economies

Tracked for Impact Factor

CITESCORE 2.7

Article

The Industrial Pattern of Italian Regions: A Disaggregated Sectoral Analysis Based on Input–Output Tables

Clio Ciaschini, Margherita Carlucci, Francesco Maria Chelli, Giuseppe Ricciardo Lamonica and Luca Salvati

Special Issue
Recent Topics in Economic Research – Feature Papers for Cerebrating the 10th Anniversary of Economies

Edited by
Prof. Dr. Ralf Fendel, Prof. Dr. Robert Czudaj and Prof. Dr. Sajid Anwar

MDPI

https://doi.org/10.3390/economies10120300 economies

MDPI

Article

The Industrial Pattern of Italian Regions: A Disaggregated Sectoral Analysis Based on Input–Output Tables

Clio Ciaschini [1], Margherita Carlucci [2], Francesco Maria Chelli [1], Giuseppe Ricciardo Lamonica [1] and Luca Salvati [3,*]

[1] Department of Economic and Social Sciences, Polytechnic University of Marche, 60121 Ancona, Italy
[2] Department of Social and Economic Sciences, Sapienza University of Rome, 00185 Rome, Italy
[3] Department of Methods and Models for Economics, Territory and Finance, Sapienza University of Rome, 00185 Rome, Italy
* Correspondence: luca.salvati@uniroma.it

Abstract: Italy joined the so-called 'Industry 4.0' European framework in 2016, which designed and approved a national plan to regulate this key issue for regional development. To better support such a framework, the present study attempts to quantify the contribution of the Italian regions to the output formation process. More specifically, a multi-sectoral Input–Output (IO) model that supports national policies was proposed to cumulatively consider 29 industries that partition the Italian economy into representative branches at the level of administrative regions. Elementary input data were derived from the inter-sectoral table of the economy released by the Italian National Institute of Statistics (ISTAT). The economic outcomes of the Italian regions were estimated using a non-survey procedure, based on Flegg Location Quotients, to determine the upstream and downstream positions of each industry at country and regional levels. Indices grounded on the Hypothetical Extraction Method (HEM) further delineated the role each industry plays in the regional economy. The empirical findings of this study demonstrate how non-survey IO regionalization and the resulting industry-based indices provide appropriate knowledge for regional development policies.

Keywords: Input–Output; regionalization; Hypothetical Extraction Method; linkage analysis

check for updates

Citation: Ciaschini, Clio, Margherita Carlucci, Francesco Maria Chelli, Giuseppe Ricciardo Lamonica, and Luca Salvati. 2022. The Industrial Pattern of Italian Regions: A Disaggregated Sectoral Analysis Based on Input–Output Tables. *Economies* 10: 300. https://doi.org/10.3390/economies10120300

Academic Editors: Ralf Fendel, Sajid Anwar and Robert Czudaj

Received: 3 October 2022
Accepted: 14 November 2022
Published: 28 November 2022

1. Introduction

The COVID-19 pandemic has produced devastating effects, whose consequences depend on the capability of the economic structures to react to the macroeconomic shocks affecting both supply and demand (Li et al. 2021; Notteboom et al. 2021; Pham et al. 2021). The measures imposed by governments to contain the spreading of the virus are examples of strict supply-side constraints (Chen et al. 2021). As soon as the lockdown would end and the containment measures gradually be lifted (Seetharaman 2020), the pre-crisis levels of activity could be expected to recover (Sigala 2020; Maples et al. 2021; Song et al. 2021). These dynamics apply to the economic system as a whole, although the restrictive effects have had different sectoral impacts (Bashir et al. 2020). Such impacts, spread over the whole economy at a magnitude that depends on the relevance of individual sectors, depend on the inter-sectoral relation characteristics of the production system (Hirschman 1958; Dean et al. 2021; Belitski et al. 2022). A comprehensive assessment of the inter-industry relationship characteristics of the Italian economy is the base for a more exhaustive analysis of COVID-19s effect on production sectors (Ascani et al. 2021; Bragatto et al. 2021; Cutrini and Salvati 2021).

At the global level, Italy ranks high within the industrialized countries (Bigerna 2013). The most significant industries that undoubtedly shape and lead inter-industry interactions are manufacturing and, among services, those related to wholesale and retail trade, as well as transport (Archibugi et al. 1991; Cainelli and Leoncini 1999; ISTAT 2016). Manufacturing relies on specialized and high-quality products that are realized by a network of small- and medium-size enterprises (Bertolini and Giovannetti 2006). In the last decades, globalization has further stimulated the expansion of manufacturing (Ghisellini and Ulgiati 2020). However, since 2018, this expansion wave decelerated because of marked instances influencing the stability of international markets (Cainelli et al. 2018; Basso 2020; D'Ingiullo and Evangelista 2020). The inward-looking American commercial policies, the economic outcomes of Brexit, the latent tensions between the USA and China, and the uncertain political outcomes of national elections in many European countries resulted in insecure landscapes for economic interactions. Within this uncertain climate, Italy suffered from political instability, economic stagnation, and a lack of structural reforms (Rubino and Vitolla 2018; Cainelli et al. 2019; Ciffolilli et al. 2019). In fact, even before the Great Recession (e.g., between 2001 and 2007), Italy was growing by less than 1.3% per year, on average. The 2008 crisis exacerbated the weakness of the Italian economy (Da Roit and Iannuzzi 2022). In 2009, its gross domestic product declined by 5.5%, and has been recovering slowly and only partly (Crespí-Cladera et al. 2021). Moreover, the crisis has deepened the divide between affluent and industrialized Northern regions and disadvantaged, agriculture-dependent, Southern regions, which has been particularly evident for gross domestic product, unemployment, and capital formation (Dei Ottati 2018).

Stagnation affects both public investments in infrastructures and private capital formation, notwithstanding the support provided by the incentives to the 4.0 digital conversion of manufacturing (Confindustria Report 2019). However, internal weaknesses and the increasing concentration of industrial development in small districts—mainly in Northern regions—did not prevent Italy from becoming the seventh world manufacturing power by 2018, and the ninth in the world for export capacity (Table 1).

Table 1. Value added and Exports (2018) in percent values of world's total (source: our elaboration on Confindustria Report 2019).

	Value Added		Exports	
1	China	28.5	China	12.8
2	USA	17.2	USA	8.6
3	Japan	8.1	Germany	8.0
4	Germany	6.1	Japan	3.8
5	South-Korea	3.1	The Netherlands	3.7
6	India	3.0	South-Korea	3.1
7	**Italy**	**2.3**	France	3.0
8	France	2.1	Hong Kong	2.9
9	Unted Kingdom	1.9	**Italy**	**2.8**
10	Indonesia	1.6	United Kingdom	2.5

In this context, the 4.0 transformation of manufacturing has played a role in improving firms' efficiency. Technology 4.0 was aimed at fastening decision processes and facilitating new forms of interaction between humans and machines to connect the entire value chain within the firms (Ghisellini and Ulgiati 2020). Italy joined the European framework of Industry 4.0 in 2016, enforcing a National Plan called 'Industria 4.0'. Hyper–amortization investments, estimated to account for 10 billion euros, have been the main measure stimulating firms' development (Da Roit and Iannuzzi 2022).

The regional framework in which economic activities are performed also has relevance, together with the dimensions of firms within the region. Italian regions consist of levels of territorial subdivision and public authorities, i.e., public bodies with legal status and wide autonomy regulated by the Constitution (Salvati and Zitti 2009). The 20 Italian administrative regions (see Figure 1) can be grouped into three macro-areas (Zambon et al. 2017). The North macro-area comprises nine regions: Liguria, Lombardy, Piedmont, Aosta Valley, Veneto, Friuli-Venezia Giulia, Emilia-Romagna, and the two autonomous provinces of Trento and Bolzano in the Trentino-Alto-Adige/Sudtirol region. The Central macro-area includes Tuscany, Latium, Marche and Umbria. The South/Islands macro-area includes Abruzzo, Basilicata, Calabria, Campania, Molise, Apulia, Sicily, and Sardinia (Salvati et al. 2008).

Figure 1. A map illustrating the geography of Italian administrative regions (Source: own elaboration on Eurispes (2022)).

According to a qualified source of regional analysis in Italy, "there is no doubt that the social and economic disunity of Italy still remains nowadays the most apparent and the most ignored structural limit" (Eurispes 2022). The most relevant inconsistency of Italy is that a part of it (corresponding to 41% of the territory) lives in disadvantaged socio-economic conditions. A measure of the relative economic performance of each region can be quantified using per-capita GDP as shown in Table 2, where the 2019 percent gap of the regional per-capita GDP with respect to the country figure is given. In 1951, per-capita GDP in Southern Italy amounted to 53 per cent of country GDP. In 1973, this economic aggregate reached the lowest peak (51 per cent), and that result was never observed again.

Table 2. Per-capita GDP departure (%) of Italian Regions from the national average in 2019 (ISTAT 2020).

Macro-Area	Region	Per-Capita GDP Gap	Macro-Area	Region	Per-Capita GDP Gap
North	Bolzano	+62.2	South	Abruzzo	−11.8
	Aosta Valley	+34.3		Basilicata	−24.6
	Lombardy	+33.9		Sardinia	−27.6
	Trento	+31.5		Molise	−28.8
	Emilia-Romagna	+25.1		Apulia	−35.7
	Veneto	+14.7		Campania	−35.9
	Liguria	+11.2		Sicily	−39.0
	Piedmont	+8.6		Calabria	−41.5
	Friuli-V. Giulia	+8.1			
Center	Latium	+15.8	Italy		29,000
	Tuscany	+8.8			
	Marche	−3.2			
	Umbria	−12.8			

Our contribution sheds light on the role of each of the 29 industries, described in Table 3, characterizing the technological structure of the Italian economy by considering each of the 20 administrative regions separately. Defining and quantifying the role and relevance of each activity allow for a convenient comparison with national dynamics, as well as an appropriate analysis of the role of each activity within and between macro-areas (Lamonica and Chelli 2018). For this aim, on the one hand, we regionalized the Italian Input-Output 2016 Table, with a disaggregation level corresponding to the 29 representative sectors estimated at the level of Italian administrative regions, by using Flegg Location Quotient methodology (Lamonica et al. 2020).

Table 3. A list of industry denominations used in this study.

Industries	Denominations
S1	Crop and animal production, hunting and related service activities
S2	Fishing and acquaculture
S3	Mining and quarring
S4	Manufacture of food products, beverages, and tobacco products
S5	Manufacture of textiles and wearing apparel
S6	Manufacture of wood and of products of wood, paper and paper products and printing
S7	Manufacture of coke and refined petroleum products
S8	Manufacture of rubber, plastic products, and other non-metallic mineral products
S9	Manufacture of fabricated metal products, except machinery and equipment
S10	Manufacture of computer, electronic and optical products, electrical equipment machinery and equipment n.e.c.
S11	Manufacture of transport equipment
S12	Manufacture of furniture, Other manufacturing Repair and installation of machinery and equipment
S13	Electricity, gas, steam, and air conditioning supply
S14	Water collection, treatment, and supply
S15	Construction
S16	Wholesale and retail trade and repair of motor vehicles and motorcycles
S17	Trasportation and storage
S18	Accommodation and food service activities
S19	Information and communication
S20	Financial and insurance activities
S21	Real estate activities
S22	Professional, scientific, and technical activities
S23	Administrative and support service activities
S24	Public Administration and defence; compulsory social security
S25	Education
S26	Human health and social work activities
S27	Arts, entertainment and recreation
S28	Other services activities
S29	Activities of households as employers; undifferentiated goods/services producing activities of households for own use

By performing a non-survey regionalization, this approach avoided time-consuming and costly data collection. On the other hand, with the aim of revealing and quantifying the regional/sectoral role of each activity, we performed a linkage analysis determining the sector potential in the national rank. The specific roles of key production branches in the Italian regions were also determined. Linkage analysis was performed by adopting the most suitable definitions and operational frames for the aims of our study. In particular, we use the outcomes of linkage definition based on the Hypothetical Extraction Method (HEM) approach.

This paper is structured as follows. The next section briefly presents the most relevant literature on linkage analysis. Section 3 illustrates the regionalization technique and the methodology adopted to derive Hypothetical Extraction Method (HEM) coefficients. Section 4 illustrates the empirical results of this analysis. Section 5 discusses the main research findings and concludes the paper.

2. Literature

2.1. Linkage Analysis and the Hypothetical Extraction Method

In the context of multiple industries interacting within the economic system, the relevance of production sectors, especially local ones and their contributions to economic growth, requires a measure that delineates both forward and backward linkages in order to empirically analyze the complete role of an industry and to evaluate the technological connections between economic sectors (Kay et al. 2007). Within this framework, intersectoral linkages are regarded as techno-economic connections between industries that are embodied in the exchange of tangibles and intangibles (Hauknes and Knell 2009). Intersectoral linkages, therefore, estimate interdependencies between sectors, which affect the paths of vertical specialization (Reis and Rua 2009). In the literature on regional economics, different indicators have been suggested and widely adopted for the identification of key sectors. These sectors, characterized by relevant intermediate purchases (backward linkages) and sales (forward linkages), are more likely than the other sectors to propagate growth impulses all over the economy (OECD 2021). Golan et al. (1994) integrated this definition to include three further conditions to appropriately define a key cluster, i.e., (i) a well-developed domestic market, (ii) a competitive local business climate, and (iii) efficient production factors.

This broader definition takes the size of the linkages as an approximation for the potential benefits of stimulating the sector. This should imply that the taxpayer cost of acquiring these benefits would be the same among sectors and among forward and backward linkages. In reality, stimulating wider sectors is more expensive than smaller ones; hence, key sector measures have to be corrected in consideration of their dimensions to more accurately achieve this objective (Temurshoev and Oosterhaven 2014). In addition, industries of the same size do not necessary require similar policy measures. This fact has been considered in the net backward linkages, which correct the standard (gross) backward linkages for the size of final demand, assuming that a relatively wide final demand is more easily stimulated than a small-sized one (Oosterhaven 2004, 2007). Lastly, the creation of benefits of sizeable backward linkages requires demand-stimulating measures, whereas the generation of benefits of wide forward linkages requires a further improvement in productivity, i.e., price reducing policies to strengthen output growth. Obviously, the cost of these quite different policy measures per unit of potential benefit, i.e., per linkage measures, will not be the same. Hence, selecting key sectors requires much more analysis than just establishing which sectors have the largest forward and backward linkages. To address this issue, many key sectors' measures have been proposed in the literature (Golan et al. 1994).

On the one side, the various measures result from methodological enhancements, such as the substitution of the direct backward linkages (Chenery and Watanabe 1958) with the total backward linkages originated by the column sums of the Leontief-inverse (Rasmussen 1956), or the substitution of the row sums of the Leontief-inverse (Rasmussen 1956) with the row sums of the Ghosh-inverse (Beyers 1976), in the case of total forward linkages (Jones 1976). On the other side, these measures originate from different labelling of the same measure in different works. Among these measures, it is worth mentioning the output-to-output multiplier (Miller and Blair 2009), analogous to the total flow multiplier (Szyrmer 1992), is comparable to the earlier Hypothetical Extraction Method (HEM) of whole sectors (Strassert 1968; Schultz 1977; Temurshoev 2010), which was later reformulated by Meller and Marfán (1981), Cella (1984), and Clements (1990).

In the present work, we adopted the latter, straightforward and flexible version of the HEM, since it allows for the extraction of any subset of transactions, instead of a mere removal of full rows and columns, (Miller and Lahr 2001; Gallego and Lenzen 2005). The HEM identifies the 'keyness' of a sector through the hypothetical output loss in the economic system due to the abrupt stop of the related activity, i.e., assuming all sales to (and purchases from) the other sectors are set to zero. The Hypothetical Extraction Method (HEM) was adopted in this study to assess the position occupied by various economic sectors within a given (country or regional) economy. This method is regarded as an improvement of the Classical Multiplier Method (Rasmussen 1956), which measures the 'keyness' of a sector only in terms of simple averages of direct and indirect technical coefficients. HEM, indeed, weights the 'keyness' of a sector by assuming its external linkages, i.e., sales and purchases from all other sectors, as null (Guerra and Sancho 2010).

The output loss deriving from this extreme condition quantifies the underlying network of economic linkages (Miller and Lahr 2001) and provides a measure of 'keyness' (Miller and Blair 2009). Therefore, the HEM evaluates the extent at which the total output of the economy would change (e.g., decrease) if a j-th sector is removed from the economic system.

The bulk of this approach lies in the inverse Leontief matrix, i.e., $L = (I - A^n)^{-1}$ in the first case and $L = (I - R)^{-1}$ in the second case, where A^n and R, are the matrices of national and regional direct input coefficients, respectively. The generic L_{ij} entry of the L matrix measures the total requirement (multiplier), both direct and indirect, of goods and services produced by the i-th industry needed to satisfy one unit of final use of the j-th sector. Consequently, the j-th column-sum (L_j) of L measures the total requirements of the j-th sector to produce one (final) production unit. In other words, it is the extent to which a unitary increase in the final demand of the j-th sector causes a production increase in all sectors. On the contrary, the row-sum of the L matrix ($L_i.$) measures the total production requirements of the i-th sector needed to off-set a unitary increase in the final uses of each product. In other words, output magnitude increases in the i-th sector if the final demand of all sectors increases by one unit. Initially, this was modelled in an input–output context by deleting row and column j from the A matrix of the technical coefficients (Ali et al. 2019).

To this regard, let $\overline{A}_{(j)}$ be the $(k-1) \times (k-1)$ matrix without the sectors j and $\overline{f}_{(j)}$ in the correspondingly reduced final demand vector (see Miller and Blair 2009 for details), then, the total output in the 'reduced' economy reads as $\overline{x}_{(j)} = \left[I - \overline{A}_{(j)}\right]^{-1} \overline{f}_{(j)}$. On the contrary, in the full k-sector model, the total output is $x = [I - A]^{-1} f$. Consequently, $\boldsymbol{i}'x - \boldsymbol{i}'\overline{x}_{(j)}$ (where $\boldsymbol{i}$ is a column vector of ones) is an aggregate measure of the economy loss (reflecting a decrease in gross output value) if sector j disappears, and is in turn an indirect, overall estimate of the multi-dimensional linkages of the j-th sector.

Normalization by total gross output ($\boldsymbol{i}'x$) and multiplication by 100 provides an estimate of the percent loss in total economic activity. The hypothetical extraction approach can also be used to measure backward and forward linkage components separately. We assume that the j-th sector buys no intermediate inputs from any production sector by replacing the j-th column in A with zeroes. Then, the following index is a candidate measure of (aggregate) backward linkage for the j-th sector:

$$\overline{BL}_j = \frac{\boldsymbol{i}'x - \boldsymbol{i}'\overline{x}_{(j)}}{\boldsymbol{i}'x} 100 \tag{1}$$

Similarly, replacing the i-th row of the output coefficients matrix ($B = \left[\frac{x_{ij}}{x_i}\right]$) with zeroes and denoting this matrix as $\overline{B}_{(I)}$ makes $\overline{x}'_{(i)} = v'\left[I - \overline{B}_{(i)}\right]^{-1}$ the row vector whose entries are the sectoral production when the i-th sector is removed from the economy, i.e., the total production of all other sectors if the i-th sector sells no intermediate input. An aggregate measure of a given sector (i) forward linkage is:

$$\overline{FL}_i = \frac{\boldsymbol{i}'x - \overline{x}'_{(i)}\boldsymbol{i}}{\boldsymbol{i}'x} 100 \tag{2}$$

For the sake of comparison, the previous indices were normalized as follows:

$$\overline{\overline{BL}}_j = \frac{\overline{BL}_j}{\frac{1}{k}\sum_{j=1}^{k} \overline{BL}_j} \tag{3}$$

$$\overline{\overline{FL}}_i = \frac{\overline{FL}_i}{\frac{1}{k}\sum_{i=1}^{k} \overline{FL}_i} \tag{4}$$

The index reported in Equation (1), known as the 'backward linkage' (or 'dispersion power'), measures the activation degree of a given economic sector. Values greater than 1 indicate the importance of a given sector in the regional economy, because it requires a production level from the other sectors above the average. By contrast, the more the index falls below 1, the less important the sector considered is.

The index reported in Equation (2), known as the 'forward linkage' (or 'dispersion sensitivity'), measures the level at which the output of one sector is used as input for the remaining production sectors, and thus measures the degree of reaction characteristic of a given economic sector. As in the previous case, the greater the index is than 1, the more important the corresponding sector is, because it supplies its production to the other sectors at a level which exceeds the general average. By contrast, the more the index falls below 1, the less important the sector considered is. The joint analysis of these two indices makes it possible to determine how an individual sector is woven into the economic structure of a region, as well as its relative importance. Based on these premises, we define:

- 'Key Sectors', with values of both forward and backward linkages higher than 1;
- 'Low Impact' sectors, with both forward and backward linkages lower than 1;
- 'Prime Vendor' sectors, with forward linkages higher than 1 and backward linkages lower than 1;
- 'Prime User' sectors with forward linkages lower than 1 and backward linkages higher than 1.

2.2. Regionalization of the Italian Input-Output Table

Regionalized Input–Output matrices make it possible to perform a linkage analysis that compares the importance of each sector in providing and buying goods and services for the remaining sectors. Unfortunately, the Italian Institute of Statistics (ISTAT) does not provide regionalized Input-Output Tables. As remarked by Hewings and Jensen (1988), non-survey methods regionalizing a national Input-Output Table (NIOT) have been developed, with the aim of avoiding the huge costs and considerable release delays associated with the construction of regional tables through direct surveys. Non-survey methodologies were based (i) on Location Quotients (LQs) or (ii) on constrained matrix-balancing approaches. The former methodologies included Simple and Cross-Industry LQs (SLQ and CILQ), along with refinements such as Round (RLQ) formula (Round 1983), Flegg FLQ formula (Flegg et al. 1995; Flegg and Webber 2000), as well as the augmented FLQ (AFLQ) approach (Flegg and Webber 2000). These methods hinged on the assumption that regions and nations employed the same production technology, with the implication that regional input coefficients only differed from their national counterparts for the fact that each region imports goods and services from other regions (Cuello et al. 1992). By contrast, constrained matrix-balancing procedures estimate unknown data from limited initial information and are subject to a set of linear constraints (e.g., Salvati and Zitti 2009). The most popular techniques include RAS and Cross-Entropy (CE) approaches (Schultz 1977) and those based on minimizing squared or absolute differences (Golan et al. 1994). However, such methods are more time-consuming than the LQ-based approach and normally require the solution of a constrained non-linear optimization problem, whereas the LQ-based methods are quick and simple to apply. The present study concentrates on the FLQ method briefly explained in Section 3, since it is one of the best-performing LQ-based approaches (Bonfiglio and Chelli 2008; Flegg and Tohmo 2016).

2.3. Regionalization Methodologies Using Location Quotiens

In this section, we review the most used location quotient (LQ) methods to estimate a Regional Input-Output Table (RIOT) representative of the 20 Italian regions. We used the most recent NIOT released by the Italian Institute of Statistics (ISTAT) for the year 2016. In Table 2, we show the national and regional IOT for an economic system of k sectors in block matrix notation, where:

National Input–Output Table

$$\begin{pmatrix} \mathbf{X}^n & \mathbf{f}^n & \mathbf{x}^n \\ (\mathbf{v}^n)' & 0 & 0 \\ (\mathbf{x}^n)' & 0 & 0 \end{pmatrix}$$

Regional Input–Output Table

$$\begin{pmatrix} \mathbf{X}^r & \mathbf{f}^r & \mathbf{x}^r \\ \mathbf{M}^r & 0 & 0 \\ (\mathbf{v}^r)' & 0 & 0 \\ (\mathbf{x}^r)' & 0 & 0 \end{pmatrix}$$

- $X^n = \left[x_{ij}^n\right]$ is the matrix whose entries are the total internal flows for intermediate use from the i-th sector to the j-th sector at the national level;
- $X^r = \left[x_{ij}^r\right]$ is the matrix whose entries are the flows of intermediate use from the i-th sector to the j-th sector at the regional level, with both i and j sectors located in region r;
- f^n and f^r are the national and regional final demand vectors;
- $M^r = \left[imp_{ij}^r\right]$ is the matrix of imported (intermediate) inputs produced by the i-th sector of the other regions and acquired by the regional j-th sector;
- $(v^n)'$ and $(v^r)'$ are row vectors whose entries are the primary input by sector at the national and regional level.

Moreover, we define $A^n = \left[a_{ij}^n = \frac{x_{ij}^n}{x_j^n}\right]$, $R = \left[r_{ij} = \frac{x_{ij}^r}{x_j^r}\right]$, and $M^r = \left[m_{ij}^r = \frac{imp_{ij}^r}{x_j^r}\right]$ as the matrices whose entries are the national technical coefficients, the regional input coefficients, and the regional import coefficients, respectively. Assuming that only NIOT (A^n) and the vector of the regional total sectorial output (x_j^r, j = 1, . . . , k) are known, the LQ methods estimate the matrix of the regional input coefficients R by adjusting the national technical coefficient in the following way:

$$\hat{r}_{ij} = a_{ij}^n q_{ij} \tag{5}$$

where q_{ij} represents the degree of modification of the national coefficient. Interregional import coefficients (the entries of M^r) are estimated as the difference between the national and the estimated regional input coefficient:

$$m_{ij}^r = a_{ij}^n - \hat{r}_{ij} \tag{6}$$

The first LQ method introduced in the literature (Flegg and Tohmo 2016) was the Simple Location Quotient (SLQ), where the regional input coefficients are estimated as:

$$\hat{r}_{ij} = \begin{cases} a_{ij}^n \cdot SLQ_i & \text{if } SLQ_i < 1 \\ a_{ij}^n & \text{if } SLQ_i \geq 1 \end{cases} \tag{7}$$

and where SLQ_i is defined as:

$$SLQ_i = \frac{\frac{x_i^r}{x^r}}{\frac{x_i^n}{x^n}} \tag{8}$$

and x_i^r and x_i^n are the total outputs of the i-th regional and national sector, respectively, where $x^n = \sum_{i=1}^{k} x_i^n$ and $x^r = \sum_{i=1}^{k} x_i^r$.

Several other LQ methods have been proposed in the literature (Miller and Blair 2009). However, earlier studies (Bonfiglio and Chelli 2008; Hermannsson 2016; Morrissey 2016; Jahn 2017) have demonstrated how FLQ provides more accurate results than the other LQ methods and, based on such evidence, this method was chosen to estimate the 20 Italian RIOTs.

The basic idea underlying FLQs is that a region's propensity to import from other domestic regions is inversely and non-linearly related to its relative size (Ciommi et al. 2019). By incorporating explicit adjustments for interregional trade, the method provides more accurate estimates of regional input coefficients. As with other non-survey techniques, the main aim of the FLQ approach is to delineate an optimal frame to estimate input–output tables that are representative of the regional economic structure (Lamonica et al. 2020). FLQ coefficients can be expressed as follows:

$$FLQ_{ij} = \begin{cases} CILQ_{ij}\lambda & \text{for } i \neq j \\ SLQ_{ij}\lambda & \text{for } i = j \end{cases} \tag{9}$$

where λ stands for the relative size of the region and takes the following form:

$$\lambda = \left[\log_2\left(1+\frac{x^r}{x^n}\right)\right]^\delta \tag{10}$$

and

$$CILQ_{ij} = \frac{x_i^r / x_i^n}{x_j^r / x_j^n} = \frac{SLQ_i}{SLQ_j}$$

based on Flegg et al. (1995). Here, δ ($0 \leq \delta < 1$) is a sensitivity parameter that controls the degree of convexity in Equation (5). Referring to Flegg et al. (1995) for details, the larger the value of δ, the lower the value of λ, so that greater adjustments of regional imports are made. The implementation of the FLQ formula is carried out in line with other LQ methods:

$$\hat{r}_{ij} = \begin{cases} a_{ij}^n FLQ_{ij} & \text{if } FLQ_{ij} < 1 \\ a_{ij}^n & \text{if } FLQ_{ij} \geq 1 \end{cases} \tag{11}$$

To apply the FLQ, a value for the unknown parameter (δ) has to be chosen. A number of empirical studies (Flegg and Webber 2000; Flegg et al. 2016; Flegg and Tohmo 2016; Jahn et al. 2020) were devoted to find appropriate values of δ. In consideration of their results, a value of δ = 0.3 was considered appropriate in our case.

3. Data and Indicators

This study relied on the 2016 Italian Input-Output Table (IOT) using a disaggregation nomenclature of 63 sectors, and was retrieved from an official database (ISTAT 2020). The 63 sectors' classification was based on the NACE Rev.2 Statistical classification of economic activities in the European Community (EUROSTAT 2008). Unfortunately, the only available data at the regional level are related with the employment number and the added value of the 29 sectors' disaggregation (NACE Rev. 2). As a consequence, the National Input-Output Table was then reaggregated in 29 sectors that were used as the starting point for regionalization by means of the Flegg Location Quotient (FLQ), as pointed out in Section 2.2, which allowed for a comparative analysis at regional scale.

The regional sectorial employment number was used as a generalization of the national coefficient based on the fact that "in cases where regional output data are not consistently available, or where analysts feel it is appropriate, other measures of regional and national economic activity are often used—including employment (probably the most popular), personal income earned, value added, and so on, by sector" (Miller and Blair 2009, p. 349). Moreover, the practical calculation of Equations (1) and (2) requires the sectorial final demand as input data at the regional level. Unfortunately, these data are unavailable for Italy. To overcome this drawback, we assumed the regional share of the i-th sector as coinciding with the share allocated for the whole country economy. This assumption was derived from the fundamental input–output relationship $\mathbf{v}'i = i\prime f$, and following the argumentations of Round (1983). Thus, the regional sectoral final demand was estimated as follows:

$$f_i^r = v^r \frac{f_i^n}{\sum_{i=1}^k f_i^n} \tag{12}$$

where $v^r = (v^r)'i$ is the regional (total) added value.

4. Results

The pandemic-driven economic recession affected all areas of Italy. However, the drop in GDP has been partly attenuated at the regional level through the measures adopted by the national government and European authorities. The campaign of vaccination, the progressive easing of restrictions aimed at the containement of contagion, and the perseverance in the measures benefitting households and firms helped in sustaining the economic recovery. According to the quarterly indicator of the regional economy (ITER) elaborated by the Bank of Italy, recovery was particularly evident in Northern Italy. Exports have grown in all areas and investments appear higher than those planned. Positive signals were observed on incomes and consuption expenditures. Savings have continued to be addressed, due in large part to liquid financial instruments as deposits (Banca d'Italia 2020). National results in terms of linkage, that we obtained from the empirical analysis, are shown in Table 4. The forward and backward linkages were computed for the 29 industries of the Italian economy. In Table 5, following the taxonomy defined in the methodological Section 2.1, industries were classified in the relevant panel according to the following denominations: Key Sectors, Low Impact, Prime Vendors and Prime Users.

Table 4. Forward and backward linkage results for the 29 industries constituting the national economy.

INDUSTRIES		ITALY_FL	ITALY_BL
S1	Crop and animal production, hunting and related service activities	0.908	0.452
S2	Fishing and acquaculture	0.452	0.015
S3	Mining and quarring	0.846	0.080
S4	Manufacture of food products, beverages, and tobacco products	0.998	1.847
S5	Manufacture of textiles and wearing apparel	0.734	0.913
S6	Manufacture of wood and of products of wood, paper and paper products and printing	0.907	0.588
S7	Manufacture of coke and refined petroleum products	1.325	1.431
S8	Manufacture of rubber, plastic products, and other non-metallic mineral products	1.032	0.929
S9	Manufacture of fabricated metal products, except machinery and equipment	1.475	1.544
S10	Manufacture of computer, electronic and optical products, electrical equipment machinery and equipment n.e.c.	1.265	2.292
S11	Manufacture of transport equipment	0.819	1.342
S12	Manufacture of furniture, Other manufacturing Repair and installation of machinery and equipment	0.712	0.783
S13	Electricity, gas, steam, and air conditioning supply	1.054	0.937
S14	Water collection, treatment, and supply	0.745	0.432
S15	Construction	1.037	2.101
S16	Wholesale and retail trade and repair of motor vehicles and motorcycles	1.772	2.907
S17	Trasportation and storage	1.721	1.656
S18	Accommodation and food service activities	0.732	1.091
S19	Information and communication	1.196	1.078
S20	Financial and insurance activities	1.493	0.842
S21	Real estate activities	1.085	0.561
S22	Professional, scientific, and technical activities	1.864	1.211
S23	Administrative and support service activities	1.386	1.026
S24	Public Administration and defence; compulsory social security	0.651	0.809
S25	Education	0.512	0.229

Table 4. *Cont.*

INDUSTRIES		ITALY_FL	ITALY_BL
S26	Human health and social work activities	0.620	1.135
S27	Arts, entertainment and recreation	0.640	0.424
S28	Other services activities	0.559	0.329
S29	Activities of households as employers; undifferentiated good and services producing activities of households for own use	0.443	0.000

Table 5. Classification of Italian industries according to their role in the economic interactions.

	FL < 1	FL > 1
BL < 1	Low impact (I panel) (S1) Crop and animal production, hunting and related service activities (S2) Fishing and acquaculture (S3) Mining and quarring (S5) Manufacture of textiles and wearing apparel (S6) Manufacture of wood and of products of wood, paper and paper products and printing (S12) Manufacture of furniture, Other manufacturing Repair and installation of machinery (S14) Water collection, treatment and supply (S24) Public Administration and defence; compulsory social security (S25) Education (S27) Arts, Entertainment and recreation (S28) Other services activities (S29) Activities of households as employers; undifferentiated good and services producing activities of households for own use	Prime Vendors (II panel) (S8) Manufacture of rubber, plastic products and other non-metallic mineral products (S13) Electricity, gas, steam and air conditioning supply (S20) Financial and insurance activitites (S21) Real estate activities
BL > 1	Prime Users (III panel) (S4) Manufacture of food products, beverages and tobacco products (S11) Manufacture of transport equipment (S18) Accomodation and food service activities (S26) Human health and social work activities	Key Sectors (IV panel) (S7) Manufacture of coke and refined petroleum products (S9) Manufacture of fabricated metal products, except machinery and equipment (S10) Manufacture of computer, electronic and optical products, electrical equipment (S15) Construction (S16) Wholesale and retail trade and repair of motor vehicles and motorcycles (S17) Trasportation and storage (S19) Information and communication (S22) Professional, scientific, and technical activities (S23) Administrative and support service activities

Each industry was assumed to be part of a network that developed through inter-industry interactions. A set of interactions was given by the inflow of commodities, from raw materials to finished products, realized by the industry's intermediate purchases, and used for producing the industry's total output. These interactions, which define the role of each industry in the inter-sectoral interactions in the upstream supply chain, were then given by the backward linkage coefficient quantified in the last column of Table 4. The second set of interactions was the downstream network that involved processing the materials collected during the upstream stage into a finished product and the actual sale of the industry's total output to other industries. The last column of Table 4 displays the capability of each industry in activating the other industries downstream. In order to synthetize the features of each industry in the interaction, we rearranged the results in Table 4 according the linkage value, as shown in Section 2.1. Table 5 shows the resulting industry classifications at the national economy.

From this table, nine industries emerged as Key Sectors, and provided a relevant impulse to the production process in terms of both upstream and downstream interaction. Four industries emerged as Prime Users and Prime Vendors, respectively. Twelve industries actually proved to be Low Impact activities. More information could be attained by adopting the regional viewpoint. Considering a regional perspective, results similar to those obtained for the national economy, shown in Tables 4 and 5, were observed. In this way, a further development got results for each sector according to the role in the economic interaction and according to the regional allocation of the economic activity, since the regional economic context easily influenced the efficiency of the economic interactions among industries. Here, we regrouped the five macro-regions into three groups: North, Center, and South. The islands were considered within the Southern region.

When compared with national outcomes, some specificities emerge. Table 6 shows the Low Impact sectors for all the Italian regions. As expected, regional outcomes reflected, in most cases, the national ones. Nevertheless, some regional aspects that did not reflect the national trend should be taken into consideration. The industry S1—crop and animal production, hunting and related service activities, and agricultural and hunting—result was classified as a 'Prime Vendor', (Table 7) since it provided its output to other industries, and its activities were allocated prevalently in the eight regions of the south. The textile industry (S5) emerged as a 'Prime User' (Table 8) in Veneto, Tuscany, Umbria, Abruzzo, Campania, and Apulia, and as a 'Prime Vendor' in Marche. The manufacture of rubber, plastic products, and other non-metallic mineral products (S8) was classified as a 'Low Impact' sector in Aosta Valley, Liguria, Sicily, Sardinia, Tuscany, Latium, Calabria, Campania, and Apulia, and as a 'Prime User' in Marche.

The accommodation and food service activities (S18) were classified as 'Prime Vendors' in Marche. In all the other regions of Italy, they were 'Prime Users', with the exception of Latium ('Low Impact'). In both Calabria and Latium, public administration (S24) was classified as a 'Prime User,' while in all other regions it was a low impact one. These findings are coherent with the geography of Latium, whose economic system gravitates to Rome, the Italian capital city, where most of central administrations are located. Public administration is regarded as the main customer for the providers of intermediate inputs; while in Calabria, a similar outcome may have depended on the limited development of the industrial system.

Additional specificities can be found with reference to S4—food, beverage and tobacco industry—emerging as a 'Key Sector' in all Italian regions, with the exception of Liguria, Lombardy, Tuscany, and Latium, where it was regarded as a 'Prime User' (Table 7) and in Marche, where it was classified as a 'Prime Vendor' (Table 8). With reference to the coke and petroleum industry (S7), exceptions emerged for Trentino Alto Adige, Umbria, Campania, Apulia, and Calabria, where this sector was classified as a 'Prime User', as well as for Aosta Valley, Friuli-Venezia-Giulia, and Basilicata, where it was classified as a 'Low Impact' sector.

The manufacture of metals (S9), in the well-known 'Industrial Triangle' encompassing Lombardy, Piedmont and Liguria, emerged as a 'Key Sector' (Table 9) because of the intense links between naval industries, machineries, aerospace, and automobiles concentrated in the area. Exceptions, in reference to the manufacture of computer and electronic devices (S10) with respect to the national classification (Key sector), emerged for Latium, Molise, Campania, Apulia, Basilicata, Calabria, Sicily, and Sardinia, where the sector emerged as a 'Prime User'. Electricity and gas (S11) in seven regions (Veneto, Friuli Venezia Giulia, Emilia Romagna, Tuscany, Marche, Abruzzo, and Campania), emerged as a 'Low Impact' sector. This was different from the national level in the remaining regions, where the sector was classified as a 'Key Sector.' Information and communication (S19) was revealed as a 'Prime Vendor' sector, while in Umbria, Marche, Abruzzo, Molise, Puglia, and Basilicata, it was classified as a 'Low Impact' Sector and as a 'Prime User' in Campania. The only region which included financial and insurance activities within 'Key Sectors' was Latium, while in Marche this sector was included within 'Prime Users'. Peculiarities for administrative and support service activities (S3) were observed in Liguria, Trentino Alto Adige, Veneto, Umbria, Molise, Calabria, and Sicily, where this activity was a 'Prime Vendor' and in Marche, where administrative and support services were a 'Prime User'.

Table 6. Low Impact Sectors in the Italian regions.

SECTORS	S1		S2		S3		S5		S6		S7		S8		S9		S12		S13		S14		S18		S19		S24		S25		S27		S28		S29	
	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL
NORTHERN REGIONS																																				
EMILIA R.	0.92	0.47	0.01	0.01	0.39	0.05	0.46	0.86	0.84	0.57	-	-	-	-	-	-	0.52	0.80	0.67	0.57	0.57	0.41	-	-	-	-	0.24	0.82	0.10	0.23	0.32	0.39	0.21	0.30	0.00	0.00
FRIULI V. G.	0.91	0.43	0.01	0.01	0.28	0.04	0.14	0.59	0.95	0.57	0.76	0.95	-	-	-	-	0.56	0.81	0.65	0.54	0.54	0.42	-	-	-	-	0.42	0.85	0.13	0.25	0.40	0.45	0.22	0.32	0.00	0.00
LIGURIA	0.61	0.38	0.02	0.01	0.27	0.04	0.04	0.57	0.36	0.32	-	-	0.76	0.78	-	-	0.53	0.76	-	-	0.62	0.45	-	-	-	-	0.44	0.95	0.13	0.28	0.44	0.47	0.25	0.36	0.00	0.00
LOMBARDIA	0.48	0.31	0.00	0.01	0.75	0.08	0.57	0.96	0.88	0.59	-	-	-	-	-	-	0.50	0.81	-	-	0.43	0.36	-	-	-	-	0.20	0.81	0.09	0.24	0.33	0.39	0.19	0.34	0.00	0.00
PIEMONTE	0.75	0.41	0.00	0.01	0.46	0.05	0.44	0.84	0.87	0.58	-	-	-	-	-	-	0.49	0.80	-	-	0.57	0.42	-	-	-	-	0.27	0.81	0.11	0.23	0.36	0.42	0.21	0.33	0.00	0.00
TRENTINO A. A.	-	-	0.00	0.01	0.55	0.06	0.14	0.63	0.96	0.56	-	-	-	-	-	-	0.44	0.81	-	-	0.36	0.34	-	-	-	-	0.42	0.81	0.14	0.25	0.30	0.41	0.21	0.36	0.00	0.00
V. D'AOSTA	0.91	0.40	0.00	0.01	0.45	0.06	0.04	0.59	0.85	0.49	0.08	0.85	0.45	0.52	-	-	0.28	0.73	-	-	0.54	0.42	-	-	-	-	0.49	0.91	0.14	0.30	0.48	0.48	0.26	0.35	0.00	0.00
VENETO	0.95	0.47	0.01	0.01	0.25	0.03	-	-	0.90	0.59	-	-	-	-	-	-	0.53	0.81	0.68	0.57	0.55	0.40	-	-	-	-	0.27	0.87	0.11	0.24	0.31	0.39	0.21	0.32	0.00	0.00
CENTRAL REGIONS																																				
LAZIO	0.66	0.38	0.01	0.01	0.79	0.08	0.10	0.61	0.62	0.44	-	-	0.54	0.69	0.82	0.88	0.31	0.71	-	-	0.59	0.45	0.60	0.99	-	-	-	-	0.14	0.29	0.45	0.50	0.26	0.38	0.00	0.00
MARCHE	0.45	0.85	0.01	0.01	0.05	0.41	-	-	0.59	0.89	-	-	-	-	-	-	0.83	0.54	0.66	0.80	0.42	0.62	-	-	0.87	0.87	0.86	0.38	0.23	0.13	0.42	0.35	0.31	0.22	0.00	0.00
TOSCANA	0.84	0.43	0.01	0.01	0.74	0.07	-	-	0.91	0.62	-	-	0.95	0.88	-	-	0.53	0.80	0.91	0.77	0.57	0.42	-	-	-	-	0.35	0.89	0.12	0.25	0.40	0.45	0.22	0.33	0.00	0.00
UMBRIA	-	-	0.00	0.01	0.44	0.06	-	-	0.92	0.60	-	-	-	-	-	-	0.53	0.80	-	-	0.63	0.44	-	-	0.82	0.84	0.42	0.86	0.13	0.25	0.32	0.41	0.23	0.34	0.00	0.00
SOUTHERN REGIONS																																				
ABRUZZO	-	-	0.01	0.01	0.77	0.07	-	-	0.90	0.59	-	-	-	-	-	-	0.41	0.80	0.99	0.82	0.61	0.43	-	-	0.67	0.76	0.42	0.82	0.13	0.23	0.37	0.43	0.23	0.32	0.00	0.00
BASILICATA	-	-	0.00	0.01	0.62	0.05	0.17	0.69	0.63	0.42	0.24	0.90	-	-	-	-	0.47	0.79	-	-	0.69	0.45	-	-	0.86	0.91	0.47	0.93	0.15	0.26	0.33	0.43	0.24	0.36	0.00	0.00
CALABRIA	-	-	0.02	0.01	0.73	0.06	0.08	0.67	0.57	0.40	-	-	0.74	0.69	-	-	0.30	0.73	-	-	0.72	0.46	-	-	-	-	-	-	0.17	0.29	0.35	0.44	0.28	0.36	0.00	0.00
CAMPANIA	-	-	0.02	0.01	0.32	0.05	-	-	0.73	0.49	-	-	0.79	0.72	-	-	0.43	0.78	0.99	0.78	0.63	0.44	-	-	-	-	0.44	0.93	0.15	0.26	0.43	0.48	0.25	0.33	0.00	0.00
MOLISE	-	-	0.02	0.01	0.71	0.07	0.16	0.68	0.79	0.53	-	-	-	-	-	-	0.31	0.75	-	-	0.45	0.38	-	-	0.91	0.89	0.43	0.83	0.15	0.25	0.32	0.42	0.25	0.34	0.00	0.00
PUGLIA	-	-	0.02	0.01	0.59	0.06	-	-	0.67	0.47	-	-	0.77	0.74	-	-	0.50	0.77	-	-	0.64	0.45	-	-	0.95	0.91	0.44	0.93	0.14	0.27	0.36	0.44	0.25	0.35	0.00	0.00
SARDEGNA	-	-	0.02	0.01	0.88	0.08	0.06	0.60	0.54	0.40	-	-	0.69	0.76	-	-	0.37	0.69	-	-	0.66	0.44	-	-	-	-	0.47	0.95	0.15	0.28	0.43	0.46	0.26	0.36	0.00	0.00
SICILIA	-	-	0.02	0.01	0.78	0.08	0.08	0.63	0.49	0.38	-	-	0.75	0.78	-	-	0.37	0.69	-	-	0.66	0.43	-	-	-	-	0.47	0.93	0.15	0.27	0.46	0.47	0.26	0.36	0.00	0.00

Table 7. Prime Vendors in the Italian regions.

SECTORS	S1		S4		S5		S8		S9		S11		S13		S18		S19		S20		S21		S23		S26	
	FL	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**
NORTHERN REGIONS																										
EMILIA R.	-	-	-	-	-	-	1.14	0.92	-	-	-	-	-	-	-	-	1.04	0.92	1.94	0.82	1.19	0.57	-	-	-	-
FRIULI V. G.	-	-	-	-	-	-	1.21	0.81	-	-	-	-	-	-	-	-	-	-	2.20	0.93	1.25	0.63	-	-	-	-
LIGURIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.17	0.91	1.40	0.62	1.66	0.95	-	-
LOMBARDIA	-	-	-	-	-	-	1.12	0.95	-	-	-	-	1.02	0.86	-	-	-	-	2.04	0.90	1.16	0.59	-	-	-	-
PIEMONTE	-	-	-	-	-	-	1.12	0.92	-	-	-	-	1.00	0.83	-	-	-	-	2.01	0.88	1.18	0.58	-	-	-	-
TRENTINO A. A.	1.11	0.47	-	-	-	-	1.03	0.81	-	-	-	-	1.30	0.99	-	-	1.02	0.97	2.34	0.96	1.27	0.64	1.54	0.95	-	-
V. D'AOSTA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.38	0.94	1.53	0.62	-	-	-	-
VENETO	-	-	-	-	-	-	1.18	0.89	-	-	-	-	-	-	-	-	1.05	0.95	1.99	0.84	1.23	0.60	1.61	0.98	-	-
CENTRAL REGIONS																										
LAZIO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.43	0.66	-	-	-	-
MARCHE	-	-	1.89	0.94	1.02	0.63	-	-	-	-	1.37	0.51	-	-	1.07	0.54	-	-	-	-	-	-	-	-	1.20	0.37
TOSCANA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.06	0.96	2.03	0.87	1.26	0.59	-	-	-	-
UMBRIA	1.04	0.48	-	-	-	-	1.19	0.84	-	-	-	-	1.26	0.99	-	-	-	-	1.85	0.76	1.29	0.59	1.52	0.93	-	-
SOUTHERN REGIONS																										
ABRUZZO	1.02	0.49	-	-	-	-	1.20	0.93	-	-	-	-	-	-	-	-	-	-	1.58	0.64	1.20	0.56	-	-	-	-
BASILICATA	1.27	0.49	-	-	-	-	1.13	0.78	-	-	-	-	1.29	0.99	-	-	-	-	1.62	0.66	1.29	0.66	-	-	-	-
CALABRIA	1.17	0.46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.03	0.96	1.73	0.71	1.58	0.58	1.98	0.98	-	-
CAMPANIA	1.15	0.49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.69	0.72	1.37	0.59	-	-	-	-
MOLISE	1.18	0.54	-	-	-	-	1.09	0.93	-	-	-	-	-	-	-	-	-	-	1.67	0.68	1.34	0.55	1.70	0.99	-	-
PUGLIA	1.15	0.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.83	0.76	1.37	0.58	-	-	-	-
SARDEGNA	1.13	0.52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.12	0.96	1.72	0.71	1.45	0.57	-	-	-	-
SICILIA	1.10	0.50	-	-	-	-	-	-	1.03	0.99	-	-	-	-	-	-	1.02	0.94	1.86	0.76	1.45	0.57	1.76	0.95	-	-

Table 8. Prime Users in the Italian regions.

SECTORS	S4		S5		S7		S8		S10		S11		S18		S20		S21		S23		S24		S26	
	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL
NOTHERN REGIONS																								
EMILIA R.	-	-	-	-	-	-	-	-	-	-	0.73	1.43	0.52	1.13	-	-	-	-	-	-	-	-	0.34	1.18
FRIULI V. G.	-	-	-	-	-	-	-	-	-	-	0.75	1.48	0.56	1.12	-	-	-	-	-	-	-	-	0.40	1.11
LIGURIA	0.78	1.77	-	-	-	-	-	-	-	-	0.85	1.28	0.62	1.04	-	-	-	-	-	-	-	-	0.45	1.35
LOMBARDIA	0.96	1.66	-	-	-	-	-	-	-	-	0.50	1.28	0.43	1.07	-	-	-	-	-	-	-	-	0.30	1.18
PIEMONTE	-	-	-	-	-	-	-	-	-	-	0.71	1.40	0.43	1.09	-	-	-	-	-	-	-	-	0.35	1.16
TRENTINO A. A.	-	-	-	-	0.72	1.04	-	-	-	-	0.70	1.41	0.59	1.25	-	-	-	-	-	-	-	-	0.41	1.11
V. D’AOSTA	-	-	-	-	-	-	-	-	0.29	2.00	0.68	1.29	0.67	1.14	-	-	-	-	-	-	-	-	0.46	1.08
VENETO	-	-	0.61	1.00	-	-	-	-	-	-	0.36	1.24	0.55	1.15	-	-	-	-	-	-	-	-	0.34	1.20
CENTRAL REGIONS																								
LAZIO	0.51	1.61	-	-	-	-	-	-	0.62	1.91	0.44	1.11	-	-	-	-	-	-	-	-	0.45	1.01	0.44	1.36
MARCHE	-	-	-	-	-	-	0.91	1.20	-	-	-	-	-	-	0.84	2.03	0.59	1.26	0.87	1.37	-	-	-	-
TOSCANA	0.77	1.74	0.62	1.04	-	-	-	-	-	-	0.63	1.31	0.56	1.03	-	-	-	-	-	-	-	-	0.38	1.26
UMBRIA	-	-	0.64	1.03	0.75	1.01	-	-	-	-	0.35	1.26	0.57	1.26	-	-	-	-	-	-	-	-	0.39	1.14
SOUTHERN REGIONS																								
ABRUZZO	-	-	0.63	1.02	-	-	-	-	-	-	0.75	1.32	0.56	1.17	-	-	-	-	-	-	-	-	0.38	1.19
BASILICATA	-	-	-	-	-	-	-	-	0.50	2.07	0.87	1.18	0.61	1.42	-	-	-	-	-	-	-	-	0.49	1.13
CALABRIA	-	-	-	-	0.54	1.07	-	-	0.29	2.07	0.21	1.30	0.70	1.27	-	-	-	-	-	-	0.50	1.01	0.53	1.21
CAMPANIA	-	-	0.57	1.01	0.71	1.02	-	-	0.64	2.03	0.81	1.18	0.61	1.33	-	-	-	-	-	-	-	-	0.45	1.16
MOLISE	-	-	-	-	-	-	-	-	0.39	1.90	0.80	1.09	0.60	1.32	-	-	-	-	-	-	-	-	0.44	1.28
PUGLIA			0.59	1.03	0.77	1.09			0.53	1.96	0.80	1.17	0.61	1.33									0.44	1.19
SARDEGNA	-	-	-	-	-	-	-	-	0.28	1.84	0.07	1.21	0.64	1.29	-	-	-	-	-	-	-	-	0.47	1.34
SICILIA									0.63	2.07	0.20	1.30	0.64	1.26									0.47	1.31

Table 9. Key Sectors in the Italian regions.

SECTORS	**S4**		**S7**		**S9**		**S10**		**S13**		**S15**		**S16**		**S17**		**S19**		**S20**		**S22**		**S23**	
	FL	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**	**FL**	**BL**
NORTHERN REGIONS																								
EMILIA R.	1.10	1.96	1.71	1.37	2.03	1.59	1.57	2.42	-	-	1.08	2.17	2.50	2.99	2.39	1.67	-	-	-	-	2.59	1.18	1.73	1.02
FRIULI V. G.	1.04	1.95	-	-	2.22	1.65	1.71	2.54	-	-	1.24	2.34	2.27	3.13	2.41	1.63	1.14	1.02	-	-	2.71	1.23	1.79	1.05
LIGURIA	-	-	1.68	1.39	1.06	1.01	1.34	2.20	1.31	1.05	1.44	2.29	2.63	3.42	2.85	1.91	1.14	1.04	-	-	3.01	1.24	-	-
LOMBARDIA	-	-	1.65	1.48	1.98	1.58	1.55	2.40	-	-	1.08	2.16	2.52	2.92	2.20	1.57	1.44	1.13	-	-	2.71	1.24	1.78	1.02
PIEMONTE	1.03	1.81	1.58	1.35	1.99	1.59	1.56	2.38	-	-	1.14	2.19	2.35	2.94	2.14	1.53	1.41	1.11	-	-	2.63	1.22	1.72	1.01
TRENTINO A. A.	1.31	2.15	-	-	1.91	1.47	1.10	2.29	-	-	1.38	2.23	2.62	3.14	2.34	1.56	-	-	-	-	2.65	1.17	-	-
V. D'AOSTA	1.09	2.00	-	-	2.32	1.59	-	-	1.47	1.09	1.63	2.24	2.34	3.64	3.12	1.80	1.38	1.12	-	-	2.73	1.19	1.81	1.02
VENETO	1.17	2.03	1.46	1.23	2.08	1.60	1.59	2.43	-	-	1.23	2.27	2.63	2.94	2.44	1.65	-	-	-	-	2.55	1.16	-	-
CENTRAL REGIONS																								
LAZIO	-	-	1.78	1.57	-	-	-	-	1.31	1.10	1.28	2.08	2.52	3.40	2.82	1.94	1.71	1.26	2.43	1.08	3.16	1.32	2.08	1.06
MARCHE	-	-	1.33	1.51	1.66	2.16	2.50	1.64	-	-	2.29	1.21	2.92	2.62	1.57	2.26	-	-	-	-	1.14	2.54	-	-
TOSCANA	-	-	1.72	1.51	1.39	1.20	1.18	2.17	-	-	1.16	2.18	2.56	3.07	2.42	1.72	-	-	-	-	2.78	1.23	1.81	1.06
UMBRIA	1.22	2.12	-	-	2.01	1.60	1.03	2.15	-	-	1.29	2.28	2.64	3.02	2.63	1.68	-	-	-	-	2.75	1.18	-	-
SOUTHERN REGIONS																								
ABRUZZO	1.21	2.07	1.64	1.50	1.85	1.51	1.07	2.19	-	-	1.25	2.24	2.47	3.02	2.34	1.64	-	-	-	-	2.45	1.10	1.73	1.01
BASILICATA	1.50	2.33	-	-	1.53	1.26	-	-	-	-	1.57	2.33	2.56	3.47	2.76	1.71	-	-	-	-	2.90	1.19	2.08	1.01
CALABRIA	1.06	2.17	-	-	1.19	1.03	-	-	1.52	1.19	1.70	2.25	3.01	3.37	3.32	1.96	-	-	-	-	2.85	1.13	-	-
CAMPANIA	1.38	2.31	-	-	1.28	1.12	-	-	-	-	1.43	2.23	2.79	3.29	2.86	1.83	1.17	1.03	-	-	2.88	1.22	1.90	1.04
MOLISE	1.42	2.33	1.89	1.56	1.11	1.03	-	-	1.36	1.05	1.44	2.19	2.50	3.30	2.86	1.85	-	-	-	-	2.60	1.12	-	-
PUGLIA	1.37	2.28	-	-	1.38	1.19	-	-	1.31	1.04	1.42	2.22	2.76	3.21	2.63	1.72	-	-	-	-	2.73	1.17	1.86	1.02
SARDEGNA	1.21	2.27	1.67	1.56	1.15	1.02	-	-	1.41	1.12	1.52	2.15	2.83	3.23	2.93	1.88	-	-	-	-	2.83	1.16	1.90	0.98
SICILIA	1.13	2.20	1.56	1.50	-	-	-	-	1.39	1.10	1.49	2.13	2.87	3.22	3.07	1.92	-	-	-	-	2.69	1.12	-	-

Our results confirmed the performance of the industries linked to the so-called "Made in Italy" designation, which was intended as high-value, and mostly consisted of artisan and non-routinely products realized exclusively in Italy (Salvati and Zitti 2011). According to recent official statistics, the agri-food system as a whole (including agroindustry, wholesale and retail trade, and catering), produced 522 billion euros, and accounted for 15% of the country's gross domestic product, which thus ensured a prominent position in Europe. Significant growth was also observed in the last decade for the food industry (S4), +12% value added and +8% production index, which doubled the production of manufacturing.

The contribution of agriculture (S1) and the food industry (S4) was also particularly evident in Italy, which displayed an absolute growth in sales (1.3%) by 324 billion euros (CREA 2020). The manufacture of food products, beverages, and tobacco products (S4) emerged as a 'Key Sector' in most Italian regions, except for Liguria, Lombardy, Tuscany, and Latium, which were North-Central regions where it emerged as a Prime User. The role of the Prime User in the economic interactions also applied to this activity at the national level (see Table 4). Although the economic systems proved to be able to regain their average performance at pre-pandemic levels, the agri-food system in Italy seemed to call for supporting policy actions. At the same time, the manufacturing of textiles and wearing apparel (S5) is another industry with a longstanding tradition. Sales of this sector accounted for 9% of total manufacture, with wool and linen as the dominant yarn productions. Artisan products and the export of footwear were recognized to have a prominent role in the sector. While this activity was classified as 'Low Impact' in most regions, the linkage indices at the national level amounted to FL = 0.734 and BL = 0.913. At the regional level, however, six regions emerged as 'Prime Users': Veneto, Tuscany, Umbria, Abruzzo, Campania, and Apulia. In Marche, a well-known shoe production region, the industry arose as a 'Prime Vendor'.

Delocalization processes affected the most recent dynamics of this sector. Usually, delocalization operates by displacing Italian production towards low-cost countries, which possibly reduces (or subtracts) the technological assets developed by the creativity of Italian workers. The liberalization of international commerce, which involved more than half of the textile firms, was an additional factor influencing the recent development of the fiber and yarn industries. The prominent role of Italy in the global rank should be preserved with targeted duties and other supportive measures (Chiaradia 2019). The metal product industry (S9) produced the most investment goods, through which technical innovation can be transmitted to all branches of the economy. In this way, this activity supports the intrinsic competitiveness of the entire manufacturing sector, whose growth depends on the latent capacity of the industry to grow and renew.

5. Discussion

Since the 1950s, as a consequence of industrialization in emerging economies, the need for a universally recognized method to measure inter-industry linkages began to emerge (Rubino and Vitolla 2018). This method was aimed at assessing the relationship between and within industries by promoting the balanced development of the economic system and by optimizing the industrial structure of the national economy (Lamonica and Chelli 2018). After a short description of the literature related to linkage analysis, we focused on a specific methodology based on the Hypothetical Extraction Method approach, which measures the relative importance of a given sector by taking into account its net importance to the external connections with the other sectors (Lamonica et al. 2020). By means of a 'non-survey' regionalization method, i.e., the Flegg Location Quotient, we regionalized the Input–Output matrix of 2016 and applied linkage analysis at both the national and regional levels to highlight the relevance of the weights in the location of the sectors, based on *a-priori* classes, namely Low Impact sectors, Prime Vendors, Prime Buyers, and Key Sectors (OECD 2021).

This methodology provided an economically robust tool for building the 20 Italian regional input–output tables, in a regional framework where innovation is basically created by larger firms, with limited innovation results of small- and medium-enterprises (SMEs) representing the dominant part of the industrial system (Cainelli et al. 2019). Given the burden of bureaucratic procedures and the relevant delays in the completion of the third industrial revolution (Salvati et al. 2017), the ICT revolution was consolidated in terms of infrastructure (both technical and administrative), even in a context where the Italian industrial sectors revealed a markedly fragmented structure (Ghisellini and Ulgiati 2020). Under such conditions, the most suitable candidate for Industry 4.0 provisions might be medium/large firms, including multi-nationals (ISTAT 2016). Through internally organized competences, this type of firm is prepared to deal with managerial and financial issues, and is equipped to deal with international trade procedures (D'Ingiullo and Evangelista 2020), while small firms need to hire external abilities and, possibly, find further credit sources to cover the commonly long delays in the operation of public administration (Da Roit and Iannuzzi 2022).

This could mean that, as policy beneficiaries, large businesses will eventually crowd out the small firms that constitute the backbone of the Italian economy (Ciffolilli et al. 2019), and have relevant limitations in terms of innovation diffusion (Ciaschini 2022). Such weak performance of SMEs has also been observed in applied works, such as Muscettola (2015) and Bartoloni et al. (2020), in which the patterns of growth of a representative panel of Italian manufacturing firms were investigated. We observed that, although the estimates suggest that small firms grow faster than larger ones, the applied results did not show a significant change in the average size of businesses at the end of the period under investigation (Bugamelli et al. 2018).

The slow pace in the realization of the ICT infrastructures was in turn influenced by austerity policies on public expenditures in the area of technology (Ciffolilli et al. 2019). Since the 1980s, the funds for private and public institutions and universities have not been considered as policy priorities by governments (e.g., Corona 2019). A recent diminution of 19% of public funding for research that took place in the period between 2008 and 2016 may confirm this assumption. However, the decline in public research and university activities has progressively stimulated an improvement in research for R&D (Bigerna 2013). However, due to the weakening of the system of public research, the scientific goals recently attained could be only temporary (Cutrini and Salvati 2021). The observed emigration of younger researchers, due to easier and more rewarding job opportunities (e.g., Recanatesi et al. 2015), as well as higher research funding, is a context where competences are recognized is a key issue at stake in this development dimension (Bertolini and Giovannetti 2006). The persistent weakness of Italian firms in the technological innovation of human capital and corporate governance—and especially the insufficient improvement of the context in which business activity develops—has certainly influenced the low increase in total factor productivity (Cainelli et al. 2019) that has characterized the unfavorable trend in hourly productivity, which definitely determines lazy growth—or even stagnation—in present times.

6. Conclusions

Based on the empirical data shown in this paper and the related discussion, some perplexities emerge on the topics of innovation, which are connected with the features of the Italian economy and social framework. The innovation policy is expected to strengthen regional innovation capabilities to increase regional competitiveness and nurture innovative and dynamic enterprises. Since its inception, the policy design has supported collaborative research and development (R&D), including through innovation clusters, and the promotion of partnerships in important areas such as the smart factory, Industry 4.0, life sciences, and the bio-economy. Yet, strong concentration in manufacturing and sophisticated/specific innovation activities within local core industries is at risk of decline, due to ongoing industrial transitions. Some specific features of the present Italian economy, characterized by the slowness of bureaucratic procedures with respect to other competing economies, as well as the swiftness of the political economic cycle (that weakens the monitoring process of innovative changes and influences the fragmented structure of sectors that are predominantly small- and medium- enterprises (SMEs)) tend to burden the innovation process and leave the entire load of innovation to the private sector. Policy should consider the results of regionalized IO exercises when designing general or disaggregated strategic instruments and measures aimed at fueling economic development through the leverage of industrial interlinkage improvements.

Author Contributions: Conceptualization, M.C. and F.M.C.; methodology, G.R.L. and C.C.; validation, C.C., L.S. and G.R.L. formal analysis, C.C.; resources, G.R.L., C.C. and L.S.; data curation, G.R.L. and C.C.; writing—original draft preparation, C.C.; writing—review and editing, C.C. and L.S. supervision, M.C., L.S. and F.M.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are openly available in Istat: https://www.istat.it/it/archivio/253253, accessed on 13 November 2022.

Conflicts of Interest: The authors declare no conflict of interest.

References

Ali, Yousaf, Muhammad Sabir, and Noor Muhammad. 2019. A comparative input-output analysis of the construction sector in three developing economies of South Asia. *Construction Management and Economics* 37: 643–58. [CrossRef]

Archibugi, Daniele, Sergio Cesaratto, and Giorgio Sirilli. 1991. Sources of innovative activities and industrial organization in Italy. *Research Policy* 20: 299–313. [CrossRef]

Ascani, Andrea, Alessandra Faggian, and Sandro Montresor. 2021. The geography of COVID-19 and the structure of local economies: The case of Italy. *Journal of Regional Science* 61: 407–41. [CrossRef] [PubMed]

Banca d'Italia. 2020. Economie regionali Dinamiche recenti ed aspetti strutturali Banca d'Italia (2020) Economie regionali L'economia delle regioni Italiane 22. Rome: Bank of Italy. Available online: https://www.bancaditalia.it/pubblicazioni/economie-regionali/2020/2020-0022/index.html (accessed on 16 November 2022).

Bartoloni, Eleonora, Maurizio Baussola, and Luca Bagnato. 2020. Waiting for Godot? Success or failure of firms' growth in a panel of Italian manufacturing firms. *Structural Change and Economic Dynamics* 55: 259–75. [CrossRef]

Bashir, Muhammad Farhan, Benjiang Ma, and Luqman Shahzad. 2020. A brief review of socio-economic and environmental impact of COVID-19. *Air Quality, Atmosphere & Health* 13: 1403–9.

Basso, Gaetano. 2020. The Evolution of the Occupational Structure in Italy, 2007–17. *Social Indicators Research* 152: 673–704. [CrossRef]

Belitski, Maksim, Christina Guenther, Alexander S. Kritikos, and Roy Thurik. 2022. Economic effects of the COVID-19 pandemic on entrepreneurship and small businesses. *Small Business Economics* 58: 593–609. [CrossRef]

Bertolini, Paola, and Enrico Giovannetti. 2006. Industrial districts and internationalization: The case of the agri-food industry in Modena, Italy. *Entrepreneurship and Regional Development* 18: 279–304. [CrossRef]

Beyers, William B. 1976. Empirical identification of key sectors: Some further evidence. *Environment and Planning A* 8: 231–36. [CrossRef]

Bigerna, Simona. 2013. The regional growth-instability frontier in Italy. *Atlantic Economic Journal* 41: 463–64. [CrossRef]

Bonfiglio, Andrea, and Francesco Chelli. 2008. Assessing the behaviour of non-survey methods for constructing regional input–output tables through a Monte Carlo simulation. *Economic Systems Research* 20: 243–58. [CrossRef]

Bragatto, Paolo, Tomaso Vairo, Maria Francesca Milazzo, and Bruno Fabiano. 2021. The impact of the COVID-19 pandemic on the safety management in Italian Seveso industries. *Journal of Loss Prevention in the Process Industries* 70: 104393. [CrossRef]

Bugamelli, Matteo, Monica Amici, Fabrizio Colonna, Francesco D. Amuri, Francesco Manaresi, Giuliana Palumbo, Filippo Scoccianti, and Enrico Sette. 2018. *Productivity Growth in Italy: A Tale of a Slow-Motion Change*. Bank of Italy Occasional Paper 422. Rome: Bank of Italy. Available online: https://www.bancaditalia.it/pubblicazioni/qef/2018-0422/QEF_422_18.pdf?language_id=1 (accessed on 16 November 2022).

Cainelli, Giulio, and Riccardo Leoncini. 1999. Externalities and long-term local industrial development. Some empirical evidence from Italy. *Revue d'Economie Industrielle* 90: 25–39. [CrossRef]

Cainelli, Giulio, Roberto Ganau, and Anna Giunta. 2018. Spatial agglomeration, global value chains, and productivity. Micro-evidence from Italy and Spain. *Economics Letters* 169: 43–46. [CrossRef]

Cainelli, Giulio, Roberto Ganau, and Marco Modica. 2019. Does related variety affect regional resilience? New evidence from Italy. *The Annals of Regional Science* 62: 657–80. [CrossRef]

Cella, Guido. 1984. The input-output measurement of interindustry linkages. *Oxford Bulletin of Economics and Statistics* 46: 73–84. [CrossRef]

Chen, Ji, Jiayan Huang, Weihua Su, Dalia Štreimikienė, and Tomas Baležentis. 2021. The challenges of COVID-19 control policies for sustainable development of business: Evidence from service industries. *Technology in Society* 66: 101643. [CrossRef] [PubMed]

Chenery, Hollis B., and Tsunehiko Watanabe. 1958. International comparisons of the structure of production. *Econometrica* 26: 487–521. [CrossRef]

Chiaradia, Giuseppe. 2019. La delocalizzazione dei prodotti del tessile deve essere disincentivata con pesanti dazi sulle merci di qualità. Available online: https://www.lineaitaliapiemonte.it/2019/07/30/leggi-notizia/argomenti/editoriali/articolo/la-delocalizzazione-dei-prodotti-del-tessile-deve-essere-disincentivata-con-pesanti-dazi-sulle-merci.html (accessed on 11 December 2021).

Ciaschini, Clio. 2022. A quantitative evaluation of Industra 4.0 through simulation of QUEST III Italia. *Rivista Internazionale di Scienze Sociali, Vita e Pensiero* 3: 251–92. [CrossRef]

Ciffolilli, Andrea, Eleonora Cutrini, and Marco Pompili. 2019. Do European Funds support the formation of firms? New evidence from Italy. *Regional Science Policy & Practice* 11: 549–69.

Ciommi, Mariateresa, Francesco M. Chelli, and Luca Salvati. 2019. Integrating parametric and non-parametric multivariate analysis of urban growth and commuting patterns in a European metropolitan area. *Quality & Quantity* 53: 957–79.

Clements, Benedict J. 1990. On the decomposition and normalization of interindustry linkages. *Economics Letters* 33: 337–40. [CrossRef]

Confindustria Report. 2019. Dove va l'industria italiana. 2019. Rapporto sull'industria Italiana 2019. Available online: https://www.confindustria.it/home/centro-studi/temi-di-ricerca/tendenze-delle-imprese-e-dei-sistemi-industriali/tutti/dettaglio/rapporto-industria+-italiana+-2019 (accessed on 11 December 2021).

Corona, Piermaria. 2019. Global change and silvicultural research. *Annals of Silvicultural Research* 43: 1–3.

CREA. 2020. *Annuario della Agricoltura Italiana*. Rome: Consiglio per la Ricerca in Agricoltura e l'analisi dell'Economia Agraria.

Crespí-Cladera, Rafel, Alfredo Martín-Oliver, and Bartolomé Pascual-Fuster. 2021. Financial distress in the hospitality industry during the COVID-19 disaster. *Tourism Management* 85: 104301. [CrossRef]

Cuello, Federico A., Fayçal Mansouri, and Geoffrey JD Hewings. 1992. The identification of structure at the sectoral level: A reformulation of the Hirschman–Rasmussen key sector indices. *Economic Systems Research* 4: 285–96. [CrossRef]

Cutrini, Eleonora, and Luca Salvati. 2021. Unraveling spatial patterns of COVID-19 in Italy: Global forces and local economic drivers. *Regional Science Policy & Practice* 13: 73–108.

D'Ingiullo, Dario, and Valentina Evangelista. 2020. Institutional quality and innovation performance: Evidence from Italy. *Regional Studies* 54: 1724–36. [CrossRef]

Da Roit, Barbara, and Francesco E. Iannuzzi. 2022. One of many roads to industry 4.0? Technology, policy, organisational adaptation and worker experience in 'Third Italy' SMEs. *New Technology, Work and Employment*. Available online: https://onlinelibrary.wiley.com/doi/epdf/10.1111/ntwe.12241 (accessed on 16 November 2022).

Dean, Mark, Al Rainnie, Jim Stanford, and Dan Nahum. 2021. Industrial policy-making after COVID-19: Manufacturing, innovation and sustainability. *The Economic and Labour Relations Review* 32: 283–303. [CrossRef]

Dei Ottati, Gabi. 2018. Marshallian industrial districts in Italy: The end of a model or adaptation to the global economy? *Cambridge Journal of Economics* 42: 259–84. [CrossRef]

Eurispes. 2022. Rapporto Italia 2021. Rome. Available online: http:www.eurispes.eu (accessed on 13 September 2022).

EUROSTAT. 2008. NACE Rev.2 Statistical classification of economic activities in the European Community. Available online: https://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF (accessed on 11 December 2021).

Flegg, Anthony T., and Chris D. Webber. 2000. Regional size, regional specialization and the FLQ formula. *Regional Studies* 34: 563–69. [CrossRef]

Flegg, Anthony T., and Timo Tohmo. 2016. Estimating Regional Input Coefficients and Multipliers: The Use of FLQ is Not a Gamble. *Regional Studies* 50: 310–25. [CrossRef]

Flegg, Anthony T., Chris D. Webber, and Matthew V. Elliott. 1995. On the appropriate use of location quotients in generating regional input–output tables. *Regional Studies* 29: 547–61. [CrossRef]

Flegg, Anthony T., Leonardo J. Mastronardi, and Carlos A. Romero. 2016. Evaluating the FLQ and AFLQ formulae for estimating regional input coefficients: Empirical evidence for the province of Córdoba, Argentina. *Economic Systems Research* 28: 21–37. [CrossRef]

Gallego, Blanca, and Manfred Lenzen. 2005. A consistent input–output formulation of shared producer and consumer responsibility. *Economic Systems Research* 17: 365–91. [CrossRef]

Ghisellini, Patrizia, and Sergio Ulgiati. 2020. Circular economy transition in Italy. Achievements, perspectives and constraints. *Journal of Cleaner Production* 243: 118360. [CrossRef]

Golan, Amos, George Judge, and Sherman Robinson. 1994. Recovering information from incomplete or partial multisectoral economic data. *The Review of Economics and Statistics* 76: 541–49. [CrossRef]

Guerra, Ana-Isabel, and Ferran Sancho. 2010. Measuring energy linkages with the hypothetical extraction method: An application to Spain. *Energy Economics* 32: 831–37. [CrossRef]

Hauknes, Johan, and Mark Knell. 2009. Embodied knowledge and sectoral linkages: An input–output approach to the interaction of high-and low-tech industries. *Research Policy* 38: 459–69. [CrossRef]

Hermannsson, Kristinn. 2016. Beyond intermediates: The role of consumption and commuting in the construction of local input–output tables. *Spatial Economic Analysis* 11: 315–39. [CrossRef]

Hewings, Geoffrey J., and Rodney C. Jensen. 1988. Emerging challenges in regional input-output analysis. *The Annals of Regional Science* 22: 43–53.

Hirschman, Albert O. 1958. *The Strategy of Economic Development*. New Haven: Yale University Press.

ISTAT. 2016. *Il Sistema delle Tavole Input-Output*. Rome: ISTAT.

ISTAT. 2020. *Regional Accounts | Years 2017–2019 (dataset)*. Rome: ISTAT. Available online: https://www.istat.it/it/archivio/253253 (accessed on 16 November 2022).

Jahn, Malte. 2017. Extending the FLQ formula: A location quotient-based interregional input–output framework. *Regional Studies* 51: 1518–29. [CrossRef]

Jahn, Malte, Anthony T. Flegg, and Timo Tohmo. 2020. Testing and implementing a new approach to estimating interregional output multipliers using input–output data for South Korean regions. *Spatial Economic Analysis* 15: 165–85. [CrossRef]

Jones, Leroy P. 1976. The measurement of Hirschmanian linkages. *The Quarterly Journal of Economics* 90: 323–33. [CrossRef]

Kay, David L., James E. Pratt, and Mildred E. Warner. 2007. Role of services in regional economy growth. *Growth and Change* 38: 419–42. [CrossRef]

Lamonica, Giuseppe Ricciardo, and Francesco Maria Chelli. 2018. The performance of non-survey techniques for constructing sub-territorial input-output tables. *Papers in Regional Science* 97: 1169–202. [CrossRef]

Lamonica, Giuseppe R., Maria C. Recchioni, Francesco M. Chelli, and Luca Salvati. 2020. The efficiency of the cross-entropy method when estimating the technical coefficients of input–output tables. *Spatial Economic Analysis* 15: 62–91. [CrossRef]

Li, Zhong-Fei, Qi Zhou, Ming Chen, and Qian Liu. 2021. The impact of COVID-19 on industry-related characteristics and risk contagion. *Finance Research Letters* 39: 101931. [CrossRef]

Maples, Joshua G., Jada M. Thompson, John D. Anderson, and David P. Anderson. 2021. Estimating covid-19 impacts on the broiler industry. *Applied Economic Perspectives and Policy* 43: 315–28.

Meller, Patricio, and Manuel Marfán. 1981. Small and large industry: Employment generation, linkages, and key sectors. *Economic Development and Cultural Change* 29: 263–74.

Miller, Ronald E., and Michael L. Lahr. 2001. A taxonomy of extractions. *Contributions to Economic Analysis* 249: 407–41.

Miller, Ronald E., and Peter D. Blair. 2009. *Input-Output Analysis: Foundations and Extensions*. Cambridge: Cambridge University Press.

Morrissey, Karyn. 2016. A location quotient approach to producing regional production multipliers for the Irish economy. *Papers in Regional Science* 95: 491–506. [CrossRef]

Muscettola, Marco. 2015. Difficulties for small firms to invest in research prerogatives. An empirical analysis of a sample of Italian firms. *Applied Economics* 47: 1495–510. [CrossRef]

Notteboom, Theo, Thanos Pallis, and Jean-Paul Rodrigue. 2021. Disruptions and resilience in global container shipping and ports: The COVID-19 pandemic versus the 2008–9 financial crisis. *Maritime Economics & Logistics* 23: 179–210.

OECD. 2021. *Regional Innovation in Piedmont, Italy: From Innovation Environment to Innovation Ecosystem OECD*. Paris: Regional Development Studies OECD Publishing.

Oosterhaven, Jan. 2004. *On the Definition of Key Sectors and the Stability of Net Versus Gross Multipliers*. Groningen: SOM Research School, University of Groningen.

Oosterhaven, Jan. 2007. The net multiplier is a new key sector indicator: Reply to De Mesnard's comment. *The Annals of Regional Science* 41: 273–83. [CrossRef]

Pham, Tien Duc, Larry Dwyer, Jen-Je Su, and Tramy Ngo. 2021. COVID-19 impacts of inbound tourism on Australian economy. *Annals of Tourism Research* 88: 103179. [CrossRef]

Rasmussen, Poul Nørregaard. 1956. *Studies in Inter-Sectoral Relations*. København: E. Harck Publisher, vol. 15.

Recanatesi, Fabio, Matteo Clemente, Efstathios Grigoriadis, Flavia Ranalli, Marco Zitti, and Luca Salvati. 2015. A fifty-year sustainability assessment of Italian agro-forest districts. *Sustainability* 8: 32. [CrossRef]

Reis, Hugo, and António Rua. 2009. An input–output analysis: Linkages versus leakages. *International Economic Journal* 23: 527–44. [CrossRef]

Round, Jeffery I. 1983. Nonsurvey techniques: A critical review of the theory and the evidence. *International Regional Science Review* 8: 189–212. [CrossRef]

Rubino, M., and F. Vitolla. 2018. Implications of network structure on small firms' performance: Evidence from Italy. *International Journal of Business and Management* 13: 46–56. [CrossRef]

Salvati, Luca, and Marco Zitti. 2009. Substitutability and weighting of ecological and economic indicators: Exploring the importance of various components of a synthetic index. *Ecological Economics* 68: 1093–99. [CrossRef]

Salvati, Luca, and Marco Zitti. 2011. Economic growth vs. land quality: A multidimensional approach in Italy. *Journal of Environmental Planning and Management* 54: 733–48. [CrossRef]

Salvati, Luca, Marco Petitta, Tomaso Ceccarelli, Luigi Perini, Federica Di Battista, and Maria Elisa Venezian Scarascia. 2008. Italy's renewable water resources as estimated on the basis of the monthly water balance. *Irrigation and Drainage: The Journal of the International Commission on Irrigation and Drainage* 57: 507–15. [CrossRef]

Salvati, Luca, Marco Zitti, and Margherita Carlucci. 2017. In-between regional disparities and spatial heterogeneity: A multivariate analysis of territorial divides in Italy. *Journal of Environmental Planning and Management* 60: 997–1015. [CrossRef]

Schultz, Siegfried. 1977. Approaches to identifying key sectors empirically by means of input-output analysis. *The Journal of Development Studies* 14: 77–96. [CrossRef]

Seetharaman, Priya. 2020. Business models shifts: Impact of COVID-19. *International Journal of Information Management* 54: 102173. [CrossRef]

Sigala, Marianna. 2020. Tourism and COVID-19: Impacts and implications for advancing and resetting industry and research. *Journal of Business Research* 117: 312–21. [CrossRef]

Song, Hyoung J., Jihwan Yeon, and Seoki Lee. 2021. Impact of the COVID-19 pandemic: Evidence from the US restaurant industry. *International Journal of Hospitality Management* 92: 102702. [CrossRef] [PubMed]

Strassert, Günter. 1968. Zur bestimmung strategischer sektoren mit hilfe von input-output-modellen. *Jahrbücher für Nationalökonomie und Statistik* 182: 211–15. [CrossRef]

Szyrmer, Janusz M. 1992. Input—Output coefficients and multipliers from a total-flow perspective. *Environment and Planning A* 24: 921–37. [CrossRef]

Temurshoev, Umed. 2010. Identifying optimal sector groupings with the hypothetical extraction method. *Journal of Regional Science* 50: 872–90. [CrossRef]

Temurshoev, Umed, and Jan Oosterhaven. 2014. Analytical and empirical comparison of policy-relevant key sector measures. *Spatial Economic Analysis* 9: 284–308. [CrossRef]

Zambon, Ilaria, Andrea Colantoni, Margherita Carlucci, Nathan Morrow, Adele Sateriano, and Luca Salvati. 2017. Land quality, sustainable development and environmental degradation in agricultural districts: A computational approach based on entropy indexes. *Environmental Impact Assessment Review* 64: 37–46. [CrossRef]