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SOCIOECONOMIC TYPOLOGIES FOR PORTUGAL: A LOOK AT THE PRESENT AND THE FUTURE THROUGH THE LENS OF SOCIAL, REGIONAL AND ENVIRONMENTAL DEVELOPMENT

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Socioeconomic Typologies for Portugal:

A look at the present and the future through the lens of social, regional and environmental development

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Abstract

There are considerable differences in Portugal's economy between regions and economic sectors. This work aims to generate an analysis of the country's economy considering five main themes: current economic situation, future competitiveness, social inequality, regional inequality, and decarbonization of the economy. Based on the Portuguese interregional input-output matrix of 2017 and using established methods in input-output analysis, we developed a typological view based on indicators calculated at the sectoral and regional levels of the country – 7 regions and 65 sectors. The results show the relative strengths and weaknesses for each sector and region. With the results, we transformed each index into a score with a value between 0 and 1. Finally, we developed a tool that allows choosing the level of importance for each of the five dimensions of analysis and for each indicator, in order to generate a weighted average score for each sector and region by dimension and also a global weighted average score across all dimensions. This type of analysis enables the formulation of strategies for creating public policies or investment plans aimed at strengthening social, regional, and environmental development according to the social planner's preferences.

1 Introduction

The economy of Portugal is primarily centered around activities such as wholesale and retail trade, accommodation and food services and manufacture of food products, beverages and tobacco products. Its geographic location and incentives in sectors relevant to the era of mercantile capitalism, such as navigation, allowed the country to become a global economic power in 16th Century. Just like in the past, mapping the advantages that

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regions and industries within a country possess is of utmost importance for policymakers and investors to consider the development of the economy in the present and future. A widely used methodology in regional economics is the input-output matrix, which enables the analysis of how stimuli in the final demand of each sector generate effects that propagate through the production chain, affecting the entire economy due to sectoral interconnection.

In this sense, this work aims to generate an “X-ray” of Portugal’s economy with metrics for each of its sectors and regions considering social, regional and environmental aspects. Provided with the interregional input-output matrix of the country for 2017 [1], we developed a typological analysis based on indicators calculated at the regional and sectoral levels - 7 regions of Portugal (NUTSII - 2013) and 65 sectors (CAE Rev.3). These indicators were designed to allow a description of the economy in five dimensions: present economic growth, future economic competitiveness, social inequality, regional inequality and decarbonization of the economy. For the sake of conciseness, we simply call these dimensions present, future, social, regional and environmental.

Economic sectors have relations between them. An activity demands products from other sectors, which, in turn, have their own demands. Sectors have impacts on the whole economy through this economic linkages, which can be analyzed with Input-Output methodology. The analysis reveals connections and effects that are not obvious in the national accounts and other statistics, because the sectors have different degrees of dependence in the economy.

Our work follows a similar approach to the one proposed by Haddad and Araújo (2023)[2]. We explore various economic, social, and environmental dimensions and subdimensions through measurement via indices constructed from the relationship of economic-statistical magnitudes. Each index provides a stylized representation of an economic process. For example, in the context of this work, a CO2 emissions generator represents a physicochemical and economic process triggered by a demand shock and propagation estimated in the underlying input-output model. Nevertheless, it is essential to contextualize the significance of these indices from a sociological perspective, as they take into account the socio-environmental aspects embedded in the reality of the population. Understanding the indicators and the economic scenario in which they are embedded is the basis for developing policies aimed at guiding economic development according to the policymaker’s preferences (which, in some way that will not be discussed here, may also take into account societal preferences). To this end, we built a tool that allows the user to allocate their preferences among the dimensions addressed in this article. Specifically, the user must distribute a unit of importance according to their hierarchy of preferences regarding the indicators representing aspects of social reality. This distribution can be done either disproportionately or proportionately. For example, a society concerned solely with social inequality would assign a weight of 1 to the "Social" dimension and zero to the others. Furthermore, within this dimension, they would rank in order of importance, also totaling 1, the indicators that represent socio-economic processes, such as job creation for society in general, or increasing the participation of employed women, or the participation of employed youth, or immigrants.

The data used to construct the indicators are from 2017. A technical policymaker observing the economic data at the time to decide how to prioritize actions in order to achieve progress in certain areas would encounter the following situation: an unemployment rate of 8.9% in the country. Expanding by regions, they would find that the North (Norte) and Região Autónoma de Madeira (RAM) regions have the highest unemployment rates, with 9.8% and 10.4% respectively. When comparing unemployment by gender, they would see that there is a slightly higher rate of idle labor among women, with a 9.3% unemployment rate compared to 8.4% for men. The unemployment rates by gender for the European Union (EU - 27) are 8.5% for women versus 7.9% for men. They would also see that by age, there is a high unemployment rate (23.9%) for the 15 to 24 age group, due to the dynamics of entering the labor market. However, the figure for the European Union for the same age group was 18.0%. The policymaker would observe such data and, based on their analyses and beliefs about what is good for the nation, could make choices to improve employment levels in certain areas, such as increasing employment among 15 to 24-year-olds to get closer to the European Union's value. [1] [2]

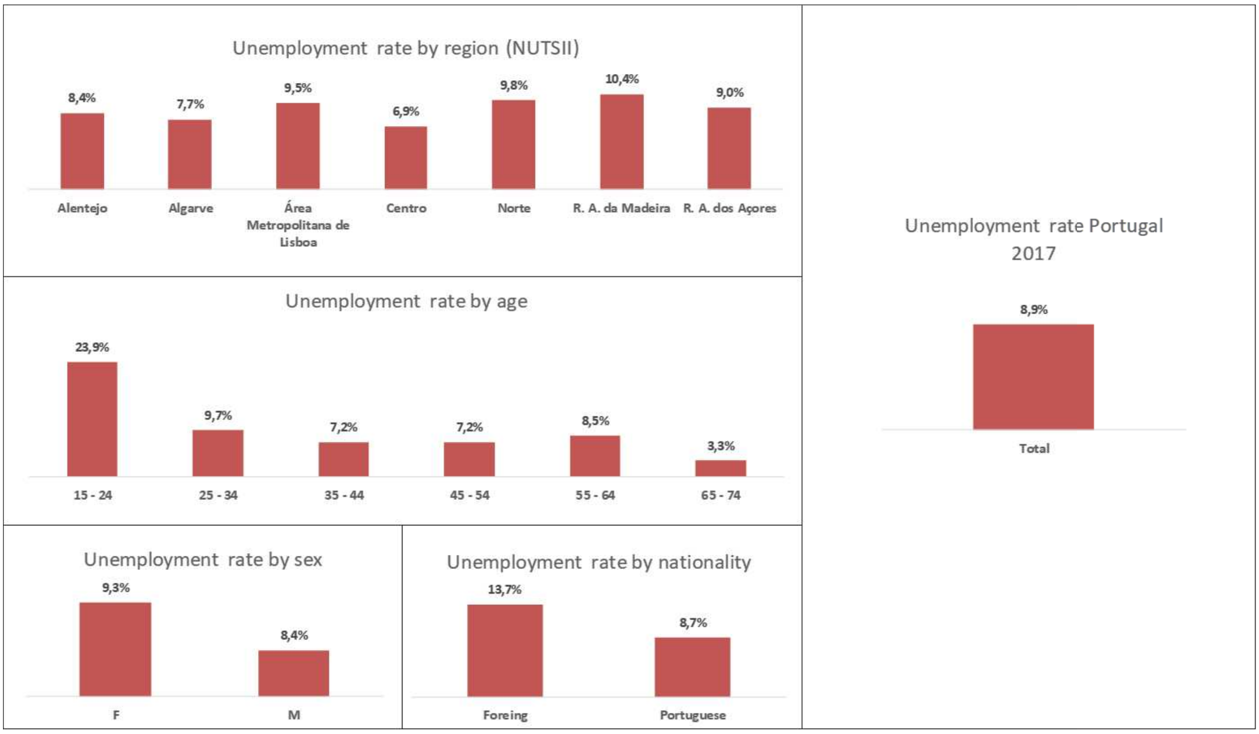


Figure 1: Socioeconomic context from the perspective of unemployment rates.

However, imagine that our policymaker is concerned not only with unemployment but also with environmental issues. Therefore, they will choose to consider the environmental pillar with some relevance. According to data from Directorate-General for Energy and Geology (DGEG), Portugal has a high energy dependence and primarily needs to import oil, which represents more than 60% of imports in the energetic balance. In both primary consumption, for electricity generation, and final consumption, oil still accounts for about 45% of consumption. Despite this, it is noteworthy that the production of electricity from renewable sources has been increasing its share in the country's energy matrix. Driven mainly by hydropower in the North and wind power in the center, in

[1] Unemployment data for Portugal were obtained from the 2017 Employment Survey ("Inquérito ao Emprego" in portuguese) - INE.

[2] Unemployment data for EU-27 were obtained from Eurostat.

2022, the contribution of renewable energy sources exceeded the 30% mark for both primary and final consumption. In the same year, Portugal was the fourth country in the European Union (EU-27) with the highest incorporation of renewable sources in electricity production. With these data in mind, along with the goal of carbon neutrality by 2050 – which is part of the commitment to the Paris Agreement – the policymaker equipped with the tool we developed will be able to assess which sectoral and regional interconnections intensify oil consumption and generate the most CO2 emissions. In this way, they can seek more effective environmental policies to meet their committed targets. [3] [4]

Of course, this is a simplified version of the decision-making process in public policy and regional development project formulation, but it serves to illustrate the usefulness of our tool in providing an X-ray of the economy and a shock and response model to the policymaker who can prioritize their set of actions by themes. Therefore, the main contribution of this work is to generate a multidimensional view about the strengths of each region and each sector in Portugal in the predefined dimensions of analysis. In a world where economic development that takes into account social and environmental aspects is gaining increasing importance, a stylized description of how sectoral and regional stimuli affect socio-environmental indicators is of utmost value for strategic planning in both the public and private sectors.

The main results are the five dimension indices for Portugal's 7 regions and 65 sectors. They show how the interconnections of the country's productive structure affect some aspects of the Portuguese economy and society. The most developed regions, Norte and the Área Metropolitana de Lisboa (Lisbon Metropolitan Area in english, will be reffered to as AML in the rest of the text), have the best indicators for current economic activity and competitiveness, with the exception for gross value added (GVA) generation. These regions also stand out in employment for women. The Portuguese archipelagos, Região Autónoma de Madeira (RAM) and Região Autónoma dos Açores (RAA), have good indicators for employment generation, particularly for immigrants.

This paper is organized as follows. Section 2 describes our data sources. Section 3 presents in details our methodology and the expressions for each indicator used in the analysis, while section 4 describes the indices and the hierarchical analysis, providing details on how our tool works. Section 5 presents the results of some preference hierarchy examples and section 6 offers final remarks and discusses the implications for policy.

2 Data

The Interregional Input-Output System for Portugal was calculated by the Portuguese National Accounts. It relates 65 sectors across 7 regions of Portugal in order to consider the interconnection between all pairs of sector and region. The IIOS have data of the level of employment (persons) and CO2 emissions (thousand tonnes), both obtained from Eurostat. To generate employment data by sex, age, nationality and level of education, we used the employment percentuals from a 5% sample of the Portuguese 2021 Census microdata, provided by INE (Portuguese for "National Institute for Statistics"), and projected to the 2017 employment level. Unemployment data for Portugal were obtained

[3] Energectic Balance DGEG - https://www.dgeg.gov.pt/media/vt3bqpmn/dgeg-ben-2022.pdf

[4] Renewables DGEG - https://www.dgeg.gov.pt/media/um5jqbue/dgeg-arr-2024-04.pdf

from the 2017 Employment Survey ("Inquérito ao Emprego" in portuguese) - INE. Data on the number of jobs, to obtain the participation of technical-scientific personnel, and on wages, to calculate the GINI index, were obtained from the "Quadros de Pessoal" survey conducted by GEP (Gabinete de Estratégia e Planeamento) in 2017. The data of oil sales in Portugal was gathered from DGEG.

3 Methodology

The methodology employed focuses on input-output analysis techniques [3, 4] and follows the application made by Haddad & Araújo [2]. To generate a multidimensional analysis of the Portuguese economy, we calculated a series of indicators that express some metric of the capacity of a sector or region related to a specific dimension. Each indicator is transformed into a normalized score, then each score is weighted according to the analysis purpose and finally the scores are aggregated in each dimension, what makes possible to rank the regions and sectors according to their socioeconomic performance on the theme. In this section, we will detail the indicators that comprise each of the five dimensions explored in our analysis.

We devised various indicators to assess regional and sectoral performance across five key themes: (i) present economic growth, (ii) future economic competitiveness, (iii) social inequality, (iv) regional inequality and decarbonization of the economy. For brevity, we will refer to these simply as "present, future, social, regional, and environmental". Table 1 presents each indicator categorized by theme along with a concise explanation and the data sources utilized. Each of Portugal's 7 regions and 65 economic sectors have all of these indicators.

The base of our analysis uses the Leontief open model for the Portuguese Interregional Input-Output Matrix (IIOS) of 2017. With the IIOS, we compute the Leontief inverse matrix, which allows us to study the chain effects that final demand has on the Portuguese economy. With additional information (variables such as employment or emissions) by sector and region, we use the inverse matrix to create "generator" indices, which show how much the variable of interest change in Portugal given a increase of 1 million euros in the final demand of the region or sector. The employment generator, for example, shows that a increase of 1 million euros in the final demand of the Norte region creates approximately 23 new jobs across Portugal.

Table 1: Indexes for the Portuguese economy

Theme	Index Name	Description	Source
Present	SGO (%)	Share of the Gross Output (GO).	IIOS
	SGVA (%)	Share of the Gross Value Added (GVA).	IIOS
	STAX (%)	Share of the collected taxes.	IIOS
	M	Economy multiplier of the final demand.	IIOS
	GVAG	The GVA generated in euro from 1 euro increase in the final demand.	IIOS

Theme	Index Name	Description	Source
	TAXG	The increase of collected taxes in euro with an increase of 1 euro in the final demand.	IIOS
Future	TEXP (€10^6)	Total exports to other countries and other regions	IIOS
	TBAL (€10^6)	Trade balance with the exterior	IIOS
	HEJG (jobs/ €10^6)	High education employment generator	IIOS
	SSTM (%)	Share of STEM (science, technology, engineering, and math) occupation in the total number of employees.	GEP [5]
Social	EMPG (jobs/ €10^6)	Total employment generator due to 1 million euros increase in the final demand.	IIOS
	WEGP (%)	Percentage of women employment generated due to 1 million euros increase in the final demand.	IIOS, Census [6]
	YEGP (%)	Percentage of youth employment generated due to 1 million euros increase in the final demand.	IIOS, Census
	IEGP (%)	Percentage of immigrant employment generated due to 1 million euros increase in the final demand.	IIOS, Census
	GINI	Gini Index for Portuguese workers salaries.	GEP
Regio-	IGVG	GVA generator for all regions except AML and Norte.	IIOS
nal	DW	Δ-Williamson Coefficient for Portugal's GVA per capita.	IIOS
Environ-	CO2G (kton/ €10^6)	CO2 emissions increase in Portugal for 1 million euros increase in the final demand.	IIOS
mental	OILG (kton/€10^6)	Oil sales increase for 1 million euros more in the final demand.	DGEG [7]
	COVA (kton/€10^6)	Emissions increase in Portugal for one euro of GVA generated.	IIOS
	OIVA (kton/€10^6)	Oil sales in Portugal for one euro of GVA generated.	DGEG

[5] Survey "Quadros de Pessoal" conducted by GEP - Gabinete de Estratégia e Planeamento (Office for Strategy and Planning) - in 2017

[6] 2021 Portuguese Census

[7] Direção-Geral de Energia e Geologia

The following subsections presents the indices in details, such as its mathematical definition as well its interpretation.

3.1 Economic Effects in the Present

The indicators of this theme are developed from the input-output matrix. They concern the current economic configuration (in relation to the moment - 2017 - depicted in the national statistics matrix).

1. **Share of Gross Output**: It measures how much the gross output value in each sector or region represents in the gross output aggregate. Let GO_i^r be the Gross Output of sector i in the region r. Hence, the share of gross output of the region r, SGO^r, is:

$$SGO^r = \frac{\sum_i GO_i^r}{\sum_r \sum_i GO_i^r}, \quad with\, i = 1, ..., 65\, and\, r = 1, ..., 7 \tag{1}$$

In the same way, the share of gross output of the sector i, SGO_i is:

$$SGO_i = \frac{\sum_r GO_i^r}{\sum_r \sum_i GO_i^r}, \quad with\, i = 1, ..., 65\, and\, r = 1, ..., 7 \tag{2}$$

2. **Share of Gross Value Added**: This is an indicator that measures the participation of the sector or region in the aggregate value added. The value added shares by region and by sector are given, respectively, by:

$$SGVA^r = \frac{\sum_i GVA_i^r}{\sum_r \sum_i GVA_i^r}, \quad with\, i = 1, ..., 65\, and\, r = 1, ..., 7 \tag{3}$$

$$SGVA_i = \frac{\sum_r GVA_i^r}{\sum_r \sum_i GVA_i^r}, \quad with\, i = 1, ..., 65\, and\, r = 1, ..., 7 \tag{4}$$

3. **Share of Taxes**: Similar to the previous ones, this is an indicator that measures the participation of the sector or region in aggregate taxes. The shares of taxes by region and by sector are given, respectively, by:

$$STAX^r = \frac{\sum_i TAX_i^r}{\sum_r \sum_i TAX_i^r}, \quad with\, i = 1, ..., 65\, and\, r = 1, ..., 7 \tag{5}$$

$$STAX_i = \frac{\sum_r TAX_i^r}{\sum_r \sum_i TAX_i^r}, \quad with\, i = 1, ..., 65\, and\, r = 1, ..., 7 \tag{6}$$

4. **Output Multiplier**: It is an indicator that measures all the production generated in the economy from an increase of 1 million euros in final demand (the monetary unit of the IIOS matrix is €10^6). The increase of 1 million euros in the final demand for sector j in region s has a direct impact on production, which is the initial effect to meet the immediate demand, and an indirect impact, which are the effects on

production due to other sectors that are activated to provide inputs for sector j in region s to meet its incremental demand. This multiplier is well known in the input-output literature and is calculated as follows:"

$$M_j^s = \sum_r \sum_i b_{ij}^{rs}, \quad with\ i, j = 1, ..., 65\ and\ r, s = 1, ..., 7$$

Where b_{ij}^{rs} is an element of the Leontief inverse matrix that indicates how much an additional 1 million euros in the demand for sector j in region s increases the production of sector r in region j.

From the multipliers by sector and region M_j^s, the aggregate multiplier by sector j is calculated with their weighted average, where the weights are the volumes of final demand. The summation is made over all regions s:

$$M_j = \frac{\sum_s M_j^s \cdot d_j^s}{\sum_s d_j^s}, \quad with\ j = 1, ..., 65\ and\ s = 1, ..., 7 \tag{7}$$

Where d_i^r is the final demand for goods of the sector i of region r.

For the multiplier aggregated by region s, the summation is over all sectors j:

$$M^s = \frac{\sum_j M_j^s \cdot d_j^s}{\sum_j d_j^s}, \quad with\ j = 1, ..., 65\ and\ s = 1, ..., 7 \tag{8}$$

5. **GVA Generator**: This indicator shows how much a increase of 1 million euros in the final demand from a sector or region increases the Gross Value Added of Portugal. It is similar in concept to the Output Multiplier, which regards the GO instead of the GVA.

   This generator is calculated through the sum of the elements b_{ij}^{rs} of the Leontief inverse matrix weighted by the ratio between the GVA and the GO of each sector i in each region r. Thus, the GVA generator of a sector j in a region s is:

$$GVAG_j^s = \sum_r \sum_i \frac{GVA_i^r}{GO_i^r} \cdot b_{ij}^{rs}$$

   Similarly to what was done for the aggregate multipliers by region or sector, the aggregate generators by region or sector are averages weighted by the final demands. Thus, the GVA generator by sector j is:

$$GVAG_j = \frac{\sum_s GVAG_j^s \cdot d_j^s}{\sum_s d_j^s} \tag{9}$$

   And the GVA generator by region s is:

$$GVAG^s = \frac{\sum_j GVAG_j^s \cdot d_j^s}{\sum_j d_j^s} \tag{10}$$

6. **Taxes Generator**: This indicator shows the increase in taxes paid in Portugal caused by the increase in the final demand of a sector or region. The tax generator of a sector j in a region s is:

$$TAXG_j^s = \sum_r \sum_i \frac{TAX_i^r}{GO_i^r} \cdot b_{ij}^{rs}$$

Where TAX_i^r is the total taxes paid by sector i in region r.

From TAX_i^r, the aggregate tax generators by sector and by region are:

$$TAXG_j = \frac{\sum_s TAXG_j^s \cdot d_j^s}{\sum_s d_j^s} \tag{11}$$

$$TAXG^s = \frac{\sum_j TAXG_j^s \cdot d_j^s}{\sum_j d_j^s} \tag{12}$$

3.2 Future Competitiveness

7. **Total Exports**: This indicator shows the sum of international exports for the Portuguese sectors and regions. It is calculated from the IIOS matrix. The index for sector j and region s are, respectively:

$$TEXP_j = \sum_s EXP_j^s \tag{13}$$

$$TEXP_s = \sum_j EXP_j^s \tag{14}$$

Where EXP_j^s is the total exports of sector j in region s.

8. **Trade Balance**: This indicator shows the trade balance of a sector j or region s, and is calculated from Portugal's Input-Output Matrix. The trade balance of a sector j and of a region s are, respectively:

$$TBAL_j = \sum_s (EXP_j^s - IMP_j^s) \tag{15}$$

$$TBAL_s = \sum_j (EXP_j^s - IMP_j^s) \tag{16}$$

Where IMP_j^s is the total imports by sector j in region s.

9. **High Education Jobs Generator**: These indicate how much an additional euro in final demand of a sector or region increases high-level jobs in Portugal. Like other generators, it is calculated through the sum of the elements b_{ij}^{rs} of the Leontief

inverse matrix weighted by the ratio of the quantity of high education jobs in sector i in region r (HEJ_i^r) to the respective gross output (GO_i^r):

$$HEJG_j^s = \sum_r \sum_i \frac{HEJ_i^r}{GO_i^r} \cdot b_{ij}^{rs}$$

Using $HEJG_i^r$, the high education jobs generator by sector and by region are, respectively:

$$HEJG_j = \frac{\sum_s HEJG_j^s \cdot d_j^s}{\sum_s d_j^s} \tag{17}$$

$$HEJG^s = \frac{\sum_j HEJG_j^s \cdot d_j^s}{\sum_j d_j^s} \tag{18}$$

10. **Share of STEM employees**: This indicator measures the participation of technical-scientific personnel. Using the 2010 Portuguese classification of professions, we consider the following occupations as belonging to the STEM category:

    - Specialists in physics sciences, mathematics, engineering, and related technical fields;
    - Specialists in finance, accounting, administrative organization, public relations, and commercial relations;
    - Specialists in information and communication technologies (ICT);
    - Technicians and professionals in sciences and engineering, at intermediate level;
    - Technicians in information and communication technologies (ICT);
    - Data operators, accounting, statistics, financial services and related registration services.

    The participation of technical-scientific personnel by sector is:

$$SSTM_j = \frac{STEMEmployees_j}{TotalEmployees_j} \tag{19}$$

And the regional indicator is:

$$SSTM^r = \frac{STEMEmployees^r}{TotalEmployees^r} \tag{20}$$

3.3 Social Inequality

11. **Total Employment Generator**: This indicator is analogous to the high education job generator, but considering all jobs. Let EMP_j^s be the employment level for the sector j in region s. Thus, the job generator in Portugal for a sector j in a region s is:

$$EMPG_j^s = \sum_r \sum_i \frac{EMP_i^r}{GO_i^r} \cdot b_{ij}^{rs}$$

Where EMP_i^r is the total number of employees in sector i in region r.

The aggregate job generators by sector and by region are, respectively:

$$EMPG_j = \frac{\sum_s EMPG_j^s \cdot d_j^s}{\sum_s d_j^s} \tag{21}$$

$$EMPG^s = \frac{\sum_j EMPG_j^s \cdot d_j^s}{\sum_j d_j^s} \tag{22}$$

12. **Women Employment Generator**: This indicator shows the participation of women in the jobs generated for each 1 million euros increment in the final demand of the sector or region. The women employment generator for sector j in region s is:

$$WEMPG_j^s = \sum_r \sum_i \frac{WEMP_i^r}{GO_i^r} \cdot b_{ij}^{rs}$$

And the generators for sector j and for region s are:

$$WEMPG_j = \frac{\sum_s WEMPG_j^s \cdot d_j^s}{\sum_s d_j^s} \tag{23}$$

$$WEMPG^s = \frac{\sum_j WEMPG_j^s \cdot d_j^s}{\sum_j d_j^s} \tag{24}$$

The indicator we will use in constructing the scores will be the ratio between jobs generated for women and the total jobs generated, in order to classify the sector or region based on its relative capacity to generate female employment rather than its absolute capacity.

Let $WEGP$ be the ratio between women jobs generated and total jobs generated. So the relative indices for sector and region are respectively:

$$WEGP_j = \frac{WEMPG_j}{EMPG_j}$$

$$WEGP^s = \frac{WEMPG^s}{EMPG^s}$$

13. **Youth Employment Generator**: This index shows the job generation for young people (aged 15 to 24) in Portugal in response to an increase of 1 million euros in the final demand of a sector or region. The disaggregated generator for sector j in region s is:

$$YEMPG_j^s = \sum_r \sum_i \frac{YEMP_i^r}{GO_i^r} \cdot b_{ij}^{rs}$$

And the generator for sector j and region s are, respectively:

$$YEMPG_j = \frac{\sum_s YEMPG_j^s \cdot d_j^s}{\sum_s d_j^s} \tag{25}$$

$$YEMPG^s = \frac{\sum_j YEMPG_j^s \cdot d_j^s}{\sum_j d_j^s} \tag{26}$$

The indicator we will use in constructing the scores will be the ratio between jobs generated for youngsters and the total jobs generated, in order to classify the sector or region based on its relative capacity to generate youth employment rather than its absolute capacity. Analogous to what we did for women employment generator ratio, these are the expressions for youth employment generator ratio:

$$YEGP_j = \frac{YEMPG_j}{EMPG_j}$$

$$YEGP^s = \frac{YEMPG^s}{EMPG^s}$$

14. **Immigrant Employment Generator**: The last job generator concerns jobs for immigrants, indicating how many of these jobs in Portugal are generated given an increase of 1 million euros in the final demand of a sector or region. Therefore, the disaggregated generator for sector j in region s is:

$$IEMPG_j^s = \sum_r \sum_i \frac{IEMP_i^r}{GO_i^r} \cdot b_{ij}^{rs}$$

The generator for a sector j or region s are:

$$IEMPG_j = \frac{\sum_s IEMPG_j^s \cdot d_j^s}{\sum_s d_j^s} \tag{27}$$

$$IEMPG^s = \frac{\sum_j IEMPG_j^s \cdot d_j^s}{\sum_j d_j^s} \tag{28}$$

The indicator we will use in constructing the scores will be the ratio between jobs generated for immigrants and the total jobs generated, in order to classify the sector or region based on its relative capacity to generate immigrant employment rather than its absolute capacity. Analogous to the above two indicators, the sectoral and regional immigrant employment generator ratio are respectively:

$$IEGP_j = \frac{IEMPG_j}{EMPG_j}$$

$$IEGP^s = \frac{IEMPG^s}{EMPG^s}$$

15. **Salary Gini Index**: These indexes measure the wages inequality within a sector or region. Thus, the index for each sector j or region s considers only the wages of workers in the sector or region. It was calculated from the microdata of the "Inquérito ao Emprego" of Portugal of 2021.

    The index for sector j is:

    $$GINI_j = \frac{\sum_a \sum_b |w_a - w_b|}{2n \sum_b w_b} \tag{29}$$

    Where a and b indexes all workers in sector j in Portugal and w_a is the wage of worker a.

    The index for region s is calculated similarly:

    $$GINI^s = \frac{\sum_c \sum_d |w_c - w_d|}{2n \sum_d w_d} \tag{30}$$

    Where c and d indexes all workers in region s.

3.4 Regional Inequality

16. **Interior GVA Generator**: This index considers the generation of GVA only in regions of Portugal different from AML (because of Lisbon) and Norte (because of Porto) regions. These two regions are the most developed regions of Portugal. We call the remaining regions "inland" or "interior". the index indicates how much an increase of 1 million euros in the final demand of a sector or region increases the GVA of the interior. The formula is similar to the GVA generator, but the sum is over the inland regions only.

    Thus, starting from the disaggregated generator $GVAG_j^s$ already calculated, the inland GVA generators by sector j and by region s are, respectively:

    $$IGVG_j = \frac{\sum_{s \in I_s} GVAG_j^s \cdot d_j^s}{\sum_s d_j^s} \tag{31}$$

    $$IGVG^s = \frac{\sum_{j \in I_j} GVAG_j^s \cdot d_j^s}{\sum_j d_j^s} \tag{32}$$

    Where I_j is the set of all sectors located in the inland Portugal and I_s is the set of all inland regions of Portugal.

17. **Δ-Williamson Coefficient**: This index measures how a increase of 1 million euro of the final demand for goods of a sector or region changes (thus the Δ) the regional dispersion of the GVA per capita (measured by the Williamson coefficient). A negative index indicates that an increase in demand reduces the Portuguese regional inequality.

To calculate the index, first we obtain the Williamson coefficient for Portugal before any increase in demand:

$$WC_0 = \frac{\sqrt{\sum_s (G^s - G)^2 (\frac{POP^s}{POP})}}{G}$$

Where G^s is the GVA per capita of region s and G is GVA per capita of Portugal. POP^s is the population of region s and POP is the population of Portugal.

The regional impact of the increase in demand can be calculated decomposing the $GVAG$ indexes from 3.1-5: where the original shows the GVA generated in Portugal due to a increase in demand for goods in a sector or region, the decomposition shows the GVA generated in each of the Portuguese regions (it is a 7x1 vector). To compensate for differences in population and GVA in each region, we use weighted vectors: $GVAG(j)$ for sector j and $GVAG(s)$ for region s.

The new Williamson coefficient for Portugal after a increase in the final demand for goods of the sector j is:

$$WC_j = \frac{\sqrt{\sum_r (\hat{G}(j)^r - \hat{G}(j))^2 (\frac{POP^r}{POP})}}{\hat{G}(j)}$$

Where POP^r is the population of region r and POP is the population of Portugal. GVA^r is region r original GVA and $GVAG(j)^r$ is the GVA increase in region r after an increase in demand for goods of sector j. $\hat{G}(j)^r = (GVA^r + GVAG(j)^r)/POP^r$ is the new GVA per capita in region r and $G(j)$ is the new Portuguese GVA per capita.

Analogously, the coefficient after an increase in demand for goods of region s is:

$$WC^s = \frac{\sqrt{\sum_r (\hat{G}(s)^r - \hat{G}(s))^2 (\frac{POP^r}{POP})}}{\hat{G}(s)}$$

With these, the Δ-Williamson coefficient for a sector j and region s are, respectively:

$$DW_j = WC_j - WC_0 \tag{33}$$

$$DW^s = WC^s - WC_0 \tag{34}$$

3.5 Environmental

18. CO_2 **Emissions Generator**: This indicator measures how much an increase of 1 million euros in the final demand of a sector or region generates in CO_2 emissions (in kton). It is a measure of emissions intensity per sector and region.

$$CO2G_j^s = \sum_r \sum_i \frac{CO2_i^r}{GO_i^r} \cdot b_{ij}^{rs}$$

The generators aggregated by the sector j and region s are, respectively:

$$CO2G_j = \frac{\sum_s CO2G_j^s \cdot d_j^s}{\sum_s d_j^s} \tag{35}$$

$$CO2G^s = \frac{\sum_j CO2G_j^s \cdot d_j^s}{\sum_j d_j^s} \tag{36}$$

19. **Oil Sales Generator**: This indicator measures how much the increase of 1 million euros in the final demand of a sector or region generates in thousand tonnes of oil sales [8] in Portugal. It is a measure of fossil fuel dependence.

$$OILG_j^s = \sum_r \sum_i \frac{OIL_i^r}{GO_i^r} \cdot b_{ij}^{rs}$$

The generator by sector j and region s are, respectively:

$$OILG_j = \frac{\sum_s OILG_j^s \cdot d_j^s}{\sum_s d_j^s} \tag{37}$$

$$OILG^s = \frac{\sum_j OILG_j^s \cdot d_j^s}{\sum_j d_j^s} \tag{38}$$

20. CO_2 **Emissions per GVA generated**: This indicator represents a relative measure of emissions generation per value added generation, and the unit is kton/ €10^6. This index adjusts environmental damage by economic benefits. Its definition is simply the ratio of the emissions generator by the GVA generator.

    Thus, the index for sector j is:

$$COVA_j = \frac{CO2G_j}{GVAG_j} \tag{39}$$

And the index for region s is:

$$COVA^s = \frac{CO2G^s}{GVAG^s} \tag{40}$$

[8] List of oil products considered: Butane, Propane, Auto Gas, Gasoline IO 95 and 98, Chemical Naphta and Aromatics, Kerosene/Fuel, Road and Colored Diesel, Colored Diesel for heating, Fuel Oil, Petroleum Coke, Lubricants, Asphalts, Paraffins, Solvents. It does not include Aviation fuel

21. **Oil Sales per GVA generated**: This indicator represents a relative measure of oil sales generation per value added generation. Its unit is kton/ €10^6. It is defined by the ratio of the oil sales generator by the GVA generator.

    The index for sector j is:

$$OIVA_j = \frac{OILG_j}{GVAG_j} \tag{41}$$

    The index for region s is:

$$OIVA^s = \frac{OILG^s}{GVAG^s} \tag{42}$$

4 Indices Analysis

The main results are the indices described in section 3 calculated for Portugal's 7 regions and 65 sectors. They show how the interconnections of the country's productive structure affect some aspects of the Portuguese economy and society. To display all the results, we arranged the indicators in tables separated by dimension. Next, we will discuss the main highlights of these results, exploring the regional and sectoral typologies.

4.1 Regional Typologies

The regional typologies are presented in the tables in Figure 2. We see that AML, Norte, and Centro are the largest regional economies, as shown by the SGO, SGVA, and STAX indicators. These indicators are quite similar for each region. The highest multiplier is in Lisbon, meaning that for every €1 of stimulus in its demand, €1.57 of production is generated in the economy. The regional scenario does not change much when viewed through the lens of the Future dimension. We see that the largest economies in production value are also the ones that generate the most higher education jobs, with Lisbon standing out as the region that most concentrates technical-scientific activities in its workforce.

When we move to the Social dimension, the picture begins to change. The archipelagos of RAA and RAM stand out in job creation, generating 26 and 25 jobs respectively per million euros of final demand increase. The AML has the worst GINI salary index, but it stands out as the largest generator of jobs for women in proportion to the total jobs created in its territory due to an increase of €1 million in demand. For immigrants, the region that proportionally generates the most jobs is the Algarve, and for young people aged 15 to 24, it is the RAA. In terms of the regional dimension, RAA and Alentejo are the regions that most contribute to the reduction of regional inequality. AML is the region that contributes the least to reducing regional inequalities.

For the environmental axis, we will highlight Alentejo as the region with the worst performance in environmental indicators. For every €1 million increase in its final demand, 280 tons of CO2 are emitted into the atmosphere, and 80 tons of petroleum products are sold. The Algarve stands out as the region with the best environmental indicators.

Present

Region	SGO	SVA	STX	M	GVAG	TAXG
Norte	30%	29%	27%	1,53	0,73	0,02
Centro	19%	19%	18%	1,54	0,75	0,03
Área Metropolitana de Lisboa	36%	36%	40%	1,57	0,75	0,03
Alentejo	7%	7%	7%	1,52	0,72	0,03
Algarve	4%	5%	4%	1,47	0,86	0,03
Região Autónoma dos Açores	2%	2%	2%	1,46	0,85	0,03
Região Autónoma da Madeira	2%	2%	2%	1,46	0,86	0,03

Future

Region	TEXP (million €)	TBAL (million €)	HEJG (jobs/million €)	SSTM
Norte	24.095	6.994	6	12%
Centro	13.751	3.912	5	12%
Área Metropolitana de Lisboa	22.332	6.560	6	17%
Alentejo	4.489	-710	5	9%
Algarve	906	82	5	6%
Região Autónoma dos Açores	386	-98	5	10%
Região Autónoma da Madeira	407	-57	5	9%

Social

Region	EMPG (jobs/million €)	GINI	WEGP	IEGP	YEGP
Norte	23	0,33	49%	4%	6%
Centro	23	0,30	48%	5%	6%
Área Metropolitana de Lisboa	18	0,42	50%	11%	6%
Alentejo	20	0,32	47%	7%	6%
Algarve	23	0,29	49%	14%	5%
Região Autónoma dos Açores	26	0,34	47%	2%	7%
Região Autónoma da Madeira	25	0,34	47%	3%	4%

Regional

Region	IGVG	WC
Norte	0,01	0,98
Centro	0,91	0,96
Área Metropolitana de Lisboa	0,00	0,00
Alentejo	0,91	0,84
Algarve	0,96	0,53
Região Autónoma dos Açores	0,99	1,00
Região Autónoma da Madeira	1,00	0,78

Environmental

Region	CO2G (kton/million €)	OILG (kton/million €)	COVA (kton/million €)	OIVA (kton/million €)
Norte	0,20	0,03	0,27	0,04
Centro	0,24	0,04	0,32	0,05
Área Metropolitana de Lisboa	0,22	0,03	0,29	0,04
Alentejo	0,28	0,08	0,39	0,10
Algarve	0,16	0,04	0,19	0,05
Região Autónoma dos Açores	0,22	0,07	0,25	0,08
Região Autónoma da Madeira	0,18	0,05	0,21	0,06

Figure 2: Results obtained for each indicator described in the section 3.

4.2 Sectoral Typologies

The sectoral typologies are presented in the tables in Figure 3. For this analysis, we will present the 15 sectors that stand out the most positively in each dimension. For the environmental dimension only, we chose to show the sectors with the worst indicators. Since there are 65 sectors, it would be exhausting to list them all.

In the Present dimension, we identify the largest sectors of the economy in order of gross output: Wholesale Trade (no vehicles/motorcycles), Public Administration, Accommodation /Food Services, Food/Beverage Manufacturing, and Electricity/ Gas/ Steam and Air Conditioning Supply. Unlike the regional analysis, we see variability among the SGO, SGVA, and STAX indicators, which is normal as each sector has different production processes, potentially generating more or less added value and being subject to different forms of taxation. For the future dimension, activities such as IT Services and Telecommunications stand out in the concentration of higher-level jobs. Food/Beverage Manufacturing stands out in terms of exports. On the Social side, we highlight the Employment Activities sector, which encompasses various temporary jobs and plays a significant role in immigrant and young employment, and the Accommodation/Food Services sector, which is one of the largest in the economy in terms of production value and presents excellent social indicators. In the Regional axis, we also identify the Employment

Activities sector as the largest generator of added value in regions other than AML and Porto (Norte).

Finally, for the Environmental axis, we list the sectors that contribute the most to the carbonization of the economy, with emphasis on Electricity/Gas/Steam/Air Conditioning and Land Transport, which are respectively the highest emitters and consumers of oil products. This shows that the pursuit of a less carbonized economy involves transforming sectors that have a significant weight in the economy.

Present

Sector	SGO	SGVA	STAX	M	GVAG	TAXG
Public Administration	5%	7%	9%	1,31	0,90	0,04
Construction	5%	4%	10%	1,77	0,69	0,05
Health Services	4%	5%	11%	1,47	0,80	0,06
Land Transport	2%	2%	11%	1,68	0,72	0,11
Wholesale Trade (no vehicles/motorcycles)	6%	7%	4%	1,54	0,86	0,02
Financial Services	3%	4%	7%	1,47	0,89	0,05
Accommodation/Food Services	5%	6%	3%	1,60	0,82	0,02
Imputed Rents	4%	8%	1%	1,10	0,98	0,01
Retail Trade (no vehicles/motorcycles)	4%	5%	2%	1,54	0,88	0,02
Education	3%	6%	3%	1,16	0,95	0,02
Warehousing/Transport Support	2%	2%	5%	1,73	0,81	0,06
Electricity/Gas/Steam/Air conditioning	5%	2%	1%	2,32	0,74	0,01
Food/Beverage Manufacturing	5%	2%	1%	1,95	0,63	0,02
Real Estate Activities	3%	5%	2%	1,28	0,94	0,02
Insurance/Pension Funding	1%	1%	3%	1,71	0,83	0,08

Future

Sector	TEXP (million €)	TBAL (million €)	HEJG (jobs/million €)	SSTM
IT Services	997	649	12,74	75%
Textile/Leather Manufacturing	6.592	3.581	2,71	10%
Architectural/Engineering Services	361	164	15,72	61%
Motor Vehicles Manufacturing	7.318	1.896	2,24	18%
Other Professional/Technical Services	589	498	18,77	27%
Air Transport	3.566	2.592	3,49	27%
Legal/Accounting/Consultancy	610	286	15,47	39%
Research and Development	60	18	10,04	57%
Telecommunications	407	-217	5,46	74%
Wholesale Trade (no vehicles/motorcycles)	2.894	1.594	4,62	21%
Computer/Electronic Products	1.849	822	5,57	37%
Food/Beverage Manufacturing	4.418	773	3,92	12%
Publishing	59	-5	11,47	37%
Chemical Manufacturing	2.560	797	2,63	35%
Membership Organisations	6	-59	18,50	9%

Social

Sector	EMPG (jobs/million €)	GINI	WEGP	IEGP	YEGP
Household Services	102	0,00	88%	14%	2%
Employment Services	65	0,37	52%	24%	12%
Personal Services	34	0,23	77%	10%	5%
Accommodation/Food Services	27	0,28	52%	12%	9%
Security/Administrative Services	53	0,41	57%	14%	6%
Retail Trade (no vehicles/motorcycles)	35	0,30	56%	6%	9%
Residential/Social Care	40	0,29	84%	5%	5%
Other Professional/Technical Services	33	0,34	54%	10%	7%
Telecommunications	13	0,30	48%	11%	8%
Computer/Electronic Products	16	0,32	50%	9%	9%
Textile/Leather Manufacturing	28	0,24	67%	2%	6%
Crop/Animal Production	60	0,28	33%	9%	4%
Research and Development	20	0,33	54%	10%	6%
Health Services	23	0,33	72%	5%	5%
Legal/Accounting/Consultancy	25	0,41	48%	9%	8%

Regional

Sector	IGVG	WC
Employment Services	1,03	0,47
Financial Services	0,17	0,00
Forestry	0,64	0,52
Mining	0,51	0,45
Fishing	0,47	0,41
Security/Administrative Services	0,10	0,06
Legal/Accounting/Consultancy	0,18	0,20
IT Services	0,12	0,16
Accommodation/Food Services	0,38	0,42
Water Collection/Treatment/Supply	0,34	0,40
Telecommunications	0,12	0,19
Rental/Leasing	0,33	0,40
Waste Management	0,30	0,38
Water Transport	0,29	0,37
Repair Services	0,29	0,37

Sector	CO2G (kton/million €)	OILG (kton/million €)	COVA (kton/million €)	OIVA (kton/million €)
Food/Beverage Manufacturing	0,26	0,05	0,41	0,08
Mining	0,37	0,06	0,54	0,09
Crop/Animal Production	0,32	0,08	0,46	0,12
Basic Metals Manufacturing	0,42	0,03	0,86	0,06
Fishing	0,67	0,04	0,88	0,05
Paper Manufacturing	0,59	0,06	0,97	0,09
Household Services	0,00	0,35	0,00	0,35
Waste Management	0,94	0,03	1,25	0,04
Air Transport	1,02	0,01	1,77	0,02
Water Transport	1,26	0,04	1,69	0,06
Petroleum Products Manufacturing	0,64	0,02	2,83	0,11
Chemical Manufacturing	0,52	0,28	1,10	0,60
Non-Metallic Mineral Manufacturing	1,79	0,15	2,71	0,23
Electricity/Gas/Steam/Air conditioning	2,39	0,06	3,25	0,08
Land Transport	0,69	0,78	0,96	1,07

Environmental

Figure 3: Results obtained for each indicator described in the section 3 for the first 15 sectors in order of value added.

4.3 Hierarchical Analysis

As the previous section highlighted the construction of indicators, this section is dedicated to explaining how the tool we developed combines the indicators and the policymaker's preferences. From the normalized indices that compose each of the defined themes, a system of weights is created between the sub-dimensions, represented by each index, and the dimensions, which are the pillars that will support the desired form of development.

Let $\mathcal{I}^d$ be the set of S_d indicators of dimension d that we defined in Section 3.

$$\mathcal{I}^d = \{I_1^d, I_2^d, I_3^d, \ldots, I_{S_d}^d\}$$

We will abstract the differentiation between regional and sectoral indicators for the sake of exemplification. However, the same reasoning applies to both regional and sectoral indicators. For regional indicators, each I_s^d belonging to $\mathcal{I}^d$ represents a list of 7 elements, that is, an indicator value calculated for each region. For sectoral indicators, each I_s^d belonging to $\mathcal{I}^d$ represents a list of 65 elements, an indicator value calculated for each sector.

Before we enter the hierarchical analysis stage itself, we need to define a way to compare indicators of different magnitudes and representing different economic processes. Since we are seeking an ordering among sectors or regions to identify which ones stand out in each dimension, we define a normalization function that preserves the ordering among the elements of the vectors but transforms each element of the vector into a number in the range [0,1], meaning the range of its elements varies from 0 to 1. The normalization function is given by:

$$\mathcal{N} : \mathcal{I}^d \to [0,1] \quad \textit{such that} \quad \mathcal{N}(I_s^d) = \begin{cases} \frac{I_s^d - \min(I_s^d)}{\max(I_s^d) - \min(I_s^d)}, & \text{if the indicator is positive} \\ \frac{\max(I_s^d) - I_s^d}{\max(I_s^d) - \min(I_s^d)}, & \text{if the indicator is negative} \end{cases}$$

Thus, $\mathcal{N}(I_s^d)$ is the normalized vector I_s^d, composed of elements of the type $\mathcal{N}_j(I_{s,j}^d)$, where the index j generically represents the sector or region for which the indicator is calculated.

With the normalized indicators, the measures represented by each of them are comparable. Now we can create a weighting system to calculate a weighted score, which is the central point of hierarchical analysis. First, we consider the weights for each of the five dimensions and then for the sub-dimensions. The weight vectors for the dimensions and sub-dimensions are defined as follows:

For the dimensions:

$$\mathbf{W} = (W_1, W_2, W_3, W_4, W_5) \quad \text{with} \quad \sum_{d=1}^{5} W_d = 1$$

where:

- W_d is the weight of dimension d.

For the sub-dimensions within each dimension d, denoted by s:

$$\mathbf{w}_d = (w_{d,1}, w_{d,2}, \ldots, w_{d,S_d}) \quad \text{with} \quad \sum_{s=1}^{S_d} w_{d,s} = 1$$

where:

- $w_{d,s}$ is the weight of sub-dimension s within dimension d,
- S_d is the number of sub-dimensions in dimension d.

Therefore, $\mathbf{W}$ is a weight vector that assigns importance to each dimension d, and $\mathbf{w}_d$ are specific weight vectors for each sub-dimension within dimension d.

The weighted score is calculated as follows:

$$SCORE = \sum_{d=1}^{5} W_d \cdot \sum_{s=1}^{S_d} w_{d,s} \cdot \mathcal{N}(I_s^d)$$

The score for dimension d is calculated as the weighted sum of normalized indicators $\mathcal{N}(I_s^d)$, where s ranges from 1 to S_d. This is weighted by the weight vector $\mathbf{w}_d$, which assigns relative importance to each sub-dimension within dimension d:

$$SCORE^d = \sum_{s=1}^{S_d} w_{d,s} \cdot \mathcal{N}(I_s^d)$$

This calculation represents how the indicators of each sub-dimension are aggregated to form a single score that reflects the relative importance of sub-dimensions within dimension d. Note that $SCORE$ and $SCORE^d$ are also vectors, whose elements are $SCORE_j$ and $SCORE_j^d$, respectively. Thus, we can create a regional (or sectoral) ranking by simply ordering the score values for each of the j regions (or sectors).

Our tool allows the user to choose the weights for each dimension and sub-dimension, thus generating rankings of sectors and regions that contribute most to achieving the policymaker's objectives. Next, we will present two examples of applying the tool to prioritize dimensions.

4.4 Example 1: Equal Weights

This example is the case where the policymaker assigns equal importance to each subdimension and similarly assigns equal importance among the 5 dimensions.

Hierarchy of importance in the economic development of Portugal

	Dimensions	*Weight*
1	Economic effects in the present	0,200
2	Future competitiveness	0,200
3	Reduce social inequality	0,200
4	Reduce regional inequality	0,200
5	Decarbonization of the economy	0,200
	Total	1,000

	Subdimensions	*Weight*
	Dimension 1: Economic effects in the present	
1	GVP (%) Portugal	0,167
2	VA (%) Portugal	0,167
3	Revenue (%)	0,167
4	Output multiplier	0,167
5	VA generator	0,167
6	Revenue generator	0,167
	Total	1,000
	Dimension 2: Future competitiveness	
1	Increase the comparative advantage of Portugal internationally	0,250
2	Increase the trade balance with other Portuguese regions and the world	0,250
3	Increase the participation of higher education in the workforce	0,250
4	Increase the participation of technical-scientific occupations	0,250
	Total	1,000
	Dimension 3: Reduce social inequality	
1	Generate additional jobs in the region as a whole	0,200
2	Decrease wage inequality (GINI)	0,200
3	Increase the participation of women in the workforce in Portugal	0,200
4	Increase the participation of immigrant workers	0,200
5	Increase opportunities for young people in the job market in Portugal	0,200
	Total	1,000
	Dimension 4: Reduce regional inequality	
1	Reduce the participation of Lisbon and Porto in Portugal's GDP	0,500
2	Reduce regional inequality in Portugal (Williamson coefficient)	0,500
	Total	1,000
	Dimension 5: Decarbonization of the economy	
1	Reduce CO2 emissions in Portugal	0,250
2	Reduce oil product sales in Portugal	0,250
3	Reduce the CO2 emission intensity per unit of value added generated in Portugal	0,250
4	Reduce the oil product sales per unit of value added generated in Portugal	0,250
	Total	1,000

Figure 4: Weighting structure with equivalent distribution of weights among subdimensions and also among dimensions.

Ranking	*Region*	*Score*	*Present*	*Future*	*Social*	*Regional*	*Environmental*	*Value added (mi. €)*	*Value added (%)*
1	Norte	0,654	0,511	0,836	0,611	0,496	0,815	49.929	29,4%
2	Centro	0,623	0,465	0,561	0,516	0,936	0,638	31.895	18,8%
3	Área Metropolitana de Lisboa	0,614	0,878	0,967	0,481	0,000	0,742	60.955	35,9%
4	Algarve	0,561	0,228	0,175	0,713	0,747	0,943	7.989	4,7%
5	Região Autónoma da Madeira	0,509	0,302	0,247	0,319	0,891	0,789	4.183	2,5%
6	Região Autónoma dos Açores	0,496	0,226	0,253	0,537	0,995	0,467	3.563	2,1%
7	Alentejo	0,326	0,204	0,115	0,436	0,875	0,000	11.129	6,6%

Figure 5: Ranking of regions according to the Final Score, which is the weighted average of the scores of each dimension. However, it can be seen that at the dimension level, the order is not always the same.

Ranking	Sector	Score	Present	Future	Social	Regional	Environmental	Value added (mi. €)	Value added (%)
1	Employment Services	0,619	0,281	0,325	0,723	0,767	0,997	1.512	0,9%
2	Financial Services	0,566	0,595	0,294	0,368	0,580	0,992	6.351	3,7%
3	IT Services	0,559	0,345	0,570	0,415	0,478	0,985	2.488	1,5%
4	Legal/Accounting/Consultancy	0,555	0,425	0,457	0,427	0,484	0,980	3.432	2,0%
5	Wholesale Trade (no vehicles/motorcycles)	0,553	0,670	0,391	0,357	0,393	0,955	11.989	7,1%
6	Security/Administrative Services	0,537	0,379	0,300	0,506	0,518	0,981	3.683	2,2%
7	Accommodation/Food Services	0,537	0,591	0,135	0,523	0,472	0,963	10.030	5,9%
8	Telecommunications	0,534	0,356	0,413	0,456	0,462	0,982	2.454	1,4%
9	Other Professional/Technical Services	0,526	0,306	0,470	0,469	0,408	0,977	583	0,3%
10	Membership Organisations	0,524	0,456	0,361	0,410	0,429	0,962	736	0,4%
11	Retail Trade (no vehicles/motorcycles)	0,522	0,551	0,225	0,499	0,380	0,957	9.009	5,3%
12	Health Services	0,521	0,709	0,180	0,428	0,306	0,980	7.897	4,7%
13	Architectural/Engineering Services	0,520	0,335	0,521	0,351	0,418	0,977	1.307	0,8%
14	Research and Development	0,512	0,309	0,415	0,434	0,418	0,984	550	0,3%
15	Textile/Leather Manufacturing	0,508	0,392	0,544	0,443	0,212	0,947	4.186	2,5%

Figure 6: Weighting importance across dimensions equally

With this weighting configuration, the AML region stands out with the highest aggregate score, primarily driven by the "Present" and "Future" dimensions. Following this is the Algarve region, which excels mainly in the Social, Regional, and Environmental dimensions. However, there is a significant GDP disparity between these two leading regions. The key takeaway from this ranking is the distribution of strengths and weaknesses of each region, given the importance values assigned to each dimension and sub-dimension. This reveals how the current economic structure favors certain processes, such as job creation, CO_2 emissions generation, and wage inequality reduction, with an increase in demand through private or governmental investments or household consumption. Regarding the sectoral ranking, the interpretation is analogous to that of the regions. The sectors are ordered by their aggregate score, but with different rankings across the various dimensions and distinct contributions to GDP. This shows how each sector favors certain processes and how relevant they are in the economy. These data are highly valuable for a policymaker aiming to strengthen a specific dimension in a given region. For example, identifying economically significant sectors that can generate fewer environmental impacts and could be developed in Alentejo or leveraging Algarve's advantage in the environmental dimension to further strengthen the Accommodation/Food services sector, which has a significant relevance in the country (5,9%).

4.5 Example 2: Weighting focused on social and environmental dimensions

This example illustrates a case where the policymaker is equally concerned only with the social and environmental dimensions. Equal importance is assigned to the respective sub-dimensions.

Hierarchy of importance in the economic development of Portugal	
Dimensions	**Weight**
1 Economic effects in the present	0,000
2 Future competitiveness	0,000
3 Reduce social inequality	0,500
4 Reduce regional inequality	0,000
5 Decarbonization of the economy	0,500
Total	1,000
Subdimensions	**Weight**
Dimension 1: Economic effects in the present	
1 GVP (%) Portugal	0,167
2 VA (%) Portugal	0,167
3 Revenue (%)	0,167
4 Output multiplier	0,167
5 VA generator	0,167
6 Revenue generator	0,167
Total	1,000
Dimension 2: Future competitiveness	
1 Increase the comparative advantage of Portugal internationally	0,250
2 Increase the trade balance with other Portuguese regions and the world	0,250
3 Increase the participation of higher education in the workforce	0,250
4 Increase the participation of technical-scientific occupations	0,250
Total	1,000
Dimension 3: Reduce social inequality	
1 Generate additional jobs in the region as a whole	0,200
2 Decrease wage inequality (GINI)	0,200
3 Increase the participation of women in the workforce in Portugal	0,200
4 Increase the participation of immigrant workers	0,200
5 Increase opportunities for young people in the job market in Portugal	0,200
Total	1,000
Dimension 4: Reduce regional inequality	
1 Reduce the participation of Lisbon and Porto in Portugal's GDP	0,500
2 Reduce regional inequality in Portugal (Williamson coefficient)	0,500
Total	1,000
Dimension 5: Decarbonization of the economy	
1 Reduce CO2 emissions in Portugal	0,250
2 Reduce oil product sales in Portugal	0,250
3 Reduce the CO2 emission intensity per unit of value added generated in Portugal	0,250
4 Reduce the oil product sales per unit of value added generated in Portugal	0,250
Total	1,000

Figure 7: Weighting importance across dimensions equally

Ranking	*Region*	*Score*	*Present*	*Future*	*Social*	*Regional*	*Environmental*	*Value added (mi. €)*	*Value added (%)*
1	Algarve	0,828	0,228	0,175	0,713	0,747	0,943	7.989	4,7%
2	Norte	0,713	0,511	0,836	0,611	0,496	0,815	49.929	29,4%
3	Área Metropolitana de Lisboa	0,611	0,878	0,967	0,481	0,000	0,742	60.955	35,9%
4	Centro	0,577	0,465	0,561	0,516	0,936	0,638	31.895	18,8%
5	Região Autónoma da Madeira	0,554	0,302	0,247	0,319	0,891	0,789	4.183	2,5%
6	Região Autónoma dos Açores	0,502	0,226	0,253	0,537	0,995	0,467	3.563	2,1%
7	Alentejo	0,218	0,204	0,115	0,436	0,875	0,000	11.129	6,6%

Figure 8: Weighting importance across dimensions equally

Ranking	Sector	Score	Present	Future	Social	Regional	Environmental	Value added (mi. €)	Value added (%)
1	Employment Services	0,860	0,281	0,325	0,723	0,767	0,997	1.512	0,9%
2	Household Services	0,777	0,262	0,128	0,747	0,435	0,808	1.114	0,7%
3	Personal Services	0,753	0,309	0,135	0,534	0,438	0,972	1.341	0,8%
4	Security/Administrative Services	0,744	0,379	0,300	0,506	0,518	0,981	3.683	2,2%
5	Accommodation/Food Services	0,743	0,591	0,135	0,523	0,472	0,963	10.030	5,9%
6	Residential/Social Care	0,729	0,456	0,232	0,490	0,384	0,968	3.008	1,8%
7	Retail Trade (no vehicles/motorcycles)	0,728	0,551	0,225	0,499	0,380	0,957	9.009	5,3%
8	Other Professional/Technical Services	0,723	0,306	0,470	0,469	0,408	0,977	583	0,3%
9	Telecommunications	0,719	0,356	0,413	0,456	0,462	0,982	2.454	1,4%
10	Computer/Electronic Products	0,714	0,232	0,387	0,453	0,357	0,974	504	0,3%
11	Research and Development	0,709	0,309	0,415	0,434	0,418	0,984	550	0,3%
12	Health Services	0,704	0,709	0,180	0,428	0,306	0,980	7.897	4,7%
13	Legal/Accounting/Consultancy	0,704	0,425	0,457	0,427	0,484	0,980	3.432	2,0%
14	IT Services	0,700	0,345	0,570	0,415	0,478	0,985	2.488	1,5%
15	Postal/Courier Services	0,699	0,351	0,201	0,425	0,440	0,972	486	0,3%

Figure 9: Weighting importance across dimensions equally

We see that this new weight configuration places the Algarve in the first place in the ranking. This means that a policymaker who cares more about social and environmental issues should consider the Algarve as a potential region for investment. Note that at no point are we considering the potential return on investment or any other financial metrics of investment analysis. We reiterate that this tool only presents the strengths and weaknesses of the regions and sectors in the considered dimensions and serves to indicate which sectors and regions meet the requirements of investors and policymakers.

4.6 Highlights by Dimension

To make our exercise more comprehensive, we will analyze by assigning all the weight to just one dimension and zeroing out the others. We will do this for each dimension. The results will be presented through graphs and maps (figures 10 and 11, respectively) showing the scores of the main sectors and regions for each dimension.

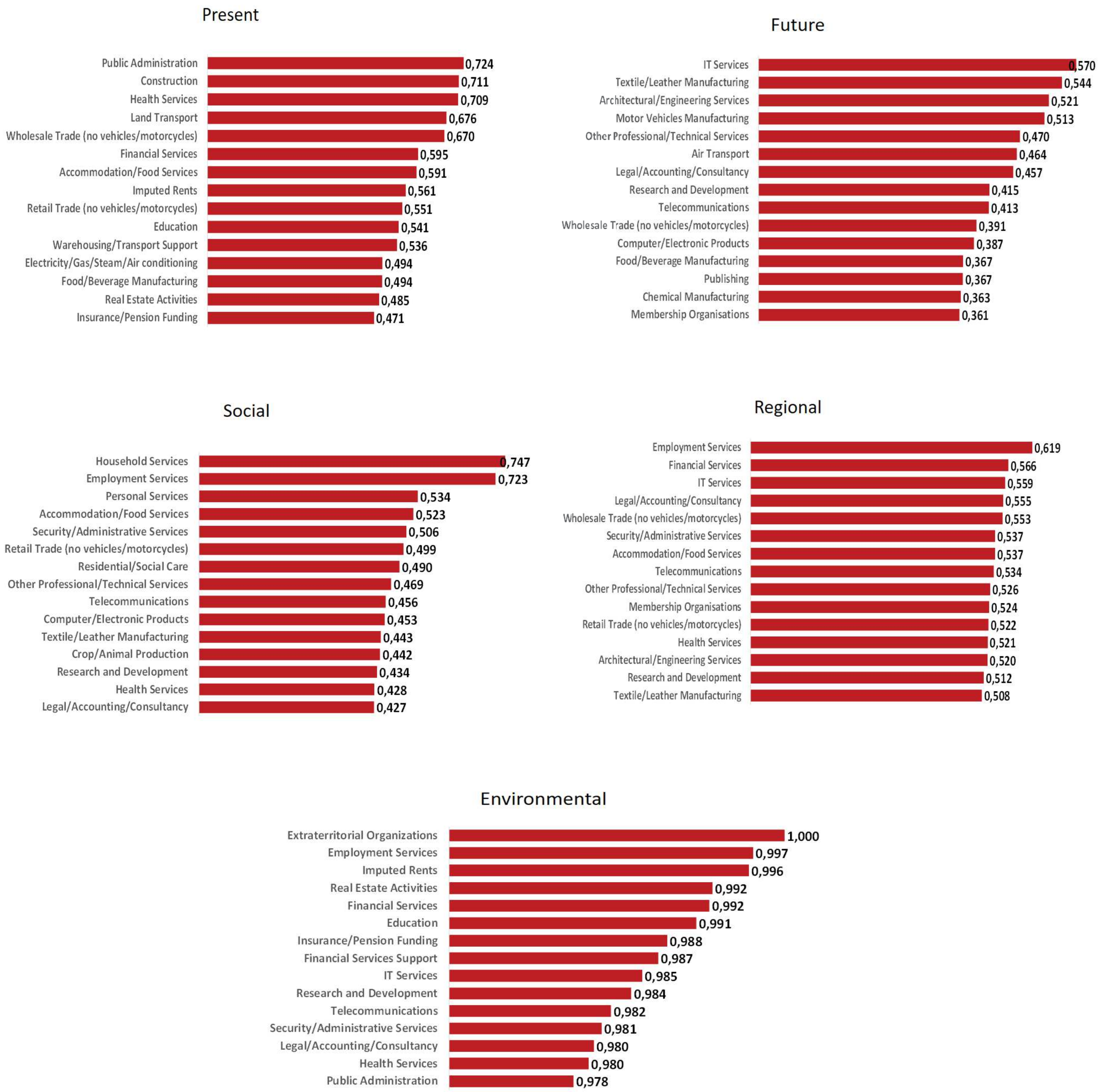


Figure 10: Sectoral strengths at the five dimensions of analysis.

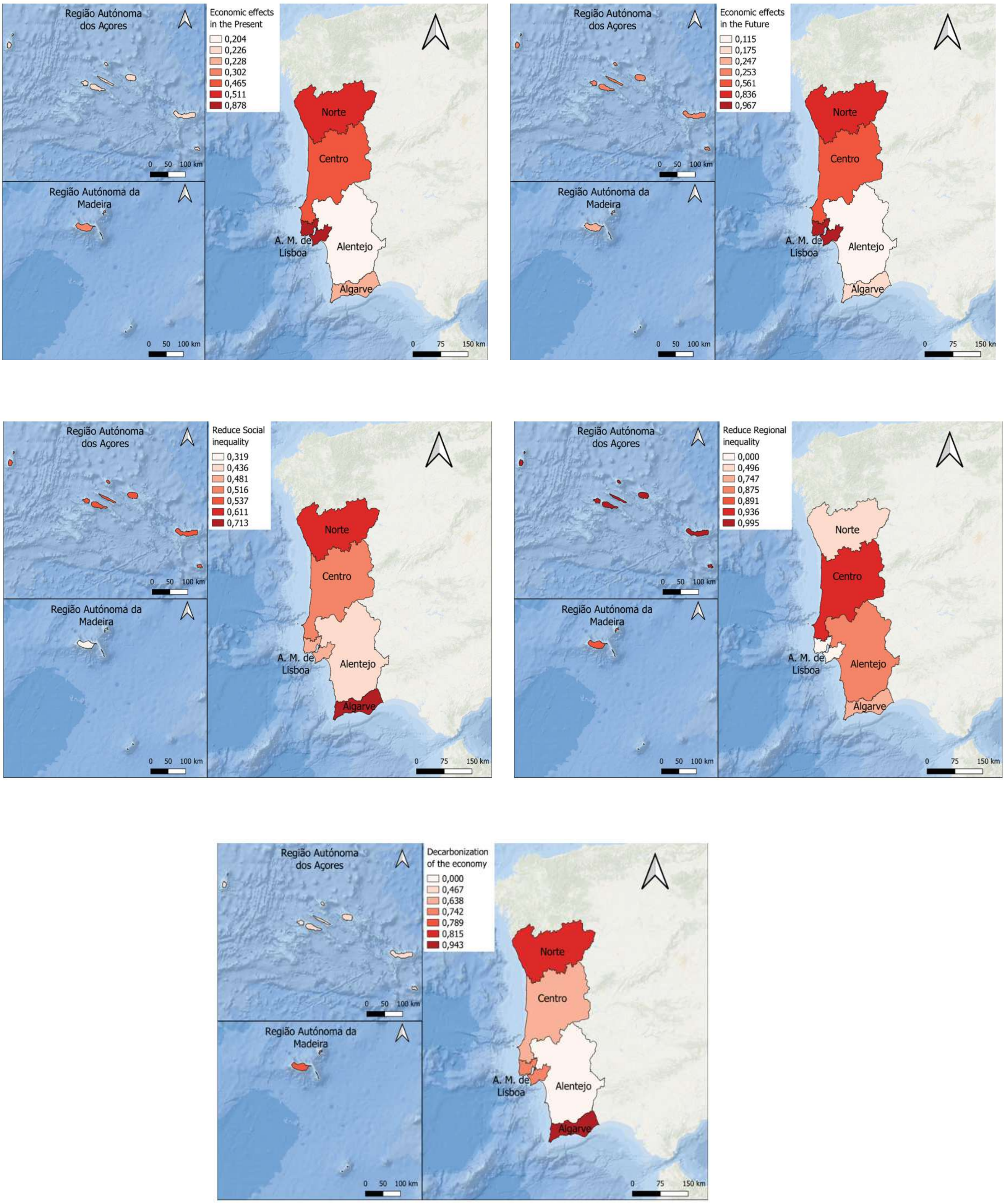


Figure 11: Regional strengths at the five dimensions of analysis.

5 Consolidated Analysis

To have a holistic view of the analysis, we consolidated all five dimensions into qualitative charts. These charts are displayed in Figures 12 to 16, with one for the regional analysis and the others for sectors, which were split into four figures to preserve the readability of the graphs. It makes it easier to identify strengths and weaknesses of sectors or regions and compare the results to the strategy that policymakers wishes to follow in their economic development proposal.

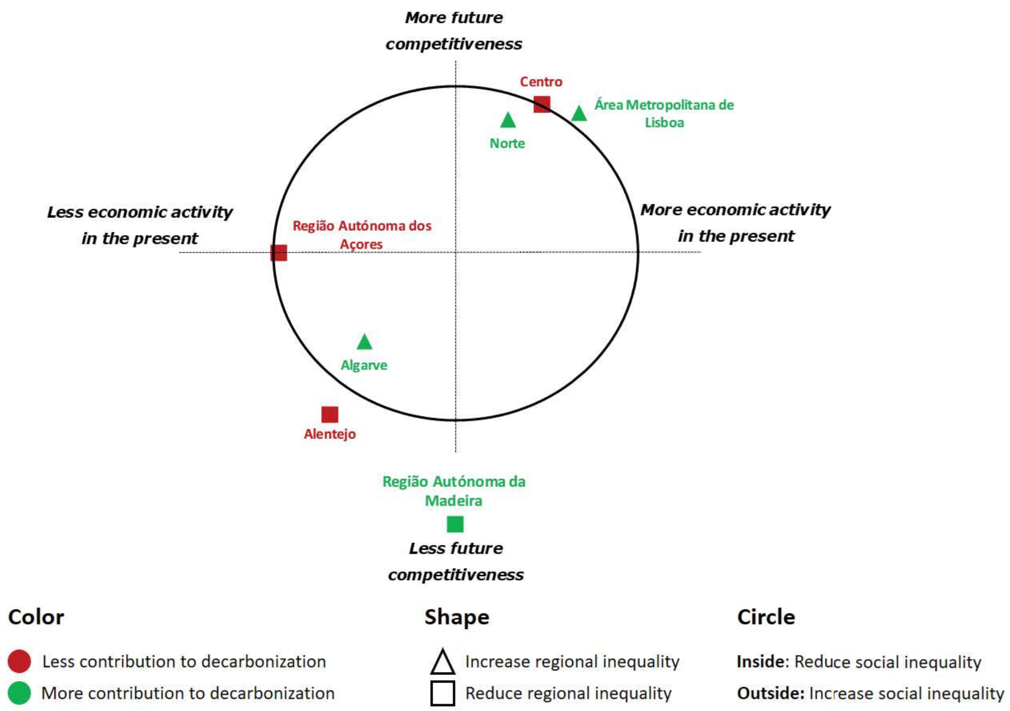


Figure 12: Regional Synthesis.

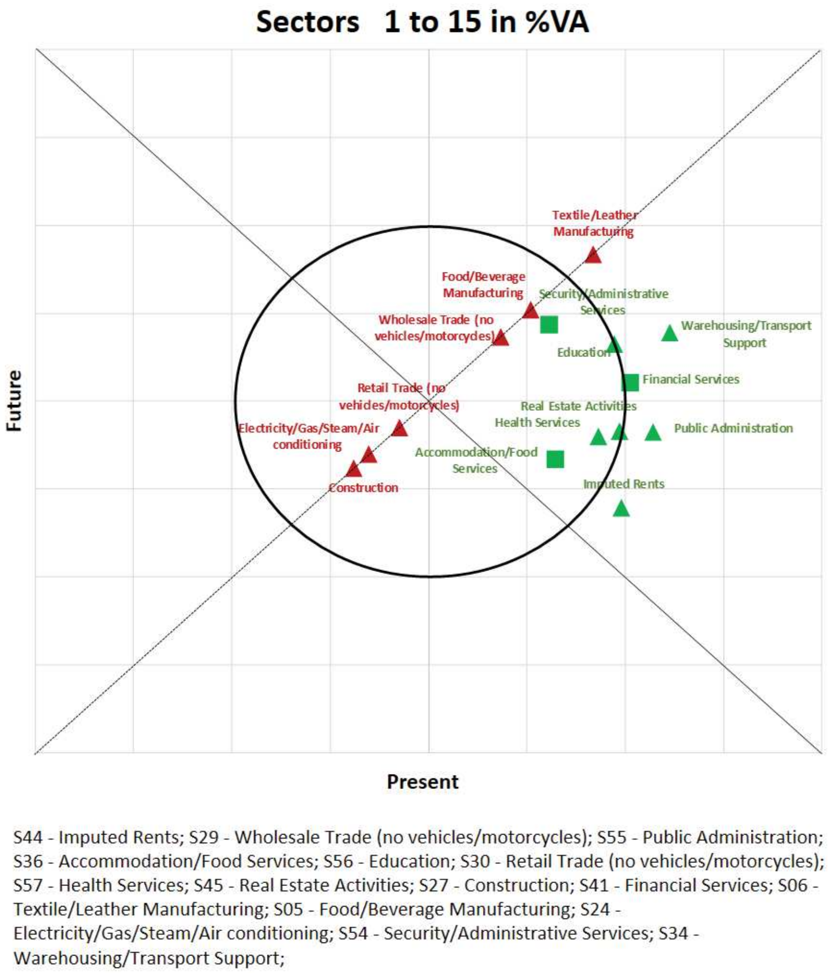


Figure 13: Sectoral Synthesis - Sectors 1 to 15.

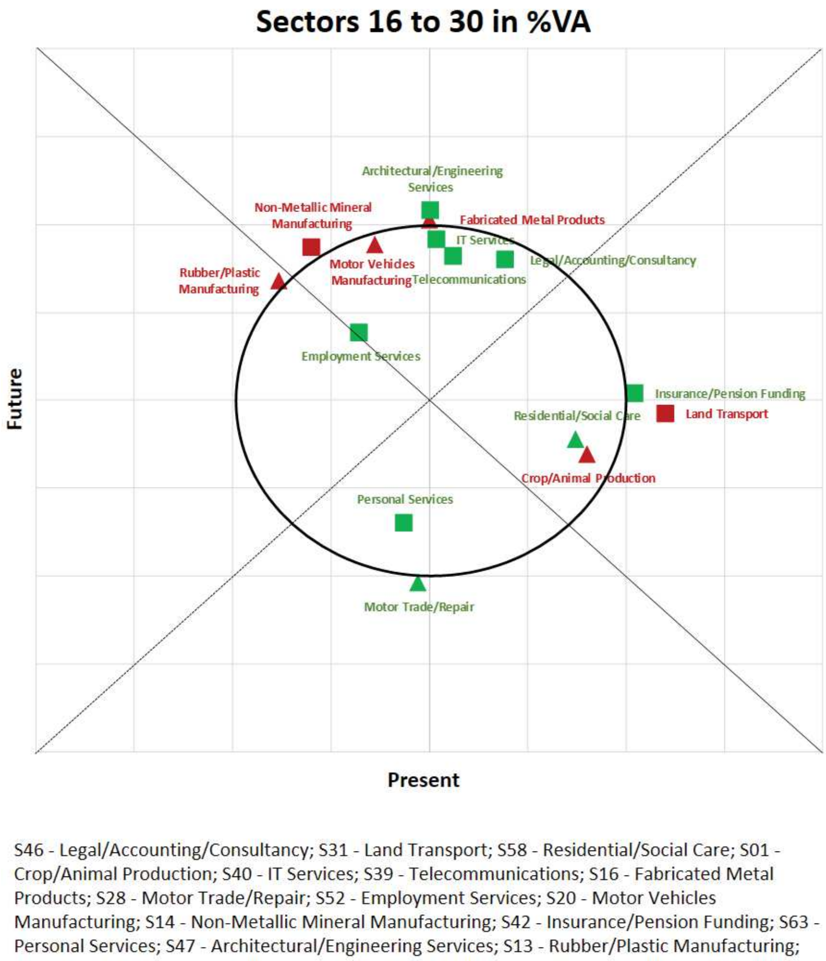
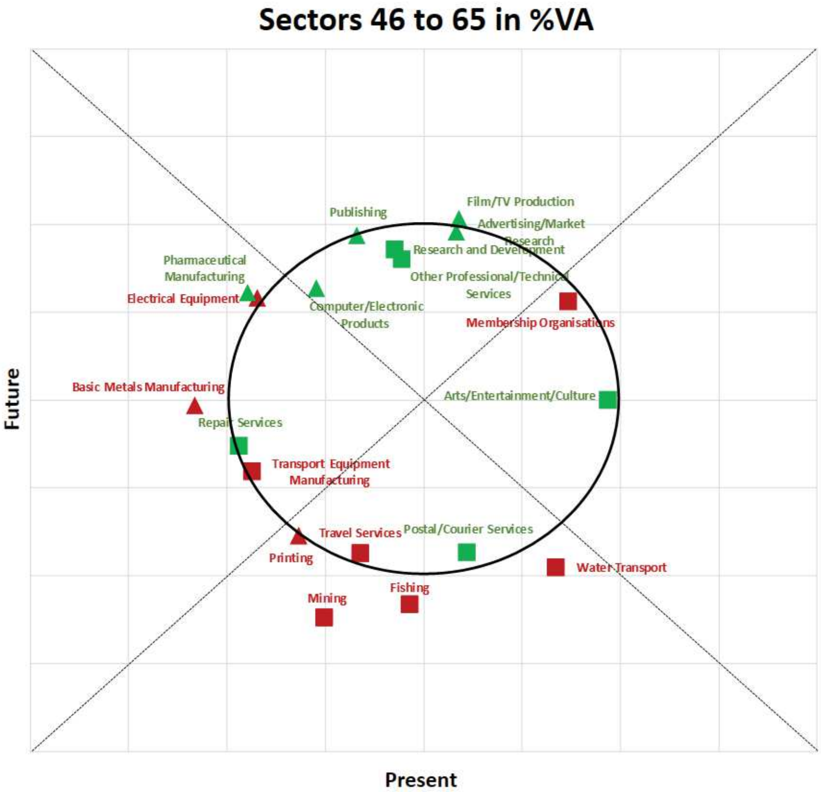
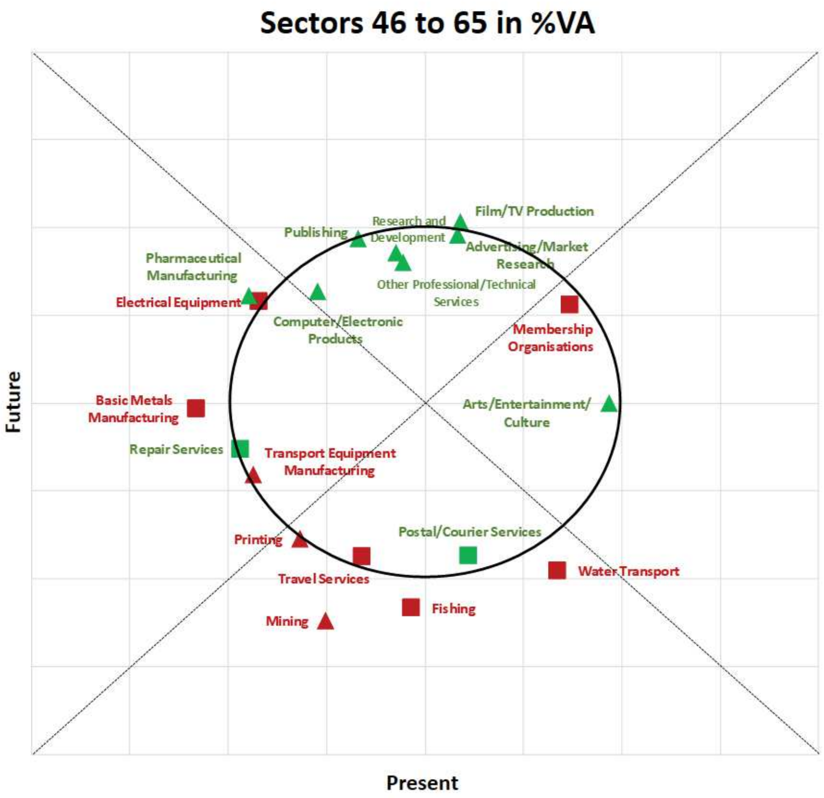


Figure 14: Sectoral Synthesis - Sectors 16 to 30.



S59 - Arts/Entertainment/Culture; S61 - Membership Organizations; S18 - Electrical Equipment; S38 - Film/TV Production; S04 - Mining; S12 - Pharmaceutical Manufacturing; S50 - Other Professional/Technical Services; S48 - Research and Development; S17 - Computer/Electronic Products; S49 - Advertising/Market Research; S35 - Postal/Courier Services; S15 - Basic Metals Manufacturing; S09 - Printing; S37 - Publishing; S53 - Travel Services; S03 - Fishing; S62 - Repair Services; S21 - Transport Equipment Manufacturing; S32 - Water Transport; S65 - Extraterritorial Organizations;

Figure 15: Sectoral Synthesis - Sectors 31 to 45.



S59 - Arts/Entertainment/Culture; S61 - Membership Organizations; S18 - Electrical Equipment; S38 - Film/TV Production; S04 - Mining; S12 - Pharmaceutical Manufacturing; S50 - Other Professional/Technical Services; S48 - Research and Development; S17 - Computer/Electronic Products; S49 - Advertising/Market Research; S35 - Postal/Courier Services; S15 - Basic Metals Manufacturing; S09 - Printing; S37 - Publishing; S53 - Travel Services; S03 - Fishing; S62 - Repair Services; S21 - Transport Equipment Manufacturing; S32 - Water Transport; S65 - Extraterritorial Organizations;

Figure 16: Sectoral Synthesis - Sectors 46 to 65.

The graphics can be read as follows:

- Colors indicate contribution to the environment: sectors or regions in red generate relatively more emissions and those in green generate fewer emissions. So the green ones are those which could help to achieve the objective of the decarbonization of the economy;
- Shapes show relative contributions to regional inequality: regions or sectors identified with triangles are those which contribute to increase regional inequality. If the region or sector is marked with a square, then it contributes to reduce region inequality;
- The central circle represents the relative strength of social inequality: the distance from the origin indicates how severe the social inequality is in a region or sector. Thus, those inside the circle contribute to the reduction of social inequality and the ones outside the circle contribute to the increase;
- The vertical and horizontal axis concerns the ratio of present situation and future competitiveness. This means that a region that is relatively better index in the present than it is for the future, such as AML, is located more at the right. The

Basic Metals Manufacturing, in the other hand, has a relatively worse present index and thus is located at the left. A region or sector with a relatively better ration for future competitiveness, such as Architectural/Engineering Services, are located more at the top.

Some sectors are relatively good in all indexes, such as Education, Real State Activities and Telecommunication. Others are relatively bad in all aspects, such as Water Collection and Basic Metals Manufacturing. It is interesting to observe that the largest sectors in terms of value added are overall good in the present and future competitiveness, as it can be seen in the top left panel in Figure 13, which shows the fifteen largest sectors in VA. There is also many sectors with good indices. For example, if the policymaker wishes to increase future competitiveness, decrease regional inequality and decarbonize the economy, sectors such as Architectural/Engineering Services, Film and TV Making and Publishing could help to achieve these goals.

6 Conclusion

We presented an analysis using indicators that represent economic processes with respect to social, regional and environmental issues, primarily constructed using input-output analysis techniques. We have categorized the indicators into sets representing five dimensions that outline the choices a policymaker must make to achieve their economic development goals. We have developed a tool that allows policymakers to assign weights to these dimensions based on their importance and the desired development strategy. The results are sectoral and regional rankings that highlight the sectors and regions most effective in achieving specific goals, serving as a guide for creating investment or incentive policies aimed at strengthening certain characteristics in the regional economy, such as reducing social inequalities and decarbonizing the economy. Additionally, we generate visualizations that provide a holistic understanding of the role each sector or region plays in pursuing sustainable and socially fair development. It is important to note that our analysis does not make judgments regarding potential financial returns but offers a comprehensive view of fundamental aspects crucial for determining the direction of economic development, especially in an era where we need to rethink investments to favor a more inclusive and low-carbon economy. Therefore, we consider it a fundamental complementary tool in the development of investment strategies.

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