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Research article

The economy of Tuscany in the post Covid-19 era: struggling with energy crisis and inflation. What to do to resume the journey?[1]

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Abstract: The Covid-19 pandemic has wrought significant challenges on both national and regional economic systems, resulting in an exacerbation of poverty and a deceleration of economic growth. These repercussions have led to increased social tensions and discontent.

Tuscany a key player in the Italian and European economies, warrants scrutiny concerning its economic structure post-pandemic, particularly in relation to the role played by industry districts and the ways for it to get out of the crisis and get back on track.

This paper undertakes an analysis of the strengths and weaknesses of the Tuscan economy, with a focus on EMAS-APO industry districts. It examines the region's standing in terms of national and European ERCI competitiveness, placing it at an average level. Additionally, the region ranks in the third decile of the DESI digitalization, indicating a commendable technological dynamism. An equally satisfying spending power in R&D, in percentage of GDP higher than the national one, and ranking 6th in the regions' rank, is flanked by a particularly vigorous innovation capacity of the production sector.

Employing a symmetric branch-by-branch SAM 2019 analysis, derived from a sector-by-product 2014 SAM constructed by IRPET, serves as the foundational step in understanding the interventions and investments necessary for resuming growth.

[1] We would like to thank IRPET for providing the 2014 SAM for Tuscany.

While affirming Tuscany's competitiveness, digitalization and technological dynamism, the analysis underscores the pivotal role of manufacturing. Notably, the textile, fashion and leather sectors hold significant weight, along with the slightly less impactful paper and pharmaceutical sectors, and the noteworthy role of tourism. The region emerges as innovative, competitive and export-oriented, albeit with certain sectors grappling with environmental challenges.

The IMM based analysis reveals a satisfactory average integration degree of the production system, suggesting that, for an effective, robust and sustainable post-Covid recovery and economic resurgence, focused investments and demand stimulus policy should be directed towards the textile, fashion and leather industries. Additionally, there is a strong indication to channel investments into pharmaceuticals and health care, and on transportation (especially freight transportation), as well as wholesale and retail trade. While weaker, there is a notable suggestion to invest in metallurgy, computer hardware, tourism and paper industries.

Keywords: Tuscany; Covid-19; regional economic system; economic districts; symmetric branch-by-branch SAM; Impact Multiplier Model; endogenous accounts; exogenous accounts

JEL Codes: E00, E01, E16

1. Introduction

The Covid-19 pandemic has inflicted severe challenges on global economic systems, prompting a critical exploration of potential pathways to recovery.

Regional economies, alongside significant territorial configurations, have experienced similar adverse effects.

The growing prominence of subnational areas in the overall economic landscape underscores the importance of studying their situation and growth in the post-Covid world.

Tuscany, holding a significant position in the Italian and European economies, becomes a focal point for analysing its economic structure post-pandemic and devising strategies for recovery.

The insight derived from this analysis can serve as a reference tramework for other comparable national and European regions.

Tuscany, renowned all over the world for its history, culture, art, as witnessed by the countless architectural, pictorial and sculptural masterpieces and its museums, holds a distinctive position as the birthplace of the Renaissance. This cultural heritage has not only marked the region's history, but also made it a hub of historical and social events of huge importance for more than two centuries, and Florence one of the world's cultural and economic capitals, indelibly marking the history of Italy and the whole world.

On an economic level, with the reunification of Italy in the late XIX century, Tuscany has gained remarkable importance within Italy and beyond. Boasting a Gross Domestic Product (GDP) of approximately 111.6 billion euro at current prices in 2020, approximately 110.2 billion euro at 2019 prices - and a households' disposable income of approximately 743 billion euro — it is the 6th largest regional economy in Italy, with a share of 6.7% of the total GDP (ISTAT, 2021). Per capita GDP of approximately 30.2 thousand euro and per capita disposable income of approximately 20.1 thousand

euro, have placed it 8th and 9th, respectively, in the ranking of the 20 Italian regions. In the Italian panorama, Tuscany is recognized for its open approach to exports, both within Italy and internationally.

The region's productive structure relies heavily on small and medium enterprises, with investments primarily originating from regional sources.

Many are the factors that have contributed to the economic growth of the region. A natural environment represented by geographical and weather favourable elements, such as the vast extension of the easily workable hilly area made fertile by a mild Mediterranean climate, which have allowed the development of specialized crops, namely the vineyard and the olive tree, has certainly played a key role. A fair amount of mineral and geothermal wealth, the coastal and inland hill-mountain landscape beauties, and the just mentioned incomparable historical, cultural and artistic heritage, have crucially helped.

Agriculture has always played an important role, not so much quantitative (although not negligible), but rather qualitative. The wine sector represents for Tuscany an economic flagship, with the wine production chain remaining one of the leading production chains of the whole agro-food sector. The Region can boast approximately 60,000 hectares of vineyards. More than 96% of the regional vineyard area falls into areas with designation of origin, testifying to the absolute quality of the product. The wine production related to the 2021 harvest amounts to about 2.2 million hectolitres of product (Regione Toscana, 2022a), slightly less than 4% of Italy's overall production and nearly 9% of the production of quality wines (DOC/IGT) (ISTAT, 2022a).

Olive cultivation holds significant importance in Tuscany due to its irreplaceable environmental, landscape, territorial, and biodiversity functions. Regional olive growing encompasses more than 80,000 hectares of land, with over 15 million plants representing approximately 80 varieties of native olive trees. (Regione Toscana, 2022b).

In the last century, great importance has gained the production of flowers and ornamental plants, which constitutes approximately 30% of the production of the entire agricultural sector of Tuscany, and, accounting for about 15% of national production, positions Tuscany as the leading region in Italy and in a prominent position at European level.

Among the main cultivations, there are wheat, maize, sugar beet, vegetables, and fruit. Farmhouse is also growing up well.

Mining no longer holds the importance it had in past; however, it remains a non-negligible activity: the white marble of the Apuan Alps, are famous all over the world, and the geothermal energy, one of the first renewable sources to be exploited for industrial and energy purposes, retain great importance. Tuscany has two areas of geothermal development: the historical one, where the geothermal-electric activity, while not without its problems, is part of the economic, productive, social and cultural system of those territories, and the more recent one of the mountain area, which, being much more polluting, clashes with political and social resistance. In Italy, the geothermal-electric industry is present only in Tuscany (Regione Toscana, 2022c). Currently, there are 35 geothermal-electric power plants.

Beyond these flagships that make it a very particular region, Tuscany basically is an economy of industrial transformation in which the typical industry is manufacturing, with manufacturing being the typical industry, partly of artisan origin. According to the Regional Institute for Economic Development of Tuscany IRPET (2020a), for the region, it represents:

1. an engine of growth in terms of productivity, exports, investments and innovation,
2. a hub for advanced services,
3. a pool of good employment (at a contractual and wage level).

The textile sector is quite widespread: the city of Prato is one of the foremost Italian centres in the creation of woollen fabrics and a paradigmatic example of a Marshallian industrial district. The treatment of hides and skins is also significant, characterized by small enterprises. The strength of these sectors, coupled with the creativity of the Tuscans, has contributed not a little to making the region highly specialized in the fashion sectors. The paper sector has gained momentum, as well, establishing itself as a leader in the national industry. Unfortunately, both this sector and the pharmaceutical sector are highly polluting. However, the pharmaceutical sector represents one of the niches of excellence, both in terms of employment and innovation. The automotive industry, including railway material, also experiences robust development.

Other productions include ceramics, glass, and footwear. In support of a particularly esteemed tourist sector, various handicraft activities keep having great development. This includes the production of hats and straw bags, wrought iron items, and objects crafted from alabaster.

Tourism plays a significant role in the Tuscan economy, attracting over 11.5 million visitors, with half of them being foreigners. This sector contributes to a GDP that represents 6%–7% of Italy's overall GDP (IRPET, 2020b). The primary tourist flows are directed towards art sites and seaside resorts. Noteworthy is the thermal tourism, which targets the numerous spas abundant in the region. Tuscany has a historical affinity for spa activities and is among the regions that boast the highest number of spa facilities. According to the Statistical Service of the Tuscany Region, customers visiting spa destinations account for approximately 10% of the total number of tourists in the region.

The outline of this general framework of the economy of Tuscany serves as a foundation for describing, albeit succinctly, the region's characteristics, for introducing the themes of our research, and as a basis for the study we are about to undertake.

This involves analysing the current state of the production structure at branch (industry) level, of the production factors and of the household consumption demand for trying to understand what are the potential pathways for the economic recovery in Tuscany, after almost three years of stress caused by Covid-19 and in the face of a situation where raw materials and energy prices have increased significantly, reaching nearly unsustainable levels, coupled with high inflation derived from the international economic situation, an explosive mixture that raises concerns about the potential degeneration into stagflation. The viable paths for growth will be explored within the comprehensive framework of the Tuscan economy outlined by the 2014 Social Accounting Matrix (SAM) for Tuscany, as developed by (IRPET, 2021), and subsequently revised and updated by us to 2019. The methodology employed to identify potential growth paths involves analysing branch output, cost coefficients, GVA/GDP distribution, and utilizing the impact multiplier model.

To this aim, our focus will be on elucidating the characteristics of the Tuscan economy, emphasizing its existing strengths and weaknesses within a national and European comparative framework (Section 2). Following that, based on the above 2019 SAM, enterprises' production, GVA/GDP, households' consumption and export-import will be comparatively analysed. Additionally, the impact multiplier model will be discussed (Section 3). Building upon the evidence shown by the longitudinal analysis and the multiplier impact model, Section 4 will focus on identifying and suggesting potential pathways for recovering from the Covid-19 emergency and the current energy crisis/dramatic inflation shock to reignite the region's growth. Ultimately, the research findings will be summarized in the conclusions presented in Section 5.

2. The economic system of Tuscany: current strengths and weaknesses

2.1. Competitiveness, technological and digital development, and R&D spending capacity in the Italian and European framework

In the European Regional Competiveness Index (ERCI) scorecards, which are elaborated every three years by the European Commission, Tuscany positioned itself approximately in the middle of the national ranking and 173rd out of 268 European regions in 2019.

The ERCI measures with more than 70 comparable indicators the ability of a region to offer an attractive and sustainable environment for firms and residents to live and work, thus allowing regions to monitor and evaluate their growth in time and compared to other regions.

Among the 11 pillars that make up the index — which returns an economic measure of competitiveness, also evaluating some social indicators such as welfare, infrastructure, level of education, functioning of the labour market — Tuscany ranks better than the Italian average in all of them, except infrastructure. The infrastructural weakness is attributable to a system of transport links, which, except for some excellences, does not manage to have the capillarity necessary to guarantee the same level of accessibility to the entire regional population. In fact, although the region is intersected by the main road and rail connection ridges, there are still many problems related to the Tyrrhenian ridge, still not sufficiently developed, and those related to the difficulty of crossing the Apennines.

The Digital Economy and Society Index (DESI) of the European Commission (EC), summarises the 4 indicators human capital, connectivity, digital technology integration, digital public services on Europe's digital performance and tracks the progress of EU countries, by monitoring Member States' digital progress. In 2022, Italy's digital performance reached 49.3%, quite a lot lower than the 52.3% EU average (European Commission, 2022). No regional indicators are published. Using the same methodology, the "Politecnico di Milano" (2022) forms a ranking of the DESI of the Italian regions, including the Province of Trento (which ranks 1st), in which Tuscany, with an index equal to 51.3%, ranks 7th.

As far as the level of digitization of enterprises is concerned, according to the annual survey conducted by the Tuscany Region (Regione Toscana, 2022d) on a sample of enterprises with 10 employees and more, 98.6% of enterprises had the fixed broadband connection, compared to 97.7% of Italian enterprises. The digitization of households was much lower, as is also the case in Italy and the EU. According to data reported by Eurostat (2022), in 2021 household access to broadband internet was 90.0% in Tuscany, the same value as in Italy, compared to 91.0% in EU27.

From all of the above, one can deduce a good technological dynamism of Tuscany, with respect to both accessibility and the spread of digitalization, if compared with the other Italian regions and the country as a whole, but still below the European average.

Regarding Research and Development (R&D), Tuscany demonstrates a robust spending power. It accounted for 1.60% of regional GDP in 2019, higher than the Italian average of 1.47%. Among the Italian regions, it ranks 6th, and can count on good public research (University, CNR, IMT-School of Advanced Studies, and other public research bodies). 60% of the expenditure is borne by enterprises, 10% by public institutions, and the remaining 30% by universities (IRPET, 2021). Despite this good situation, the innovation capacity of the production sector does not appear particularly vigorous, perhaps because it specializes in traditional manufacturing sectors, and is largely made up

of small and medium-sized enterprises led by small entrepreneurs, with a somewhat narrow economic training and view.

2.2. Productive structure

Tuscany follows a production model organized into production districts, each situated in geographically defined areas characterized by strong industrial specialization.

In 2000, the Tuscany Region formally recognized 11 districts characterized by different production areas. Of these, the following 4 are the most important and obtained an EMAS (Eco-Management and Audit Scheme) certification of Homogeneous Production Area (APO), taken place through European projects:

- Textile and clothing district of Prato;
- Textile and clothing district of Empoli;
- Leather district of Santa Croce sull'Arno;
- Paper district of Lucca.

The area of the textile district of Prato includes 12 municipalities located between the provinces of Prato, Pistoia and Florence, with an area of 700 sq km and a population of more than 300,000 inhabitants, which strongly contributes to making textiles a highly polluting sector.

A strong feature of Prato's industrial system is its relations with international markets: the textile sector exports more than half of its production and entertains commercial relations with more than 100 countries.

Empoli district includes 10 municipalities in central Tuscany. The total area of the district is 670 sq km. Its development was driven by clothing and two specific products: raincoats and leather clothing. Empoli is the third largest industrial centre in Tuscany, after Prato and Florence, and it is not one of the super-specialized industrial districts as textile production is flanked by enterprises of many other sectors. However, clothing remains the sector on which the development of the territory is based with an extremely dense network of small and very small local enterprises that trace the economic system of a particularly lively area (Regione Toscana, 2022e).

The leather district of Santa Croce sull'Arno, located between the provinces of Pisa and Florence, includes 7 municipalities and covers an area of 330.44 sq km. The production specialization of the district is represented by the leather and the footwear industries, in particular soles and components. About 98% of Italian sole leather production is made in the district (70% of that of the EU countries) and 35% of the national production of leather for footwear, leather goods and clothing. Exports represent about 50% of the tannery's turnover and 60% of the footwear's turnover (Regione Toscana, 2022f).

The paper district, which includes 12 municipalities, extends over an area of approximately 750 sq. km between the provinces of Lucca (where most of the municipalities are located), and Pistoia. It controls about 80% of the national production of tissue paper and a value close to 40% of the production of national corrugated cardboard and is made up of enterprises characterized by a high level of know-how and high specialization, it is a particularly dynamic district, whose enterprises have developed network strategies in order to create common services for the entire supply chain and for the protection of the environment (Regione Toscana, 2022g).

As far as the manufacturing sectors are concerned, in addition to the leather and textile and clothing sectors, the sectors that stand out as more specialised than in Italy as a whole are goldsmithery

and furniture production. Specialised manufacturing is distributed varyingly over the region (see Figure 1).

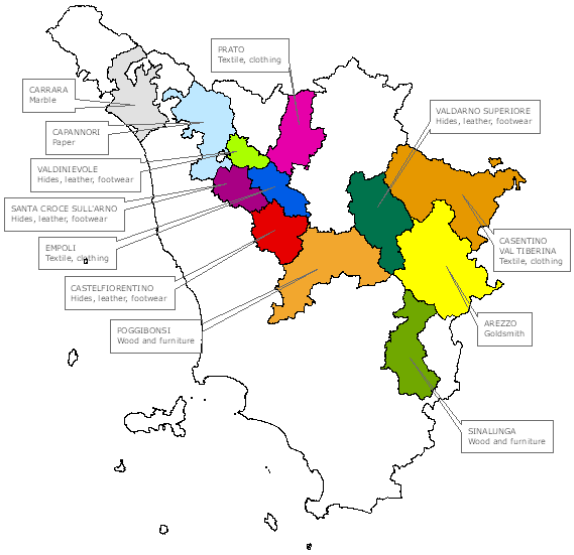

Figure 1. Distribution of specialised manufacturing.

3. The 2019 SAM for Tuscany, the current economic situation and the impact multiplier model

3.1. The symmetric 2019 SAM branch-by-branch

The initial database for our research was represented by the 2014 SAM for Tuscany provided by IRPET, which presents the section of inter-industry exchanges in the form of a supply and use table (SUT). Therefore, we transformed it into a symmetric SAM branch-by-branch, according to branch technology, which postulates fixed sales structures by product, that is, which assumes that the proportion of output of a product sold to intermediate and final users is independent on the branch that produced it.

Indeed, even if a branch-by-branch symmetric SAM shows less homogeneous flows than a product-by-product symmetric SAM does, for the purposes of this paper of using the SAM for the description of the production structure and for the formulation of the interpretative model, this is the appropriate choice.

To obtain a branch-by-branch 2014 SAM, following ISTAT (2011), we transferred the inputs and outputs of the SUT along the rows, so as to transform the CPA product classification of the rows into the NACE Rev. 2 branch classification of the columns.

By denoting:

- **S**, the product by branch matrix of the intermediate production of the supply table;
- **U**, the branch by product matrix of the intermediate production of the use table;
- **s**, the vector of the output by branch;
- **u**, the vector of the output by product.

The branch by product matrix of the intermediate coefficients of the supply table resulted $\mathbf{B} = \mathbf{S}'(\mathbf{u}^{-1})\hat{}$, where $(\mathbf{u}^{-1})\hat{}$ is the diagonalized vector of the reciprocals of the outputs by product, and

the product by branch matrix of the intermediate coefficients of the use table resulted $\mathbf{C}=\mathbf{U}'(\mathbf{s}^{-1})^{\wedge}$, where $(\mathbf{s}^{-1})^{\wedge}$ is the diagonalized vector of the reciprocals of the outputs by branch.

Hence, the branch-by-branch matrix of the intermediate coefficients was $\mathbf{A}=\mathbf{B}\cdot\mathbf{C}$, and the related matrix of the inter-industry flows resulted:

$\mathbf{X}=\mathbf{A}\cdot\mathbf{g}^{\wedge}$.

Being already by industry, we did not modify the GVA. Instead, it was necessary to transform by branch the final demand **E**, including the capital account, as follows:

$\mathbf{F} = \mathbf{S}\cdot\mathbf{E}$.

We carried out the balancing using the RAS iterative scaling method, taking row totals as targets (Eurostat, 2011). The process converged after just over a thousand iterations. This way, we obtained the branch-by-branch symmetric 2014 SAM.

Still using the RAS method, we obtained the branch-by-branch symmetric 2019[2] SAM as follows.

The row total values of the 2014 SAM were extrapolated to 2019 based on the information contained in ISTAT (2022b). Thus, the row totals of each of the 28 branches were obtained by multiplying the 2014 row totals by the variation by branch of the GVA in the period 2014–2019, calculated based on the data from the aforementioned source. The underlying assumption is that of the absence of returns to scale and technological progress, which implies the invariance of the technical coefficients over the period, which in turn implies that the intermediate outputs have no influence on the variation of the total outputs, which therefore depend on the variations of the GVA only.

Likewise, to obtain the row totals at 2019 of the GVA and GDP items, as well as those of the expenses and incomes of the institutional sectors and those of the capital account, 34 items in all, we applied to the row totals of 2014 the average rates of variation 2014–2019 of the respective items in the above source. Taking these row totals as objectives, after about a thousand iterations, we obtained the 2019 SAM.

Conducting a SAM-based analysis encompasses several advantages:

1. it is possible to act in a general macroeconomic framework, which allows all economic functions, production, consumption and accumulation, to be taken into account simultaneously and to do so in detail;
2. the sphere of production is divided into branches which can be adequately specified in number according to the objectives being pursued;
3. it is possible to capture the GVA created by the branches and its subdivision into labour income (wages and salaries) and capital income (gross operating surplus);
4. into the sphere of the final use of income, consumption and capital formation are analysed with reference to institutional sectors, basically firms, households and government, which allows to highlight the complex mechanisms of income distribution and redistribution.

Given all these advantages, the sole significant limitation lies in the macroeconomic analysis conducted based on a SAM: it is not feasible to delve into more disaggregated levels beyond branches and institutional sectors.

The utilization of SAMs for applied economic analysis has gained prominence in research since the nineties, following the seminal work of Stone (1962). This has led to a vast body of literature that has evolved in numerous directions, encompassing both methodological and applied aspects.

[2] The 2020 SAM, besides being more difficult to derive because of some lack of information, would not represent a good basis for study, being affected by the distorting effects of COVID-19.

Noteworthy are the works that bear relevance to this paper, as they touch on its contents, contributing to a more comprehensive understanding of the analysis being conducted, its methodological assumptions, and results.

Stone's work paved the way for contemplation on the conceptual foundations of SAMs, subsequently positioning them within existing accounting frameworks (Ferrari, 1999; Pyatt, 1999; Fofana et al., 2005) and their estimation (Robinson et al., 2001; Scandizzo and Ferrarese, 2015; Mainar-Causapé et al., 2018).

In the meantime, research has ventured into various directions, from the extension of SAMs to the environment, with the fundamental work of Keuning (1991) and NAMEA and the pioneering work of Xie (2000) and ESAM, to concrete applications (Morilla et al., 2007; De Anguita and Wagner, (2010), to their use as bases for planning (Pyatt and Round, 1977, 1985), and for policy (Santos, 2010, 2012).

Moreover, gaining increasing relevance, particularly in alignment with our work, is the focus on the spatial scope (Madsen and Jensen-Butler, 2005). This extends to regional considerations, encompassing the structural analysis of a regional economy (Lima et al., 2004), the impact assessments of events on a regional economy (Van Wyk et al., 2015), and both regional and interregional social analyses (Thorbecke, 2017).

The application of SAMs for economic analysis, encompassing both descriptive and multiplier impact assessments, has found significant traction in the tourism sector. Noteworthy studies, such as the examination of the importance of international tourism for the Turkish economy by Akkemik (2012) and the exploration of the role of tourism in the economic system and development of China by Ferrari et al. (2021), align with the direction of our research. Although these studies operate at a national rather than a regional level, similar to our case, our research constitutes a novel contribution in this specific regional context.

Scholars have dedicated considerable attention to the use of SAMs for impact analysis, particularly through the application of multipliers. This scrutiny begins with methodological and accounting considerations (Pyatt and Round, 1979; Breisinger et al., 2009) and extends into the social realm (Holst et al., 2013). Additionally, SAMs have been employed for analyzing the relationship between income distribution and production structure (Pyatt, 2001), assessing the impact of poverty policies on income distribution (Round, 2003), and examining the effects of rural industrialization on village life and economy (Parikh and Thorbecke, 1996).

Furthermore, the analysis has been extended to the realm of tourism, involving the modeling of the regional and local impact of tourism (Madsen and Zhang, 2010), the estimation of tourism multipliers at both regional (Van Leeuwen et al., 2009) and island levels (Polo and Valle, 2009), and the examination of tourism's influence on the economy of Tuscany (Ferrari et al., 2018). Notably, attention has also been directed towards estimating the multiplier effect of tourism on China's economic system and its development (Ferrari et al., 2021), as well as its impact following a VAT rate cut after the tax reform in China (Ferrari et al., 2020).

Of considerable significance for the utilization of SAMs in impact analysis is the decomposition of multipliers and their correlation with input-output multipliers (Washington State University, 1993). This decomposition enables the measurement of the intragroup or direct effects, the extragroup (indirect or open loop) effects, and the intergroup (cross or closed loop) effects (Pyatt and Round, 1979; Holland and Wyeth, 1993; Civardi and Lenti, 2008).

3.2. The current economic situation

3.2.1. The output

Armed with our SAM 2019, let's analyse the situation in Tuscany that emerges from it, focusing on the production sphere and the breakdown of output, i.e., the entries. Table 1 illustrates both the overall situation and the specific details of manufacturing, a sector we have identified as pivotal to the regional economy.

The depiction is that of an economic system featuring a production sector, with approximately three-quarters of its output reused by enterprises. Notably, manufacturing stands out as the predominant force, contributing to an output that is closely approaching half of the regional total.

This characterizes the region's economy as one undergoing transformation, characterized by significant innovation and high competitiveness, aligning with Italy's manufacturing orientation. Unfortunately, the region is notably vulnerable to energy crises, as evidenced by the significant surge in prices, particularly during the summer months of 2022, exacerbated by the closure of gas and water supplies.

Table 1. Subdivision of the total output, and of manufacturing and of three branches of it (Billion euro).

	Intermediate Output		Output to Final Demand		Total Output	
	Absolute value	%	Absolute value	%	Absolute value	%
Total	318.1	73.3	115.6	26.7	433.7	100.0
Manufacturing	153.1	48.1[1] 80.0[2]	38.3	33.1[1] 20.0[2]	191.4	100.0
- Textile, Clothing, etc.	53.3	34.8	7.6	19.8	60.9	31.8
- Wood, Paper, etc.	9.8	6.4	2.3	6.0	12.1	6.3
- Coke ovens, …, Pharmaceuticals	16.9	11.0	6.1	15.9	23.0	12.0

Note: [1] % of total; [2] % of manufacturing.

Among the three branches, the "Textile, Clothing, etc." sector alone generates an output equivalent to approximately one-third of the total manufacturing output. While the other two branches hold less prominence, they remain notably significant, contributing to the manufacturing output with "Wood, Paper, etc." representing slightly over 6%, and "Coke ovens,…, Pharmaceutical" contributing 11%. All three branches bear witness to the innovative and distinctive nature of manufacturing in Tuscany.

As observed in Paragraph 2.2, three sectors—namely, fashion, paper, and pharmaceuticals—have experienced a growing significance in the regional production structure. Given that the current analysis is conducted at the branch level, it does not allow for a detailed understanding of the production characteristics specific to these sectors. Nevertheless, we can reason based on their respective branches of belonging, considering them as linear combinations of the sectors, $a_1 s_1, a_2 s_2, \dots, a_i s_i, \dots, a_n s_n$, where the weights a_i can differ each other, but the sectors s_i behave similarly to the branch and each of them holds the same relevance as the branch, fully representing it in spite of its weight. Conversely, each branch represents any of the sectors composing it. Taking account of branches' composition as

aggregation of homogeneous production units, this is a reasonable assumption, obviously more sustainable the more homogeneous a branch is. This hypothesis will be at the basis of our analysis and comments below.

We have previously highlighted the relevance of four typical productions: wine and oil, belonging to the branch of agriculture, and marble and geothermal, belonging to the extractive industry. The analysis of the respective branches does not yield notably values of the outputs produced.

A special mention should be made for tourism. The branch "Hotels & Restaurants", which does not encompass the entirety of tourism, but a very significant part that may well represent the sector, contributes just under 4% of regional output.

Regarding the classic classification in the three Clark's sectors of economic activity, the output of the branches is distributed as shown in Table 2.

Table 2. Distribution of the output of the branches by Clark's sectors of economic activity (Billion euro).

	Intermediate Output		Output to Final Demand		Total Output	
	Absolute value	%	Absolute value	%	Absolute value	%
Primary Sector	2.7	0.8	0.9	0.8	3.6	0.8
Secondary Sector	172.2	54.1	46.1	40.0	218.3	50.3
Tertiary Sector	143.6	45.1	68.2	59.2	211.8	48.9
Total	318.5	100.0	115.2	100.0	433.7	100.0

3.2.2. The costs and the GVA/GDP

Let's assess the situation from the perspective of inputs, that is, from the cost side. The cost ratios, calculated as $a_{ij} = \frac{x_{ij}}{X_j}$, with *X* denoting the total cost, *x* the intermediate cost and *i=j=1,….,28,* show a production system in which the branches have a good degree of integration (see Table A5)

The central role of manufacturing is also highlighted from this point of view, and within this, the role of fashion, whose costs represent almost 30% of manufacturing costs and reuse almost 90% of its intermediate output.

Very interesting is the analysis of the GVA produced, of the allocation of income and of the GDP as reported in Table 3.

Table 3. GVA, allocation of income and GDP for total economy, manufacturing and some sectors (Billion euro).

	GVA						GDP	
	Absolute value	%	Labour income	%	Capital income	%	Absolute value	%
Total	109.8	6.8[0]	47.0	6.5[0]	62.8	7.1[0]	115.5	6.4[0]
Manufacturing	30.9	28.1[1] 11.6[0]	12.1	25.7[1]	18.8	29.9[1]	32.2	27.9[1] 12.1[1]
- Fashion	14.8	47.7[2]	6.4	52.9[2]	8.4	44.7[2]	15.3	47.5[2]
- Paper	2.3	7.4[2]	1.0	8.3[2]	1.3	6.9[2]	2.3	7.1[2]
- Pharmaceuticals	3.9	12.6[2]	1.6	13.2[2]	2.3	12.2[2]	3.9	12.1[2]

Note: [0] % of Italy; [1] % of Total; [2] % of Manufacturing.

Tuscany contributes a GVA equal to 6.8% to that of Italy. The burden of the net indirect taxes on production and products and VAT transforms it into a GDP equal to 6.4% of that of the country, positioning both aggregates in the sixth position in the regional ranking.

Manufacturing maintains its status as a pivotal activity with a GVA equal to approximately 28% of the regional GVA, and nearly 12% of the national GVA. This GVA is allocated to the factors, with around 12 billion euro (39%) to labour and just under 19 billion euro (61%) to capital, denoting a clearly capital-intensive sector. Labour income, however, is close to 26% of the regional one, while capital income surpasses 32% of the regional one.

Within the manufacturing sector, fashion carves out nearly half of the GVA, underscoring its significant importance. Furthermore, it stands out as a sector where the allocation of income between labour and capital is well-balanced. Paper and pharmaceuticals contribute slightly over 7% and almost 13%, respectively, to the overall manufacturing GVA.

Labour income and capital income range between 1 and 2 billion euros, averaging around 10% of the values within the manufacturing sector, albeit with some variability.

The analysis of the GDP aligns with the previously illustrated GVA, as expected. However, the analysis of branches containing wine, oil, marble, and geothermal does not reveal significant values of GVA, income allocation, and GDP.

Tourism contributes a GVA of 4.6 billion euro and a GDP of 4.9 billion euro, accounting for 4.2% and 4.5% of the regional figures, respectively. This sector exhibits a well-balanced allocation of income to labour and capital.

Table 4. GVA, allocation of income and GDP by Clark's sectors of economic activity (Billion euro).

	GVA						GDP	
	Absolute value	%	Labour income	%	Capital income	%	Absolute value	%
Primary Sector	1.5	1.4	0.4	0.9	1.1	1.7	1.2	1.0
Secondary Sector	44.6	40.6	20.0	42.5	20.2	32,2	46.3	40.1
Tertiary Sector	63.7	58.0	26.6	56.6	41.5	66.1	68.0	58.9
Total	109.8	100.0	47.0	100.0	62.8	100.0	115.5	100.0

Tables 2 and 4 highlight the significant role of the secondary sector, primarily driven by manufacturing and its nature as a processing sector. Simultaneously, the strength of the tertiary sector is evident in terms of output, GVA/GDP, and income allocated. The primary sector, on the other hand, maintains a comparatively lower importance. In accordance with the law of the three sectors and Fourastié's theory of structural transformation, the economy of Tuscany therefore is positioned between the transition period of the second phase, characterized by the prevalence of the secondary, and that of the tertiary civilization of the third phase, characterized by the prevalence of tertiary.

Overall, the picture emerges of an economy where the secondary still predominates, but which proceeds towards outsourcing, in which manufacturing and its components confirm the characteristics of a region driven by sectors that, despite their strong innovative and competitive content, are largely export-oriented. Unfortunately, this orientation comes with significant environmental challenges.

All the information gathered through the descriptive analysis conducted needs to be complemented with a 'relational' analysis. In other words, there is a requirement for a tool that can describe and quantify the mechanism of stimulus from external demand and response from the regional economic system. This tool is represented by the Impact Multiplier Model (IMM).

As the objective of this paper is to identify, based on a SAM, potential strategies for the regional economy to fully recover the development levels recorded before the Covid epidemic, the IMM stands out as the most suitable tool. It enables a comprehensive understanding of how, and above all, to what extent, exogenous demand directly and indirectly impacts the production system, the contribution to the formation of the GVA by the various branches and its allocation to the production factors, the distribution and redistribution of income to the institutional sectors, primarily households, and the household consumption.

3.3. The Impact Multiplier Model

To design the IMM, we first identified the exogenous account by aggregating: 1. Government expenditure, 2. NPISH expenditure, 3. Exports to the RoI, 4. Exports to the Rest of the World (RoW), 5. Expenditure in Tuscany by the other Italians, 6. Expenditure by non-residents, 7–13. Six capital accounts for as many sectors: Consumer Households, Producer Households, Non Financial Corporations, Financial Corporations, NPISH, Government and Social Security Institutions, 14. Income from the RoI, and 15. Income from the RoW. In all, 15 accounts.

Endogenous accounts amounted to 34:

1. value of goods and services produced;
2. output from activities;
3. payment from factors, and
4. households' expenditure.

Out of the initial 48, they have been reduced to 34 by merging the labour income account and the social contributions accounts, the net indirect taxes on production and on products, including VAT, accounts, the other capital income and the mixed income accounts, and the institutional sector accounts.

The information we used comes from the four submatrices of the 2019 SAM reported in Tables A1, A2, A3, and A4 in Appendix.

As a result, the IMM is represented by the following system of simultaneous linear equations,

$$X = AX + Z \tag{1}$$

where **X** is the (34x1) vector of the endogenous accounts total outputs, **A** is the (34x34) matrix of the endogenous accounts column coefficients, describing the structure of the economy, and **Z** is the (34x1) vector of the exogenous account (total demand), obtained by aggregating the 15 column vectors of the (34x15) **D** demand matrix (Ferrari et al., 2018; Bellù, 2012).

This model combines the elegant linearity of the Leontief hypothesis with the Keynesian macroeconomic theory. Representing an economy as a system of simultaneous linear equations is equivalent to assuming:

1. absence of substitution between different inputs and factors for all productive sectors and between different final goods for all institutions);

2. that the exogenous demand is fully supplied with goods and services from the economic system, that is, that it does not encounter constraints in terms of productive capacity (hypothesis of surplus productive capacity); and
3. that the prices of goods and services do not change because of the impact of changes on exogenous demand (hypothesis of fixed prices).

The IMM (1) solution is,

$$X = (I - A)^{-1} Z = M\, Z \tag{2}$$

where **I** is the identity matrix, and the (34x34) $(\mathbf{I}\text{-}\mathbf{A})^{-1}$ = **M** inverse matrix is the impact multiplier matrix. Because of the above merging, vector collinearity and therefore singularity and non-invertibility problems are avoided and matrix (**I**-**A**) is full column rank one.

Matrices **A**, reported in Table 1, provides the integration degree of the production system. Prospectus 1 reports the branch average intermediate cost coefficients (bold row in Table 1).

Prospectus 1. Average intermediate cost coefficients by branches.

Branches	Average cost coefficients
Real estate	0.019
Agriculture, Wholesale and retail trade, Hotels & Restaurants, Professional services, Public Administration, Education, Health, Other services	0.022–0.024
Fishing, Mining, Textile, clothing and leather items, Water, Constructions, Freight transportation and warehousing, Communications, Finance, Administrative services, Arts, etc.	0.025–0.027
Electricity, Furniture, Transport, Computers, Rubber and plastic products, Coke, etc., Food, Wood, paper, etc,	0.028–0.030
Metallurgy	0.031

These cost coefficients, encompassing the reuses, vary from 1.9% of "Real estate" to 3.1% of "Metallurgy". Thus, the average integration degree of the production system seems satisfactory.

Indeed, the assessment of the degree of integration should be conducted by branch, excluding reuses, to check with which other branches it integrates. Considering the average degree of integration makes the assessment less specific, but it has the advantage of providing a measure of considerable indicative utility, because it reveals the degree of integration of the branch with the whole production system.

Table 5. Endogenous accounts cost coefficients matrix.

		Agriculture, hunting and forestry	Fishing, fish farming and related services	Mining	Food, beverage and tobacco	Textile, clothing and leather items	Wood, paper and publishing	Coke ovens, refineries, chemicals, pharmaceuticals	Rubber and plastic and other nonmetallic mineral products	Metallurgy	Computers and electrical equipment, electronic and optical products	Transport	Furniture	Electricity, gas, steam and air conditioning	Water; sewerage, waste treatment and remediation	Construction
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agriculture	1	0.063	0.000	0.002	0.019	0.001	0.002	0.020	0.006	0.002	0.002	0.001	0.011	0.008	0.002	0.005
Fishing	2	0.000	0.003	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mining	3	0.000	0.000	0.003	0.001	0.000	0.000	0.003	0.001	0.000	0.001	0.000	0.001	0.001	0.002	0.000
Food, etc.	4	0.274	0.191	0.011	0.312	0.001	0.020	0.022	0.028	0.005	0.008	0.009	0.006	0.012	0.010	0.006
Textile, etc.	5	0.042	0.000	0.018	0.054	0.668	0.016	0.046	0.061	0.011	0.018	0.017	0.043	0.018	0.030	0.019
Wood, etc.	6	0.024	0.000	0.015	0.004	0.016	0.316	0.020	0.023	0.008	0.016	0.006	0.016	0.035	0.016	0.006
Coke ovens	7	0.008	0.006	0.258	0.039	0.006	0.015	0.274	0.062	0.024	0.025	0.028	0.036	0.032	0.016	0.004
Rubber, etc.	8	0.008	0.000	0.049	0.002	0.004	0.012	0.050	0.140	0.017	0.014	0.019	0.009	0.022	0.008	0.005
Metallurgy	9	0.004	0.000	0.040	0.004	0.003	0.015	0.016	0.043	0.393	0.043	0.027	0.017	0.038	0.330	0.009
Computers	10	0.004	0.000	0.013	0.003	0.002	0.011	0.012	0.038	0.093	0.336	0.061	0.103	0.009	0.007	0.010
Transport	11	0.001	0.000	0.008	0.002	0.006	0.011	0.010	0.045	0.065	0.078	0.202	0.033	0.004	0.012	0.009
Furniture	12	0.004	0.002	0.011	0.003	0.007	0.039	0.015	0.027	0.112	0.047	0.109	0.157	0.010	0.006	0.007
Electricity, etc.	13	0.013	0.000	0.040	0.003	0.000	0.005	0.003	0.010	0.005	0.010	0.003	0.005	0.337	0.012	0.003
Water, etc.	14	0.001	0.000	0.004	0.001	0.001	0.003	0.004	0.006	0.006	0.004	0.014	0.010	0.012	0.052	0.005
Construction	15	0.005	0.000	0.039	0.002	0.001	0.020	0.016	0.130	0.039	0.031	0.033	0.039	0.010	0.018	0.389
Wholesale, etc.	16	0.070	0.041	0.069	0.072	0.013	0.033	0.037	0.054	0.023	0.035	0.173	0.054	0.056	0.035	0.042
Transportation	17	0.007	0.077	0.021	0.021	0.002	0.024	0.097	0.024	0.014	0.020	0.045	0.025	0.044	0.013	0.020
Hotels&Restaurats	18	0.065	0.359	0.012	0.267	0.001	0.015	0.004	0.011	0.003	0.006	0.006	0.010	0.028	0.015	0.020
Communications	19	0.002	0.000	0.010	0.002	0.001	0.021	0.003	0.007	0.004	0.027	0.009	0.013	0.008	0.007	0.005
Finance, etc.	20	0.002	0.000	0.010	0.003	0.001	0.031	0.004	0.008	0.002	0.007	0.010	0.005	0.006	0.003	0.017
Real estate	21	0.001	0.001	0.007	0.002	0.001	0.006	0.003	0.013	0.006	0.005	0.002	0.006	0.002	0.002	0.038
Professional, etc.	22	0.006	0.001	0.020	0.005	0.002	0.042	0.009	0.016	0.011	0.022	0.013	0.024	0.018	0.007	0.021
Administrative, etc.	23	0.018	0.001	0.011	0.003	0.003	0.090	0.004	0.018	0.006	0.016	0.010	0.021	0.012	0.007	0.015
Public Administration	24	0.004	0.002	0.009	0.002	0.001	0.011	0.003	0.002	0.004	0.007	0.007	0.017	0.021	0.080	0.030
Education	25	0.004	0.000	0.004	0.001	0.001	0.005	0.002	0.002	0.001	0.002	0.002	0.005	0.011	0.004	0.005
Health, etc.	26	0.003	0.001	0.011	0.008	0.001	0.009	0.141	0.009	0.009	0.014	0.006	0.090	0.022	0.008	0.015
Arts, etc.	27	0.005	0.001	0.005	0.003	0.002	0.023	0.002	0.006	0.002	0.006	0.005	0.012	0.004	0.003	0.005
Other services	28	0.003	0.002	0.004	0.002	0.003	0.013	0.006	0.007	0.003	0.006	0.002	0.010	0.028	0.004	0.005
Average		0.023	0.025	0.025	0.030	0.027	0.029	0.030	0.029	0.031	0.029	0.029	0.028	0.029	0.025	0.026
Gross wages	29	0.085	0.137	0.109	0.069	0.105	0.083	0.069	0.097	0.067	0.100	0.100	0.090	0.038	0.108	0.104
Gross operating	30	0.364	0.181	0.136	0.083	0.137	0.105	0.099	0.092	0.061	0.091	0.079	0.125	0.148	0.164	0.166
Net indirect tax	31	–0.091	–0.006	0.051	0.006	0.009	0.004	0.005	0.010	0.004	0.005	0.004	0.007	0.003	0.018	0.014
Other capital income	32	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Houseold expend	33	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Consumer	34	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Continued on next page

		Wholesale and retail trade; repair of motor vehicles and motorcycles	Transportation and warehousing	Hotels and restaurants	Communications	Finance and insurance	Real estate	Professional, scientific and technical services	Administrative and support services	Public administration and defense; compulsory social insurance	Education	Health and social assistance	Arts, entertainment and leisure	Other services	Gross wages	Gross operating surplus	Net indirect taxes	Otherr capital income	Household expenditure	Consumer households
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Agriculture	1	0.005	0.004	0.002	0.001	0.005	0.000	0.003	0.004	0.000	0.001	0.000	0.000	0.007	0.000	0.000	0.000	0.000	0.007	0.000
Fishing	2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mining	3	0.002	0.003	0.001	0.003	0.001	0.001	0.001	0.002	0.001	0.001	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.002	0.000
Food, etc.	4	0.040	0.028	0.005	0.012	0.011	0.006	0.017	0.011	0.016	0.010	0.001	0.023	0.006	0.000	0.000	0.000	0.000	0.049	0.000
Textile, etc.	5	0.067	0.025	0.034	0.025	0.027	0.033	0.038	0.046	0.039	0.016	0.004	0.051	0.035	0.000	0.000	0.000	0.000	0.065	0.000
Wood, etc.	6	0.018	0.023	0.014	0.013	0.010	0.007	0.011	0.015	0.031	0.006	0.001	0.026	0.010	0.000	0.000	0.000	0.000	0.018	0.000
Coke ovens	7	0.056	0.023	0.030	0.017	0.011	0.005	0.021	0.019	0.104	0.037	0.003	0.030	0.026	0.000	0.000	0.000	0.000	0.045	0.000
Rubber, etc.	8	0.019	0.017	0.018	0.014	0.010	0.006	0.011	0.013	0.022	0.008	0.002	0.016	0.009	0.000	0.000	0.000	0.000	0.018	0.000
Metallurgy	9	0.029	0.011	0.026	0.013	0.009	0.008	0.012	0.021	0.047	0.008	0.003	0.007	0.016	0.000	0.000	0.000	0.000	0.028	0.000
Computers	10	0.042	0.016	0.024	0.018	0.007	0.005	0.022	0.017	0.008	0.014	0.004	0.009	0.009	0.000	0.000	0.000	0.000	0.028	0.000
Transport	11	0.032	0.013	0.008	0.015	0.009	0.005	0.018	0.014	0.007	0.010	0.001	0.003	0.012	0.000	0.000	0.000	0.000	0.027	0.000
Furniture	12	0.025	0.009	0.019	0.011	0.008	0.008	0.010	0.014	0.005	0.007	0.003	0.008	0.017	0.000	0.000	0.000	0.000	0.024	0.000
Electricity, etc.	13	0.007	0.022	0.029	0.012	0.007	0.005	0.010	0.008	0.007	0.009	0.001	0.007	0.022	0.000	0.000	0.000	0.000	0.021	0.000
Water, etc.	14	0.006	0.009	0.007	0.008	0.003	0.003	0.005	0.017	0.008	0.005	0.004	0.002	0.023	0.000	0.000	0.000	0.000	0.009	0.000
Construction	15	0.020	0.015	0.046	0.012	0.020	0.010	0.043	0.044	0.003	0.013	0.003	0.011	0.023	0.000	0.000	0.000	0.000	0.028	0.000
Wholesale, etc.	16	0.122	0.177	0.067	0.108	0.138	0.187	0.129	0.122	0.153	0.092	0.005	0.031	0.020	0.000	0.000	0.000	0.000	0.154	0.000
Transportation	17	0.036	0.257	0.050	0.023	0.030	0.023	0.021	0.065	0.037	0.045	0.004	0.008	0.014	0.000	0.000	0.000	0.000	0.058	0.000
Hotels&Restaurats	18	0.025	0.007	0.023	0.028	0.017	0.059	0.015	0.023	0.005	0.007	0.002	0.048	0.011	0.000	0.000	0.000	0.000	0.059	0.000
Communications	19	0.013	0.004	0.012	0.170	0.011	0.022	0.032	0.032	0.010	0.024	0.001	0.025	0.012	0.000	0.000	0.000	0.000	0.025	0.000
Finance, etc.	20	0.036	0.009	0.009	0.061	0.245	0.041	0.032	0.015	0.010	0.011	0.002	0.003	0.003	0.000	0.000	0.000	0.000	0.040	0.000
Real estate	21	0.005	0.002	0.012	0.007	0.032	0.014	0.016	0.012	0.010	0.001	0.001	0.006	0.004	0.000	0.000	0.000	0.000	0.012	0.000
Professional, etc.	22	0.016	0.010	0.028	0.051	0.015	0.019	0.069	0.037	0.029	0.030	0.053	0.019	0.043	0.000	0.000	0.000	0.000	0.028	0.000
Administrative, etc.	23	0.021	0.013	0.104	0.022	0.016	0.013	0.033	0.042	0.025	0.036	0.055	0.031	0.081	0.000	0.000	0.000	0.000	0.040	0.000
Public Administration	24	0.007	0.015	0.025	0.019	0.025	0.013	0.018	0.057	0.043	0.057	0.017	0.009	0.068	0.000	0.000	0.000	0.000	0.024	0.000
Education	25	0.003	0.004	0.037	0.006	0.003	0.007	0.010	0.010	0.010	0.104	0.020	0.006	0.020	0.000	0.000	0.000	0.000	0.014	0.000
Health, etc.	26	0.022	0.005	0.023	0.010	0.007	0.014	0.015	0.021	0.007	0.011	0.414	0.009	0.078	0.000	0.000	0.000	0.000	0.040	0.000
Arts, etc.	27	0.008	0.003	0.006	0.016	0.007	0.013	0.013	0.014	0.017	0.007	0.016	0.320	0.014	0.000	0.000	0.000	0.000	0.017	0.000
Other services	28	0.005	0.005	0.018	12	0.010	0.014	0.009	0.008	0.002	0.051	0.002	0.019	0.036	0.000	0.000	0.000	0.000	0.016	0.000
Average		0.024	0.026	0.024	0.025	0.025	0.019	0.023	0.025	0.023	0.022	0.022	0.026	0.022						
Gross wages	29	0.105	0.094	0.130	0.091	0.105	0.003	0.075	0.135	0.210	0.291	0.200	0.100	0.205	0.000	0.000	0.000	0.000	0.000	0.000
Gross operating	30	0.198	0.166	0.174	0.191	0.172	0.379	0.282	0.152	0.095	0.045	0.137	0.150	0.163	0.000	0.000	0.000	0.000	0.000	0.000
Net indirect tax	31	0.011	0.011	0.017	0.009	0.031	0.072	0.010	0.009	0.041	0.042	0.041	0.022	0.012	0.000	0.000	0.000	0.000	0.103	0.000
Other capital income	32	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.178
Houseold expend	33	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.299
Consumer	34	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	0.000	0.523

Very interesting and significant results emerge from the analysis of **M** matrix, reported in Table 2. These findings are summarized and grouped in Prospectus 2.

It is reasonable to assume that a direct effect equal to or greater than 1.8–1.9, and an indirect effect equal to or greater than 0.3–0.4, serve as thresholds indicating a dynamic impact on the productive structure. These values suggest a significant activation of a branch's production. Specifically, an 80%–90% increase in the production of one branch, coupled with an average increase of 30%–40% in the production of other branches due to a unitary increase in exogenous demand for the product of the branch itself, is commonly accepted as a lower limit significant enough to signify an important multiplying effect.

Prospectus 2. Branches grouped according to the increasing ordering of direct and indirect average impacts.

Branches	Average direct and indirect impacts
Agriculture, Fishing, Water, Mining, Rubber and plastic products, Real estate, administrative services, Education, Other services	*Very low*. Direct 1.1–1.3. Indirect: <0.1
Public Administration, Communications, Arts, etc.	*Low*. Direct 1.2–1.5. Indirect: <0.2
Food, Wood, paper, etc, Hotels & Restaurants, Finance, Transport, Furniture, Electricity, Professional services	*Moderate*. Direct 1.3–1.7. Indirect: 0.2–0.3
Metallurgy, Computers	*Significant*. Direct 1.8–1.9. Indirect: 0.3
Coke, etc., Constructions, Health	*Good*. Direct 1.7–2.0. Indirect: 0.3–0.4
Freight transportation and warehousing	*Very good*. Direct 1.7. Indirect: 0.4
Wholesale and retail trade	*Optimal*. Direct 1.9. Indirect: 0.8–0.9
Textile, clothing and leather items	*Excellent*. Direct 3.8. Indirect: 1.1

Eleven branches, accounting for almost 40%, display a very low or low impact both on themselves and on the other branches. This category includes certain branches from the primary sector, such as "Agriculture," as well as significant services such as "Education," "Public Administration," and "Communications." This result is somewhat inconsistent with expectations in a region with the characteristics of Tuscany, where agriculture holds qualitative importance, and education, especially at the university level, maintains a satisfactory national and international standing. Another eight branches, constituting about 28%, exhibit a moderate compliance. Among these, "Food," "Hotels & Restaurants," and "Transport," all closely tied to tourism, present a result that contrasts with Tuscany's tourist vocation. Overall, nearly 70% of the branches demonstrate a low or moderate multiplier capability, falling below the minimum activation level commonly considered satisfactory.

In the remaining 30% of branches, "Metallurgy" and "Computers" display direct and indirect multipliers that are noteworthy but not particularly attention-worthy.

Table 6. Impact multiplier matrix.

		Agriculture, hunting and forestry	Fishing, fish farming and related services	Mining	Food, beverage and tobacco	Textile, clothing and leather items	Wood, paper and publishing	Coke ovens, refineries, chemicals, pharmaceuticals	Rubber and plastic and other nonmetallic mineral products	Metallurgy	Computers and electrical equipment, electronic and optical products	Transport	Furniture	Electricity, gas, steam and air conditioning	Water; sewerage, waste treatment and remediation	Construction
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Agriculture	1	1.122	0.049	0.056	0.075	0.044	0.045	0.075	0.056	0.053	0.048	0.050	0.059	0.063	0.050	0.053
Fishing	2	0.002	1.005	0.002	0.003	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Mining	3	0.011	0.011	1.014	0.012	0.009	0.009	0.014	0.011	0.011	0.011	0.011	0.011	0.013	0.013	0.011
Food, etc.	4	0.701	0.533	0.299	1.725	0.246	0.279	0.319	0.313	0.276	0.273	0.286	0.273	0.315	0.282	0.279
Textile, etc.	5	1.130	0.923	1.021	1.146	3.813	0.893	1.087	1.121	0.980	0.965	1.000	1.038	1.057	1.013	0.991
Wood, etc.	6	0.228	0.179	0.220	0.196	0.225	1.628	0.225	0.226	0.207	0.213	0.200	0.210	0.272	0.216	0.194
Coke ovens	7	0.377	0.348	0.689	0.414	0.317	0.332	1.710	0.431	0.399	0.379	0.395	0.387	0.429	0.382	0.342
Rubber, etc.	8	0.154	0.138	0.216	0.148	0.135	0.145	0.215	1.306	0.176	0.164	0.171	0.151	0.189	0.160	0.145
Metallurgy	9	0.298	0.277	0.363	0.294	0.257	0.288	0.315	0.369	1.957	0.386	0.357	0.323	0.405	0.862	0.303
Computers	10	0.307	0.285	0.332	0.301	0.265	0.297	0.319	0.377	0.565	1.825	0.443	0.475	0.347	0.390	0.314
Transport	11	0.212	0.195	0.230	0.207	0.202	0.209	0.224	0.282	0.370	0.358	1.485	0.267	0.237	0.273	0.221
Furniture	12	0.228	0.211	0.248	0.223	0.218	0.265	0.243	0.274	0.465	0.323	0.394	1.417	0.263	0.306	0.229
Electricity, etc.	13	0.155	0.137	0.187	0.142	0.113	0.124	0.132	0.141	0.137	0.142	0.130	0.132	1.644	0.145	0.132
Water, etc.	14	0.056	0.053	0.061	0.055	0.048	0.053	0.059	0.062	0.068	0.061	0.073	0.066	0.077	1.112	0.060
Construction	15	0.312	0.298	0.380	0.311	0.262	0.316	0.334	0.541	0.424	0.374	0.377	0.369	0.348	0.361	1.922
Wholesale, etc.	16	0.844	0.769	0.816	0.827	0.676	0.709	0.776	0.793	0.782	0.774	0.955	0.778	0.862	0.775	0.800
Transportation	17	0.390	0.464	0.427	0.408	0.321	0.365	0.518	0.400	0.396	0.391	0.435	0.390	0.468	0.383	0.392
Hotels&Restaurats	18	0.444	0.678	0.274	0.642	0.233	0.258	0.265	0.274	0.254	0.253	0.261	0.258	0.316	0.268	0.288
Communications	19	0.129	0.119	0.137	0.124	0.113	0.149	0.124	0.133	0.139	0.168	0.139	0.143	0.146	0.135	0.133
Finance, etc.	20	0.204	0.186	0.211	0.195	0.180	0.234	0.196	0.208	0.199	0.204	0.213	0.199	0.219	0.198	0.232
Real estate	21	0.071	0.068	0.078	0.071	0.062	0.072	0.070	0.090	0.080	0.074	0.072	0.075	0.075	0.073	0.128
Professional, etc.	22	0.190	0.176	0.208	0.187	0.162	0.227	0.202	0.201	0.205	0.211	0.198	0.214	0.222	0.192	0.211
Administrative, etc.	23	0.026	0.025	0.024	0.025	0.020	0.033	0.024	0.024	0.023	0.024	0.023	0.025	0.026	0.023	0.024
Public Administration	24	0.136	0.131	0.141	0.134	0.115	0.134	0.134	0.135	0.139	0.137	0.138	0.150	0.173	0.216	0.177
Education	25	0.082	0.083	0.077	0.084	0.064	0.072	0.078	0.072	0.071	0.070	0.071	0.078	0.095	0.074	0.079
Health, etc.	26	0.374	0.347	0.454	0.384	0.321	0.344	0.667	0.388	0.415	0.392	0.392	0.531	0.443	0.383	0.383
Arts, etc.	27	0.123	0.107	0.122	0.116	0.110	0.149	0.120	0.122	0.120	0.123	0.122	0.133	0.129	0.119	0.123
Other services	28	0.083	0.080	0.083	0.083	0.077	0.088	0.083	0.084	0.081	0.082	0.078	0.086	0.124	0.080	0.082
Gross wages	29	0.085	0.086	0.087	0.086	0.091	0.078	0.087	0.087	0.088	0.087	0.088	0.086	0.085	0.088	0.087
Gross operating	30	1.427	1.174	1.182	1.160	1.217	1.065	1.168	1.150	1.138	1.122	1.136	1.157	1.292	1.185	1.244
Net indirect tax	31	0.165	0.235	0.304	0.251	0.258	0.227	0.258	0.255	0.248	0.243	0.246	0.254	0.268	0.268	0.277
Other capital income	32	0.998	0.891	0.937	0.892	0.933	0.816	0.901	0.888	0.877	0.865	0.875	0.892	0.979	0.918	0.958
Houseold expend	33	1.677	1.495	1.574	1.498	1.566	1.370	1.513	1.492	1.474	1.453	1.469	1.498	1.644	1.542	1.609
Consumer house	34	5.605	5	5.26	5.01	5.235	4.579	5.056	4.987	4.926	4.856	4.911	5.006	5.496	5.152	5.377

Continued on next page

		Wholesale and retail trade; repair of motor vehicles and motorcycles	Transportation and warehousing	Hotels and restaurants	Communications	Finance and insurance	Real estate	Professional, scientific and technical services	Administrative and support services	Public administration and defense; compulsory social insurance	Education	Health and social assistance	Arts, entertainment and leisure	Other services	Gross wages	Gross operating surplus	Net indirect taxes	Otherr capital income	Household expenditure	Consumer households
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Agriculture	1	0.054	0.054	0.044	0.049	0.054	0.054	0.052	0.005	0.045	0.037	0.034	0.046	0.046	0.006	0.059	0.059	0.059	0.059	0.059
Fishing	2	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.000	0.002	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Mining	3	0.012	0.015	0.011	0.014	0.012	0.013	0.012	0.001	0.010	0.009	0.008	0.011	0.009	0.001	0.013	0.013	0.013	0.013	0.013
Food, etc.	4	0.333	0.335	0.250	0.298	0.298	0.330	0.313	0.028	0.271	0.223	0.203	0.302	0.231	0.036	0.360	0.360	0.360	0.360	0.360
Textile, etc.	5	1.144	1.056	0.927	1.037	1.048	1.191	1.095	0.102	0.962	0.759	0.696	1.095	0.857	0.119	1.190	1.190	1.190	1.190	1.190
Wood, etc.	6	0.218	0.235	0.189	0.213	0.206	0.226	0.211	0.020	0.217	0.153	0.137	0.231	0.169	0.023	0.230	0.230	0.230	0.230	0.230
Coke ovens	7	0.424	0.396	0.349	0.378	0.368	0.408	0.388	0.036	0.454	0.321	0.256	0.381	0.320	0.043	0.432	0.432	0.432	0.432	0.432
Rubber, etc.	8	0.167	0.172	0.149	0.164	0.156	0.170	0.161	0.015	0.159	0.120	0.104	0.161	0.127	0.017	0.175	0.175	0.175	0.175	0.175
Metallurgy	9	0.340	0.324	0.304	0.321	0.308	0.345	0.322	0.032	0.339	0.238	0.216	0.286	0.273	0.036	0.358	0.358	0.358	0.358	0.358
Computers	10	0.374	0.342	0.307	0.339	0.316	0.356	0.349	0.032	0.291	0.251	0.223	0.299	0.259	0.037	0.370	0.370	0.370	0.370	0.370
Transport	11	0.261	0.240	0.202	0.239	0.227	0.251	0.246	0.022	0.204	0.174	0.154	0.203	0.187	0.026	0.263	0.263	0.263	0.263	0.263
Furniture	12	0.264	0.245	0.225	0.244	0.236	0.266	0.246	0.023	0.216	0.179	0.164	0.223	0.203	0.027	0.274	0.274	0.274	0.274	0.274
Electricity, etc.	13	0.139	0.171	0.158	0.152	0.141	0.158	0.149	0.013	0.123	0.111	0.097	0.136	0.136	0.017	0.167	0.167	0.167	0.167	0.167
Water, etc.	14	0.061	0.067	0.057	0.065	0.059	0.066	0.063	0.007	0.057	0.049	0.047	0.055	0.069	0.007	0.068	0.068	0.068	0.068	0.068
Construction	15	0.339	0.335	0.344	0.331	0.340	0.360	0.384	0.036	0.278	0.249	0.224	0.310	0.280	0.037	0.369	0.369	0.369	0.369	0.369
Wholesale, etc.	16	1.875	0.988	0.734	0.893	0.936	1.061	0.920	0.084	0.820	0.671	0.554	0.738	0.625	0.095	0.953	0.953	0.953	0.953	0.953
Transportation	17	0.417	1.715	0.392	0.405	0.415	0.453	0.409	0.043	0.383	0.342	0.271	0.360	0.314	0.047	0.466	0.466	0.466	0.466	0.466
Hotels&Restaurats	18	0.296	0.283	1.252	0.299	0.289	0.366	0.293	0.027	0.238	0.202	0.195	0.323	0.222	0.035	0.346	0.346	0.346	0.346	0.346
Communications	19	0.142	0.134	0.127	1.333	0.143	0.174	0.171	0.016	0.123	0.126	0.097	0.162	0.118	0.016	0.163	0.163	0.163	0.163	0.163
Finance, etc.	20	0.247	0.220	0.189	0.299	1.528	0.292	0.257	0.021	0.191	0.166	0.152	0.195	0.165	0.026	0.263	0.263	0.263	0.263	0.263
Real estate	21	0.075	0.071	0.075	0.080	0.111	1.094	0.090	0.008	0.070	0.053	0.052	0.074	0.061	0.009	0.086	0.086	0.086	0.086	0.086
Professional, etc.	22	0.200	0.195	0.194	0.247	0.200	0.229	1.263	0.021	0.192	0.175	0.225	0.203	0.201	0.023	0.226	0.226	0.226	0.226	0.226
Administrative, etc.	23	0.025	0.024	0.031	0.025	0.024	0.028	0.027	0.103	0.023	0.021	0.026	0.026	0.027	0.003	0.028	0.028	0.028	0.028	0.028
Public Administration	24	0.138	0.150	0.147	0.157	0.163	0.166	0.157	0.019	1.159	0.167	0.127	0.139	0.183	0.017	0.165	0.165	0.165	0.165	0.165
Education	25	0.074	0.077	0.106	0.081	0.076	0.093	0.086	0.008	0.074	1.171	0.090	0.080	0.084	0.009	0.093	0.093	0.093	0.093	0.093
Health, etc.	26	0.410	0.380	0.366	0.384	0.374	0.439	0.402	0.038	0.357	0.303	1.966	0.368	0.431	0.046	0.457	0.457	0.457	0.457	0.457
Arts, etc.	27	0.125	0.121	0.110	0.142	0.127	0.151	0.139	0.013	0.125	0.098	0.123	1.578	0.116	0.015	0.146	0.146	0.146	0.146	0.146
Other services	28	0.082	0.084	0.090	0.094	0.090	0.105	0.090	0.008	0.071	0.116	0.062	0.103	1.101	0.010	0.099	0.099	0.099	0.099	0.099
Gross wages	29	0.086	0.087	0.080	0.086	0.087	0.083	0.084	0.009	0.089	0.090	0.085	0.085	0.084	0.108	0.083	0.083	0.083	0.083	0.083
Gross operating	30	1.237	1.246	1.087	1.263	1.246	1.529	1.3351	0.114	1.019	0.829	0.935	1.175	1.001	0.113	2.131	1.131	1.131	1.131	1.131
Net indirect tax	31	0.265	0.267	0.244	0.270	0.298	0.379	0.2280	0.025	0.263	0.234	0.266	0.274	0.225	0.037	0.365	1.365	0.365	0.365	0.365
Other capital income	32	0.945	0.953	0.841	0.964	0.970	1.186	1.022	0.088	0.816	0.687	0.766	0.913	0.780	0.154	1.535	1.535	2.535	0.940	1.535
Houseold expend	33	1.588	1.600	1.412	1.619	1.630	1.991	1.7716	0.147	1.371	1.153	1.286	1.533	1.310	0.258	2.579	2.579	2.579	2.579	2.579
Consumer house	34	5.307	5.348	4.718	5.41	5.448	6.655	7.735	0.493	4.581	3.855	4.298	5.125	4.377	0.862	8.62	8.62	8.62	5.277	8.62

"Coke, etc.", "Constructions", "Health", "Freight transportation and warehousing", and notably "Wholesale and retail trade", are branches whose multiplier capacity appears to be significant and worthy of consideration.

Above all, it is the textile, clothing and leather items industry that stands out as the branch whose productive liveliness is strongly activated, exhibiting very high multiplier effects, both direct and on the entire economic system, in response to impulses from the exogenous demand.

The textile industry encompasses the districts of Prato and Empoli, showcasing substantial productive strength that centres on fabrics and clothing. This industry involves a large number of municipalities and their populations, generating significant employment opportunities and boasting national and international prominence.

This branch includes leather, thereby highlighting it as a focal point and revolving around the district of Santa Croce sull'Arno. Remaining within the EMAS districts framework, this does not seem to be the case for paper, categorized under the branch "Wood, paper, and publishing", which appears to be among those with a moderate multiplier impact.

Outside the productive sphere, there are the payments from factors and households' expenditure, along with the outputs from activities (distribution and redistribution of income) that we have merged, making the interpretation of their multiplier effect challenging.

The multiplier response of the GVA to unit increases in exogenous demand is robust, particularly concerning income from labour (wages and salaries) and very strong for income from capital. The activation of households' expenditure is also very strong.

Households' income, in the sphere of income distribution and redistribution, exhibits an average multiplier of around 5 because we have merged the sector's quintiles.

4. Recovering from the Covid-19 emergency and the current energy crisis and inflation shock. resuming the path

Now, let's explore the insights gleaned from the analysis conducted in paragraphs 3.2 and 3.3 to identify potential avenues for fully restoring the economic development achieved before 2020 and propose investment hypotheses.

This is of paramount importance for our specific objectives related to Tuscany outlined in this study. Furthermore, these findings can serve as a benchmark for other Italian regions and districts with similar economic and social structures, such as the industrial districts of the so-called "Third Italy" (Bagnasco, 1977; Becattini, 1979, 1989) or those in the category of "Middle Italy" (Bracalente, 2010).

Additionally, concerning the methodology employed, the findings may be applicable to European territorial configurations, including regions participating in the "District Plus" innovation project initiated in 2011 by Tuscany. These regions encompass Vastra Gotland (Sweden), Lower Silesia (Poland), Brasov County (Romania), Saxony-Anhalt (Germany), and the West Midlands (Great Britain). In a broader context, the insights may extend to regions affiliated with the "Enterprise Europe Network" (EEN), the most extensive support network for small and medium-sized enterprises (SMEs).

For an effective, robust, and sustainable recovery, the evidence suggests that focusing on the textile, fashion, and leather industries would be advantageous. Converging the overall regional investment and demand stimulus policy onto these sectors seems advisable.

Similarly, there is a strong indication to channel investments towards pharmaceuticals and healthcare, as highlighted in the Introduction as vibrant and expanding activities. Additionally,

investing in transportation, particularly in freight transportation, as well as wholesale and retail trade, appears to be a promising avenue.

Furthermore, it is important not to overlook metallurgy and computer hardware as sectors suitable for potential residual investment.

Tourism warrants a distinct comment. The analysis results regarding Hotels & Restaurants may not entirely align with the prevailing sentiment among decision-makers, both political and economic, as well as households, regarding the potential of tourism as a key sector. Nevertheless, the outcomes are generally favourable, providing a basis for optimism regarding a positive response from the sector to investment programs aimed at contributing to regional economic recovery.

Similar considerations apply to the paper industry, the production of which we observed concentrated in one of the four dynamic EMAS districts. This concentration makes it a sector worthy of investment.

As for oil, wine, and geothermal, which are both typical and significant, our current level of analysis does not allow us to fully capture their multiplier impact. Therefore, it is challenging to make informed guesses about the strength of their potential contribution to the recovery.

The highly dynamic responses observed in GVA components and household expenditures should not be directly interpreted as indications of investment in these two directions being a driving force for the post-COVID economic recovery. Nevertheless, they do attest to the remarkable reactivity and the robust capacity of the economic system to generate income. This is especially noteworthy in the context of investment policies targeted at salary increases and consumer spending across all productive sectors.

In summary, the evidence converges to suggest that, for the recovery and revitalization of Tuscany's economic growth, resuming the trajectory interrupted in 2020, it is advisable to concentrate efforts on manufacturing, fashion, paper, pharmaceuticals, as well as tourism, metallurgy, the IT sector, and niche sectors such as wine, oil, and thermal and geothermal activities.

We can compare our recommendations with those outlined in the CDP Think Tank report, "Focus Territori" (2020), while considering the distinct economic levels at which the analyses are conducted. This paper focuses on individual branches, whereas the CDP paper examines sections (letters) and divisions (two digits) within the ATECO 2007 classification.

CDP paper argues that, to address critical issues of the Tuscan economic system and achieve better performance in terms of growth and territorial cohesion, it will be necessary to focus on specific enabling factors. These include:

1. consolidating the entrepreneurial fabric;
2. supporting an innovation ecosystem;
3. maintaining and strengthening the training system;
4. solving the infrastructural, physical and digital bottlenecks.

To this end, it will be strategic to channel available European resources for post-pandemic reconstruction into a coherent regional development project, which leverages the specific competitive advantages of the Tuscan territory and aligns with the priorities identified in the context of Next Generation EU.

Consequently, the CDP identifies "5 excellences" defined as "niche" from which to restart, even though they "have a relatively limited impact on the regional production system." These include: the Prato textile industry, the wine sector, innovation and competitiveness in the pharmaceutical sector, the integrated automotive supply chain, and geothermal energy.

These indications largely align with our findings, confirming overall what emerges from our results, thereby reinforcing our conclusions.

5. Conclusions

Numerous and diverse considerations can be drawn at the conclusion of our research.

First and foremost, we can point out that an analysis of this nature holds the advantage of being explicitly based on economic theory, operationalized through the Keynesian macroeconomic-accounting framework, and on the general economic equilibrium, or rather, the general interdependence. This can be empirically applied, through the analysis of structural interdependencies, or input-output analysis - an idea that can be traced back to François Quesnay's Tableau économique and echoed in the multi-sector model used by Karl Marx - which finds its origin in the general equilibrium model by Léon Walras.

The framework of interdependencies is integrated and complemented by the insertion, alongside the technical subjects (i.e. the branches), of the economic subjects (i.e. the institutional sectors), as is accomplished in a SAM, the economic-accounting structure utilized as database and for processing and estimating the IMM.

This comprehensive approach lends considerable reliability and robustness to the results. Nevertheless, it is essential to regard and interpret these findings in their own right light.

As the analysis is conducted at the branch level, delving into the details of specific production aspects becomes challenging. Consequently, it's difficult to individually discern the dynamics of sectors crucial to the Tuscan economy, such as textiles, fashion, leather, and paper. These are grouped under the branches of "Textile, clothing, and leather items" (the first three) and "Wood and publishing" (the fourth).

Despite this limitation, it is possible to satisfactorily and effectively understand these dynamics by reasoning through analogies, similarities, and cautious hypotheses. The situation contrasts with that of the wine and geothermal sectors, which are encapsulated as indistinguishable, homogeneous production units within the "Food, beverage, and tobacco" and "Mining" branches.

The SAM-based descriptive analysis portrays a landscape of innovation and competitiveness in manufacturing, with a predominant presence of textiles, fashion, and leather. Examining it through the lens of the Clarkian sectors, the secondary sector prevails, but in a phase of transition towards the prevalence of the tertiary sector, aligning with Fourastié's theory of structural transformation.

A production system emerges with a good degree of integration and therefore a good cost (production) step of the supply chain of Tuscany (Hayes (2023), Keaney (2021)). Although precise quantification in percentage terms is not feasible with the available information, it attests to the overall satisfactory functioning of the production system.

An average reaction capacity of the economic structure as a whole is evident from the IMM analysis, with a focus on textiles, the fashion and the leather, but with a good response also from pharmaceuticals and health care and from freight transportation and wholesale retail trade, without neglecting tourism and paper. All sectors in which to focus attention and to direct investments with decision and confidence for a robust, growing and sustainable post-Covid recovery.

The IMM analysis reveals an overall average reaction capacity of the economic structure, particularly evident in textiles, fashion, and leather. Additionally, noteworthy responses are observed in pharmaceuticals, healthcare, freight transportation, wholesale retail trade, tourism, and paper. These sectors deserve focused attention and strategic investments, providing a foundation for a resilient,

growing, and sustainable post-Covid recovery. Such targeted efforts can be approached with confidence and decisiveness.

Use of AI tools declaration

The authors declare they have used Artificial Intelligence (AI) tools in the creation of this article, mainly applied to language modification.

Conflict of interest

All authors declare no conflicts of interest in this paper.

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