Multidimensional Analysis of the Sea Economy: A Case Study for the Autonomous Region of Madeira, Portugal

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The measurement of the contribution of natural resources to any economy is a necessary condition for recognizing their importance and ensuring their correct preservation by individuals. In this context, the concept of Blue Economy was created to define sectors and cross-sectoral activities related to oceans, seas, and coastal areas (Ecorys, 2012). Viewed as a sector, the sea was responsible for 4.5 million jobs and 177 billion euros for the European economy in 2018 (Commission, 2014). In the case of an island economy, the relevance of the maritime sector is even greater due to geographic isolation, reduced territorial extension, and limited economic diversification possibilities (Vrontisi et al., 2022). Specifically, the Autonomous Region of Madeira (RAM), composed of Madeira Island and Porto Santo Island, is highly dependent on the sea for tourism, transportation, and fishing activities. The dimension of the blue economy for RAM was estimated by the National Institute of Statistics (INE) through the Satellite Account for the Sea (SAS); however, it is convenient to also evaluate the direct and indirect effects through its linkages in the Portuguese supply chain.

This study aims to define the systemic contribution of RAM's blue economy by integrating the SAS with an interregional input-output table (IIOT) and performing a hypothetical extraction of the sector. Thus, it is possible to measure the importance of Madeira's maritime economy regionally and cross-sectorally in terms of value-added, employment (in level and composition), and also CO_2 emissions.

The maritime economy has been the subject of distinct studies focused on measuring its importance for the economy of a given region or country, especially in the context of island economies. In this regard, Ram et al., 2019 produce the satellite account for the sea for Jamaica, focusing on fishing industries, coastal tourism, and maritime transport. The authors estimate that the blue economy represents 6.9% of the Jamaican economy's value-added and point to its ability to drive local development. Fernández-Macho et al., 2015 estimate that the contribution of the maritime economy in the Spanish part of the Atlantic Arc is 0.67% of Spain's economy, representing 1.1% of employment. Other studies also quantify the blue economy as representing around 1% of the Irish economy (Morrissey et al., 2011) and 4% for the Chinese (Zhao et al., 2014).

Since the concept of the blue economy is not unique, its measurement can vary depending on the definition employed, which is criticized by (Graziano et al., 2022). The work analyzes the size of the blue economy from the perspective of five different definitions for Scotland (UK) and Michigan (USA). According to the author, the greatest divergence between definitions concerns the inclusion of activities related to the exploration of natural resources from the sea. Their research indicates that the blue economy can vary from 2 to 11% of the workforce in Michigan in 2018, while the product varies from 9 to 71 billion dollars annually depending on the concept used in the measurement. For Scotland, the product varies from 3 to 24 billion pounds, with an even greater difference.

Differing from these researches, we intend to account for the systemic effects of the blue economy by making a hypothetical extraction, which means to exclude the proportion of the sea's uses in each related sector and consequently reduce the intermediate consumption from the others. Applying these new values under the input-output model gives us systemic estimates for employment composition, value-added and CO_2 emissions, as well as identifying the changes by sector and region.

However, despite its wide set of data, the SAS does not have the more disaggregated level of values for maritime production in public domain, but presents the aggregate value for six groups, composed of activities that totally, partially or residually contribute to the blue economy. To use this data, we establish a novel approach to integrate the SAS with IIOT, which is to distribute the values of the satellite account based on proxies as we would do if all possible information were available. Taking the data of production from INE to each activity and considering the distribution of the proportion of the blue economy in each US industry, we can approximately identify the use of sea by subclass and finally aggregate it into 65 sectors.

These are the same sectors presented in the IIOS for the seven NUTS-2 regions of Portugal. The values we obtain are combined into a vector, which when its inverse is multiplied by the rows and columns of the RAM in the IOM extract partially the selected sectors. Therefore, this procedure extracted the whole blue sector of RAM in the Portuguese economy but did not identify the indirect effects it has on the supply chain. To do so, it is required to calculate a new Technical Coefficient Matrix, a new Leontief Inverse Matrix, and, along with the coefficients, new outcome vectors for the interested dimensions, which are value-added, employment composition, and CO_2 emissions.

Through this process, it can be preliminarily estimated that the blue economy from the Autonomous Region of Madeira accounts directly and indirectly for approximately 750 million euros in terms of value-added, corresponding to 0.37% of the Portuguese economy. These values take into account both direct and indirect effects. The maritime economy of Madeira is still responsible for 22,780 jobs and the emission of 184 tons of CO_2, representing 0.47% and 0.37% of Portugal as a whole, respectively.

The impact of the blue economy on RAM itself is 16% of the value-added, highlighting the significance of maritime activities for the island economy. Regarding the interregional effects, the Autonomous Region of the Azores is the most affected, relatively, by the Madeiran blue economy, with 0.11% of the value-added, followed closely by the Autonomous Region of Lisbon with 0.08% of the added value. These results emphasize the greater interdependence between the Portuguese islands and among the Madeiran region and Lisboa.

The variation in employment due to the extraction of the maritime economy from the island of Madeira can also be broken down by gender. Men are more affected by Madeira's blue economy in all regions; however, it can be said that it is also important for ensuring employment for women. Almost 50% of the total effect relates to women's employment, mainly in the RAM itself. This result suggests that the Madeiran blue economy has relevance in promoting jobs with greater gender equality.

Regarding the breakdown of the effect by age groups, there is a higher proportion for the employment of adults and seniors, but there is also a high proportion of young people employed by the blue economy in the region itself. Almost 50% of the direct and indirect jobs linked to the sea are for young people aged 15 to 24. This result deserves attention as it demonstrates the capacity of the blue economy to contribute to regional development by retaining young people in the RAM and thus mitigating the effects of demographic transition in the region.

As expected, the sectors most impacted by the extraction are those with activities related to the sea and tourism. Notably, the 'fishing and aquaculture', 'water transport', 'accommodations and food services', and 'travel agencies' stand out, accounting for 7%, 9.5%, 3.16%, and 4.87%, respectively. Other sectors worth mentioning include 'storage and support activities for transportation', as well as 'rental and leasing activities', emphasizing the significance of support activities compared to those directly connected to the sea.

The present work is still in progress, and the intention is to enhance the integration of the SAS into the input-output matrix through access to production and employment microdata in Portugal. With more information, it will be possible to refine the application of weights to activities partially included in the satellite account for the sea. Additionally, indicators will be constructed regarding CO_2 emissions relative to cross-sectoral and cross-regional value-added with the aim of assessing the contribution of the blue economy to low-carbon development.

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