and so on.[6] Furthermore, this count is weighted by the share of the value of output at each production stage in total output. The upstreamness indicator can assume values equal to or greater than 1: larger values are associated with relatively higher levels of upstreamness of the output originating from one sector.

Table 4 shows the values of the GVC positioning indicators computed for Italy at the sectoral/product level. As expected, agricultural products - such as cereal grains, rice, oil seed, and sugar cane/beet- are collocated upstream in the GVC, showing more than 2.5 steps from the final market. Conversely, food products, especially bovine meat and meat products, are less upstream, with less than 2 steps from the final consumption.

[6] A production step is defined as an exchange from supply to use sectors in input-output tables. The number of steps represents a measure of the number of stages in the production process. Steps are calculated from input-output tables through matrix algebra.

Table 4. GVC positioning values

	Upstreamness
Paddy rice	2,7
Wheat	1,6
Cereal grains nec	2,8
Vegetables, fruit, nuts	1,5
Oil seeds	2,7
Sugar cane, sugar beet	2,6
Plant-based fibers	2,1
Crops nec	2,3
Animal products	2,2
Wool, silk-worm cocoons	2,4
Forestry and Fishing	1,7
Bovine meat and Meat products	1,2
Vegetable oils and fats	1,7
Dairy products	1,6
Processed rice	1,6
Sugar	1,6
Food products nec	1,9
Beverages and tobacco products	1,5

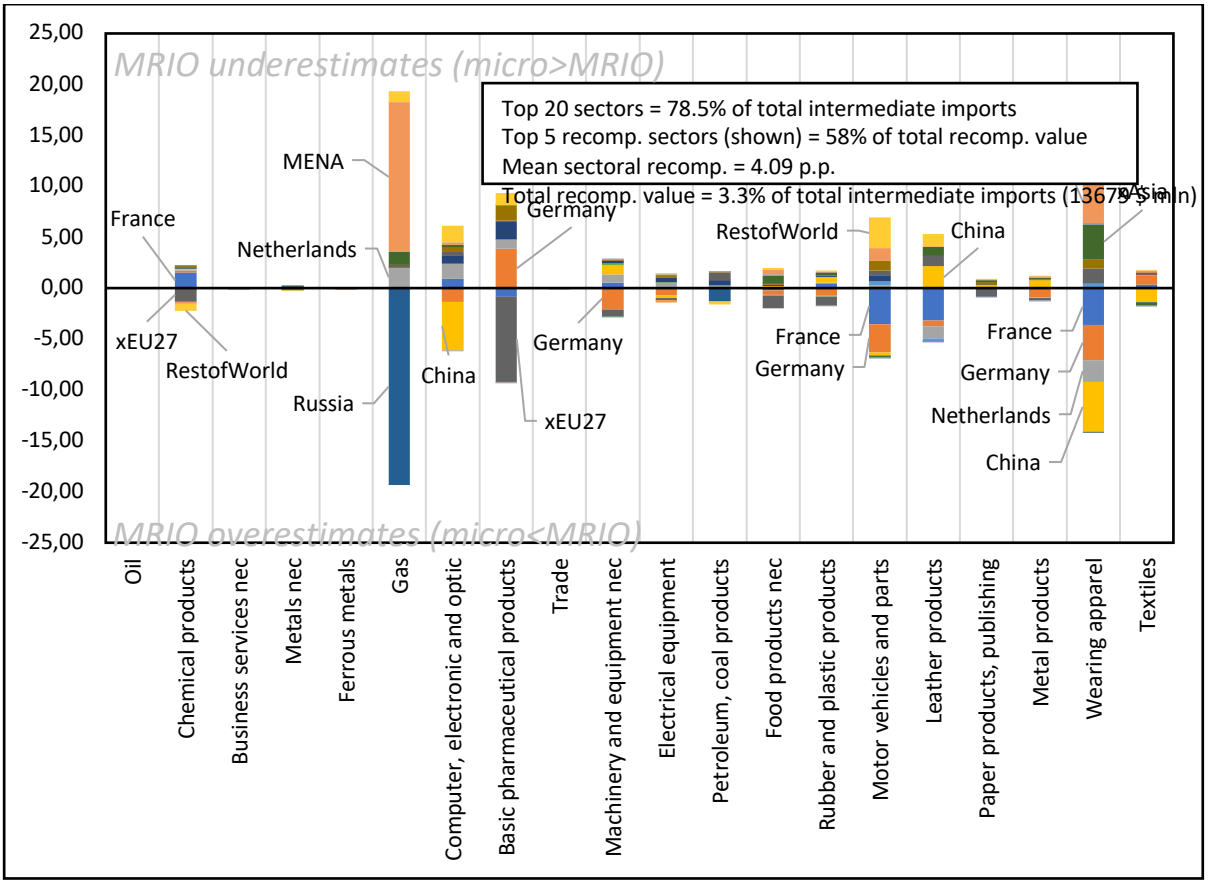
Source: Authors' computations based on the micro-founded GTAP Data Base

4. A comparison between GTAP-MRIO and GTAP-Micro

As the inclusion of micro-level data allows for a finer measurement of intermediate imports by sourcing country, it is informative to compare the standard GTAP-MRIO and the new GTAP-Micro. To this aim, we consider the geographical composition by sector and examine how the shares are reallocated into the new database. Given the intermediate imports of each sector, some sources may gain, and others may, instead, lose importance in new micro-level data relative to the standard GTAP-MRIO. In Figure 4, we report the differences in intermediate import sourcing between the standard GTAP-MRIO and the GTAP-Micro for the top 20 sectors (by construction, for each sector, positive and negative changes sum to zero).

For most sectors, the differences in the geographical composition between the two databases amount to less than 5% (4.09% on average) of sectoral intermediate import values (i.e., less than 5 p.p. are reallocated between countries). The sectors in which the reallocation is largest are Gas, Wearing apparel, and Basic pharmaceutical products. In the Gas sector, for instance, the micro-data reallocate about 20 p.p. away from Russia and attribute them mainly to MENA countries (+15 p.p.) and the Netherlands (+2 p.p.). As for the Wearing apparel, a typical "Made in Italy" sector, we can observe an intermediate import reallocation from China (-4.9), France (-3.6) and Germany (-3.4 p.p.) to MENA (+4.4 p.p.) and other Asian countries (+3.4). On aggregate, the value of the reallocated shares between GTAP-MRIO and GTAP-Micro amounts to 3.3% of total intermediate imports (i.e., 13.7 out of 417 dollar billion). The top 5 sectors with the largest reallocation of shares account for 58% of this value.

Figure 4. Geographical share decomposition of the differences between GTAP-MRIO and GTAP-Micro by sector (p.p.)

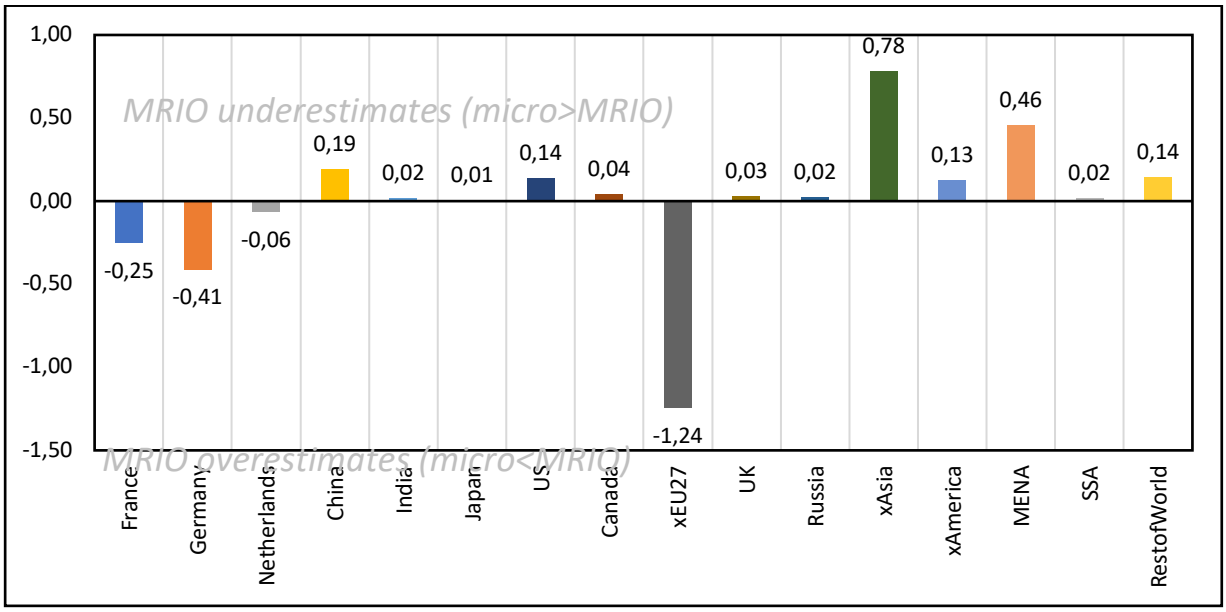


Source: Authors' computations based on the micro-founded GTAP Data Base

Other food products, the largest agrifood sector is detailed in Figure 5. The reallocation of shares is small (less than 2 p.p.). Shares are mainly reallocated from EU27 countries, Germany and France to other Asian countries (labeled as "xAsia"), MENA and China.

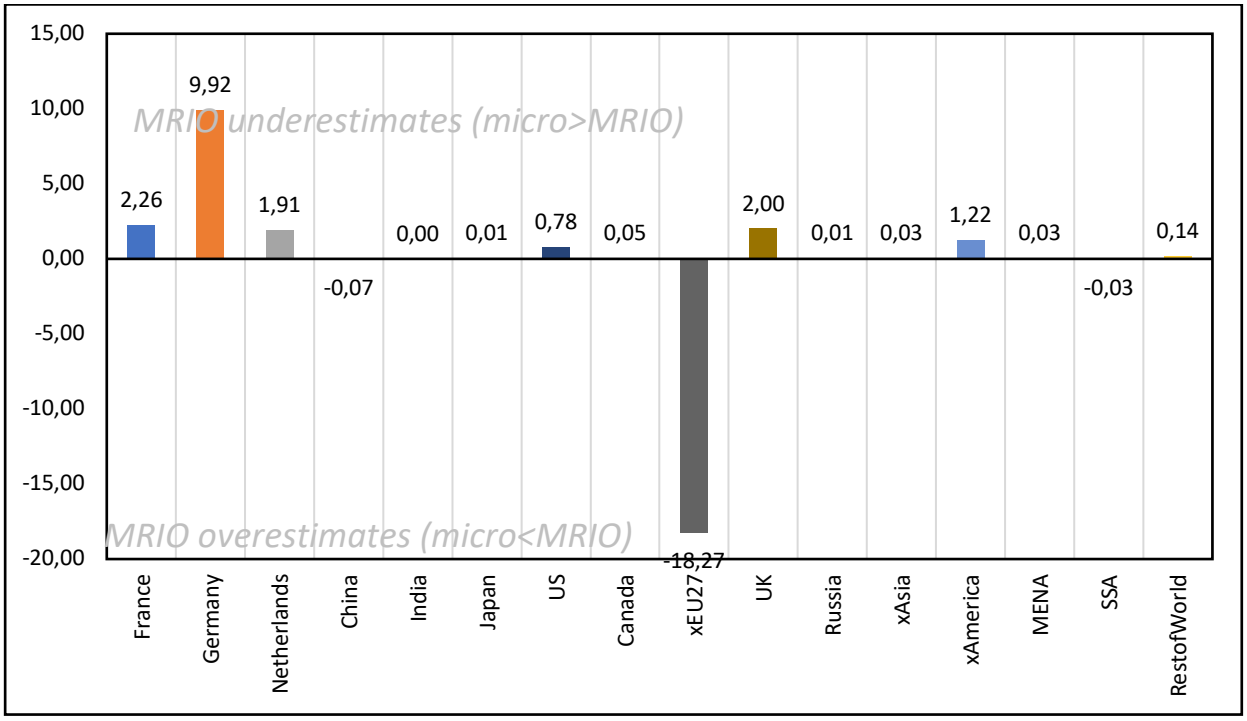
Beverages and tobacco products, reported in Figure 6, is a relatively large sector with relatively large share reallocations. In the GTAP-Micro data, other EU countries (xEU27) are a less relevant source (-18.3 p.p.), while Germany (+9.9 p.p.), France (+2.3 p.p.) and UK (+2.0 p.p.) gain importance as sources of intermediates.

Figure 5. Food products nec: Geographical share decomposition (p.p.)



Source: Authors' computations based on the micro-founded GTAP Data Base

Figure 6. Beverages and tobacco: Geographical share decomposition (p.p.)



Source: Authors' computations based on the micro-founded GTAP Data Base

5. Conclusion

The integration of firm-level data into a global ICIO accounting framework holds the potential to enhance the accuracy of estimates concerning GVC-related linkages. In this work, we have developed and implemented a methodology to integrate a country's firm-level data into a global ICIO accounting framework, marking a key methodological contribution.

From the empirical point of view, we can highlight two further contributions. First, with respect to what is available in the literature, we provide a characterization of the positioning of the Italian agricultural and food sectors at a higher resolution. Our findings reveal that agricultural products, such as cereal grains, rice, oil seed, and sugar cane/beet, are collocated upstream in the GVC, showing more than 2.5 steps from the final market. Conversely, food products, especially bovine meat and meat products, are positioned less upstream, with less than 2 steps from the final consumption.

Second, as the incorporation of micro-level data enables a finer measurement of intermediate imports by sourcing country, we illustrate and discuss the differences between the standard GTAP-MRIO (based on the BEC) and the new GTAP-Micro. Notably, we observe a significant share reallocation among providers for beverages and tobacco products, with Germany, France and the UK gaining importance as sources of intermediates.

The availability of firm-level data related to agriculture will facilitate further refinement of the measurements proposed and presented in this study. Furthermore, the use of standardized and harmonized data at the European level already allows for the replication of this exercise in other countries. This aspect adds considerable value from both research/analysis and foreign trade/industrial policies perspectives.

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Appendix

Table A1 - Sectoral coverage of Italian microdata

GTAP sector/activity	Sectors of firms	Sector of imports		GTAP sector/activity	Sectors of firms	Sector of imports
pdr		✓		bph	✓	✓
wht		✓		rpp	✓	✓
gro		✓		nmm	✓	✓
v_f		✓		i_s	✓	✓
osd		✓		nfm	✓	✓
c_b		✓		fmp	✓	✓
pfb		✓		ele	✓	✓
ocr		✓		eeq	✓	✓
ctl		✓		ome	✓	✓
oap	✓	✓		mvh	✓	✓
rmk				otn	✓	✓
wol		✓		omf	✓	✓
frs		✓		ely	✓	
fsh	✓	✓		gdt	✓	✓
coa	✓	✓		wtr	✓	
oil	✓	✓		cns	✓	
gas	✓	✓		trd	✓	
oxt	✓	✓		afs	✓	
cmt		✓		otp	✓	
omt	✓	✓		wtp	✓	
vol	✓	✓		atp	✓	
mil	✓	✓		whs	✓	
pcr		✓		cmn	✓	
sgr	✓	✓		ofi		
ofd	✓	✓		ins		
b_t	✓	✓		rsa	✓	
tex	✓	✓		obs	✓	
wap	✓	✓		ros	✓	
lea	✓	✓		osg	✓	
lum	✓	✓		edu	✓	
ppp	✓	✓		hht	✓	
p_c	✓	✓		dwe		
chm	✓	✓				

Source: Authors' elaboration.

Table A2 - Regional and sectoral aggregation

Regional aggregation

No.	*New Code*	*Region Description*	*Comprising old regions*
1	Italy		Italy.
2	France		France.
3	Germany		Germany.
4	Netherlands		Netherlands.
5	China		China.
6	India		India.
7	Japan		Japan.
8	US		United States of America.
9	Canada		Canada.
10	xEU27	Rest of European Union 27	Austria; Belgium; Bulgaria; Croatia; Cyprus; Czech Republic; Denmark; Estonia; Finland; Greece; Hungary; Ireland; Latvia; Lithuania; Luxembourg; Malta; Poland; Portugal; Romania; Slovakia; Slovenia; Spain; Sweden.
11	UK		United Kingdom.
12	Russia		Russian Federation.
13	xAsia	Southeast Asia	Hong Kong; Korea; Mongolia; Taiwan; Rest of East Asia; Brunei Darussalam; Cambodia; Indonesia; Lao People's Democratic Republ; Malaysia; Philippines; Singapore; Thailand; Viet Nam; Rest of Southeast Asia; Bangladesh; Nepal; Pakistan; Sri Lanka; Rest of South Asia.
14	xAmerica	Latin America	Mexico; Rest of North America; Argentina; Bolivia; Brazil; Chile; Colombia; Ecuador; Paraguay; Peru; Uruguay; Venezuela; Rest of South America; Costa Rica; Guatemala; Honduras; Nicaragua; Panama; El Salvador; Rest of Central America; Dominican Republic; Jamaica; Puerto Rico; Trinidad and Tobago; Caribbean.
15	MENA	Middle East and North Africa	Bahrain; Iran Islamic Republic of; Israel; Jordan; Kuwait; Oman; Qatar; Saudi Arabia; Turkey; United Arab Emirates; Rest of Western Asia; Egypt; Morocco; Tunisia; Rest of North Africa.
16	SSA	Sub-Saharan Africa	Benin; Burkina Faso; Cameroon; Cote d'Ivoire; Ghana; Guinea; Nigeria; Senegal; Togo; Rest of Western Africa; Central Africa; South Central Africa; Ethiopia; Kenya; Madagascar; Malawi; Mauritius; Mozambique; Rwanda; Tanzania; Uganda; Zambia; Zimbabwe; Rest of Eastern Africa; Botswana; Namibia; South Africa; Rest of South African Customs .
17	RestofWorld	Rest of World	Australia; New Zealand; Rest of Oceania; Switzerland; Norway; Rest of EFTA; Albania; Belarus; Ukraine; Rest of Eastern Europe; Rest of Europe; Kazakhstan; Kyrgyzstan; Tajikistan; Rest of Former Soviet Union; Armenia; Azerbaijan; Georgia; Rest of the World.

Sectoral aggregation

No.	*New Code*	*Sector Description*	*Comprising old sectors*
	Agrifood sectors		
1	pdr	Paddy rice	Paddy rice.
2	wht	Wheat	Wheat.
3	gro	Cereal grains nec	Cereal grains nec.
4	v_f	Vegetables, fruit, nuts	Vegetables, fruit, nuts.
5	osd	Oil seeds	Oil seeds.
6	c_b	Sugar cane, sugar beet	Sugar cane, sugar beet.
7	pfb	Plant-based fibers	Plant-based fibers.
8	ocr	Crops nec	Crops nec.
9	ctl_oap	Animal products	Bovine cattle, sheep and goats; Animal products nec.
10	wol	Wool, silk-worm cocoons	Wool, silk-worm cocoons.
11	frs_fsh	Forestry and Fishing	Forestry; Fishing.
12	cmt_omt	Bovine meat and Meat products	Bovine meat products; Meat products nec.
13	vol	Vegetable oils and fats	Vegetable oils and fats.
14	mil	Dairy products	Dairy products.
15	pcr	Processed rice	Processed rice.
16	sgr	Sugar	Sugar.
17	ofd	Food products nec	Food products nec.
18	b_t	Beverages and tobacco products	Beverages and tobacco products.
	Non-agrifood sectors		
19	coa	Coal	Coal.
20	oil	Oil	Oil.
21	gas	Gas	Gas.
22	oxt	Minerals nec	Minerals nec.
23	tex	Textiles	Textiles.
24	wap	Wearing apparel	Wearing apparel.
25	lea	Leather products	Leather products.
26	lum	Wood products	Wood products.
27	ppp	Paper products, publishing	Paper products, publishing.
28	p_c	Petroleum, coal products	Petroleum, coal products.
29	chm	Chemical products	Chemical products.
30	bph	Basic pharmaceutical products	Basic pharmaceutical products.
31	rpp	Rubber and plastic products	Rubber and plastic products.
32	nmm	Mineral products nec	Mineral products nec.
33	i_s	Ferrous metals	Ferrous metals.
34	nfm	Metals nec	Metals nec.
35	fmp	Metal products	Metal products.
36	ele	Computer, electronic and optic	Computer, electronic and optic.

37	eeq	Electrical equipment	Electrical equipment.
38	ome	Machinery and equipment nec	Machinery and equipment nec.
39	mvh	Motor vehicles and parts	Motor vehicles and parts.
40	otn	Transport equipment nec	Transport equipment nec.
41	omf	Manufactures nec	Manufactures nec.
42	ely	Electricity	Electricity.
43	gdt	Gas manufacture, distribution	Gas manufacture, distribution.
44	wtr	Water	Water.
45	cns	Construction	Construction.
46	trd	Trade	Trade.
47	afs	Accommodation, Food and servic	Accommodation, Food and servic.
48	otp	Transport nec	Transport nec.
49	wtp	Water transport	Water transport.
50	atp	Air transport	Air transport.
51	whs	Warehousing and support activi	Warehousing and support activi.
52	cmn	Communication	Communication.
53	ofi_ins	Financial services nec	Financial services nec; Insurance.
54	rsa	Real estate activities	Real estate activities.
55	obs	Business services nec	Business services nec.
56	ros	Recreational and other service	Recreational and other service.
57	osg_edu	Public Adm. and defe, Education	Public Administration and defe; Education.
58	hht	Human health and social work a	Human health and social work a.
59	rmk_dwe	Raw milk and Dwellings	Raw milk; Dwellings.

Source: Authors' aggregation based on the GTAP10 Data Base

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