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# REGIONAL ACTIVITY AND PARTICIPATION IN NATIONAL AND INTERNATIONAL VALUE CHAINS: EVIDENCE FOR ITALY

by Paola Monti*

**Abstract**

This work sets out the participation of Italian regions in the international economy using indicators proposed in the empirical intercountry input-output literature. First, it examines how foreign demand contributes to regional value added through direct and indirect trade (via other regions or countries) in goods and services. It shows that the relative importance of direct and indirect 'pathways' in bilateral value-added exports is associated with regional and destination countries' features. Indirect 'pathways' through other regions are proportionally more important for the South, smaller regions and destination countries, and direct ones for territories of larger size and large and contiguous countries. Secondly, it evaluates the types of regional participation in international value chains and their possible common traits. It finds that regions that participate by supplying a higher proportion of domestic value added, compared with foreign, are those for which, in addition to the manufacturing sector, advanced services and innovative activities are significant in their productive structures. They are mainly the major central and northern regions and a few southern ones.

**JEL Classification**: F1, F14, R11, R15.

**Keywords**: trade in value added, regional trade, global value chains, input-output tables.

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## 1. Introduction[1]

The effects of the global fragmentation of production along global value chains, which has characterised recent decades, have been studied from both a microeconomic perspective, focusing on the organisation of businesses, and from a more macroeconomic standpoint, trying to capture the implications for national economies. In the macroeconomic approach, applied studies using inter-country input-output (ICIO) tables have helped to distinguish between different sources of value added embedded in gross trade flows and to represent more accurately the international linkages, trade benefits and impact of trade on GDP and labour income.

The evidence produced from these input-output analyses primarily refers to national economies, rather than sub-national economies. This paper is intended to contribute to the still limited regional applications of the input-output approach and, in particular, to increase the knowledge available on Italy, which is characterised by persistent differences in the economic specialisation of its regions.

The first objective of the work is to analyse the impact of foreign demand on the economies of the Italian regions, highlighting heterogeneities in the destination countries and the 'pathways' through which regional value-added reaches these destinations. Input-output analysis tools make it possible to broaden the study of international trade beyond the direct bilateral exchanges, to encompass indirect channels, which can take place through other regions of the same country or other countries.

The second objective of this work is to apply the indicators of the ICIO literature based on the value-added content in exports crossing at least two national borders and then to draw some reflections on the type of participation of each Italian region in the international production network.

This work has some analogies with the analysis by Bentivogli et al. (2019), which breaks down the gross transactions of the Italian regions into their main value-added components to highlight the intricate network of inter-regional and international trade interdependencies, distinguishing between the origin (domestic or foreign) of gross flows and the final destination (domestic or foreign) of their value added components. This paper focuses on analysing the final foreign demand, enriching it with details on the bilateral contributions from different destination countries. It also examines the indicators of regional participation in global value chains more extensively. The source of data is a database that maintains the inter-regional data core used by Bentivogli et al. (2019), complemented with WIOD data (Timmer et al., 2015) for the inter-country part to increase the bilateral country details.

The focus on international ties is based on two main assumptions. First, international interactions have different characteristics from intra-national interactions, even within highly integrated markets. Factors such as distance, institutional differences, culture, regulatory barriers, currency and wage setting contribute to the unique characteristics of international as opposed to intra-national interrelations. It therefore makes sense to analyse international integration as a distinct phenomenon from intra-national integration. The second assumption is that within a

[1] The views expressed in this paper are those of the author and do not necessarily reflect the views of the Bank of Italy. I would like to thank the anonymous referees, Giuseppe Albanese, Valter Di Giacinto, Michele Mancini, and Roberto Torrini for helpful comments and suggestions. I am also indebted to Chiara Bentivogli, Tommaso Ferraresi, Roberto Paniccià, and Stefano Rosignoli for previous cooperation. All errors are mine own.

country, there can be a spatial concentration of the activities performed in the production systems. As a result, the type of international interactions of sub-national territories (regions) can vary, reflecting their role within the national economy.
Examining the absorption abroad of the regional value added is a way to judge the integration of regions in the international economy. However, the international fragmentation of production and the complexity of cross-border flows necessitate paying attention to the domestic value-added component in intermediate exports and the external added value needed to support them. Importing value added to export can help increase local production capacities and productivity when, for example, combined with the adoption of new technologies or a reduction in local production costs (Kummritz, 2015; Kummritz et al., 2017). Other interpretations illustrate that countries can participate in global value chains (GVC) in different ways and with different roles, which impact the relative benefits of their participation (World Bank, 2017 and 2020). This paper addresses the issue of how to measure regional participation in the international fragmentation of production by looking at two possible adaptations of a GVC-related trade indicator in the intercountry literature (Borin and Mancini, 2015 and 2019). The first is to create an index that includes the interregional segment of value chains; the second is to isolate the pure international component of value chains. These indicators are then used to draw some reflections on the type of participation of the Italian regions in the international production network.
The analysis shows that, besides the manufacturing sector, non-financial private services are an important component of the domestic content of regional exports. Compared to gross exports, the input-output indicator of regional value-added absorbed abroad increases the relative importance of distant countries that are however central in global value chains, such as the United States and China. On the contrary, it reduces the importance of closer partners such as Germany, France and Switzerland. The differences are partly attributable to the share of value added absorbed indirectly by the final recipient countries, through other countries or regions. The relative importance of direct or indirect 'pathways' in total bilateral value-added exports is associated with the regional and destination-country dimensions, and in some cases, the distance between them. For example, indirect pathways through other regions are proportionally more important for smaller regions and countries, while direct 'pathways' are more relevant for bigger regions and to large and contiguous countries. There is also a macro-territorial divide: direct value-added exports or those through foreign countries are relatively more important in the Centre-North than in the South.
Regarding GVC participation, the paper finds that the Italian regions occupying the most advantageous positions in the inter-country and inter-regional value chains are those that combine manufacturing with advanced services and innovative activities. These correspond mainly to the strong areas of the Centre-North for manufacturing and business services. The analysis also suggests that in manufacturing global value chains, a few southern regions are also relatively well positioned, considering the ratio between regional and foreign value-added in their intermediate exports.
In summary, these results marginally change the picture we know from official data, and provide a more detailed description of how regions interact to reach foreign markets and position themselves in global value chains. In particular, the results suggest that value-added trade provides a marginally different picture of regional international links and countries whose final demand affects regional economic activity. The results also reveal additional features of Italy's regional heterogeneity, i.e. they show how the various regions differ in their export of value-added and participation in the overall fragmentation of production, as well as how regional structural characteristics may affect these differences. At the same time, the results indicate

that the international positioning of the regions is not independent of the interregional links. From an economic policy perspective, the evidence presented in the paper suggests, on the one hand, that the input-output approach can, for example, provide more detailed guidance on how foreign demand shocks can spread internationally towards sub-national levels. On the other hand, information on the intensity and type of participation of the regions in value chains could help decision-makers assess the positioning of regional economies to design structural policies that support a beneficial participation in the global fragmentation of production. A prerequisite for the availability of such information is maintaining a frequent and up-to-date compilation of interregional-international input-output tables.

The paper is organised as follows: Section 2 briefly reviews the relevant literature. Section 3 describes the data, and Section 4 presents the analysis's indicators and other methodological aspects. Section 5 reports the main findings. In particular, Section 5.1 examines the impact of final foreign demand on regional activity. Section 5.2 examines how regional added value reaches the countries of final absorption. Section 5.3 provides evidence on how regions participate in global value chains. Section 6 concludes.

## 2. Related literature review

Various streams of literature have explored the implications of international production fragmentation. These include the advantages for countries to participate in the process, the search for less distorted measures of international trade, the role of multinational enterprises in fragmented production, and the environmental impact of global value chains. These issues were studied using diverse methodological approaches, often challenging to reconcile.

Although an exhaustive list of references is not within the scope of this paper, it is worth highlighting the influential contributions that have inspired subsequent theoretical and empirical studies. For example, Gereffi (1999, 2014) and Dedrick et al. (2009) significantly shaped the business and case-study approach. Antràs and Helpman (2004), Bernard et al. (2007, 2009), Baldwin and Venables (2013), and Antràs et al. (2017) provide influential theoretical contributions on the microeconomic approach that, in empirical applications, uses firm-level data to document input sourcing decisions, explore import/export links and study how multinational enterprises organise production networks. Grossman and Rossi-Hansberg (2008), Costinot et al. (2013), Costinot and Rodriguez-Clare (2014), Caliendo and Parro (2015), and Antràs and de Gortari (2020) have expanded international trade and industrial organisation models to include fragmentation of production. These models stylise how global value chains operate and influence the welfare and trade structure of countries. They generally support the idea that countries can benefit from trade by expanding their opportunities to specialise based on the comparative advantage of the tasks to be performed. Hummels, Ishii, and Yi (2001), Johnson and Noguera (2012), Dietzenbacher et al. (2013), Timmer et al. (2013), and Koopman et al. (2014) were the pioneers of the empirical macroeconomic approach, which used global (inter-country) input-output tables, built by linking national input-output tables across borders using bilateral trade data (ICIO literature). Their efforts allow us to measure trade in value-added, understand the length and location of producers in global value chains (GVCs), and explore price linkages.[2]

Some studies have tried to find convergence between these different approaches. For example, Baldwin and Lopez-Gonzales (2015) interpret the flows of imports, exports and value added

[2] Baldwin (2016 and 2023), Amador and Cabral (2016), Johnson (2018), Gereffi et al. (2019), World Bank (2020), Antràs and Chor (2022) and Antràs (2020) provide comprehensive reviews that contribute to a deeper understanding of the various approaches to studying the functioning and implications of GVCs.

derived from input-output tables with the organisation of production networks, highlighting the distinctive signs of economies that organise the production network ('headquarter economies'), provide labour ('factory economies') and are in hub-and-spoke arrangements (Baldwin, 2016). There have been efforts to find macroeconomic evidence for the so-called 'smile-curve' concept of the business literature on GVCs (World Bank, 2017 and 2017), according to which value added in manufacturing products is shifting from the fabrication stages to pre- and post-fabrication services (Shih, 1996, and Shin et al., 2012).[3]

The fragmentation of production occurs at the company level, and business decisions have a similar impact on national and sub-national economies (European Commission, 2020). At the sub-national level, as at the national level, the topic can be examined from both a microeconomic perspective and a more macroeconomic standpoint. Empirically, the input-output approach is more challenging at the sub-national level than at the country level, mainly due to the scarcity or unavailability of the required data, including regional supply and use tables (SUTs) and, in particular, official data on inter-regional trade, which require additional assumptions and estimates.

Among the first works to combine an ICIO table with a multi-regional input-output table, Dietzenbacher et al. (2013b) study the participation of Brazilian regions in global value chains (GVC), while Meng et al. (2013) and Pei et al. (2017) examine the case of China. These studies introduced methodological innovations for applying the ICIO approach at the sub-national level and, in terms of results, revealed significant territorial heterogeneity in participation in the international economy. For Italy, Bentivogli et al. (2019) and IRPET (2018) provide similar first applications, breaking down the gross transactions of the Italian regions into their main value-added components, following the approach proposed by Koopman et al. (2014) and improved by Meng et al. (2013), Nagengast and Stehrer (2014 and 2016) and Borin and Mancini (2015 and 2019). Previously, Cherubini and Los (2016) examined the links between employment and integration in GVCs for the main Italian macro-areas.

This paper contributes by adding evidence to the still limited literature of the ICIO macro-approach at the regional level, with particular reference to the case of Italy. Its results are derived from an alternative dataset to the one used by recent contributions on the participation of EU regions in GVCs (Bolea et al., 2022; Capello and Dellisanti, 2024).

The paper undertakes an analysis of the breakdown of bilateral absorption from abroad by type of channel (direct and indirect), which refers to Meng et al. (2013) and has analogies with Bentivogli et al. (2019). It adds new information by seeking to establish a relationship between the regional characteristics and those of the partner countries, including the distance between them. Regarding regional participation in GVCs, this paper adapts, for the interregional-inter-country framework, the GVC-related indicator proposed by Borin and Mancini (2015 and 2019). For the analysis of the heterogeneity of indicator values, the paper refers to the World Bank taxonomy of GVC-participation types (World Bank, 2020), which exploits GVC-participation indicators comparable to those adopted in this analysis. Among other recent works analysing regional participation in GVCs, the mentioned work of Bolea et al. (2022) explores the role played by spatial dependence in explaining the participation and positioning in GVCs of EU regions. It uses the upstreamness and downstreamness indicators proposed by Antràs et al. (2012) and Antràs and Chor (2013 and 2017) to measure the regional positioning and the

[3] The concept is defined at the company and product level. It implies a U-curve (the 'smile' curve) of value-added levels moving from pre-fabrication stages (e.g. extraction of primary resources, research and development, management, design) to post-fabrication ones (marketing, logistics, after-sales services), with the lowest values corresponding to the fabrication stages.

regional value-added exports to other regions and countries as a share of the corresponding total for all regions. The key finding is that the role of an individual region in the global value chain is affected by the behaviour of its neighbours. Capello and Dellisanti (2024) study the relationship between the type of regional participation in GVCs and regional economic growth and find that regions specialised in natural resources or high skills benefit most from GVC participation in terms of growth.

The mentioned works of Bolea et al. and Capello and Dellisanti use the EUREGIO database (Thissen et al., 2017 and 2018), an inter-country interregional input-output model (IRIC-IO) with information for EU regions and the years 2000-2010. Almazán-Gómez et al. (2023) updated and extended the analysis to 2017 (not publicly available at the time of writing). Other works that use EUREGIO data to analyse regional international integration from an input-output perspective include the works of Prades-Illanes and Tello-Casas (2020) and Chen et al. (2018). The first study explores internal and foreign trade interconnections of some Spanish regions, and the second assesses the exposure of European regions to Brexit.

## 3. Data

The paper's empirical database is a modified version of the 2012 ICIO table of WIOD released in 2016 (Dietzenbacher et al., 2013; Timmer et al., 2015). In the modified ICIO table (referred to as 'modified WIOD' in the remainder of the paper), WIOD's block for Italy is substituted with 20 regional blocks by proportionally allocating Italy's input-output transactions by sector and country to the Italian regions. (See Appendix C.1 for a list of regions, geographical classifications, and countries.)

The regional allocation of WIOD's intra-national input-output matrix (for intermediates and final demand) exploits the interregional core of the IRIC-IO dataset used by Bentivogli et al. (2019). The allocation requires harmonising the sectoral breakdown between the two datasets to 53 sectors.[4] The interregional core of the Bentivogli et al. dataset comes from the Multiregional Input-Output (MRIO) model of IRPET, relying on regional supply and use tables (SUTs) and an interregional trade matrix computed using a gravity approach. The four-partner international component (European Union – EU, United States, Canada, and Japan) of the dataset involved a balancing process exploiting information from partners' SUTs and international statistics on trade in goods and services (Casini Benvenuti and Paniccià, 2003; Paniccià and Rosignoli, 2018; Bentivogli et al., 2019). In the 'modified WIOD', WIOD's input-output international transactions for Italy, by sector and country, are proportionally allocated to regions by computing regional country-sector weights from official regional bilateral external trade statistics. For unavailable country-sector combinations, the proportions reflect those of sector totals of Bentivogli et al.'s dataset (which is often the case in the services sector).[5]

The resulting IRIC-IO table has 53 sectors, 20 Italian regions, 26 EU countries (including the UK and excluding Croatia, reflecting the EU composition in 2012), 16 extra-EU countries, and the rest of the world.

Compared to the EUREGIO data, the 'modified WIOD' offers the following advantages: i) finer sectoral breakdown, ii) use of a more recent version of the World Input-Output Database

[4] Respectively from 56 (WIOD) and 54 sectors. The differences are mainly due to slightly different breakdowns of certain types of service activities, in particular NACE sections M73-75, R, S, T, and U.

[5] MRIO's regional shares by sector serve as constraints for the regionalisation of Italy's relationships with foreign countries in WIOD.

(WIOD), that has more up-to-date economic interactions and includes more countries, and iii) better alignment with official statistics (Figure A.1). However, it is essential to consider its main disadvantage, namely the lack of EU-level regional information, which restricts the possibility to explore regional dynamics across EU countries, possible instead with the EUREGIO data. Figure 1 illustrates the basic features of our model, where N is the number of sectors, R is the number of regions, and C is the number of countries (including the rest of the world).

*Figure 1. The IRIC-IO table*

| | | **Outputs** | | **Final demand** | | **Total output** |
|---|---|---|---|---|---|---|
| | | *Regions 1…R* | *Countries R+1….R+C* | *Regions 1…R* | *Countries* R+1…R+C | |
| **Inputs** | *Regions 1 . . R* | $\mathbf{Z}^{rr}$ | $\mathbf{Z}^{rc}$ | $\mathbf{F}^{rr}$ | $\mathbf{F}^{rc}$ | $\mathbf{x}^{r}$ |
| | *Countries R+1 . . R+C* | $\mathbf{Z}^{cr}$ | $\mathbf{Z}^{cc}$ | $\mathbf{F}^{cr}$ | $\mathbf{F}^{cc}$ | $\mathbf{x}^{c}$ |
| **Value added** | | $\mathbf{w}^{r'}$ | $\mathbf{w}^{c'}$ | | | |
| **Total output** | | $\mathbf{x}^{r'}$ | $\mathbf{x}^{c'}$ | | | |

The intermediates input matrix Z is a (R+C)N×(R+C)N matrix that can be divided into four block matrices reflecting the possible supply and use (S-U) combinations by type of immediate origin and destination area (Italian regions/ other countries). The diagonal blocks ($Z^{rr}$ and $Z^{cc}$) refer to S-U relationships between sectors of areas of the same type (regions or foreign countries), and the off-diagonal matrices ($Z^{rc}$ and $Z^{cr}$) refer to transactions in different area types (respectively, from a region to a country, and from a country to a region). In particular, $z_{ij}^{rr}$ is a typical element of the RN × RN matrix $Z^{rr}$, representing the value of inputs sold by sector *i* (row) in any Italian region of origin (r=1..R) to sector *j* (column) in any other region destination (r=1..R). Similarly, $z_{ij}^{rc}$ is an element of the RN×CN matrix $Z^{rc}$, representing the supply of any sector *i* (row) in any Italian region of origin (r=1..R) to sector *j* (column) of any foreign country of destination. The other two block-matrices have analogous definitions and represent, respectively, the S-U combinations from any country to any region (the CN×RN matrix $Z^{cr}$) and from any country to any other country (the CN×CN matrix $Z^{cc}$).
The final use matrix F represents the final goods and services completed in any region and country of origin and absorbed for final use in any region and country of destination. It has size (R+C) N ×(R+C) because there is no distinction between the final uses for the N sectors' products. The four sub-matrices represent the different combinations of areas of origin and destination. Therefore, $F^{rr}$ is an RN×R matrix; $F^{rc}$ is RN×C; $F^{cr}$ has size CN×R, and $F^{cc}$ is of CN×C dimension. Finally, the matrices $\mathbf{w}^{r'}$ and $\mathbf{w}^{c'}$ represent the vectors of the value added generated in any region and country, respectively. The matrices $\mathbf{x}^{r}$ and $\mathbf{x}^{c}$ and $\mathbf{x}^{r'}$ and $\mathbf{x}^{c'}$ are composed by the vectors of the outputs of any region and any country in the system expressed, respectively, as the sum of the intermediate inputs processed and its own value added and as

the output of any region or any country used by all destinations as intermediate or final products.[6]

## 4. Methods

The following sub-sections illustrate how the indicators of the ICIO literature have been adapted to the regional context and the rationale for their use in this paper. [7]

### *4.1. The share of GDP absorbed abroad*

This statistic explores the impact on regional activity of final foreign demand as a whole and for the most important countries. Results are reported in Section 5.1.

The indicator's numerator is equivalent to 'Value-Added Exports' (VAX), as defined by Johnson and Noguera (2012).[8]

The basic relationship between gross output and final demand in an input-output context can be written as:

$$X=BY, \text{ where } B=(I-A)^{-1} \text{ and } Y= F\mathbf{i} \qquad (1)$$

where **i** stands for the summation vector that adds the elements in the final demand block F in row-wise fashion; A is a square matrix of the input coefficients $a_{ij}^{qs}$ ($a^{qs}_{ij}= z^{qs}_{ij} /x^{s}_{j}$ ) referring to both regions and countries. In our interregional-intercountry framework, q,s=1…, R, R+1,…R+C or q,s=1…G, with G the total number of regions and countries in the system, R the number of regions, and C the number of countries. Pre-multiplying the right-hand side of the system by $V_s$, the direct domestic value-added matrix for all countries, provides a matrix reporting the GDP by country pairs of source (rows) and absorption (columns). In this setting, the regions can be treated as countries and the following relationship applies to the GDP of a given country or region s (s=1…G, where G=R+C):

$$GDP_s=V_s \sum_k^G \sum_l^G B_{sk}Y_{kl} = \underbrace{V_s \sum_k^G B_{sk}Y_{ks}}_{(A)} + \underbrace{V_s \sum_k^G \sum_{l\neq s}^G B_{sk}Y_{kl}}_{(B)} \qquad (2)$$

In equation (2), k represents the regions/countries of source and l represents the regions/countries of absorption.

In an inter-country context, the first addendum (A) in equation (2) is the GDP absorbed domestically, and the second is the GDP absorbed abroad or VAX. In an interregional-intercountry setting, the second addendum can be further split into the component absorbed by

[6] $Z^{cc}$, $F^{cc}$, $x^{c}$, $x^{c'}$, and $w^{c'}$ are unchanged compared to WIOD. $Z^{rr}$, $F^{rr}$ reflect the weights of the inter-regional module of Bentivogli et al. dataset. The latter dataset is used in combination with official external statistics to obtain the allocation weights for the other matrices.

[7] For the computational aspects the analysis relies on the routines developed by Belotti et al. (2020 and 2021). The presentation of the indices uses their notation to make it easier for the reader to understand the adaptation to the interregional-international context. The experienced reader may browse the section rapidly.

[8] Los et al. (2016) and Los and Timmer (2018) propose the 'hypothetical extraction' method to compute the same type of measure. See Belotti et al. (2021), Section 3, for a more detailed discussion.

foreign countries/other foreign countries and that absorbed by regions/other regions (respectively summing over countries or regions).

The regional version of the GDP share absorbed abroad (or simply total foreign absorption) is the ratio between the GDP of a given region *s* absorbed by all foreign countries (VAX) and regional GDP, defined as follows:

$$\text{Total Foreign ABS}_s = \text{VAX}_s/\text{GDP}_s = (V_s \sum_k^G \sum_l^C B_{sk} Y_{kl})/DP_s \quad (3)$$

In this definition, l represents countries (l=R+1... C). The absorption by the other regions different from *s* can be computed analogously, considering *l*=1...R, with l ≠ s.

The bilateral foreign absorption by single countries of destination (*l*=R+1…C) or 'bilateral VAX share' is defined as:

$$\text{Bilateral VAX share}_{s,l} = DP_{sl}/DP_s = (V_s \sum_k^G B_{sk} Y_{kl})/DP_s \quad (4)$$

The decomposition of GDP by sectors of origin requires substituting the direct value-added matrix $V_s$ with its diagonal form $\hat{V}_j$ (the diagonal matrix with the direct value-added coefficients along the principal diagonal and zeros elsewhere).

### *4.2. DVA paths to final destination*

This Section presents the accounting framework to connect the bilateral foreign absorption of regional GDP to the main export paths that regional value-added may follow to the final destination. Results are reported in Section 5.2. Intuitively, the connection comes from the fact that the regional value-added absorbed by a given foreign country is equivalent to the sum of the regional value-added directly absorbed by the country and the regional value-added that reaches the same country indirectly after being embodied in other exporters' final goods (be they regions or foreign countries).[9]

This type of analysis builds upon the decomposition of gross exports proposed by Koopman et al. (2014), and improved upon by Meng et al. (2013), Nagengast and Stehrer (2014 and 2016), and Borin and Mancini (2015 and 2019). According to this decomposition, the gross value of total exports breaks down into the following main value-added components:

$$GX_{s^*} = DVA_{s^*} + DDC_{s^*} + FVA_{s^*} + FDC_{s^*} \quad (5)$$

DVA is the domestic value-added of country *s*, FVA is foreign value-added, and DDC and FDC are the domestic and foreign double-counted items (see Belotti et al., 2021, for further details).

[9] In more detail, the regional value-added absorbed by a foreign country A corresponds to the sum not only of the regional value-added contained in the final goods shipped to A or in the intermediate goods used by A to satisfy its final demand, but also of the regional value-added exported indirectly: contained in the gross exports of intermediate goods shipped first to another country B but finally embedded in products consumed by A; in gross outflows shipped first to another region and finally consumed by A; in shipments from A to other countries or regions but finally consumed in A.

In an interregional-intercountry framework, gross flows to foreign countries (gross exports) and other regions (gross outflows) can contain DVA and FVA. Additionally, the value-added from outside the home territory can come from other countries (proper FVA, or international value-added or IVA) or regions (national value added or NVA). This requires adding dimensions to the value-added breakdown of external trade flows, but does not fundamentally change equation (5).[10] $DVA_{s*}$ can be further split in the following items:

$$DVA_{s*}=VAX_{s*}+REF_{s*}=DAVAX_{s*}+\text{indirectly absorbed VAX}+REF_{s*} \qquad (6)$$

$REF_{s*}$ is the so-called reflection (DVA returning home through imports) and $DAVAX_{s*}$ is the value-added in exports directly absorbed abroad (Belotti et al., 2021).
The right-hand side of equation (6) is an approximate form of a country's GDP absorbed abroad. The right-hand side of equation (7) is its bilateral version:

$$DP_{sl} = (V_s \sum_k^G B_{sk} Y_{kl}) \cong DAVAX_{sl} + \text{indirectly absorbed } VAX_{sl} + REF_{sl} \qquad (7)$$

In the interregional-intercountry framework, it approximates the GDP of a region *s* absorbed by a country *l*. $DAVAX_{sl}$ is the regional value-added in exports directly absorbed by the foreign partner *l* (contained in final goods and intermediates embedded in products satisfying the partner's final demand), to which we'll refer to as DVA in direct links. The indirectly absorbed VAX of region *s* by country *l* is the value added originating in region *s* and contained in trade flows directed to other countries or regions, that are finally absorbed by *l* through other countries or regions (DVA via foreign countries or other regions in what follows). Computationally, it is equivalent to the FVA originating in region *s* contained in the exports of other countries (*oc*) directly absorbed by country *l* ($_sFVA_{oc,l}$) plus the value added originating in *s* and contained in other regions' export flows directly absorbed by *l* ($_sNVA_{or,l}$).
This approach is a way to describe regional participation in national and international value chains from a 'sink' perspective, that is, in the ICIO literature terminology, recording the value added as close as possible to the stage when it is ultimately absorbed. It is similar to the analyses by Borin and Mancini (2016) and Cigna et al. (2022) at the country level. It has much in common with the framework proposed by Meng et al. (2013) and applied by Bentivogli et al. (2019), but the decomposition is somewhat different from theirs.[11]

### *4.3. Indicators of GVC-participation*

This Section deals with another approach – more frequent in the ICIO literature – that measures countries' participation in GVCs using specific indicators to account for the DVA and the FVA in exports and entailing production processes that cross at least two borders. The reference indicator for our analysis is the GVC-related trade index proposed by Borin and

[10] See Bentivogli et al. (2019) for a detailed decomposition scheme in an interregional-intercountry context.
[11] Meng et al. (2013) propose a framework to measure how and by what routes a country's domestic regions engage in GVC: it decomposes regional value-added outflows and exports, each into international (or 'pure' international) and domestic (or 'pure' domestic) segments. Our decomposition of regional GDP absorbed abroad is similar to Meng et al.'s decomposition of value-added exports, but has different sub-items. Compared to Bentivogli et al., their $DVAX_b$ is further split into bilateral DAVAX ($DAVAX_{sl}$) and indirectly absorbed VAX ($VAX_{sl}$).

Mancini (2015 and 2019).[12] It adopts a 'source' perspective, accounting for the value added the first time it leaves the country. Results are reported in Section 5.3.
The numerator of the index is the value of trade flows that cross at least two borders, net of the domestic value-added absorbed by the first country of destination of the exports (therefore including double counting at the bilateral level). Gross exports are in the denominator. More formally, for the total trade of a given country/region *s,* the indicator is defined as:

$$GVC_s = \frac{\sum_{l \neq s}^{G} \mathrm{GVCX_{sl}}}{\mathrm{U_N E_{s*}}} \qquad (8)$$

where $\mathrm{U_N E_{s*}}$ is total gross exports of country/region *s*, $\mathrm{VCX_{sl}} = \mathrm{U_N E_{sl}} - \mathrm{DAVAX_{sl}}$ and $\mathrm{U_N E_{sl}}$ is total bilateral trade between region *s* and each other country/region *l*; the indicator also applies to exports by sector (see Belotti et al., 2021, for further details). It is possible to break down the index into two further additive components as follows:

$$\mathrm{GVC}_{sl} = \mathrm{GVC\ backward}_{sl} + \mathrm{GVC\ forward}_{sl} \qquad (9)$$

The first component accounts for the import content of exports (backwards GVC participation), and the second measures the part of domestic production supplied to the importing country for processing and re-export (forward GVC participation).
In an interregional-intercountry context, *s* and *l* can be countries or regions, and trade flows can cross the borders of at least two countries, two regions or a country and a region (or vice versa). To emphasise this aspect, the indicator computed for each region (*s*) referring to its total external flows (outflows and exports vis-à-vis *l*=1..R, R+1...R+C) is named the RGVCt-index. Exploiting the additivity property of the index, it is possible to compute sub-RGVCt-indices, distinguishing between the contribution of flows that at source are directed to other countries (gross exports) or regions (gross outflows).

In an interregional-intercountry framework, the distinction between gross outflows and exports does not neatly disentangle the national from the international segments of GVC participation. Gross regional outflows and exports can source external value added from other regions (NVA) or countries (IVA) and contain DVA that crosses a second border of another country or region. This paper proposes to disentangle the two segments by identifying the components of the GVC indicator that involve only international production phases and the value added content that crosses at least two foreign borders, according to a 'source' perspective. This means computing the regional GVC indicator on regional exports, denominated as the RGVCx-index, as the sum of the forward component ($\mathrm{RGVCF_x}$) and the IVA part of the backwards component ($\mathrm{RGVCB_{ix}}$), that is:

$$\text{RGVCx-index} = \mathrm{RGVCB_{ix}} + \mathrm{RGVCF_x} \qquad (10)$$

[12] The literature has proposed alternative indicators of 'intensity' of GVC participation similar to the one adopted here. See, for example, Hummels et al. (2001), Johnson and Noguera (2012), and Koopman et al. (2011 and 2014). The indicators in Dietzenbacher and Romero (2007), Antràs et al. (2012), and Antràs and Chor (2013) focus more on the length of GVCs. In Antràs and Chor (2013 and 2017), GVC positions are measured as distance from final use (upstream position) or primary factors (downstream position).

There is debate on whether and how to compare these types of GVC indices between countries. Referring to the indicator proposed by Koopman et al. (2011), similar to Borin and Mancini's, Ahmad et al. (2017) point out that its value might be high for a country with a low share of exports to GDP and low for one with a very high share.[13] Therefore, an analysis of countries' participation in GVCs should preferably emphasise the relative size of the foreign and the indirect value-added components of the index (similar to the backwards and forward components of our index, respectively).[14] A comparison of the relative sizes of the forward and backwards components of countries' trade could then provide a hint on their more or less favourable position in GVCs. A prevailing forward component would indicate that a country (or region) participates in GVC by providing inputs to other territories of a relatively higher value than imported ones. A prevalent backwards component would signal that the GVC participation entails using a large portion of imported intermediates in the production phases of intermediate exports, adding a low share of local value-added.

## 5. Results

### *5.1. Final foreign demand and regional activity*

The share of GDP absorbed abroad may offer a different picture from the export-to-GDP ratio of the impact of foreign demand on the activity of a country or region (see Section 4.1 for a formal definition of the indicator). The first accounts for the value produced regionally and absorbed abroad. The second looks at exports recorded in official statistics (gross exports), which might include the value produced outside the regional borders and disregard outflows to foreign markets through other regions. The latter phenomenon is likely particularly important in the case of Italy, where the headquarters of national and foreign multinationals, as well as large enterprises and gross exports of goods and business services, tend to be concentrated in the central and northern regions of larger size, which represent the strong areas of the national economy. In addition, regional differences, particularly between the Centre-North and the rest of the country, have been rather persistent (Accetturo et al., 2022).

A comparison of the share of regional GDP absorbed abroad and the export-to-GDP ratio indicates that the former is lower than the latter for most regions. According to both measures, openness correlates positively with the regions' GDP (Figure 2).[15] The ranking of the regions based on the two statistics also differs, particularly regarding Sicily, Sardinia, and Piedmont. The first two regions rank last in value-added openness and middle in gross export terms. Piedmont is the most open region by gross export-to-GDP and fourth by GDP absorbed abroad.

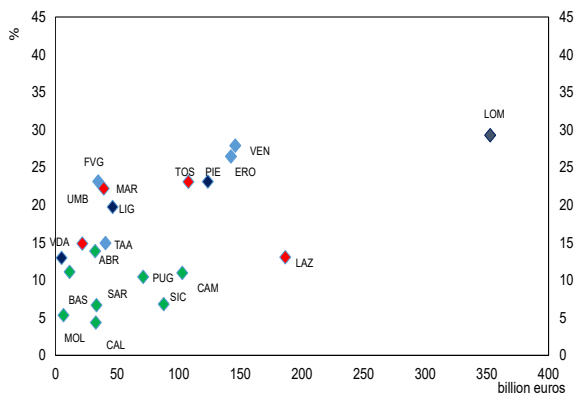
[13] For example, the index might be low for countries sending a large proportion of their intermediates' exports to larger economies, likely to process them for sale on their consumer market in a higher proportion than smaller economies.

[14] Comotti et al. (European Commission, 2020) highlight that the backwards and forward components are not symmetric: accounting for all FVA embodied in gross exports, the first tends to overstate the second, which considers only the DVA incorporated as intermediate inputs in the rest of the world's gross exports.

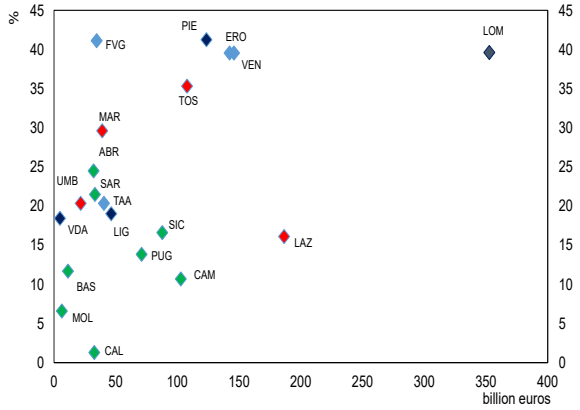
[15] Considering Italy as a benchmark, the share of GDP absorbed abroad has been significantly lower than the export-to-GDP ratio. Still, it has shown a similar trend evolution: modest growth between 1995 and 2014, slowdown in mid-2000 and 2009-2010, and growth since then until 2018 (see Figure A.2).

*Figure 2 – Regions' openness and size (1)*

a) Share of GDP absorbed abroad




b) Gross exports as a share of GDP (2)




Source: Own elaborations on 'modified WIOD' data for panel a, and Istat and Bank of Italy for panel b.
(1) Year 2012. Measures of openness on the vertical axis, and regional GDP on the horizontal axis. The marker of the North-Western regions is dark blue; that of the North-Eastern ones is light blue; red is for the Centre, and green is for the South. (2) Gross exports of goods and services (except manufacturing services on physical inputs owned by others, transport services and minor items of financial and insurance services).

Higher shares of GDP absorbed by final foreign demand correspond, by definition, to lower national absorption from other regions and the region itself. In our data, self-absorption is the main component everywhere. It ranges between the lowest value of Lombardy (51 per cent) and the highest of Sicily (81 per cent). Regarding the contribution of final demand coming from other regions, the share is relatively low in major northern regions (about 20 per cent in Lombardy, Veneto, Piedmont, and Emilia-Romagna) and high in small southern ones (about 34 per cent in Basilicata and Molise, and 28 per cent in Lazio).

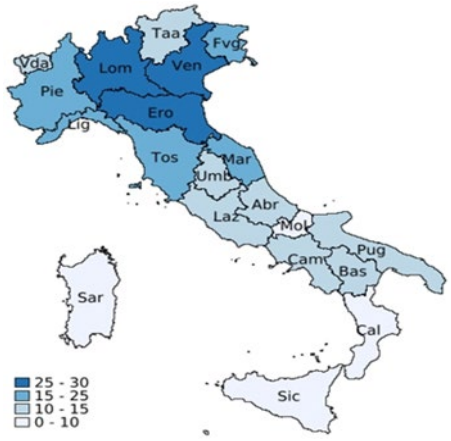
Total foreign openness in value-added terms may reflect the economy's sector composition. The more open regions, relative to size, have a high manufacturing share in their GDP absorbed abroad (Figure 3).

Manufacturing dominates the GDP absorbed abroad of the major northern regions, Friuli-Venezia Giulia, Tuscany, Marche, and Abruzzo (Figure 4). Private non-financial services are the most important sector in Lazio, the large southern regions, and the small northern regions (except for Friuli-Venezia Giulia).[16]

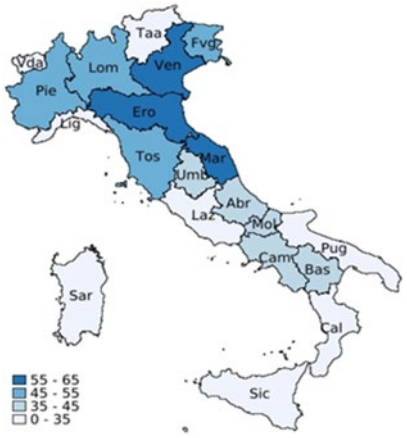
[16] Taking Italy as a benchmark, manufacturing and private non-financial services were the first two contributors to Italy's total VAX, reflecting, in the case of non-financial services, their dominant weight in Italy's GDP. Final foreign demand absorbed around 58 per cent of the total value-added of manufacturing in 2012. The equivalent share for the primary sector was about 30 per cent. In financial services and private non-financial ones, it was about 22 and 15 per cent.

*Figure 3 – Foreign absorption of regional GDP and manufacturing share*

a) GDP absorbed abroad (% of total GDP)

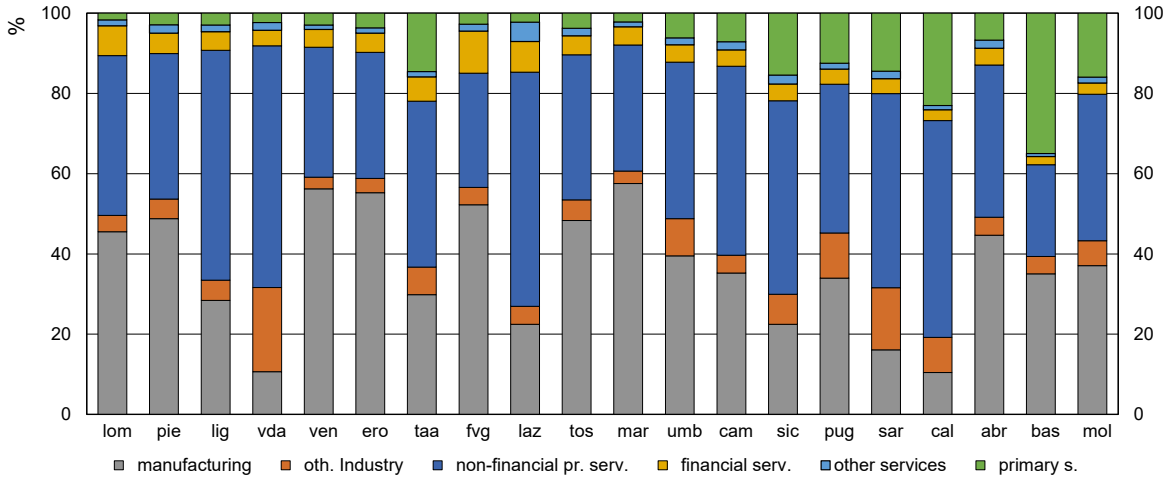



b) Manufacturing share in GDP absorbed abroad (%)




Source: Own elaborations on 'modified WIOD' data.

*Figure 4 – Sector composition of regional GDP absorbed abroad (1)*

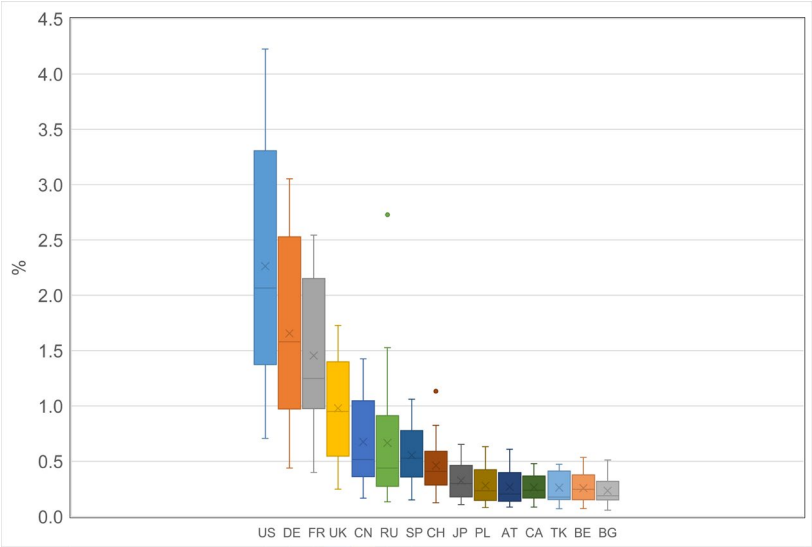



Source: Own elaborations on 'modified WIOD' data.
(1) Regions are ordered by macro-region (from North West to South) and GDP size. The indicators are computed using the complete sector detail of the datasets and aggregated into six main groups for ease of analysis and representation. The primary sector includes agriculture, forestry and fishing, mining and quarrying; other industry includes, energy, water and waste management and construction; financial services include insurance services; private non-financial services include wholesale and retail trade, repair, transport, storage and postal services, accommodation and food services, information, computer and communication, real estate services, professional, scientific, technical, administrative and support services; other services include public administration, education, human health, social, entertainment, cultural, sports and household services.

A large share of the impact of final foreign demand on Italy's GDP is from relatively few countries. The United States and Germany were the first two main contributors in 1995-2018 (Figure A.3). The other important countries were France, the United Kingdom, Spain, Switzerland, and some non-European countries, like China, Russia, and Japan. The United States lost some ground during the financial and sovereign crises of the early 2010s, while China's

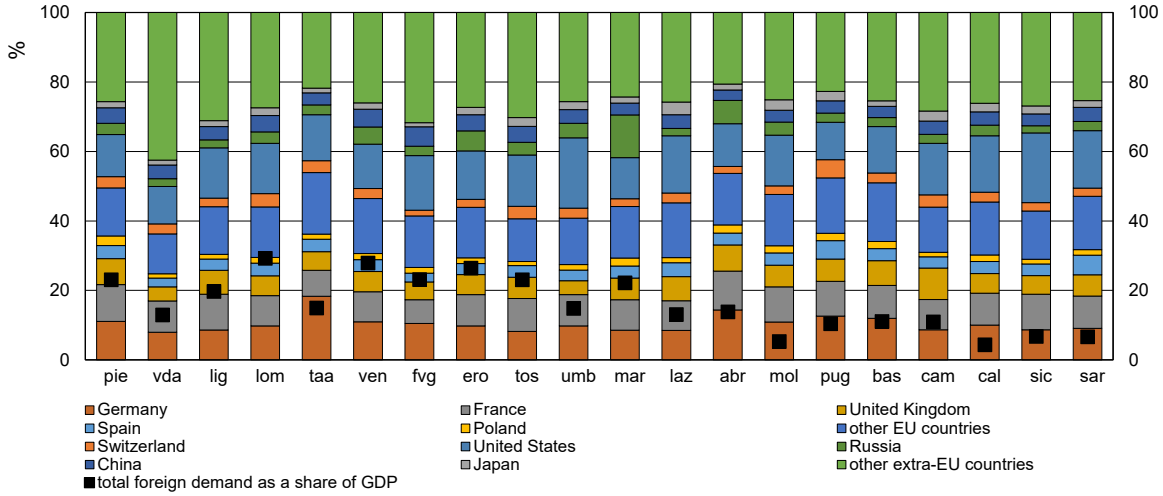
contribution has grown gradually. Russia rose in the standings between 2000 and 2013 and fell back in 2014. In general, the increase in Italian GDP absorbed abroad was from extra-EU countries: their share grew gradually from 9.7 to 13.7 per cent, while that of the EU rose only marginally (from 10 to 11 per cent). At the regional level, in 2012, the most important partners in value-added terms corresponded on average to Italy's, but with noticeable regional differences (Figures 5 and 6).

*Figure 5 – Boxplot of the shares of regional GDP absorbed by major destinations (1)*




Source: Own elaborations on 'modified WIOD' data.
(1) Top 15 countries per share, averaged over regional values: US=United States; DE=Germany; FR=France; UK=United Kingdom; CN=China; RU=Russia; SP=Spain; CH=Switzerland; JP=Japan; PL=Poland; AT=Austria; CA=Canada; TK=Turkey; BE=Belgium; BG=Bulgaria.

*Figure 6 – Composition of regional GDPs absorbed abroad by major destinations (1)*



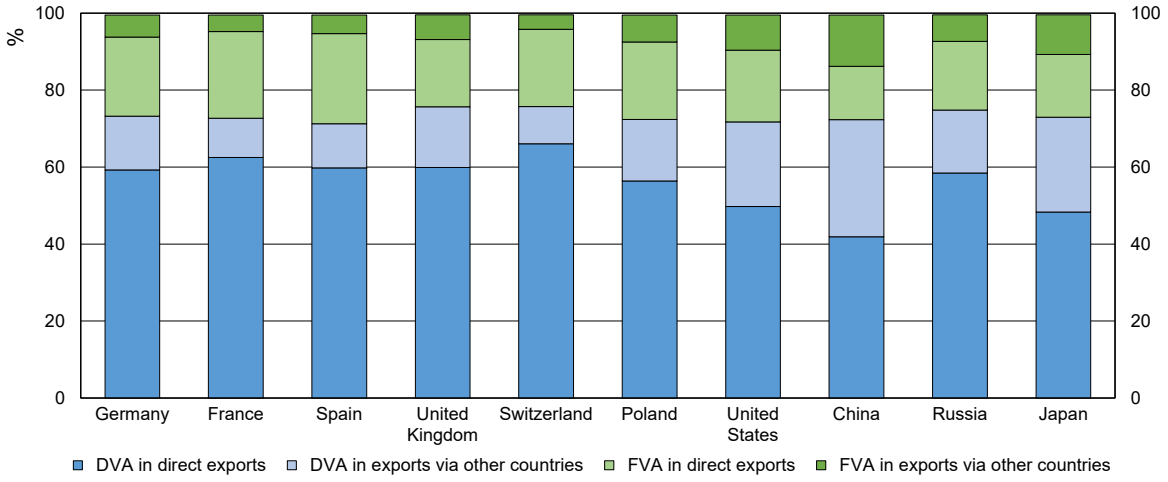

Source: Own elaborations on 'modified WIOD' data.
(1) Normalised by total foreign absorption. Regions in geographical order, from North to South. The legend reads from left to right and from top to bottom.

Measured by absorption, the relative importance of partner countries can differ from their weight in gross exports. The input-output indicator considers only the regional value-added contained in goods and services absorbed by the final demand of a given export market, either through direct exports or exports via other regions and countries. Instead, bilateral gross exports refer to direct exports that can only be partially absorbed by the direct importer and include foreign value added. The impact of absorption by the United States, China, the United Kingdom and Russia was, on average, higher than their weight in gross trade figures. That of partners like Germany, France and Switzerland was relatively lower (Figure A.4). This evidence reflects that the input-output indicator provides a more comprehensive picture of partner countries' importance, accounting for their role in global value chains.

### *5.2. Participation in national and international value chains: the paths of regional value-added to final destination*

Analysing the export channels through which the domestic value-added of an economy is absorbed abroad is a way to describe its participation in international value chains. In the case of countries, it is possible to distinguish between the channel of direct exports and that of indirect exports with other countries selling to the final absorber. The indirect channel represented by other regions should also be considered for regional economies. Benchmarking on the DVA absorbed by Italy's top ten foreign destinations, the total DVA share in direct and indirect bilateral gross export flows does not change significantly between countries. What changes most is the relative contribution of each export channel. For example, the DVA absorbed by European countries is mainly contained in direct flows; instead, the DVA absorbed by more distant countries, such as the United States, Japan and, above all, China, reaches them in a higher percentage through other countries' exports (Figure 7).

*Figure 7 – Breakdown of Italy's value added to major final foreign destinations (1)*



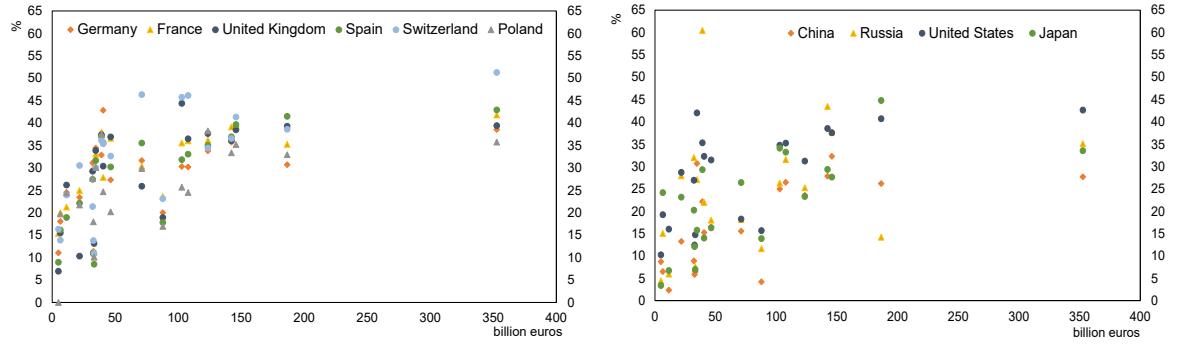

Source: Own elaborations on WIOD data.
(1) Excluding double counting, the per cent composition of total direct and indirect gross external trade flows to the final destination.

Similar evidence holds for regional bilateral DVA paths vis-à-vis Italy's top ten final destinations (for the definition of the indicators, see Section 4.2). The proportion of regional DVA

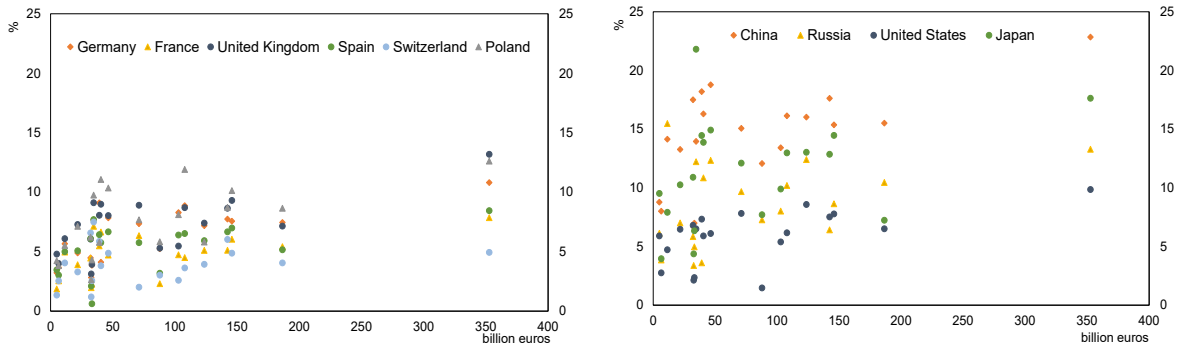
exported through direct export links is higher in the flows to European countries than those to further away extra-European countries (Figure 8.a). The flows going through other countries is proportionally higher for destinations outside the EU (Figure 8.b). There are also regional differences by economic size or the macro-areas to which they belong. For example, on average, the central and northern regions export their DVA through direct links and the intermediation of other countries in a higher proportion than the southern regions (Figure A.5).

*Figure 8 – Composition of regional DVA to major foreign destinations by main channels of absorption and regional GDP (1)*

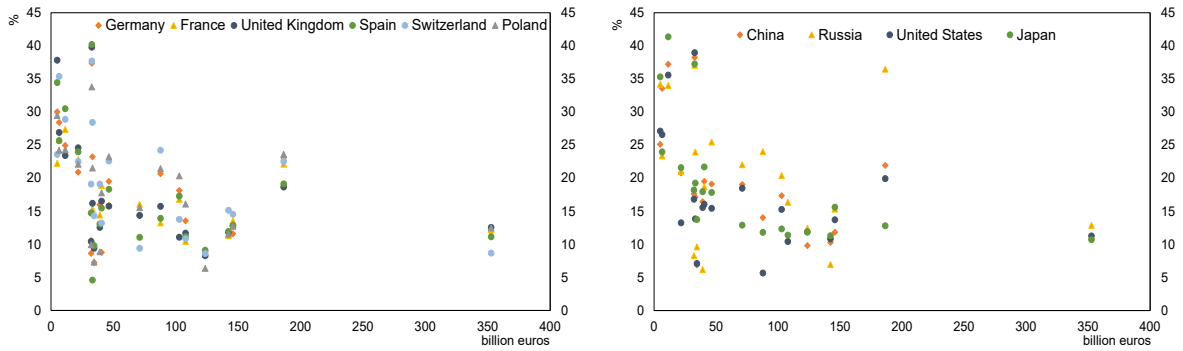
a. DVA in direct links




b. DVA through foreign countries




c. DVA through other regions




Source: Own elaborations on 'modified WIOD' data.
(1) DVA per cent of total direct and indirect gross exports to the destination on the vertical axis and regions' GDP on the horizontal axis.

To generalise this evidence, we pool the regional data and consider the following linear relationship:

$$path_{p,ij} = \alpha_{p,0} + \alpha_{p,1} size_i + \alpha_{p,2} size_j + \alpha_{p,3} distance_{ij} + \sum_k \beta_{p,k} X_i + \varphi_p C_{ij} + \delta_p South_i + \varepsilon_{p,ij} \quad (11)$$

Where *path* is the regional DVA content of a given export flow to a given foreign final destination as a share of total gross direct and indirect exports;[17] *p* stands for the four export flows examined (total, direct, and indirect via foreign countries or via other regions), *i* stands for regions, *j* for the 42 foreign countries of destination.[18] S*ize* is regional and partner country GDP; *distance* is the geodetic distance between the centre of a region and a country. The other regional characteristics ($X_i$) include factors that, according to the literature, might affect the degree of GVC participation, such as the importance of manufacturing in the regional productive structure or the internationalisation of regional firms (measured by the total stock of the equity component of regional inward and outward foreign direct investments in the previous year). [19] Both are fixed regional features. We also include the following group dummies: a) $C_{ij}$ for the region-country (0/1) *common border*, equal to one for couples of regions and countries sharing a common border and accounting for possible different dynamics in bilateral international relations of border regions due to geography; and b) *South* (0/1) dummy equal to one for the southern regions.

Table 1 reports the OLS estimates with robust standard errors clustered at the regional level of equation (11) for the different paths.

The coefficients for the regional features suggest that the DVA share from exports through direct links or other countries is higher for larger regions. In contrast, the path via other regional territories concerns regions of smaller size. In particular, the GDP coefficients, corresponding to the derivative of the DVA shares to regional GDP (measured in billions of euros), are positive for the direct export path and the indirect one via other countries (respectively around 0.12 and 0.02 percentage points) and negative for the path via other regions (around -0.11 points). The high correlation between the regional economic size and the manufacturing sector makes the latter redundant in most specifications. Foreign direct investments (FDIs) are often a relevant regional feature for correctly specifying the relationships. Still, in most cases, it cannot be rejected that their coefficients are not significantly different from zero. An exception is the role of inward FDIs in direct DVA exports.[20]

The coefficients of country size indicate that the DVA share through direct links is higher the larger the partner, while that via other countries or regions is higher the smaller the partner. As the distance from the foreign country increases, the DVA from direct exports decreases relative to total gross exports. Instead, the DVA from indirect exports grows, particularly

[17] The DVA shares from the direct and indirect export paths sum to the total DVA share.

[18] The econometric analysis does not include the bilateral path with the rest of the world.

[19] FDI data are compiled by the Bank of Italy in the context of Italy's balance of payments. They are publicly available for six regions (Emilia-Romagna, Lazio, Lombardy, Piedmont, Tuscany, and Veneto). The regional distribution of FDIs is skewed, partly reflecting the localisation of firms' headquarters.

[20] Correcting for heteroscedasticity with robust standard errors, we would reject that the following coefficients are not significantly different from zero: manufacturing for the total DVA path; inward and outward FDIs in the regressions of the DVA shares from total exports and those via other regions; the South dummy for the DVA share from exports via other regions. The t-statistic of the latter is also close to the 10 per cent significance threshold.

through other countries. Sharing common borders with a partner country implies a higher incidence of DVA from direct exports and a lower one from indirect exports. Finally, the incidence of the DVA from direct exports or exports via other countries is lower than average for southern regions.

*Table 1 – Determinants of the DVA paths to foreign final destinations (1)*

| | dependent variables: % DVA in bilateral direct and indirect gross exports, by path | | | |
|---|---|---|---|---|
| | DVA | DVA direct links | DVA foreign countries | DVA other regions |
| Regional GDP (bn eur) | 0.02 | 0.12*** | 0.02* | -0.11*** |
| | [0.32] | [3.68] | [1.95] | [2.99] |
| Partner country GDP (tn eur) | 0.03 | 0.41*** | -0.23*** | -0.16*** |
| | [0.74] | [9.87] | [10.69] | [3.60] |
| Distance (1000 km) | -0.14** | -0.71*** | 0.48*** | 0.09 |
| | [2.13] | [6.34] | [13.67] | [1.16] |
| Manufacturing (bn ) | 0.08 | | | |
| | [0.31] | | | |
| Outward FDI t-1 (bn) | 0.08 | -0.03 | -0.02 | 0.11 |
| | [0.64] | [0.85] | [1.44] | [1.28] |
| Inward FDI t-1 (bn) | -0.13 | -0.24*** | 0.01 | 0.13 |
| | [0.96] | [3.06] | [0.46] | [1.13] |
| Common border (0/1) | -5.27*** | 6.23*** | -5.14*** | -6.34*** |
| | [3.35] | [3.19] | [10.36] | [4.75] |
| South (0/1) | -5.72 | -8.54*** | -2.91** | 5.32 |
| | [1.72] | [3.16] | [2.84] | [1.63] |
| Constant | 51.57*** | 21.89*** | 7.82*** | 22.10*** |
| | [25.89] | [6.42] | [8.54] | [6.24] |
| Observations | 840 | 836 | 840 | 840 |
| R-squared | 0.31 | 0.45 | 0.22 | 0.31 |

(1) Linear regression with standard errors clustered at the regional level. Robust t statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

### *5.2.1 Robustness*

To verify the robustness of the previous results, we rerun the regressions alternatively absorbing the role of regional and/or destination country characteristics with regional and partner-country fixed effects.

First, to assess the role of regional characteristics, the size of partner countries, bilateral distance and contiguity are absorbed by the partner countries' fixed effects. The results, reported in Table 2, are consistent with those presented in Table 1. The share of explained variance increases for direct and indirect DVA pathways through other countries. Given the cross-sectional nature of the data, regional GDP absorbs much of the specified regional characteristics. Taken individually, these characteristics show a negative correlation with the DVA path through other regions and a positive correlation with the other two routes, suggesting that the path through other regions is more typical in smaller regions, where there is a smaller manufacturing sector and lower internationalisation of their firms; the opposite is true for the other two profiles (Table B.1).

*Table 2 – DVA paths and regional features (1)*

| | dependent variables: % DVA in bilateral direct and indirect gross exports, by path | | | | |
|---|---|---|---|---|---|
| | DVA | DVA | DVA direct links | DVA foreign countries | DVA other regions |
| Regional GDP (bn) | 0.02 | 0.03*** | 0.12*** | 0.02* | -0.11*** |
| | [0.33] | [3.37] | [3.55] | [1.98] | [2.90] |
| Manufacturing (bn) | 0.08 | | | | |
| | [0.30] | | | | |
| Outward FDI t-1 (bn) | 0.08 | | -0.03 | -0.02 | 0.11 |
| | [0.61] | | [0.83] | [1.48] | [1.22] |
| Inward FDI t-1 (bn) | -0.13 | | -0.23*** | 0.01 | 0.13 |
| | [0.93] | | [2.91] | [0.36] | [1.07] |
| South (0/1) | -5.64 | -6.30* | -8.86*** | -2.69** | 5.48 |
| | [1.65] | [1.84] | [3.17] | [2.61] | [1.64] |
| Constant | 50.97*** | 51.42*** | 20.21*** | 9.00*** | 22.01*** |
| | [25.91] | [35.06] | [5.96] | [9.28] | [6.22] |
| Partner country fixed effects | yes | yes | yes | yes | yes |
| Observations | 840 | 840 | 836 | 840 | 840 |
| R-squared | 0.34 | 0.33 | 0.57 | 0.75 | 0.32 |

(1) Linear regression with multiple fixed effects. Clustered standard errors. Robust t statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Second, to focus on the role of partner country features (including bilateral distance and contiguity), regional characteristics are absorbed by regional fixed effects. In this case, also the estimates reported in Table 3 are consistent with those of Table 1.

*Table 3 – DVA paths, partner country size and distance (1)*

| | dependent variables: % DVA in bilateral direct and indirect gross exports, by path | | | |
|---|---|---|---|---|
| | DVA | DVA direct links | DVA foreign countries | DVA other regions |
| Partner country GDP (tn) | 0.02 | 0.39* | -0.23 | -0.15*** |
| | [0.45] | [1.95] | [1.15] | [3.88] |
| Distance (1000 km) | -0.12* | -0.68*** | 0.48* | 0.09 |
| | [1.88] | [2.86] | [1.91] | [1.61] |
| Common border (0/1) | -3.80*** | 6.73*** | -5.37*** | -5.17*** |
| | [4.47] | [6.53] | [5.66] | [10.70] |
| Constant | 52.16*** | 25.45*** | 8.11*** | 18.69*** |
| | [141.98] | [31.86] | [10.14] | [67.85] |
| Regional fixed effects | yes | yes | yes | yes |
| Observations | 840 | 836 | 840 | 840 |
| R-squared | 0.77 | 0.63 | 0.32 | 0.76 |

(1) Linear regression with multiple fixed effects. Clustered standard errors. Robust t statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Distance and the *common border* dummy are the only variables in our regression framework that vary between regions and countries. We can further check the robustness of the previous results by absorbing regional characteristics and those of countries with fixed regional and country effects. The signs of the coefficients are the same as those of the OLS regression,

except for distance in the total DVA path (Table 4). The size of the coefficients differs slightly (smaller for the DVA from direct links and exports through other countries, and higher for the other indirect pathway and the total DVA). However, the distance coefficients do not differ significantly from zero.

Using the log transformation of distance, coefficient estimates point to a positive relationship between distance and the share of DVA from indirect exports (via other countries and regions). The contiguity dummy absorbs part of the distance effect. Without this dummy, estimates confirm a positive correlation between distance and indirect DVA shares and a negative correlation with the direct export path. In other words, the share of DVA from direct exports decreases in favour of the indirect component as the distance from the absorbing country increases.

*Table 4 – DVA paths and the roles of bilateral distances and contiguity (1)(2)*

| | dependent variables: % DVA in bilateral direct and indirect gross exports, by path | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | DVA | | DVA direct links | | DVA foreign countries | | DVA other regions | |
| | *Coeffi-cients* | *R-squared* | *Coeffi-cients* | *R-squared* | *Coeffi-cients* | *R-squared* | *Coeffi-cients* | *R-squared* |
| | *With regional and country fixed effects* | | | | | | | |
| Distance (1000 km) | 1.28 | | -0.48 | | 0.25 | | 1.29 | |
| & | [1.56] | 0.8 | [0.40] | 0.76 | [0.58] | 0.85 | [1.40] | 0.78 |
| Common border (1/0) | -5.12*** | | 3.85** | | -2.85*** | | -6.20*** | |
| | [3.72] | | [2.81] | | [4.23] | | [5.13] | |
| Distance (ln) | 0.89 | | -2.02 | | 0.74* | | 2.08** | |
| & | [1.05] | 0.8 | [1.57] | 0.76 | [1.86] | 0.85 | [2.00] | 0.78 |
| Common border (1/0) | -4.85*** | | 2.46 | | -2.36*** | | -5.03*** | |
| | [3.40] | | [1.49] | | [3.31] | | [3.80] | |
| Distance (1000 km) | 1.71** | 0.79 | -0.81 | 0.75 | 0.48 | 0.85 | 1.81** | 0.78 |
| | [2.08] | | [0.69] | | [1.15] | | [1.98] | |
| Distance (ln) | 1.78** | 0.79 | -2.46** | 0.76 | 1.17*** | 0.85 | 2.99*** | 0.78 |
| | [2.08] | | [2.16] | | [3.02] | | [3.09] | |
| Observations | 840 | | 836 | | 840 | | 840 | |

(1) Linear regression with multiple fixed effects. Robust t statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%. (2) Regressions include a constant, not reported in the table.

The relationship between distance and the shares of DVA requires further consideration. The negative elasticity between distance and bilateral gross trade flows in goods is a well-documented finding of the gravity equation and the gravity models. The relationship between the DVA content of export flows of goods and services and distance is less straightforward, particularly for flows that indirectly reach final destinations through diversified inter-regional and international routes.[21]

DVA shares are the bilateral DVA ratio to gross direct and indirect export flows. Equation (11) exhibits similarities with the log-linear version of gravity models of trade in goods, which typically assume a multiplicative relationship between the explanatory variables. For further

[21] These indirect paths might minimize trade costs or barriers, such as transportation, economies of scale, and regulations, while also reflecting choices connected to the fragmentation of production.

robustness, we consider a simpler version of equation (11), where the dependent variables are the log values of DVA flows by type of pathway rather than their shares. The explanatory variables are the natural logarithm of regional and national GDP, distance, and the *common border* dummy. Gross direct and indirect exports are also included in the dependent variables for comparison. The sign of the difference between the distance coefficients of DVA flows and the distance coefficients of gross exports should be consistent with those of the distance coefficients of the regressions with DVA shares as the dependent variable.
The equation is estimated as a regression with multiple fixed effects absorbing regional and/or country features. The results indicate a negative relationship with distance for all flow types, as in gravity models for trade (Table 5).

*Table 5 – Bilateral 'DVA flows' and gross exports and gravity (1)*

| | Gross exports (ln) | | DVA flows (ln) | | DVA flows- direct links (ln) | | DVA flows- foreign countries (ln) | | DVA flows- other regions (ln) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Coeffi-cients* | *R-squared* | *Coeffi-cients* | *R-squared* | *Coeffi-cients* | *R-squared* | *Coeffi-cients* | *R-squared* | *Coeffi-cients* | *R-squared* |
| | *With regional and country fixed effects* | | | | | | | | | |
| Distance (ln) | -0.17** | | -0.15** | | -0.24* | | -0.07** | | -0.04** | |
| & | [2.08] | | [1.95] | | [1.8] | | [2.14] | | [1.97] | |
| Common border | 0.42*** | 0.98 | 0.31** | 0.98 | 0.52*** | 0.95 | 0.01 | 0.99 | -0.03 | 0.99 |
| | [3.38] | | [2.61] | | [2.96] | | [0.29] | | [1.05] | |
| Distance (ln) | -0.25*** | 0.98 | -0.21*** | 0.98 | -0.33*** | 0.95 | -0.07*** | 0.99 | -0.03*** | 0.99 |
| | [3.38] | | [3.08] | | [2.83] | | [2.40] | | [1.94] | |
| | *With country fixed effects* | | | | | | | | | |
| Regional GDP (ln) | 1.21*** | 0.93 | 1.27*** | 0.92 | 1.56*** | 0.86 | 1.42*** | 0.89 | 0.97*** | 0.97 |
| | [17.15] | | [16.81] | | [18.83] | | [14.08] | | [16.16] | |
| | *With regional fixed effects* | | | | | | | | | |
| Partner country GDP (ln) | 0.62*** | 0.85 | 0.62*** | 0.86 | 0.60*** | 0.81 | 0.68*** | 0.92 | 0.61*** | 0.84 |
| | [9.34] | | [9.36] | | [7.32] | | [11.49] | | [9.44] | |
| Observations | 840 | | 840 | | 836 | | 840 | | 840 | |

(1) Results for distinct linear regressions with multiple fixed effects. Robust t statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

In regressions that include distance and the contiguity dummy, the difference between the distance coefficient for all DVA flows and that of gross exports is not significantly different from zero. In regressions without the contiguity dummy, the difference between the distance coefficients is significantly different from zero for the DVA content in indirect export flows. This result suggests a positive relationship between distance and the incidence of DVA from indirect export flows, as indicated by regressions where the dependent variables were DVA shares.
Our data do not suffer from the zero-value problems characteristic of fully-fledged gravity models. However, we verify the results against estimates of Poisson's Pseudo Maximum Likelihood (PPML) with multiple levels of fixed effects to account for Santos Silva and Tenreyro's (2006) criticism of constant multiplicative elasticity models. PPML estimates are close to regression estimates, particularly those without the contiguity dummy (Table B.2).

*5.3. Participation in national and international value chains: the GVC indicators*

This Section examines the participation of Italian regions in national and international value chains using a class of GVC-related trade indicators (see sub-section 4.3 for their definitions). First, it presents the results of the indicators for total extra-regional trade and those that aim to capture the inter-country segment of global value chains. It then examines the similarities and differences between regions, using the taxonomies of the types of participation in global value chains as outlined in the literature.

*5.3.1 The indicators*

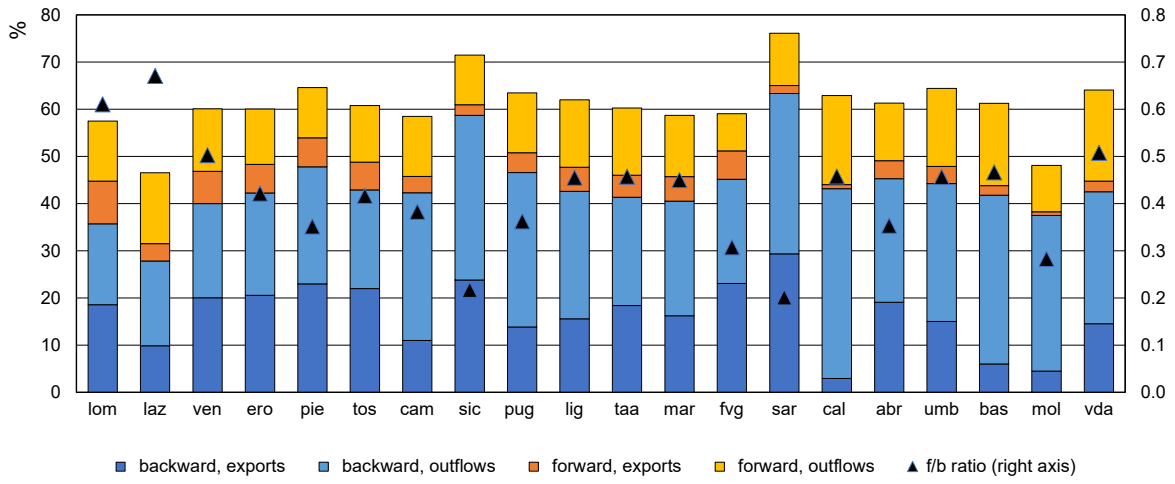
In the interregional-intercountry context, the RGVCt-index applied to total regional external flows is the analogous version of the inter-country GVC-related trade indicator. However, there is a significant difference. The regional indicator is a combined measure of the effects of the fragmentation of production chains between the Italian regions and foreign countries because, from a regional perspective, the value chains' national/interregional and international legs can be intertwined. As a result, the average of the regional indices (61.0 per cent) is higher than the GVC-related trade index computed for Italy in an inter-country setting.[22] Aside from Molise, the lowest values of the RGVCt-index are those of Lombardy and Lazio, the two largest regions, and likely at the helm of national value-chains (Figure 9). The highest values are those of Sicily and Sardinia, which play an important role in the supply chain of industrial and energy raw materials for the rest of the country.

The breakdown of the index into the contributions of outflows to other regions and exports and the forward and backwards components hints at the relative importance of the national and international segments of the value chains for regional trade. It shows, for example, that the national segment (gross outflows) weighs heavily on the total value of the index and that the backwards component dominates the forward one.

While the index level is a measure of regional participation in national and international value chains, the ratio between its forward and backwards components (forward-to-backwards ratio, also f/b ratio in what follows) indicates the relative benefit of the participation. Higher values in the ratio point to more favourable participation patterns because the DVA content in GVC-related trade is relatively higher than the value added from outside (IVA or NVA). In the international context, countries rich in natural resources are expected to exhibit values above unity because their exports enter several downstream production processes and cross several borders; countries endowed with capital and skilled labour, may have higher or lower values, depending on the relative intensity of physical capital or skilled labour in upstream versus downstream stages of production; countries with an abundant unskilled labour force and hosting low-value production phases are expected to record relatively low levels of the ratio (World Bank Report, 2020).

[22] According to WIOD data from 2012, the value of the GVC-related trade index for Italy was 45.3 per cent. The indicator showed a general tendency to increase until 2011 and then to slow down to an average of around 40 per cent (Figure A.7).

*Figure 9 –RGVCt-indices by type of regional external flows and GVC components (1)*




Source: Own elaborations on 'modified WIOD' data.
(1) Regions are ordered by decreasing GDP value on the horizontal axis. Value of the RGVCt-index by main components on the left vertical axis and forward/backwards (f/b) ratio on the right axis (units).

As regards the Italian regions, the f/b ratio of the RGVCt index is below unity, indicating a prevailing backwards component over the forward one. Relative to the regional average, Lazio and Lombardy are in the best positions, while Sardinia and Sicily are in the least favourable. Regional disparities in value chain participation indices may stem from differences in the sectoral composition of their external flows. On average, industries show varying degrees of fragmentation and f/b ratios. Manufacturing records the highest degree of fragmentation and the lowest f/b ratios. Gross exports contribute significantly to the RGVCt index of the manufacturing sector in many regions, and the upstream component dominates the downstream component everywhere (Figure 10, panel a). The high levels of the index and upstream component of Sardinia, Sicily and Valle d'Aosta reflect the weight of the processing of energy raw materials in the first two regions and base metals in the other.
Gross outflows make the most significant contribution to the RGVCt index in private nonfinancial services. In most regions, the ratio between the forward and backwards components is still below unity but, on average, higher than in manufacturing (Figure 10, panel b). [23]

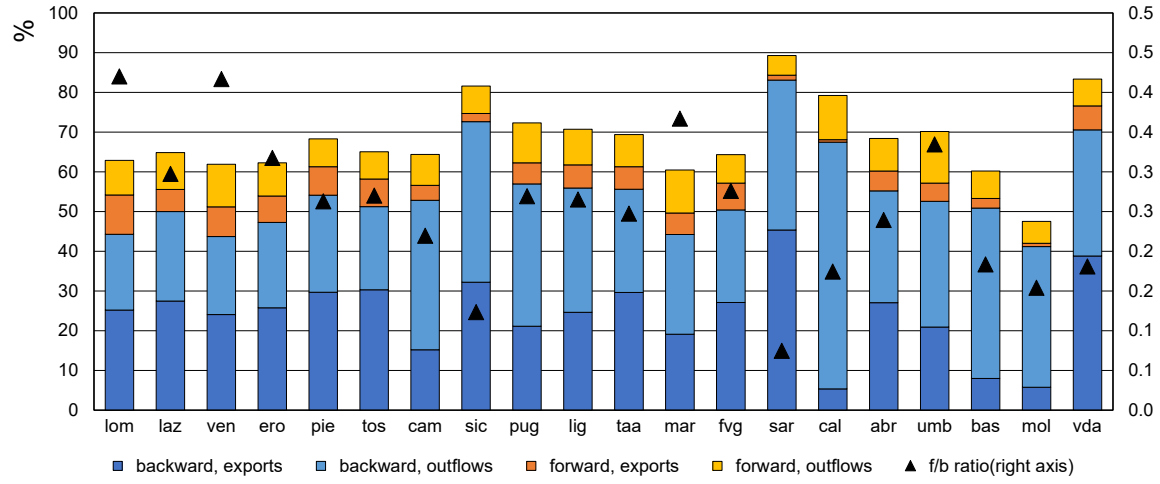
The RGVCx-index aims to improve the measurement of regional participation in the international segments of GVCs by isolating components that only involve foreign interactions. It is computed on regional exports and includes only value added from abroad in the backwards component. As expected, its values are lower than those of the RGVCt-index, and the regional average is more comparable to the GVC-related trade index computed for Italy. Concerning total exports, Sardinia and Sicily stand out for the high values of their indices due to a high backwards component (Figure 11, panel a).
The lowest levels of participation are those of Marche, Calabria and the smallest southern regions. In the case of Sardinia and Sicily, the backwards component is about 75 and 93 per cent, respectively, of the total external value added incorporated in export flows, indicating

[23] Regarding the other main sectors, the RGVCt-indices are lower than average for financial services and higher for other industry. In both cases, gross outflows make the most part of the index.

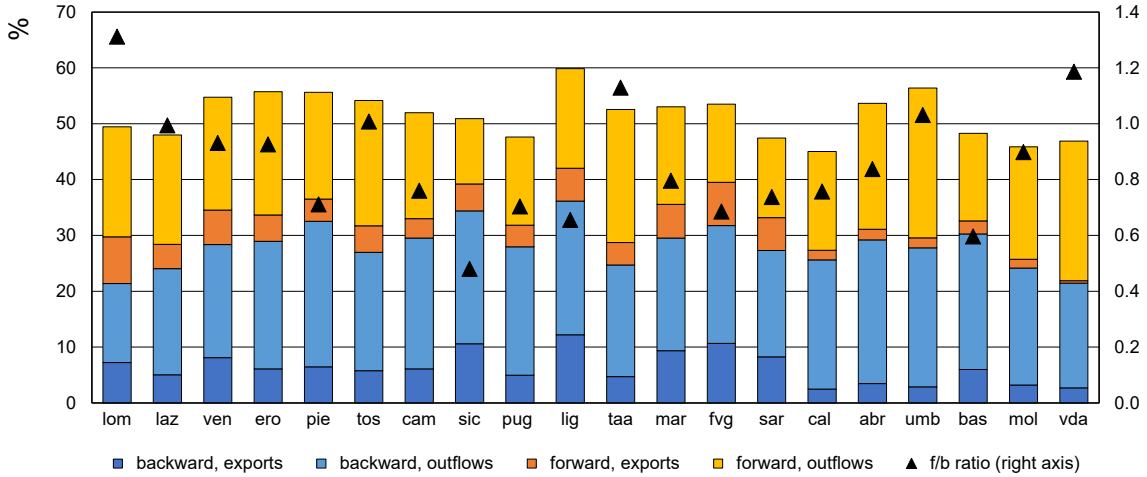
that their GVC participation relies moderately or marginally on the import content from other Italian regions. The share is also high for Lombardy (about 68 per cent), while for the other regions it is on average about 54 per cent and much lower for Calabria and the smaller regions (Basilicata, Molise, and Valle d'Aosta).
As regards the manufacturing sector (Figure 11, panel b), Sardinia and Sicily are once again outliers due to their high level of participation in GVCs and low f/b ratio. In this case, the backwards component of the index also represents a very high share of the external value-added of exports. On the contrary, Basilicata stands out for a high f/b ratio and a relatively low participation in GVCs. The backwards component is the lowest among the regional indices. It is also the lowest percentage of total external value-added of exports (around 43 per cent), indicating that the region's participation in GVCs largely depends on imports from other Italian regions. The other smaller regions (Molise, Valle d'Aosta) and Calabria have data similar to those of Basilicata.

*Figure 10 – RGVCt-index, by region, sector and GVC-leg (1)*

a) Manufacturing

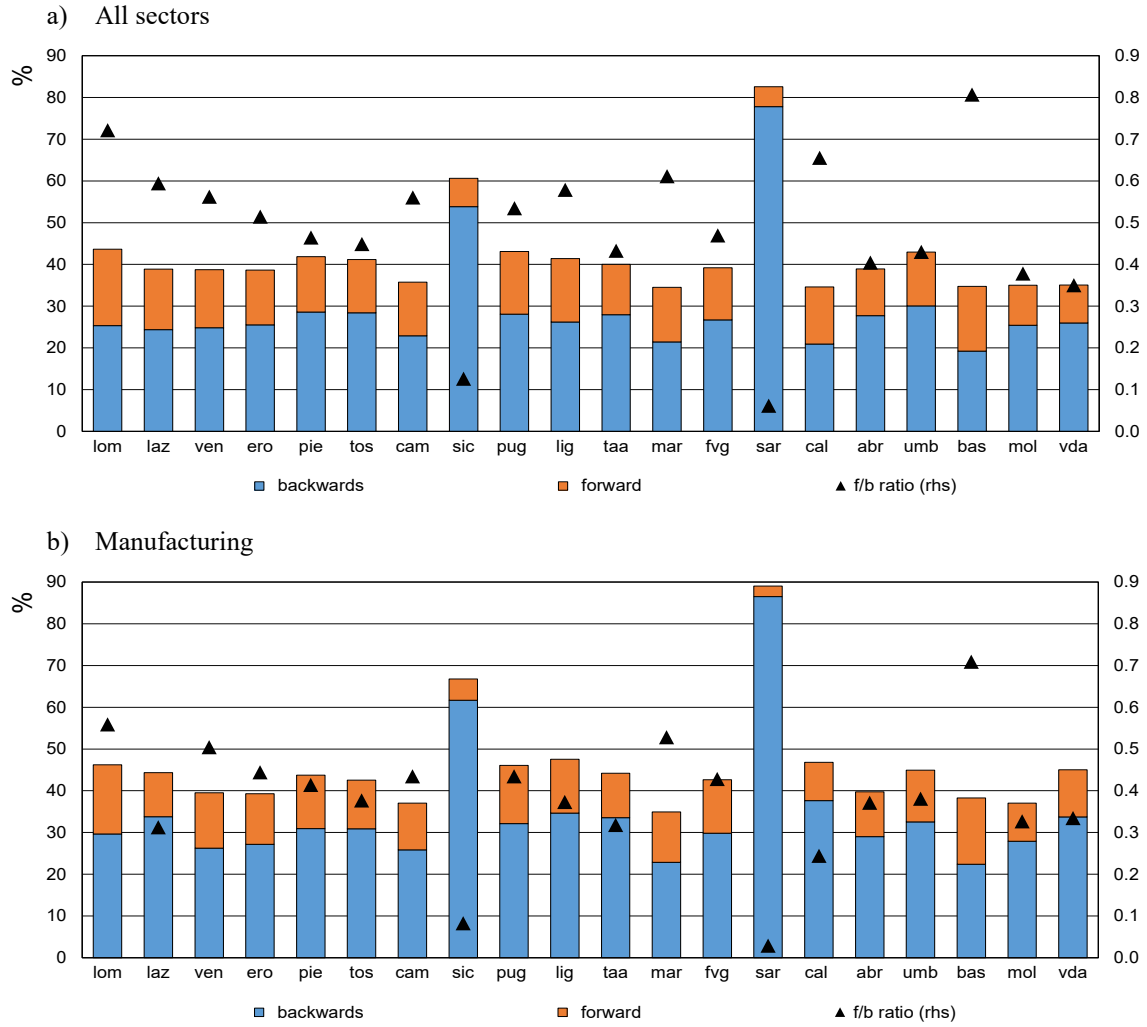



b) Private non-financial services




Source: Own elaborations on 'modified WIOD' data.
(1) Regions on the horizontal axis ordered by decreasing GDP size; value of the RGVCt-index on the left vertical axis and forward/backwards (f/b) ratio on the right axis (units).

*Figure 11 – RGVCx-index for the Italian regions and forward-to-backwards ratios (1)*




Source: Own elaborations 'modified WIOD' data.
(1) Regions on the horizontal axis ordered by decreasing GDP size; value of the RGVCx-index on the left vertical axis and forward/backwards ratio on the right axis (units).

### *5.3.2 Taxonomies and international comparisons*

This Section aims to account for the observed regional differences in the GVC-related trade indices which, as mentioned above, may depend on specific regional characteristics that affect GVC configuration decisions (e.g. resource allocation, productivity, size, geography, quality of institutions, political stability, regional trade agreements). Given the limited number of observations available, the analysis adopts a taxonomic approach. It applies the classification criteria proposed by the World Bank (World Bank, 2020) to examine how the backwards and forward components of the regional indices by type of participation vary compared with those observed for countries.

The country classification proposed by the World Bank (World Bank, 2020) is primarily based on the size of the primary, manufacturing, and business services sectors in value-added exports, and the importance of the backwards component of the GVC-related trade index, taking

into account the different dimensions of countries. In particular, it identifies a first group of countries (called *Commodities*) which have a limited share of manufacturing in exported value added and limited backwards links in manufacturing GVCs. Among the remaining countries, it identifies a second group (called *Innovative activities* or IA) with R&D expenditure and intellectual property revenues above a certain percentage of GDP. A third group (called *Advanced manufacturing and services* or AMS) is composed by countries with high proportions of manufacturing and business services out of total exported DVA and backwards links in manufacturing GVCs. The remaining countries are classified as *Limited manufacturing* (LM) countries.

The World Bank's (2020) findings indicate that the backwards component of countries' GVC-related trade indices is the lowest for those specialised in commodities and starts to expand for countries in the LM group. It increases further for those specialising in advanced manufacturing and services (AMS), which are highly reliant on imported inputs for exports; finally, it bends slightly lower for the countries in the innovative group because their activities are less dependent on imported inputs. The forward component has a 'smile' shape: it decreases between the commodity and LM groups, and rises slightly with the AMS countries and more decisively with the IA ones. Indeed, a country abundantly endowed with natural resources or agriculture shows high forward integration. With LM participation, forward integration decreases because commodities are less important in trade, and the manufacturing sector at this stage is less likely to be used as an input in destination countries. The likelihood increases when switching to GVC participation with advanced manufacturing and services, and especially with innovative activities.

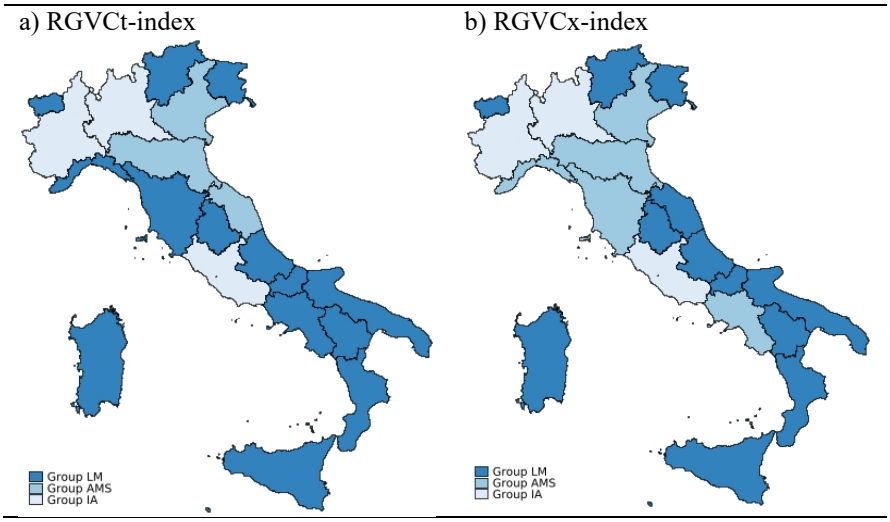
The application of the World Bank criteria to regional participation in national and international value chains, as measured by the RGVCt index, leads to the identification of three types of participation (see Appendix C.2, for further details): IA, characterising three Centre-North regions (Lazio, Lombardy and Piedmont); AMS, applicable to three other Centre-North regions (Emilia-Romagna, Marche and Veneto); and LM, for the remaining regions (Figure 12, panel a).[24] The regional classification changes slightly when considering the purely global segment of the value chains, as measured by the RGVCx-index (Figure 12, panel b). The differences are due to changes in the sectoral composition of value-added exports (with the share of manufacturing and business services increasing in some regions) and the size of the backwards component in manufacturing GVCs. The number of AMS regions increases to five, with the addition of two Centre-North regions (Liguria and Tuscany) and a southern region (Campania), and the transition of Marche to an LM region-type. Instead, the group of IA-type regions remains unchanged.

As observed in country analysis, the average values of the forward component of regional GVC-participation indices by participation-type increase between the LM, AMS and IA groups. Regarding participation in national and intercountry chains, as measured by the RGVCt-index, the increase between AMS and IA types is smaller than observed for countries (Figure 13, panel a). In the case of participation in the pure global segment, as measured by the RGVCx-index, the increase is faster and more in line with expectations (Figure 13, panel b). On the contrary, the backwards components decrease instead of increasing between the LM and AMS types. They fall further for IA regions in the case of the RGVCt-index, while the difference is slight in the case of the RGVCx-index. One possible explanation is that IA and partly AMS regions are among the largest ones and therefore, need to use external value-

[24] Notice that the processing of energy commodities, a relevant activity for Sardinia and Sicily, is classified in the manufacturing sector.

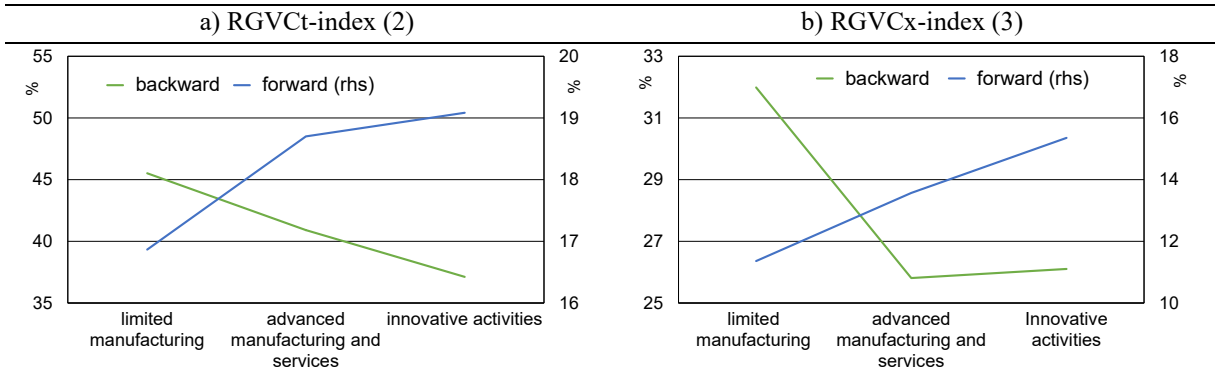
added less. Moreover, the LM group includes Sardinia and Sicily, the regions with the highest backwards components. Without these regions, the curves would be much flatter. The f/b ratio increases moderately shifting from LM to IA types, more markedly in the case of participation in the purely global segment of the value chains, indicating that the Italian regions occupying the most advantageous positions in the intercountry and interregional value chains are those that combine manufacturing with advanced services and innovative activities.

*Figure 12 – Regional types of participation in global value chains (1)*




Source: Own elaborations on WIOD and 'modified WIOD' data.
(1) WB participation types: IA – Innovative activities; AMS – Advanced manufacturing and services; LM – Limited manufacturing.

*Figure 13 - Backwards and forward participation in global value chains by type (1)*



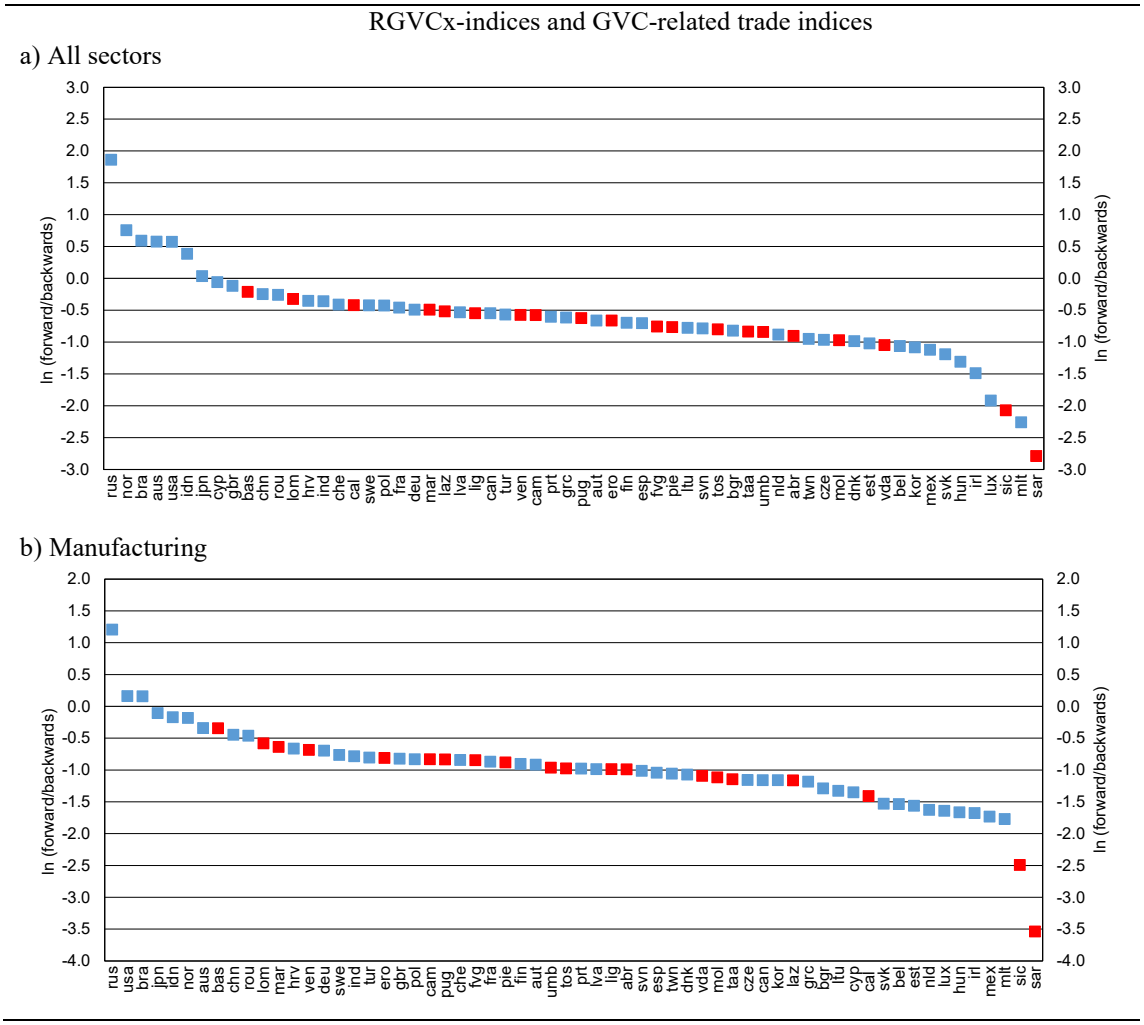

Source: Own elaborations on 'modified WIOD', Istat, and Bank of Italy data.
(1) Participation types are plotted on the horizontal axis, and the values of the backwards or forward components of the indices are plotted on the vertical axis. – (2) Innovative activities group includes Lazio, Lombardy, and Piedmont; Advanced manufacturing and services includes Emilia-Romagna, Marche, and Veneto; Limited manufacturing includes all other regions. – (3) Innovative activities group includes Lazio, Lombardy, and Piedmont; Advanced manufacturing and services includes Campania, Emilia-Romagna, Liguria, Tuscany, and Veneto; Limited manufacturing includes all other regions.

The RGVCt-index is unsuitable for international comparison when no sub-national detail is available for other countries, as in the WIOD data.

The RGVCx-index is more appropriate for the purpose, as it measures regional participation in the purely global segment of value chains and can be compared with countries' GVC-related trade indices. However, this index potentially could underestimate backwards integration that takes place with other national territories, especially in the case of smaller regions.

A way to assess the position of Italian regions in global value chains is to compare internationally the f/b ratios of the participation indices. According to this criterion, and concerning total trade, Basilicata, Lombardy, and Calabria are the regions that benefit most from participation (Figure 14, panel a).

*Figure 14 - Forward-to-backwards ratios: regions and countries (1)*




Source: Own elaborations on WIOD and 'modified WIOD' data.
(1) Countries' GVC-trade related indices are computed from WIOD, and regional RGVCx-indices are computed from 'modified WIOD'—Italian regions in red. The rest of the world is not reported, but would fit in the upper part of the curve (both for all sectors and manufacturing).

Lombardy is an IA region. Calabria and Basilicata are LM regions with a significant share of the primary sector and non-manufacturing industry in their value-added exports, which can explain their good positioning in the f/b spectrum. Furthermore, the two regions exploit more than others upstream integration with other Italian territories for their exports. The other regions that compare relatively well internationally and have f/b ratios higher than the WIOD countries' global average (of 0.6, or -0.6 in natural logarithms) are three, namely: Lazio, the second-largest region of the country, highly specialised in services; Liguria and Marche, two smaller regions of the Centre-North.
All WB types are represented in this group of regions, and half are IA or AMS regions. The LM regions are characterized by a higher-than-average weight of the primary sector and non-manufacturing industry in their value-added exports or by a lower use of foreign value-added, thanks to the possibility of relying on inputs from other regions. The group of countries with higher-than-average f/b ratios includes many European countries (such as Germany, France, Great Britain, Switzerland and Norway), the United States, Japan, some resource-rich countries, and China. Italy as a whole would figure in this group, too. All other regions exhibit a lower-than-world-average f/b ratios. These include important manufacturing regions of IA or AMS type according to WB criteria, such as Piedmont, Emilia-Romagna and Tuscany. Sicily and Sardinia are at the opposite end of the spectrum, providing small amounts of local value added together with foreign inputs.

Concerning the manufacturing sector, thirteen regions enjoy favourable f/b ratios compared to the global average (of 0.4, or -10 in natural logarithms): in the North, all major regions (Lombardy, Veneto, Emilia-Romagna, Piedmont) and Friuli-Venezia Giulia and Liguria; in the Centre, Tuscany, Marche, and Umbria; in the South, Campania, Puglia, Abruzzo and Basilicata. Basilicata, Lombardy, and Marche are the regions that benefit most from participation. The IA and AMS regions are all represented in the group, except for Lazio. A few LM regions are represented as well. Regarding the other countries, as for total trade, the largest EU economies have higher-than-average f/b ratios, as do the United States, Japan, and China, among others. Italy as a whole would figure in this group too. Sardinia and Sicily record the lowest f/b ratios.

The WB taxonomy suggests that the IA and AMS regions are the ones that more frequently participate in GVCs under favourable terms, especially in manufacturing They correspond mainly to the strong areas of the Centre-North for manufacturing and business services, where the most important firms and business groups in the country are located. Our international comparison also highlights some southern regions as being among the territories that benefit from participation in global manufacturing chains.

## 6. Conclusions

This work deals with the external transactions of the Italian regions, utilizing an approach similar to that proposed for international trade by the inter-country input-output (ICIO) literature studying global value chains. With the aim of reassessing in value-added terms what we know about the Italian regions' foreign trade from official statistics, the study uses several established indicators in the ICIO literature to document the diverse integration of the Italian regions into the international economy. It does so from two angles: an analysis of the path of domestic value added to the countries of absorption; and an adaptation of the global value

chain-related trade indices conceived for the intercountry framework to the interregional and intercountry context.

Although based only on a single-year of data, the analysis shows how differently the Italian regions participate in the global economy. The examined indicators do not radically change the picture we know from official data, but provide a better description of how the regions interact to reach foreign markets and participate in global value chains.

Final foreign demand impacts the economic activity of the Italian regions through different channels, whose relative importance varies among regions, reflecting their size and, to some extent, the distance and size of their partner countries. Large and highly developed manufacturing regions (mainly from the Centre-North) are open to final foreign demand, particularly through direct exports. Other regions expand their export links indirectly, participating in global value chains (GVCs) via other countries or regions.

Regarding regions' participation in production chains, those specializing in manufacturing and innovative activities and services hold a relatively advantageous position in national and international value chains.

Notwithstanding the structural nature of the analysis, some changes in the sectoral and partner-country composition of production and trade might have taken place (for example, more up-to-date results for Italy show an increase in the importance of China and a decrease in that of Russia). Keeping track of these changes is essential for applied economic analyses, but knowing what the application of a given methodology can offer is the first step to enhancing knowledge. Future work could examine a lengthier period and delve deeper into the relationship between regional trade, regional features (for example, region and country size, degree of development, endowments, functioning of institutions), regional growth and welfare. The development of suitable and reliable long-time-span datasets is a prerequisite.

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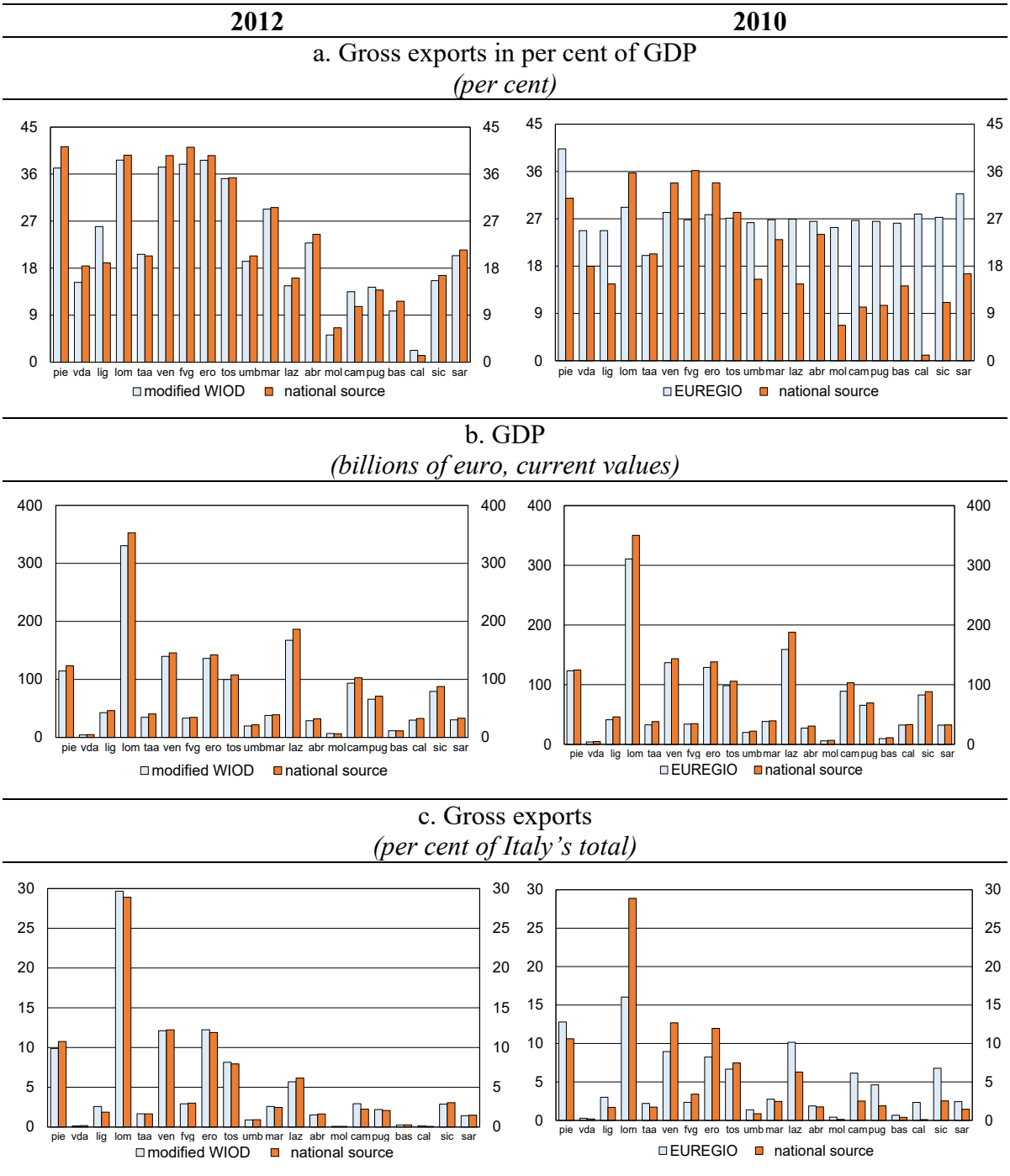
## Appendix

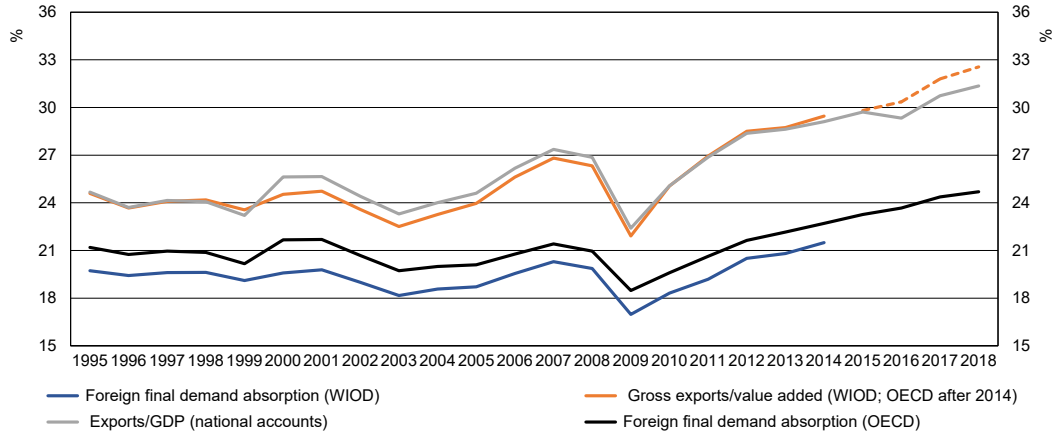
### A. Figures

Figure A.1. – A comparison between Italy's regional official statistics and IRIC-IO datasets ('modified WIOD' and EUREGIO)



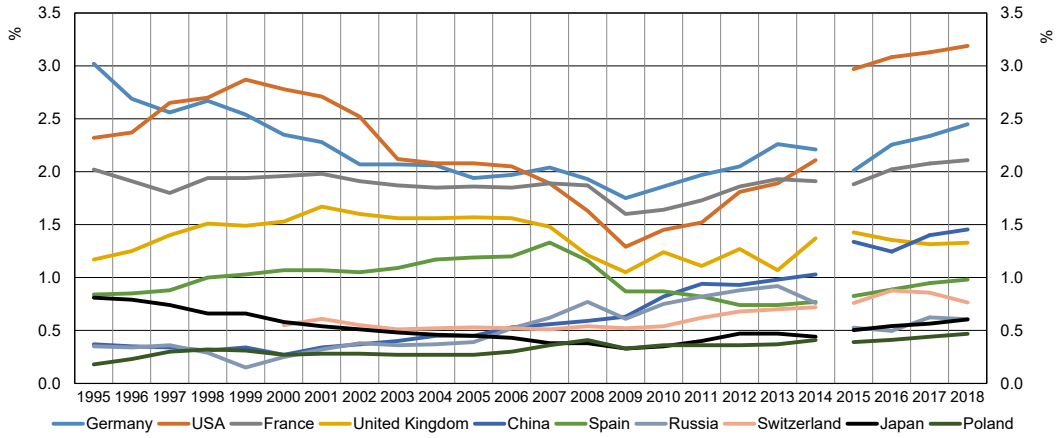

Source: Istat, Banca d'Italia and own elaborations on 'modified WIOD' and EUREGIO data.
(1) Gross exports from official statistics include services, except for manufacturing services on physical inputs owned by others, transport services and minor items of financial and insurance services.

Figure A.2. – Share of Italy's GDP absorbed by final foreign demand and exports/GDP ratio



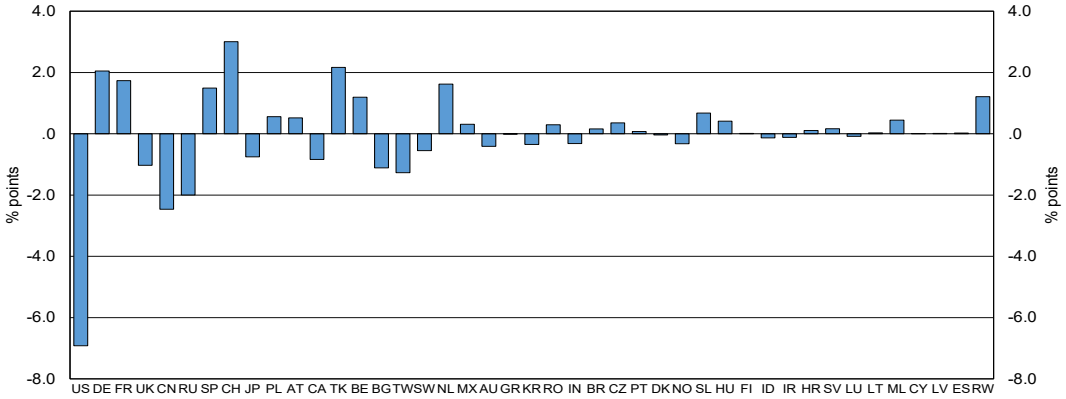

Source: Istat, National Accounts and own elaborations on ICIO data from WIOD and OECD.

Figure A.3 – Italy's GDP absorbed abroad – share of the first ten countries of absorption



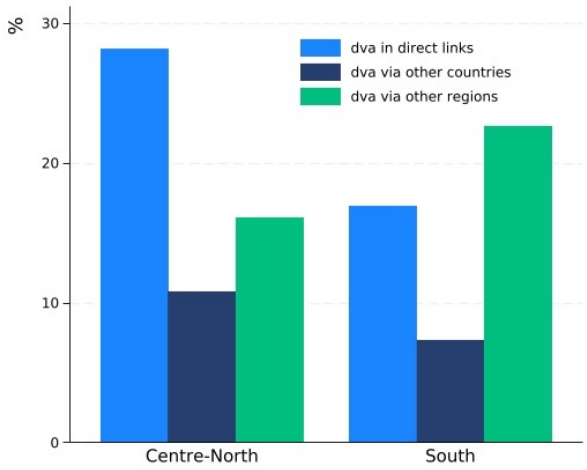

Source: Own elaborations on data from WIOD (1995-2014) and OECD (2015-2018) data.

Figure A.4 – Differences between countries' shares in gross exports and in foreign VAX (1)



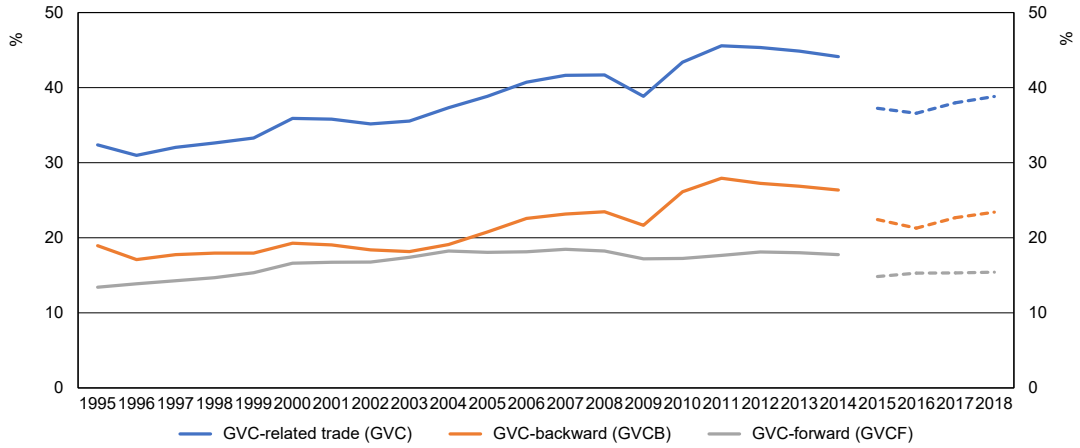

Source: Istat, Bank of Italy and own elaborations on 'modified WIOD' data.
(1) Istat and Bank of Italy's data for exports of goods and services (except manufacturing services on physical inputs owned by others, transport services and minor items of financial and insurance services). All regions' average. A positive value indicates a higher partner country's weight in official data than in VAX. Countries reported in decreasing order of their weight in VAX (except for the rest of the world).

Figure A.5 – Domestic value added exported by regions to foreign destinations – breakdown by primary export channels and macro-regions (1)




Source: Own elaborations on 'modified WIOD' data.
(1) In per cent of total direct and indirect gross external trade flows to final destination; averages of bilateral regional shares.

Figure A.6 – Italy's trade in GVCs




Source: own elaborations on data from WIOD (1995-2014) and OECD (2015-2018).

## B. Tables

*Table B.1 – DVA paths and regional features (1)*

| | dependent variables: % DVA in bilateral direct and indirect gross exports, by path | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | DVA | | DVA direct links | | DVA foreign countries | | DVA other regions | |
| | *Coefficients* | *R-squared* | *Coefficients* | *R-squared* | *Coefficients* | *R-squared* | *Coefficients* | *R-squared* |
| | *With country fixed effects* | | | | | | | |
| Regional GDP (bn) | 0.05*** | 0.22 | 0.07*** | 0.42 | 0.02*** | 0.71 | -0.05** | 0.18 |
| | [3.74] | | [3.68] | | [5.49] | | [2.44] | |
| Manufacturing (bn) | 0.22*** | 0.21 | 0.34*** | 0.43 | 0.11*** | 0.72 | -0.24** | 0.21 |
| | [3.83] | | [3.41] | | [5.40] | | [1.96] | |
| Manufacturing (2) | 0.41 | 0.15 | 0.69*** | 0.38 | 0.19*** | 0.68 | -0.48*** | 0.18 |
| | [1.62] | | [3.02] | | [2.38] | | [1.96] | |
| Manufacturing (3) | 0.21 | 0.15 | 0.46*** | 0.5 | 0.13*** | 0.73 | -0.39*** | 0.38 |
| | [1.64] | | [6.31] | | [5.02] | | [4.00] | |
| Outward IDE t-1 (2) | 0.18* | 0.15 | 0.28*** | 0.34 | 0.08** | 0.68 | -0.18* | 0.13 |
| | [1.79] | | [3.89] | | [2.84] | | [2.04] | |
| Inward IDE t-1 (2) | 0.47** | 0.19 | 0.60*** | 0.33 | 0.24*** | 0.72 | -0.38** | 0.12 |
| | [2.57] | | [3.70] | | [4.23] | | [2.14] | |
| Observations | 840 | | 836 | | 840 | | 840 | |

(1) Results for regression include a single regional feature, country fixed effects, and a constant (not reported) by type of DVA path. Linear regression with multiple fixed effects. Standard errors clustered at the regional level. Robust t statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%. (2) In per cent of GDP. (3) Manufacturing VAX, per cent share of regional VAX.

*Table B.2 – Bilateral 'DVA flows' and gross exports and gravity (1)*

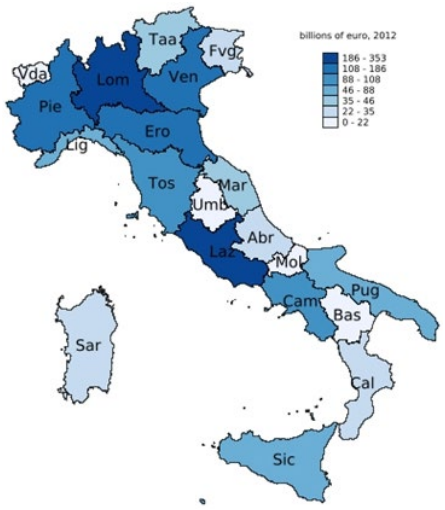
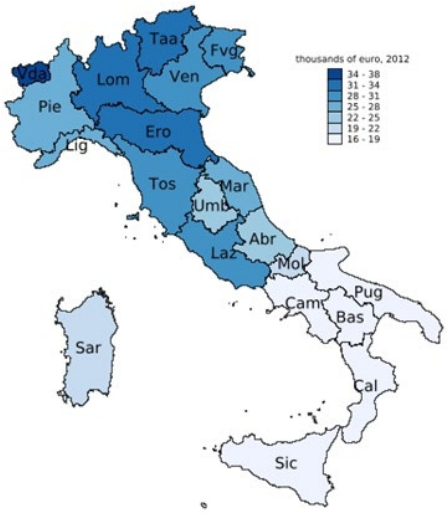
| | Gross exports (ln) | DVA flows (ln) | DVA flows - direct links (ln) | DVA flows - foreign countries (ln) | DVA flows - other regions (ln) |
|---|---|---|---|---|---|
| | *With regional and country fixed effects* | | | | |
| Distance (ln) | -0.16** | -0.06 | -0.14 | 0.02 | 0 |
| & | [2.12] | [1.00] | [1.40] | [0.48] | [0.01] |
| Common border | 0.23*** | 0.25*** | 0.22*** | 0.09*** | -0.02 |
| | [3.46] | [5.52] | [4.05] | [3.09] | [1.27] |
| Distance (ln) | -0.26*** | -0.17*** | -0.31*** | -0.01 | 0.01 |
| | [4.07] | [3.10] | [3.51] | [0.15] | [0.59] |
| | *With country fixed effects* | | | | |
| Regional GDP (ln) | 1.21*** | 1.33*** | 1.38*** | 1.48*** | 1.10*** |
| | [19.33] | [18.04] | [16.28] | [14.41] | [23.40] |
| | *With regional fixed effects* | | | | |
| Partner country GDP (ln) | 0.63*** | 0.63*** | 0.64*** | 0.57*** | 0.63*** |
| | [9.81] | [9.92] | [9.10] | [6.79] | [10.04] |
| Observations | 840 | 840 | 836 | 840 | 840 |

(1) Results for Poisson's pseudo-likelihood regression with multiple levels of fixed effects. Clustered standard errors. Robust z statistics in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

## C. Classifications and taxonomies

### C.1 Region and Country list

| Italian macro-areas and regions | | | Country list | | | |
|---|---|---|---|---|---|---|
| Macro-areas (NUTS1) | Regions (NUTS 2) | Short form | Short form | Country name | Short form | Country name |
| North-West – ITC | Piedmont - ITC1 | Pie | Aus | Australia | Irl | Ireland |
| | Valle d'Aosta – ITC2 | Vda | Aut | Austria | Jpn | Japan |
| | Lombardy – ITC4 | Lom | Bel | Belgium | Kor | Korea |
| | Liguria – ITC3 | Lig | Bgr | Bulgaria | Ltu | Lithuania |
| North-East – ITH | Veneto – ITH3 | Ven | Bra | Brazil | Lux | Luxembourg |
| | Friuli-Venezia Giulia – ITH4 | Fvg | Can | Canada | Lva | Latvia |
| | Trentino-Alto Adige – ITH2+ITH1 | Taa | Che | Switzerland | Mex | Mexico |
| | Emilia-Romagna – ITH5 | Ero | Chn | China | Mlt | Malta |
| Centre – ITI | Tuscany – ITI1 | Tos | Cyp | Cyprus | Nld | Netherlands |
| | Umbria –ITI2 | Umb | Cze | Czech Rep. | Nor | Norway |
| | Marche – ITI3 | Mar | Deu | Germany | Pol | Poland |
| | Lazio- ITI4 | Laz | Dnk | Denmark | Prt | Portugal |
| South - ITF | Abruzzo –ITF1 | Abr | Esp | Spain | Rou | Romania |
| | Molise –ITF2 | Mol | Est | Estonia | Rus | Russia |
| | Campania –ITF3 | Cam | Fin | Finland | Svk | Slovakia |
| | Apulia –ITF4 | Pug | Fra | France | Svn | Slovenia |
| | Basilicata – ITF5 | Bas | Gbr | Great Britain | Swe | Sweden |
| | Calabria – ITF6 | Cal | Grc | Greece | Tur | Turkey |
| Islands- ITG | Sicily – ITG1 | Sic | Hrv | Croatia | Twn | Taiwan |
| | Sardinia – ITG2 | Sar | Hun | Hungary | Usa | USA |
| | | | Idn | India | Rus | Russia |
| | | | Ind | Indonesia | RW | Rest of the World |

| Regional GDP | Regional GDP per capita |
|---|---|
|  |  |





*Source:* Eurostat and Istat

## C.2 Types of GVC participation and regional taxonomy

*The World Bank criteria*

The World Bank has proposed a taxonomy to classify countries' participation in GVC (World Bank, 2020, Box 1.3, Chapter 1, pages 22-23), which first, takes into account the following three classification variables: i) the sector composition of countries' exported DVA; ii) the extent of GVC participation (according to the Borin and Mancini indicator), measured as backward integration of the manufacturing sector as a share of a country's total exports; and iii) measures of innovation. Secondly, countries are divided into three groups by country size: i) small countries, ii) medium-sized countries, and iii) large countries. Third, identifies the following four groups from the interplay of the three classification variables and country size: i) *Commodities*, ii) *Innovative activities,* iii) *Advanced manufacturing and services*, and iv) *Limited manufacturing*.
*Commodities* countries are those for which manufacturing has a small share of exports and limited backwards linkages. Their manufacturing share in VAX is less than 60 per cent, and backwards manufacturing is less than 20 per cent (in the case of small countries) or less than 10 per cent (in the case of medium countries). The group can be further divided into 'Low participation' (the share of primary goods in VAX is less than 20 per cent), 'Limited commodities', and 'High commodities' (respectively with increasing primary goods' shares of total DVA in exports).
*Innovative activities* countries spend a relatively large percentage of GDP on R&D and receive a sizeable share of GDP from intellectual property. Small countries classify in the *Innovative activities* group if their intellectual property (IP) receipts as a percentage of GDP are equal to or greater than 0.15 per cent and research intensity (private and public R&D expenditure in per cent of GDP) is equal to or greater than 1.5 per cent; for medium-sized countries, the two percentages are, respectively, 0.1 and 1 per cent.
The countries that do not fall into the above-mentioned two groups but have a very high share of manufacturing and business services in total DVA in exports and a high portion of backwards linkages in manufacturing are classified as *Advanced manufacturing and services*; the remaining countries are classified as *Limited manufacturing*.
In particular, countries belonging to the *Advanced manufacturing and services* group have a share of manufacturing and business services in VAX that is equal to or greater than 80 per cent and backwards manufacturing that is equal to or greater than 30 per cent (in the case of small countries) or greater than 20 per cent (for medium countries). The World Bank's definition of business services coincides with the concept of private nonfinancial services used in this paper.

*Application of the criteria to the Italian regions*

Italian regions with less than 3 million inhabitants are classified as small, the others as medium-sized.
In particular, small economies are: Liguria, Trentino Alto Adige, Marche, Friuli-Venezia Giulia, Sardinia, Calabria, Abruzzo, Umbria, Basilicata, Molise, Valle d'Aosta. Medium-sized economies are Lombardy, Lazio, Campania, Sicily, Veneto, Emilia-Romagna, Piedmont, Puglia, and Tuscany.
The World Bank classification variables are applied to the Italian regions as if they were independent countries, and the taxonomy group in which they fit is based on the GVC-related trade indices (RGVCt-index for the participation in national and international value-chains and the RGVCx index for the pure global value-chain leg).
To identify *Innovative activities* and *Advanced manufacturing and services*, the sector composition of regional VAX considers only foreign destinations for exports and national and foreign destinations for the total index; the IP receipts are measured as credits of the item "charges for the use of intellectual property" of the balance of payments.
The resulting regional taxonomy based on the RGVCt index is as follows: *Innovative activities* regions are Lazio, Lombardy, and Piedmont; *Advanced manufacturing and services* are Emilia-Romagna, Marche, and Veneto; *Limited manufacturing:* all other regions.
The taxonomy based on the RGVCx index is as follows: *Innovative activities* regions are Lazio, Lombardy, and Piedmont; *Advanced manufacturing and services* are Campania, Emilia-Romagna, Liguria, Tuscany, and Veneto; *Limited manufacturing* is all other regions.

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