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RESEARCH PAPER

SHADES OF BLUE:

The Geography of the Atlantic Ocean Economy in Brazil

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This study quantifies the contributions of Brazil's blue economy and explores the economic interdependence between coastal and hinterland regions through interregional linkages. Employing a multi-level approach, we analyze municipality and state-level data on ocean-related activities. Using an interstate input-output model, we estimate the value chains of the blue economy, offering a deeper understanding of its systemic impacts. This study addresses gaps in national, regional, and local assessments, providing insights for more tailored policy interventions across Brazil's diverse coastal regions. As Brazil works towards achieving UN Sustainable Development Goal 14 by 2030, our analysis underscores the structural diversity and regional disparities within the blue economy. We advocate for the coordination of sector and region-specific policies, emphasizing the importance of an integrated regional approach. Such an approach recognizes the interconnectedness of coastal economies, addressing shared challenges and leveraging regional strengths for sustainable development.

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I. INTRODUCTION

The "blue economy" has been receiving growing attention from policymakers and researchers alike. Broadly defined, the blue economy refers to the sustainable use of ocean resources to drive economic growth, improve livelihoods, and promote environmental sustainability. It encompasses a wide range of sectors, including fisheries, aquaculture, tourism, shipping, renewable and non-renewable energy, and marine biotechnology.[1]

In recent years, there has been growing interest in quantifying the economic contribution of the blue economy, leading to a new body of research. Early efforts have provided opportunities to test and refine various methodologies within national accounting frameworks, aiming to measure the contribution of individual blue economy sectors to domestic economic activity. The development of Sea Satellite Accounts, integrated into national Systems of National Accounts (SNA) (Ram *et al.*, 2019; Statistics Portugal, 2016; Nicolls *et al.*, 2020), represents a significant step toward the standardization and harmonization of accounting principles, methods, and classifications across different countries. This process is crucial for ensuring consistency, comparability, and accuracy in blue economy statistics.

However, existing efforts to isolate the contribution of the blue economy to a country or region have employed various methodological approaches, with examples from Ireland (Morrissey *et al.*, 2011), China (Zhao *et al.*, 2014), USA (Kildow *et al.*, 2014), Spain (Fernández-Macho, 2015), Portugal (Statistics Portugal, 2016), Finland (Katila *et al.*, 2019), Jamaica (Ram *et al.*, 2019), EU (European Commission, 2021), Philippines (Philippine Statistics Authority, 2022), and Poland (Kwiatkowski and Zaucha, 2023), among others. The absence of fully standardized and harmonized practices still limits the comprehensive comparability of the results (Graziano *et al.*, 2022). Despite this limitation, efforts to estimate contributions of the blue economy to national economies have produced a range of figures highlighting its share in GDP for various countries: Ireland (1% of GDP in 2007), China (4.03% in 2010), USA (1.9% in 2021), Portugal (3.1%, on average, in the period 2010-2013), Jamaica (6.9% in 2017), EU (1.5% in 2018), and Poland (0.97% in 2017).

In Brazil, Carvalho (2018) and Carvalho and Moraes (2021) made the first attempt to quantify the blue economy from a sectoral perspective. Based on their estimates, which isolated marine sectors within a national input-output table, Brazil's marine economies[2] contributed 2.6% of the national GDP in 2015. The authors also expanded their analysis to include the broader coastal economy, defined by the total Gross Regional Product (GRP) of all other non-marine activities in municipalities along the coast. Altogether, the marine and coastal economies contributed 19% to national GDP that year. However, from a regional policy perspective, the aggregate nature of these estimates limits their usefulness in designing blue economy strategies tailored to the specific needs and challenges of economically diverse coastal areas across the country. Understanding local and regional differences is key to implementing more targeted interventions.

Building on the pioneering efforts by Carvalho (2018), we advance the quantification of the blue economy in Brazil by incorporating a geographical perspective. We adopt a multi-level approach, using data at both the municipality and state levels, along with various classifications of economic

1. For conceptual discussions on the blue economy see, for instance, Ecorys (2012), Statistics Portugal (2016), World Bank and United Nations Department of Economic and Social Affairs. (2017), Nicolls *et al.* (2020).

2. The terms blue economy, maritime economy, and ocean/sea economy are used interchangeably.

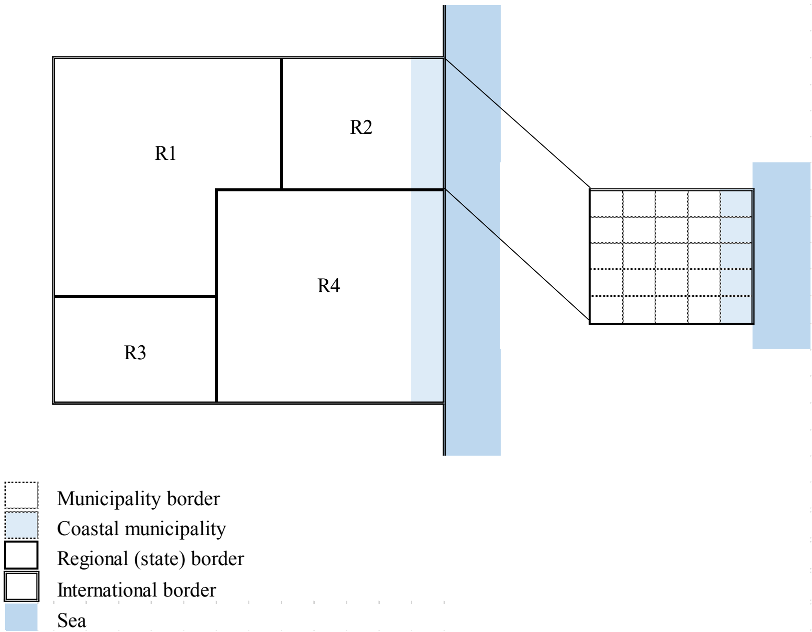
activities. We provide estimates of the size and structure of the blue economy across Brazilian municipalities and states. Additionally, we take a value-chain perspective by estimating the indirect effects of the blue economy at the state level using the partial extraction method applied to an interstate input-output (IIO) model for the country. This approach leverages rich geographical and sectoral data, alongside an IIO table that enables the assessment of the blue economy's systemic effects, incorporating both backward and forward linkages. By measuring how the blue economy impacts other sectors and regions through indirect channels, policymakers gain a deeper understanding of the economy's complexity and interconnectedness. This paper contributes to the existing literature on measuring the blue economy by presenting an alternative systemic approach to quantify its various dimensions in a large country with an extensive coastline and diverse local and regional economies.

II. METHODOLOGY

We consider a country divided into different regions (e.g. states). In our stylized example (Figure 1), the country consists of four regions: R1, R2, R3 and R4. Two are landlocked (R1 and R3), and two are coastal regions (R2 and R4). Each region can be further divided into sub-regions (e.g. municipalities). For instance, R2 is divided into 25 sub-regions, five of which are coastal. Due to data availability, we have more comprehensive information at the regional level than at the sub-regional level. Similarly, we have more detailed data at higher levels of economic activity classification. The challenge is twofold; first, we must define and isolate the contribution of sea-related activities, specified at a lower level of sectoral aggregation, which, in our framework, are located only in coastal, sea-shore adjacent sub-regions. This will enable us to quantify the blue economy's magnitude in each sub-region and region. We define direct activities as those that are either carried out at sea or producing goods used in the sea. Second, as we shift to higher levels of regional and sectoral aggregation, facilitated by the availability of interregional input-output information, we must calculate the blue economy's systemic contribution, estimating its multiplier effects.

Figure 1

Schematic Representation of the Multi-Level Geographical Setting



1. General Framework

- **Regional Setting**

Consider a country divided into R regions, r = 1, ..., R, which collectively encompass the entire national economy. Each region is further subdivided into a finite number of sub-regions, M^r, m^r = 1,..., M^r , for all r = 1, ..., R. The number of sub-regions may vary across regions.

- **Production Setting**

The economy consists of C firms, c = 1, ..., C, distributed across J sectors, j = 1, ..., J. Each firm operates within a production set contained in the sectoral production set Y^j to which it belongs. These firms are spatially distributed across the M^r sub-regions within each of the R regions. Additionally, firms may be classified into sub-sectors within sector j based on their main output characteristics. Thus, within any sector j, there may be Q^j different sub-sectors, $q^j = 1 \ldots, Q^j$, for all j = 1, ..., J. Each firm produces one unit of output, irrespective of its sub-sector or location.

- **Blue Economy Setting**

We consider two key dimensions of the blue economy. The first is the spatial dimension, which involves identifying the subset of sub-regions adjacent to the sea. Let $\breve{M}^r$ represent the subset of coastal sub-regions within r, where $\breve{m}^r$ = 1, ..., $\breve{M}^r$. We assume that activities and products related to the blue economy are located only in coastal areas. Thus, we define $\breve{Q}^j$ as a subset of sub-sectors (located in $\breve{m}^r$), which are directly linked to the presence of the sea, with $\breve{q}^j$ = 1, ..., $\breve{Q}^j$ for all j = 1, ..., J. In summary, the blue economy encompasses activities directly related to the sea ($\breve{q}^j$) that take place within the coastal regions of the country ($\breve{m}^r$).

- **Multi-Level Aggregations**

In each sub-region m^r, a firm related to sub-sector q^j is denoted by $C_{(q^j)}^{(m^r)}$, so that

$$0 \leq C_{(q^j)}^{(m^r)} \ll C \text{ and } \sum_{q^j=1}^{Q^j} \sum_{m^r=1}^{M^r} C_{(q^j)}^{(m^r)} = C.$$

Note that:

(i) $\sum_{m^r=1}^{M^r} C_{(q^j)}^{(m^r)} = C_{(q^j)}^{(\cdot r)}$ defines the total number of firms in sub-sector q^j located in region r, for all q^j = 1, ..., Q^j, j = 1, ..., J, and r = 1, ..., R.

(ii) $\sum_{m^r=1}^{M^r} \sum_{q^j=1}^{Q^j} C_{(q^j)}^{(m^r)} = C_{(\cdot j)}^{(\cdot r)}$ defines the total number of firms in sector j located in region r, for j = 1, ..., J and r = 1, ..., R

(iii) $\sum_{\breve{q}^j=1}^{\breve{Q}^j} C_{(q^j)}^{(\breve{m}^r)} = \breve{C}_{(\cdot j)}^{(\breve{m}^r)}$ defines the total number of firms related to the blue economy in sector j located in coastal sub-region $\breve{m}^r$ in region r, for all j = 1, ..., J, $\breve{m}^r$= 1, ..., $\breve{M}^r$, and r = 1, ..., R.

(iv) $\sum_{\breve{m}^r=1}^{\breve{M}^r} C_{(q^j)}^{(\breve{m}^r)} = \breve{C}_{(q^j)}^{(\cdot r)}$ defines the total number of firms in sub-sector q^j located in coastal sub-region $\breve{m}^r$, for all q^j = 1, ..., Q^j, j = 1, ..., J, and r = 1, ..., R.

(v) $\sum_{\breve{m}^r=1}^{\breve{M}^r} \breve{C}_{(\cdot j)}^{(\breve{m}^r)} = \breve{C}_{(\cdot j)}^{(\cdot r)}$ defines the total number of firms related to the blue economy operating in sector j in region r, for all j = 1, ..., J, and r = 1, ..., R.

Thus, the share of the blue economy in sector j in region r is given by:

$$BLUESH_j^r = \frac{\breve{C}_{(\cdot j)}^{(\cdot r)}}{C_{(\cdot j)}^{(\cdot r)}}, \text{ for all j = 1, ..., J, and r = 1, ..., R}$$

2. Multiplier Effects[3]

We consider an interregional input-output flow-table for a *J*-sector economy with *R* regions (Figure 2). Interregional spillovers through trade are fully accounted for by the explicit specification of interregional trade linkages.

Figure 2

Interregional Input-Output Flows

		Processing sectors							*Final demand*				*Total output*
		11	$\cdots$	rn	$\cdots$	$r1$	$\cdots$	rn					
Processing sectors	11	$\mathbf{Z}_{11}^{11}$	$\cdots$	$\mathbf{Z}_{1n}^{11}$		$\mathbf{Z}_{11}^{1r}$	$\cdots$	$\mathbf{Z}_{1n}^{1r}$	$\mathbf{c}_1^{1\bullet}$	$\mathbf{i}_1^{1\bullet}$	$\mathbf{g}_1^{1\bullet}$	$\mathbf{e}_1^{1\bullet}$	x_1^1
	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\cdots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
	$1n$	$\mathbf{Z}_{n1}^{11}$	$\cdots$	$\mathbf{Z}_{nn}^{11}$		$\mathbf{Z}_{n1}^{1r}$	$\cdots$	$\mathbf{Z}_{nn}^{1r}$	$\mathbf{c}_n^{1\bullet}$	$\mathbf{i}_n^{1\bullet}$	$\mathbf{g}_n^{1\bullet}$	$\mathbf{e}_n^{1\bullet}$	x_n^1
	$\vdots$		$\vdots$		$\ddots$		$\vdots$		$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
	$r1$	$\mathbf{Z}_{11}^{r1}$	$\cdots$	$\mathbf{Z}_{1n}^{r1}$		$\mathbf{Z}_{11}^{rr}$	$\cdots$	$\mathbf{Z}_{1n}^{rr}$	$\mathbf{c}_1^{r\bullet}$	$\mathbf{i}_1^{r\bullet}$	$\mathbf{g}_1^{r\bullet}$	$\mathbf{e}_1^{r\bullet}$	x_1^r
	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\cdots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
	rn	$\mathbf{Z}_{n1}^{r1}$	$\cdots$	$\mathbf{Z}_{nn}^{r1}$		$\mathbf{Z}_{n1}^{rr}$	$\cdots$	$\mathbf{Z}_{nn}^{rr}$	$\mathbf{c}_n^{r\bullet}$	$\mathbf{i}_n^{r\bullet}$	$\mathbf{g}_n^{r\bullet}$	$\mathbf{e}_n^{r\bullet}$	x_n^r
Imports		m_1^1	$\cdots$	m_n^1	$\cdots$	m_1^r	$\cdots$	m_n^r	$m_c^\bullet$	$m_i^\bullet$	$m_g^\bullet$	$m_e^\bullet$	m
Indirect taxes		t_1^1	$\cdots$	t_n^1	$\cdots$	t_1^r	$\cdots$	t_n^r	$t_c^\bullet$	$t_i^\bullet$	$t_g^\bullet$	$t_e^\bullet$	t
Labor payments		l_1^1	$\cdots$	l_n^1	$\cdots$	l_1^r	$\cdots$	l_n^r					l
Other payments		n_1^1	$\cdots$	n_n^1	$\cdots$	n_1^r	$\cdots$	n_n^r					n
Outlays		x_1^1	$\cdots$	x_n^1	$\cdots$	x_1^r	$\cdots$	x_n^r	c	i	g	e	
Employment		L_1^1	$\cdots$	L_n^1	$\cdots$	L_1^r	$\cdots$	L_n^r					L

z_{ij}^{rs}, with *i, j* = 1, ...*J* and *r, s* = 1 ..., *R* represents interindustry sales from industry *i* in region *r* to industry *j* in region *s*

m_i^s and t_i^s with *i* = 1, ..., *n,c,i,g,e* represent, respectively, imports and indirect taxes payments in region *s*

l_j^s and n_j^s, with *j* = 1, ..., *J* and *s* = 1, ...,*R* and represent, respectively, payments by sectors for labor services and for all other value-added items in region *s*

$c_i^{r\bullet}, i_i^{r\bullet}, g_i^{r\bullet}$ and $e_i^{r\bullet}$ with *i* = 1, ...,*J* and *r* = 1, ...,*R* represent the regional components of final demand, $f_i^{r\bullet}$, respectively, household purchases, investment purchases, government purchases,

3. This section draws on Haddad *et al.* (2022). We adapted the methodology to the context of the blue economy.

and exports from region *r*

x_i^r, with *i* = 1, ...,*J* and *r* = 1, ...*R* is the total sectoral output in region *r*

We assume we can identify the share of the blue economy in total sectoral output in each region, such that $BLUESH_j^r * x_j^r$, for all *j* = 1, ...,*J* and *r* = 1, ...,*R*, is the total sectoral output related to the sea in region *r*.

Thus, we define *jxs* factors (F_j^s) where $0 < F_j^s < 1$, to represent the share of output in each sector and region that is not directly related to the sea economy. This enables the model to account for the unique characteristics of each sector and region. For example, in landlocked regions, the factor is set to one, while in coastal regions with stronger ties to the sea—such as seawater fishing, marine salt and gem salt extraction and refining, or offshore oil and natural gas extraction—the factor is set closer to zero. After computing the F_j^s factors, the next step is to use this information to partially extract some of the sectoral flows from the interregional input-output table, accounting for both demand and supply reductions.

- Inter-industry Demand

$\forall\, z_{ij}^{rs}$, *i,j* = 1, ...,*J* and *r,s* = 1, ...,*R* we compute a corresponding restricted flow, $\overline{z_{ij}^{rs}}$, such that

$$\overline{z_{ij}^{rs}} = \begin{cases} F_i^r z_{ij}^{rs}, \text{if} F_i^r < F_j^s \\ F_j^s z_{ij}^{rs}, \text{if} F_i^r > F_j^s \end{cases} \tag{2}$$

- Final Demand

In addition to supply-side restrictions, associated with the factor (F_i^r), additional demand-side constraints can be incorporated to complete the decision rule.

For each final demand user, a demand-side factor, $F_u^s, u = c, i, g, e,$, and *s* = 1, ..., *R* can be specified as follows:

F_c^s is calculated based on the total aggregate earnings in region s, excluding earnings from workers employed in sea-related activities. Total labor income earned by formal and informal workers in the blue economy is subtracted from the total labor income in the region, with F_c^s representing the share of income not directly linked to the sea economy. We assume that aggregate labor income is fully translated into household demand changes. Other income-related adjustments, such as government transfers to specific groups of workers, can also affect F_c^s when properly mapped to household purchases.

F_i^s is calculated based on the share of the total regional gross operational surplus that is unrelated to blue economy activities. Similarly, F_g^s is calculated based on the allocation of net indirect taxes and production taxes between marine and non-marine activities. Thus, F_g^s includes only the portion of government revenue raised from taxes levied on non-marine activities in region *s*.

$F_e^\bullet$ is set to unity, assuming that export demand is fully exogenous.

For each component of final demand, f_{iu}^{rs}, we apply the following rule:

$\forall\, f_{iu}^{rs}, i = 1, \dots, J, u = c, i, g, e$ and $r, s = 1, \dots, R$ we compute a corresponding restricted flow, $\overline{f_{iu}^{rs}}$, such that

$$\overline{f_{iu}^{rs}} = \begin{cases} F_i^r f_{iu}^{rs}, \text{if} F_i^r < F_u^s \\ \\ F_u^s f_{iu}^{rs}, \text{if} F_i^r > F_u^s \end{cases} \tag{3}$$

Using the information from the original and reduced sectoral flows, we now have two matrices of inter-industry flows, $\mathbf{Z}$ and $\overline{\mathbf{Z}}$, along with two vectors of final demand, $\mathbf{f}$ and $\overline{\mathbf{f}}$. For a given vector of sectoral output, $\mathbf{x}$, we can also derive two matrices of technical coefficients, $\mathbf{A}$ and $\overline{\mathbf{A}}$.

The extraction method involves the hypothetical removal of a sector from the input-output matrix.[4] Its purpose is to quantify how much the total output of an economy with *J* sectors and *R* regions could change (or decrease) if a specific sector were removed. This method enables an analysis of the economic relevance of each sector within a given economic structure, as removing a sector leads to a reduction in overall economic activity. The greater a sector's interdependence with other sectors, the larger its systemic impact.

Following Haddad *et al*. (2022), we use a variant of the extraction method. Instead of hypothetically removing an entire sector in a specific region, we partially extract all sectors based on the information contained in $\overline{\mathbf{Z}}$, and $\overline{\mathbf{f}}$.

In the complete interregional input-output model, using the original sectoral flows, the output of the economy is given by:

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f} \tag{4}$$

Using $\overline{\mathbf{A}}$ as the matrix associated with restricted intersectoral trade flows due to the exclusion of the various blue economy activities, and $\overline{\mathbf{f}}$, the sea-related final demand, gross output in the economy would be given by:

$$\overline{\mathbf{x}} = (\mathbf{I} - \overline{\mathbf{A}})^{-1}\overline{\mathbf{f}} \tag{5}$$

Therefore, after the partial extraction:

$$\mathbf{T} = \mathbf{i}'\mathbf{x} - \mathbf{i}'\overline{\mathbf{x}} \tag{6}$$

where $\mathbf{T}$ is the aggregate measure of annual economic loss if the output related to ocean-related activities "disappears". In other words, it measures the relative importance of sea-related activities and their total linkages within the economy.

We can translate sectoral gross output outcomes into other economic variables by multiplying the vector of gross output, $\mathbf{x}$ or $\overline{\mathbf{x}}$, by a diagonal matrix, $\hat{\mathbf{v}}$. The main diagonal contains the variable's coefficients, representing the ratio of the variable's value to the respective sectoral-regional gross output.

4. The regionalal extraction method used by Dietzenbacher *et al*. (1993) is based on the foundational work of Miller (1966, 1969).

III. RESULTS

Brazil covers a land area of approximately 8.5 million square kilometers (3.2 million square miles) and has a coastline that stretches approximately 7,491 kilometers (4,655 miles) along the Atlantic coast. The country is divided into 26 states and one federal district, each with its own government and further subdivided into municipalities. Brazil has a total of 5,570 municipalities, with 280 located directly on the Atlantic coast, distributed across 17 states (see Map 1).

Map 1. Brazilian Coastal Municipalities

Brazil's coastal municipalities cover an area of 251,000 square kilometers and, in 2019, were home to 39 million people, representing 18.5% of the national population. These municipalities contributed 19.5% of Brazil's GDP and 18.2% of the national gross output in 2019.

We collected production data at the municipality level, using 2019 gross output information from Haddad *et al.* (2023) for 128 commodities, which span the entire economy and are classified according to Brazil's National Account System. The process of generating the municipality-level product data is fully aligned with Brazilian regional and national accounts.

In addition, we gathered 2019 employment and labor income data for all Brazilian municipalities, with detailed activity disaggregation. Data from RAIS (Brazilian Ministry of Labor) covers 1,331 categories (subsectors). We identified 83 subsectors that either operate in the ocean (e.g. sea fishing, oil and gas exploration, maritime freight transport), depend on the ocean (e.g. fish processing, sea salt extraction, coastal tourism, imputed rents from second homes), or are related to both (e.g. shipbuilding, port infrastructure and operations, coastal defense). By mapping each of the 1,331 subsectors to one of the 128 product groups, we were able to isolate the contribution of the blue economy to gross output in each coastal municipality using employment and labor income shares. For some products, we used complementary information (e.g. share of residential units for occasional use, share of leisure tourism in total tourism, and navy expenditures).

1. Direct Contribution

According to our estimates, in 2019 the blue economy accounted for 2.9% of Brazil's gross output, 2.91% of GDP, and 1.07% of total employment. Table 1 and Figure 3 present the direct contribution of the blue economy to the gross output of different products, aggregated across municipalities. Notably, petroleum and gas extraction (97%), water transport (73.4%), and fishing processing (65.6%) stand out, with the blue economy generating over 50% of their national gross output. Accommodation services (33.2%), transportation support (21.2%), and fishing and aquaculture (19%) also show significant concentration in coastal municipalities, as their blue economy shares exceed the national average for these areas (18.2%).

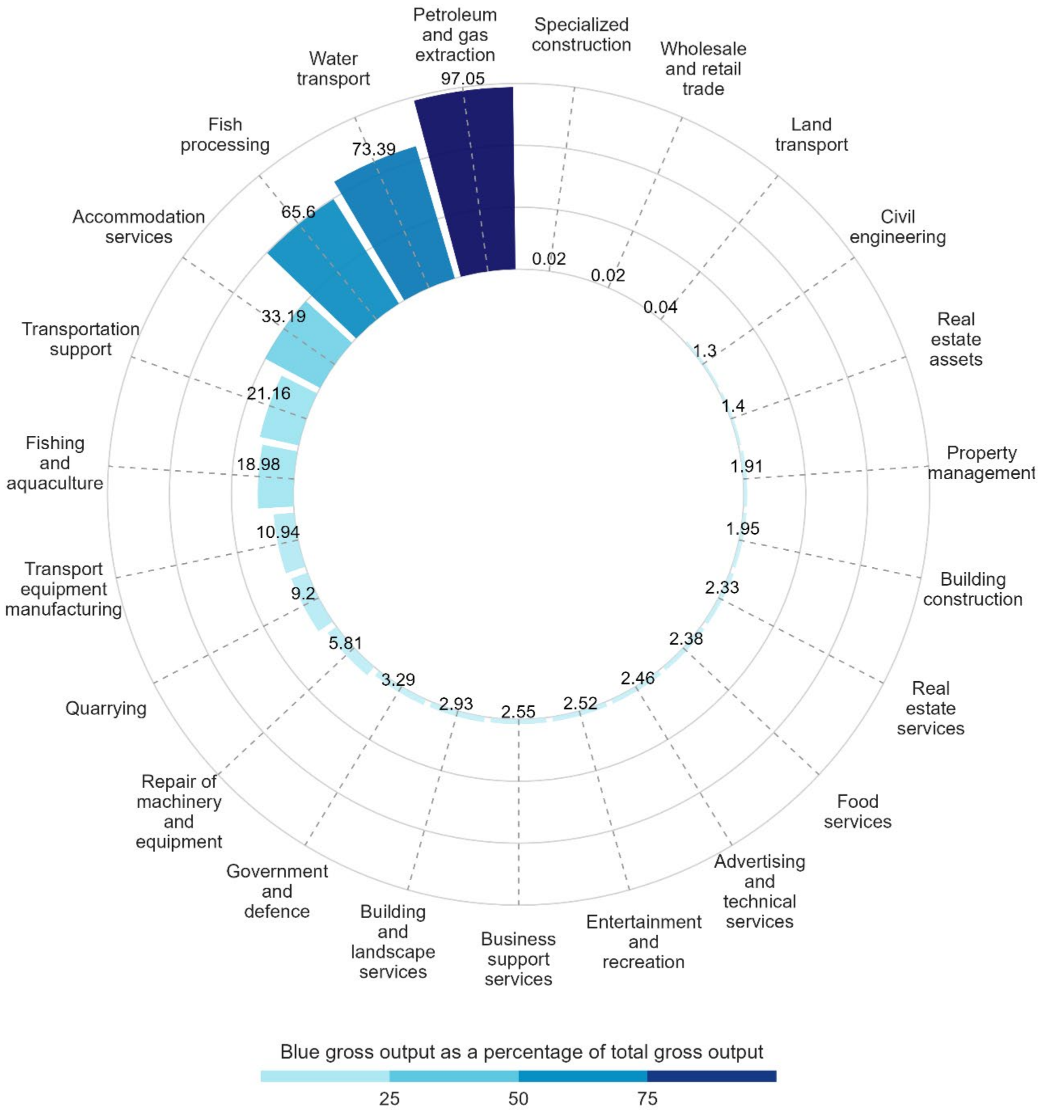
Table 1

Structure of the Blue Economy in Brazil: Gross Output in 2019, by Product

COD	Product	Total Gross Output (R$ million)	Blue Gross Output (R$ million)	Blue Gross Output (share in %)	Blue Gross Output/ Gross Output (%)
P015	Marine fishing and aquaculture	15,551	2,952	0.8%	19.0%
P017	Quarrying of stone, sand and clay	19,368	1,782	0.5%	9.2%
P018	Extraction of crude petroleum and natural gas	229,536	222,768	60.4%	97.1%
P024	Processing and preserving of fish	5,256	3,448	0.9%	65.6%
P084	Building of ships and boats	33,181	3,631	1.0%	10.9%
P087	Maintenance and repair of ships, boats and floating structures	90,339	5,247	1.4%	5.8%
P090	Construction of buildings	329,424	6,420	1.7%	1.9%
P091	Civil engineering	117,822	1,535	0.4%	1.3%
P092	Specialized construction activities	150,934	36	0.0%	0.0%
P094	Wholesale and retail trade of boats and floating structures	1,100,609	251	0.1%	0.0%
P096	Urban passenger land transport	111,656	45	0.0%	0.0%
P097	Water transport	27,690	20,323	5.5%	73.4%
P099	Warehousing and support activities for transportation	128,053	27,093	7.3%	21.2%
P101	Accommodation	32,277	10,711	2.9%	33.2%
P102	Food and beverage service activities	302,589	7,209	2.0%	2.4%
P108	Real estate activities on a fee or contract basis	260,204	6,068	1.6%	2.3%
P109	Real estate activities with own or leased property	482,425	9,220	2.5%	1.9%
P113	Advertising and other technical activities	138,696	3,416	0.9%	2.5%
P114	Rental and leasing of non-real estate assets	55,018	770	0.2%	1.4%
P115	Services to buildings and landscape activities	118,008	3,462	0.9%	2.9%
P116	Other business support activities	164,553	4,200	1.1%	2.6%
P118	Public administration and defence	825,758	27,181	7.4%	3.3%
P124	Arts, entertainment and recreation	45,636	1,150	0.3%	2.5%
	Total	**4,784,583**	**368,920**	**100.0%**	**7.7%**
	Total / Brazilian Gross Output (%)	**37.6%**	**2.9%**		

Figure 3

Share of the Blue Economy in Gross Output, by Product



From a geographical perspective, we calculated the direct contribution of the blue economy to the gross output of each coastal municipality, aggregating our base estimates across products. Table 2 presents the results for the largest "blue local economies," ranked by their total output directly associated with blue economy activities. The top 10 municipalities—eight of which are oil-producing municipalities in the state of Rio de Janeiro—account for 60% of the blue economy's gross output.

After calculating the contribution of blue economy activities to the gross output of 23 of the 128 products in each municipality, we aggregated the data at the state level to be used in our model, which was calibrated with data from Brazil's 2019 interstate input-output system. Table 3 shows the aggregated estimates for each state. Rio de Janeiro (63.5%), São Paulo (10.3%), and Espírito Santo (8.6%) represent the three largest blue state economies, collectively accounting for 82.4% of the total gross output, heavily influenced by offshore oil and natural gas extraction. However, the relative importance of the blue economy for each state (Table 3 and Figure 4) is particularly notable in Rio de Janeiro (18.3% of state gross output), Espírito Santo (13.7%), Amapá (4.2%), Rio Grande do Norte (3.8%), Sergipe (3.4%) and Ceará (2.9%), where the blue economy's share in regional output is at least as large as its share in the national economy (2.9%).

Table 2

Geography of the Blue Economy in Brazil: Gross Output in 2019, by Municipality (Top 50)

#	Municipality	R$ million	% of total	Accumulated %
1	Maricá (RJ)	55,416.8	15.02%	15.02%
2	Niterói (RJ)	39,847.2	10.80%	25.82%
3	Campos dos Goytacazes (RJ)	26,778.3	7.26%	33.08%
4	Rio de Janeiro (RJ)	26,319.8	7.13%	40.22%
5	Ilhabela (SP)	20,933.6	5.67%	45.89%
6	Saquarema (RJ)	14,580.7	3.95%	49.84%
7	Cabo Frio (RJ)	10,777.2	2.92%	52.76%
8	Macaé (RJ)	10,120.8	2.74%	55.51%
9	Presidente Kennedy (ES)	9,315.1	2.52%	58.03%
10	São João da Barra (RJ)	7,273.2	1.97%	60.00%
11	Marataízes (ES)	7,116.5	1.93%	61.93%
12	Santos (SP)	6,765.2	1.83%	63.77%
13	Rio das Ostras (RJ)	6,589.7	1.79%	65.55%
14	Itapemirim (ES)	6,331.1	1.72%	67.27%
15	Quissamã (RJ)	5,406.6	1.47%	68.73%
16	Itajaí (SC)	4,531.4	1.23%	69.96%
17	Salvador (BA)	4,374.6	1.19%	71.15%
18	Duque de Caxias (RJ)	3,882.3	1.05%	72.20%
19	Angra dos Reis (RJ)	3,846.8	1.04%	73.24%
20	Fortaleza (CE)	3,738.4	1.01%	74.26%
21	Arraial do Cabo (RJ)	3,519.5	0.95%	75.21%
22	Itaguaí (RJ)	3,102.7	0.84%	76.05%
23	Paraty (RJ)	3,002.1	0.81%	76.86%
24	Vitória (ES)	2,992.6	0.81%	77.68%
25	Paranaguá (PR)	2,977.5	0.81%	78.48%
26	Guarujá (SP)	2,950.2	0.80%	79.28%
27	São Luís (MA)	2,930.2	0.79%	80.08%
28	Armação dos Búzios (RJ)	2,729.3	0.74%	80.82%
29	São Gonçalo (RJ)	2,532.8	0.69%	81.50%
30	Recife (PE)	2,456.4	0.67%	82.17%
31	Araruama (RJ)	2,211.2	0.60%	82.77%
32	Ipojuca (PE)	2,139.0	0.58%	83.35%
33	Casimiro de Abreu (RJ)	1,997.0	0.54%	83.89%
34	Aracruz (ES)	1,908.9	0.52%	84.41%
35	Navegantes (SC)	1,874.6	0.51%	84.92%
36	Praia Grande (SP)	1,829.5	0.50%	85.41%
37	Florianópolis (SC)	1,794.2	0.49%	85.90%
38	Mangaratiba (RJ)	1,736.9	0.47%	86.37%
39	Natal (RN)	1,716.4	0.47%	86.83%
40	Rio Grande (RS)	1,636.2	0.44%	87.28%
41	Balneário Camboriú (SC)	1,365.2	0.37%	87.65%
42	Maceió (AL)	1,273.5	0.35%	87.99%
43	Cairu (BA)	1,213.4	0.33%	88.32%
44	Aracaju (SE)	1,126.0	0.31%	88.63%
45	Camaçari (BA)	1,120.5	0.30%	88.93%
46	João Pessoa (PB)	1,083.7	0.29%	89.22%
47	São Sebastião (SP)	1,075.6	0.29%	89.52%
48	Serra (ES)	1,070.6	0.29%	89.81%
49	Vila Velha (ES)	923.9	0.25%	90.06%
50	Magé (RJ)	907.2	0.25%	90.30%

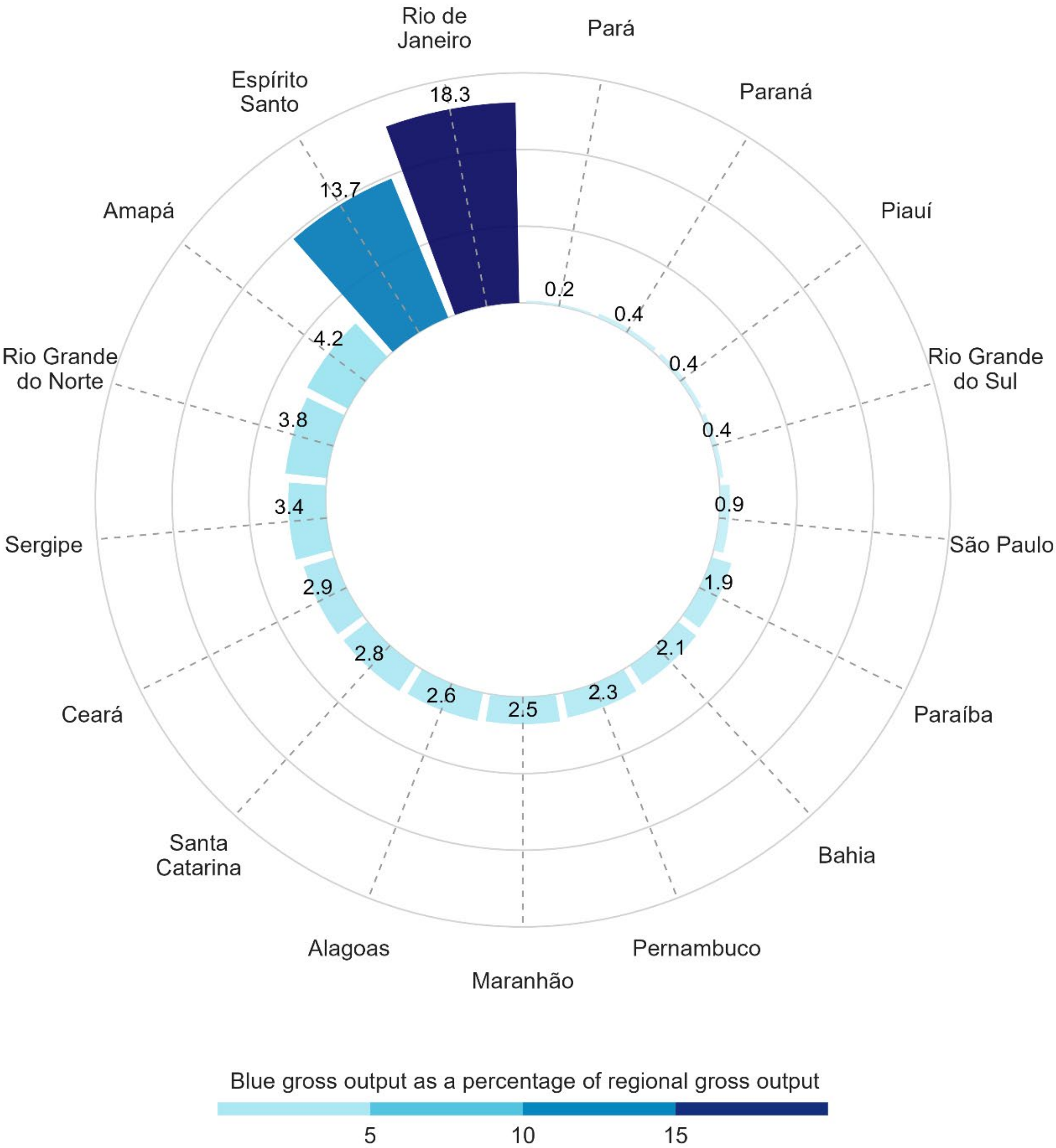
Table 3

Geography of the Blue Economy in Brazil: Gross Output in 2019, by State

State	*R$ million*	*% of BE total*	*% of regional total*
Rondônia	0	0.0%	0.0%
Acre	0	0.0%	0.0%
Amazonas	0	0.0%	0.0%
Roraima	0	0.0%	0.0%
Pará	514	0.1%	0.2%
Amapá	946	0.3%	4.2%
Tocantins	0	0.0%	0.0%
Maranhão	3,644	1.0%	2.5%
Piauí	288	0.1%	0.4%
Ceará	7,191	1.9%	2.9%
Rio Grande do Norte	4,129	1.1%	3.8%
Paraíba	1,809	0.5%	1.9%
Pernambuco	7,643	2.1%	2.3%
Alagoas	2,201	0.6%	2.6%
Sergipe	2,190	0.6%	3.4%
Bahia	11,424	3.1%	2.1%
Minas Gerais	0	0.0%	0.0%
Espírito Santo	31,830	8.6%	13.7%
Rio de Janeiro	234,147	63.5%	18.3%
São Paulo	37,834	10.3%	0.9%
Paraná	3,793	1.0%	0.4%
Santa Catarina	15,645	4.2%	2.8%
Rio Grande do Sul	3,692	1.0%	0.4%
Mato Grosso do Sul	0	0.0%	0.0%
Mato Grosso	0	0.0%	0.0%
Goiás	0	0.0%	0.0%
Distrito Federal	0	0.0%	0.0%
Brazil	**368,920**	**100.0%**	**2.9%**

Figure 4

Share of the Blue Economy in Regional Gross Output, by State

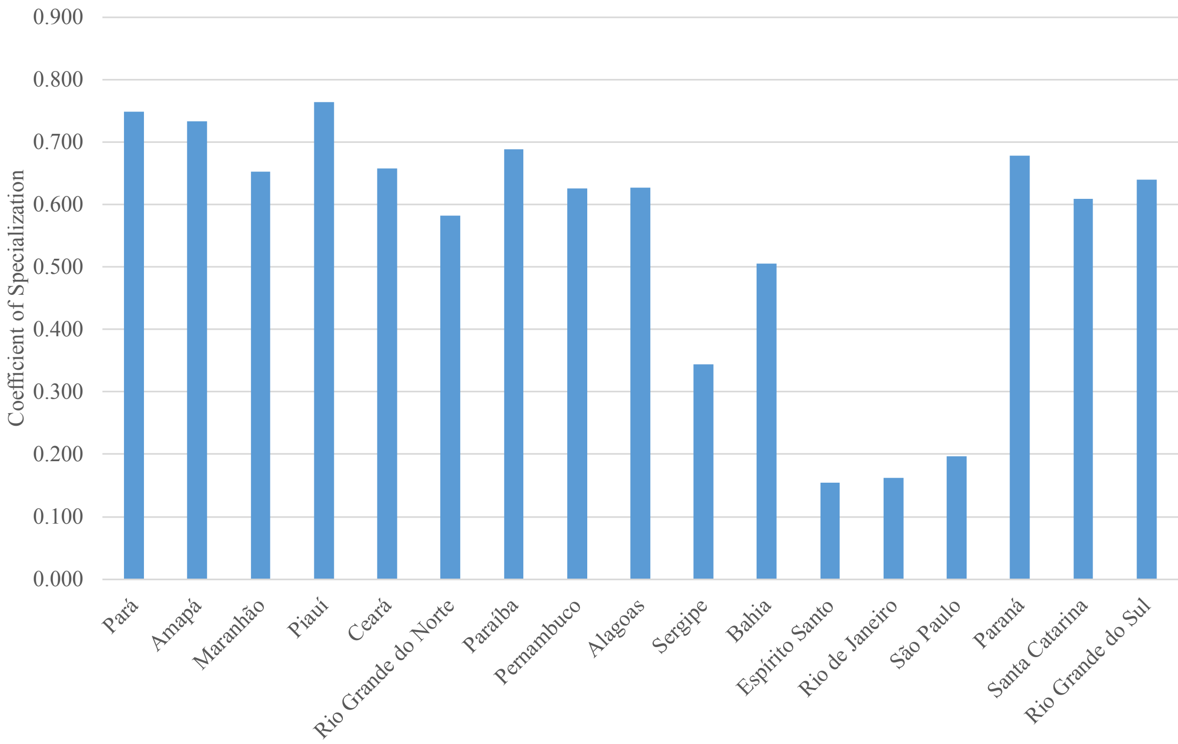


2. Regional Heterogeneity

The Brazilian blue economy is not homogeneous, exhibiting variations across regional blue economies. At the state level, Table 4 shows the blue economy's gross output by product, viewed as a system of coastal states, highlighting their respective contributions to each product's output. At the bottom of the table, we present the structure of the national blue economy. One way to compare the regional structures with the national structure is through the coefficient of specialization, which measures the diversity of a region relative to the aggregate distribution. Its lowest possible value is 0, indicating that the region's gross output is distributed in the same proportion as the national economy. The highest possible value is 1 (Hoover and Giarratani, 1971). Therefore, the closer the regional structure is to the national structure, the closer the coefficient is to 0. Figure 5 plots the values of the coefficient of specialization for the 17 state economies, revealing significant differences in terms of regional specialization in blue economy activities.

Figure 5

Coefficient of Specialization of Blue State Economies



A closer inspection of Table 4 reveals, for example, that P018 (Extraction of crude petroleum and natural gas) accounts for 60.4% of Brazil's total blue economy output, with a notably higher concentration in Rio de Janeiro (75.5% of the state total) and Espírito Santo (71.3%). In contrast, P101 (Accommodation), which contributes 2.9% overall, plays a much more significant role in Brazil's northeast states, such as Ceará (20.8% of the state total), Bahia (16.9%), Alagoas (13.8%), and Pernambuco (13.6%). To better understand these variations, we adopt the concept of relative concentration of economic activities to create a typology of state blue economies. The location quotient (LQ) is a widely used statistical measure used to assess the *relative* concentration or specialization of a particular activity in a specific geographic area compared to a larger reference area, such as a country. It helps identify the relative importance of a sector within a local economy.

We reorganized the data used to prepare Table 4 by first excluding mining products, given the dominant role of oil and gas in the national blue economy, and second, by grouping related products into four clusters of similar activities: (i) fishing, (ii) maritime transport, (iii) coastal tourism, and (iv) defense. We calculated the LQ for each cluster in each state, revealing the specific relative concentration of these activities. We then used the LQ information to create a hinge-based circle (HBC) figure, which visually illustrates the structural differences across regional blue economies in Brazil. To achieve this, we limited the LQ estimates in the range [-1, 1], redistributing values above 1 between [0, 1] and values below 1 within [-1, 0]. Figure 5 presents the resulting HBC figure, which includes the four clusters based on these LQ vectors.

Figure 6 summarizes the LQ results, focusing on the regional structural specialization in blue economic clusters across Brazilian states. We employ a visualization technique that allows for an in-depth exploration of the regional characteristics of the country's blue economy, reflecting the spatial economic phenomena of sectoral specialization. The results are presented in a manner that helps identify the different configurations of economic structures from a region's perspective.

To illustrate the findings, we plot the normalized vectors for the first two clusters (coastal tourism and maritime transport) on a Cartesian plan, where coastal tourism is represented in the x-axis and maritime transport on the y-axis. The sum of these vectors defines the direction and magnitude of the resultant vector, which determines the point's position on the plane. Next, we intersect this resultant vector with a circle of radius one, centered at the origin of the Cartesian plan.

From this intersection point, we plot the normalized vector of the "fishing" cluster, following the direction of the previously defined resultant vector. Positive values (indicating high relative specialization) for the fishing cluster are represented as points pointing towards the center of the circle, thus falling inside it. Conversely, negative values (indicting low relative specialization) falls outside the circle, meaning that states less specialized in fishing are positioned outside the circle.

Figure 6 considers all possible sign combinations among the three clusters. By analyzing the results from the three transformed LQs, we compare the importance of each cluster across Brazilian states. This allows us to identify relative differences in the structural characteristics of the country's state blue economies. An additional element represented in Figure 6 concerns the fourth cluster, "defense". For states with above-average values (indicating high relative specialization), the symbol is an upward-pointing blue triangle, while for states with below-average values (low relative specialization), the symbol is an inverted brown triangle.

With the exception of Maranhão, states in Brazil's northeast (Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe and Bahia), located in the southeast quadrant of Figure 6, show evidence of specialization in coastal tourism activities, coupled with lower LQ values for maritime transport activities. Coastal states in Brazil's southeast (Espírito Santo, Rio de Janeiro, and São Paulo), extending to the southern state of Paraná, exhibit relative specialization in maritime transport, placing them in the two upper quadrants. Distinct geographical patterns emerge for the other two clusters.

Fishing is relatively concentrated in the northern portion of the Atlantic Ocean (within the circle), encompassing state economies from Pará to Rio Grande do Norte, as well as the states of Paraíba and Alagoas. Meanwhile, defense shows a higher concentration from Rio de Janeiro northwards along the coast, excluding only Espírito Santo (represented by blue triangles). Two important exceptions to this are Santa Catarina in the south, which excels in the fishing cluster, and Maranhão in the northeast, where the blue economy is more influenced by maritime transport.

Table 4

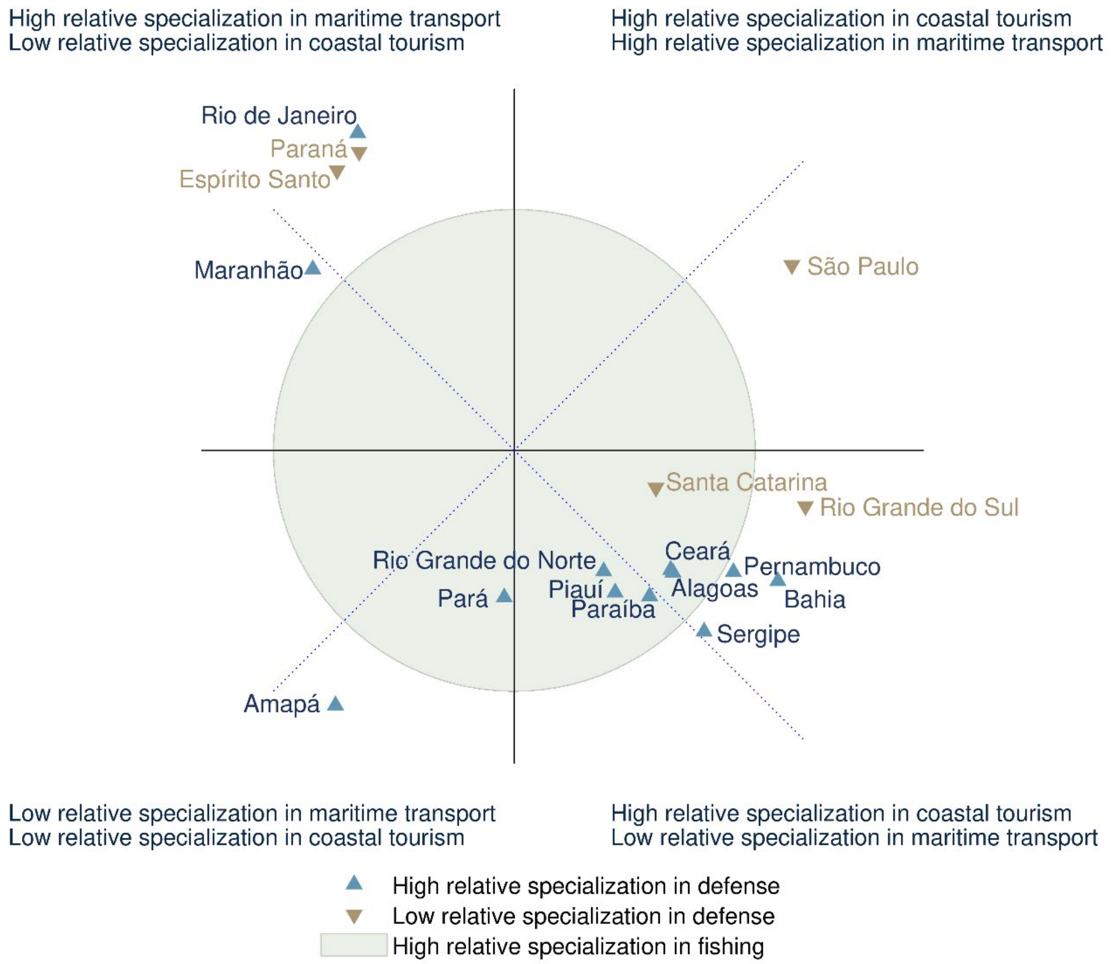
Structure of State Blue Economies in Brazil

State	P015	P017	P018	P024	P084	P087	P090	P091	P092	P094	P096	P097	P099	P101	P102	P108	P109	P113	P114	P115	P116	P118	P124	Total
Rondônia	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Acre	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Amazonas	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Roraima	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Pará	8.9%	1.5%	0.0%	10.4%	0.0%	0.3%	11.9%	0.0%	0.0%	0.1%	0.0%	0.7%	2.4%	4.4%	3.9%	8.0%	6.2%	0.1%	0.1%	0.6%	0.2%	40.0%	0.1%	100.0%
Amapá	1.5%	0.1%	0.0%	0.2%	0.0%	0.0%	1.9%	0.4%	0.0%	0.2%	0.0%	2.5%	2.8%	4.9%	3.5%	0.5%	8.7%	1.1%	0.4%	0.3%	1.1%	69.5%	0.4%	100.0%
Tocantins	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Maranhão	3.2%	1.7%	0.0%	0.0%	0.1%	0.1%	1.4%	0.4%	0.0%	0.1%	0.0%	27.4%	32.5%	2.7%	1.8%	1.8%	4.3%	0.4%	0.2%	0.5%	1.6%	19.5%	0.3%	100.0%
Piauí	19.2%	1.4%	0.0%	0.0%	0.0%	0.4%	6.0%	0.1%	0.0%	0.3%	0.0%	0.2%	1.6%	7.9%	14.4%	2.8%	5.3%	0.3%	0.3%	0.6%	0.5%	38.5%	0.2%	100.0%
Ceará	8.0%	1.8%	0.0%	2.5%	0.2%	0.2%	3.4%	0.1%	0.0%	0.1%	0.0%	2.4%	10.6%	20.8%	3.4%	3.2%	4.2%	1.9%	0.3%	1.1%	7.7%	24.9%	3.1%	100.0%
Rio Grande do Norte	20.0%	2.1%	14.2%	5.1%	0.0%	0.5%	2.5%	0.3%	0.0%	0.1%	0.0%	2.3%	0.6%	6.9%	3.3%	2.9%	5.2%	1.4%	0.1%	1.3%	8.3%	22.3%	0.6%	100.0%
Paraíba	10.1%	2.4%	0.0%	0.1%	0.0%	1.3%	10.5%	0.9%	0.0%	0.1%	0.0%	2.8%	3.5%	4.4%	6.0%	2.4%	10.7%	1.0%	0.3%	4.6%	1.6%	36.7%	0.6%	100.0%
Pernambuco	2.6%	0.6%	0.0%	1.5%	3.5%	0.9%	4.1%	0.5%	0.0%	0.1%	0.0%	3.8%	13.5%	13.6%	5.3%	3.1%	6.4%	2.4%	0.5%	1.7%	5.7%	27.9%	2.1%	100.0%
Alagoas	9.2%	0.6%	2.3%	0.3%	0.6%	1.6%	6.8%	0.5%	0.0%	0.1%	0.0%	2.6%	7.9%	13.8%	9.0%	4.7%	7.4%	0.4%	0.3%	1.9%	3.7%	26.2%	0.2%	100.0%
Sergipe	2.4%	0.1%	35.5%	0.1%	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%	0.0%	3.5%	5.1%	5.7%	3.3%	3.8%	6.0%	0.2%	0.0%	1.7%	1.7%	27.8%	0.2%	100.0%
Bahia	2.1%	1.7%	12.7%	0.2%	0.3%	0.8%	4.3%	0.2%	0.0%	0.1%	0.0%	9.1%	7.8%	16.9%	6.0%	3.7%	7.7%	0.5%	0.1%	2.5%	5.1%	17.9%	0.3%	100.0%
Minas Gerais	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Espírito Santo	0.1%	0.9%	71.3%	0.2%	4.1%	0.3%	1.8%	1.0%	0.0%	0.0%	0.0%	4.3%	7.6%	0.7%	0.9%	0.7%	1.2%	0.2%	0.0%	0.3%	0.3%	3.9%	0.1%	100.0%
Rio de Janeiro	0.1%	0.1%	75.5%	0.1%	0.3%	1.9%	0.5%	0.3%	0.0%	0.0%	0.0%	6.0%	3.5%	1.2%	0.7%	0.6%	1.2%	1.0%	0.3%	0.5%	0.7%	5.3%	0.1%	100.0%
São Paulo	0.0%	0.1%	54.1%	0.2%	0.3%	0.4%	2.6%	0.4%	0.0%	0.1%	0.0%	1.2%	17.0%	3.1%	4.5%	5.3%	3.7%	0.4%	0.0%	2.4%	0.2%	3.6%	0.2%	100.0%
Paraná	0.3%	2.4%	0.0%	0.0%	0.1%	1.1%	5.1%	4.7%	0.0%	0.1%	0.0%	10.0%	55.6%	2.6%	4.5%	1.4%	4.8%	0.8%	0.1%	1.6%	0.2%	4.6%	0.2%	100.0%
Santa Catarina	1.6%	3.5%	0.0%	15.9%	6.1%	1.1%	8.2%	0.2%	0.0%	0.3%	0.1%	7.0%	17.1%	4.6%	7.1%	4.3%	8.7%	1.4%	0.1%	1.6%	1.5%	7.8%	1.6%	100.0%
Rio Grande do Sul	0.0%	0.2%	0.0%	2.9%	3.1%	0.5%	12.9%	0.5%	0.0%	0.1%	0.0%	5.0%	23.1%	4.0%	7.8%	8.3%	14.4%	0.7%	0.1%	3.3%	0.3%	12.1%	0.6%	100.0%
Mato Grosso do Sul	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Mato Grosso	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Goiás	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Distrito Federal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Brazil	**0.8%**	**0.5%**	**60.4%**	**0.9%**	**1.0%**	**1.4%**	**1.7%**	**0.4%**	**0.0%**	**0.1%**	**0.0%**	**5.5%**	**7.3%**	**2.9%**	**2.0%**	**1.6%**	**2.5%**	**0.9%**	**0.2%**	**0.9%**	**1.1%**	**7.4%**	**0.3%**	**100.0%**

Note: P015 Marine fishing and aquaculture; P017 Quarrying of stone, sand and clay; P018 Extraction of crude petroleum and natural gas; P024 Processing and preserving of fish; P084 Building of ships and boats; P087 Maintenance and repair of ships, boats and floating structures; P090 Construction of buildings; P091 Civil engineering; P092 Specialized construction activities; P094 Wholesale and retail trade of boats and floating structures; P096 Urban passenger land transport; P097 Water transport; P099 Warehousing and support activities for transportation; P101 Accommodation; P102 Food and beverage service activities; P108 Real estate activities on a fee or contract basis; P109 Real estate activities with own or leased property; P113 Advertising and other technical activities; P114 Rental and leasing of non-real estate assets; P115 Services to buildings and landscape activities; P116 Other business support activities; P118 Public administration and defense; P124 Arts, entertainment and recreation.

Figure 6

Typology of States According to the Relative Importance of Product Clusters to their Overall Blue Economic Structure



Clusters: fishing (P015, P024), maritime transport (P084, P087, P094, P097, P099), coastal tourism (P090, P091, P092, P096, P101, P102, P108, P109, P113, P114, P115, P116, P124), security (P118).

Note: P015 Marine fishing and aquaculture; P017 Quarrying of stone, sand and clay; P018 Extraction of crude petroleum and natural gas; P024 Processing and preserving of fish; P084 Building of ships and boats; P087 Maintenance and repair of ships, boats and floating structures; P090 Construction of buildings; P091 Civil engineering; P092 Specialized construction activities; P094 Wholesale and retail trade of boats and floating structures; P096 Urban passenger land transport; P097 Water transport; P099 Warehousing and support activities for transportation; P101 Accommodation; P102 Food and beverage service activities; P108 Real estate activities on a fee or contract basis; P109 Real estate activities with own or leased property; P113 Advertising and other technical activities; P114 Rental and leasing of non-real estate assets; P115 Services to buildings and landscape activities; P116 Other business support activities; P118 Public administration and defense; P124 Arts, entertainment and recreation

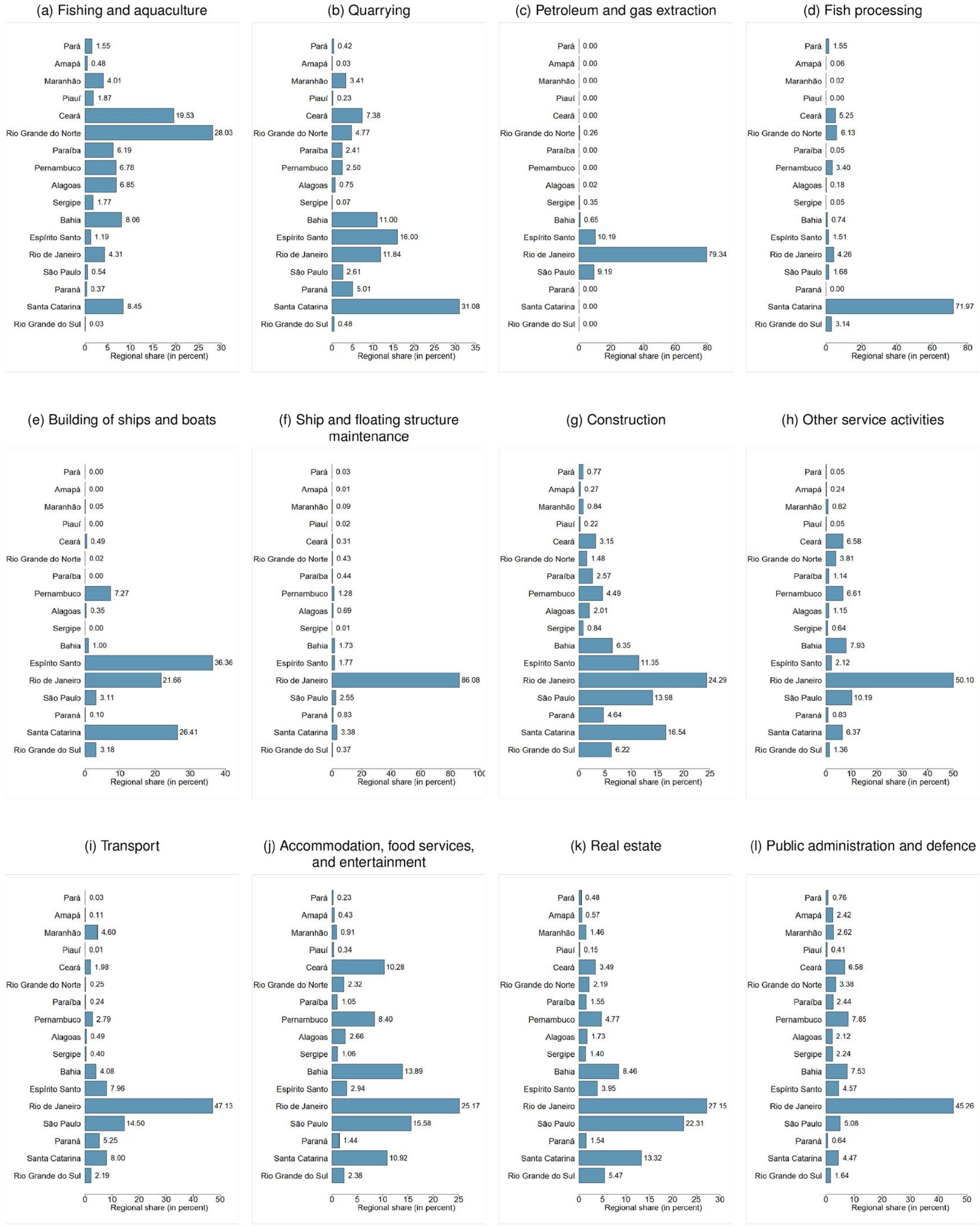
Figure 7 presents the regional distribution of various blue economy activities,[5] emphasizing structural differences within the Brazilian blue economy. This spatial analysis highlights the distinct location patterns of these activities, which vary due to factors influencing the distribution of economic activities across sectors.

For instance, the concentration of petroleum and gas extraction in Rio de Janeiro, Espírito Santo and São Paulo is driven by the availability of offshore natural resources along these states' coastlines. Meanwhile, the co-location of accommodation, food services and entertainment with real estate reveals agglomerations of coastal tourism activities. These clusters benefit from efficiency gains, knowledge spillovers, collaborative opportunities, and shared resources among related industries and support services.

Another important factor shaping the special distribution is infrastructure. In the southern part of the country, the availability of better transport infrastructure and network effects enhances the concentration of the transport sector. Similarly, dedicated ports connected to export corridors in Maranhão and Espírito Santo enhance the concentration of the transport sector in these regions.

5. The information used in the graphs is sector-level gross output. See Section 3.3.

Figure 7
Regional Distribution of Blue Economy Activities in Brazil



3. Systemic Contribution

The next step was to use the state make matrices to convert product (commodity) output to industry (sector) output. In the Brazilian input-output system, there are up to 68 sectors in each state, producing up to 128 commodities. With this data, we calculated the share of the blue economy in each sector j within each state r, denoted as $\boldsymbol{BLUESH_j^r}$, for all j = 1, ..., 68, and r = 1, ..., 27. This allowed us to define the factors F for the partial extraction of economic flows from the input-output matrix.

Product-level factors (Table 6) and sectoral-level factors were calculated for each state for the 23 products related to blue economy activities. We also estimated F-factors for domestic absorption components (Table 5) based on the sectoral structure of the blue economy in each state. According to values in Table 6, P018 (Extraction of crude petroleum and natural gas), P024 (Processing and preserving of fish), and P097 (Water transport) exhibit the lowest factors, with higher shares of ocean-related components: 97.1%, 65.6%, and 73.4%, respectively. P099 (Warehousing and support activities for transportation) and P101 (Accommodation) also show sizeable blue economy shares, above 20% of total gross output, reflected in lower F factors. All other 105 products, with no direct relation to the sea economy, have an F factor equal to 1.

Tables 7-10 present the systemic economic impacts of the extraction of blue economy-related flows in the interstate input-output system. The magnitude of the estimated effects depends on three main factors. First, the adjustment factors Fs, which exclude flows directly related to the sea economy. Second, the interregional and intersectoral linkages of the economy[6] impact sectors that have no direct connection to the ocean, including landlocked states. Third, it is assumed that domestic absorption components are directly influenced by income generation in blue economy activities (i.e. labor income, capital income and tax revenue). The higher participation of blue economy activities in state economies could result in greater effects on household demand, investment demand, government consumption, and overall regional economic activity.

The common structure of Tables 7-10 includes direct, indirect, and total effects of the blue economy across states and across sectors, measured in terms of GDP (Tables 7 and 9) and employment (Tables 8 and 10). The results are presented in both absolute terms (R$ millions and workers), and as a percentage of national and regional blue economy GDP (GRP). Overall, the blue economy contributes 6.39% of Brazil's GDP, with 2.91% directly related to the ocean, resulting in a multiplier of 2.20. In terms of employment, 1,136,111 workers (1.07% of the national workforce) are employed in blue economy activities, which in turn generate 3,585,613 additional jobs (3.38% of the total), yielding a multiplier of 4.16.

Regarding the regional distribution of blue economy impacts in Brazil, one noteworthy result is the distinct geography of direct and indirect effects (Tables 7 and 8). While the direct effects, analyzed in the previous section, reveal a pattern highly concentrated in the three largest blue state economies (80% of the blue economy GDP and 51.29% of employment[7]), indirect effects are less concentrated. The three largest shares account for less than two-thirds of total GDP (62.94%).

6. Productive linkages assess the impact of one sector on another. Backward linkages indicate how much a sector relies on input from others, while forward linkages reflect the significance of a sector as a supplier of goods and services to others.

7. Top-3 states in terms of GDP are Rio de Janeiro, São Paulo, and Espírito Santo; in terms of employment, Bahia replaces Espírito Santo in third position. Given the prominent share of oil and gas extraction in total direct effects (61.62% of GDP, and only 30.94% of employment), a capital-intensive sector, GDP becomes much more concentrated.

Interestingly, Minas Gerais, a landlocked state in Brazil's southeast that borders Rio de Janeiro, São Paulo, Espírito Santo, and Bahia, ranks third in terms of indirect effects. As a result, the ocean impacts all landlocked Brazilian states through production and income linkages (see Figure 8).

From a sectoral perspective (Tables 9 and 10), the dominance of crude petroleum and natural gas extraction in GDP terms (55.16% of the total) is not reflected in employment (only 3.74%), due to the sector's high capital-labor ratio. The direct contribution of blue economy activities to job creation in Brazil is more widely spread across different sectors, with notable importance for coastal tourism and defense. Indirect effects in GDP and employment show a different structural pattern, with higher-order contributions concentrated in non-blue manufacturing (other industrial activities) and services (trade and other service activities). Indirect effects in agriculture employment are also notable, with the sector ranking fourth in terms of the number of indirect jobs.

Table 5

F-Factor for Domestic Absorption Components, by State

State	*Investment*	*Household*	*Government*
Rondonia	1.0000	1.0000	1.0000
Acre	1.0000	1.0000	1.0000
Amazonas	1.0000	1.0000	1.0000
Roraima	1.0000	1.0000	1.0000
Pará	0.9984	0.9974	0.9985
Amapá	0.9641	0.9455	0.9717
Tocantins	1.0000	1.0000	1.0000
Maranhão	0.9769	0.9767	0.9728
Piauí	0.9956	0.9961	0.9968
Ceará	0.9707	0.9659	0.9746
Rio Grande do Norte	0.9477	0.9644	0.9718
Paraíba	0.9764	0.9807	0.9847
Pernambuco	0.9745	0.9696	0.9818
Alagoas	0.9730	0.9719	0.9729
Sergipe	0.9607	0.9723	0.9671
Bahia	0.9718	0.9753	0.9825
Minas Gerais	1.0000	1.0000	1.0000
Espírito Santo	0.8342	0.9295	0.8486
Rio de Janeiro	0.7464	0.9029	0.8229
São Paulo	0.9856	0.9936	0.9918
Paraná	0.9952	0.9951	0.9961
Santa Catarina	0.9687	0.9752	0.9722
Rio Grande do Sul	0.9940	0.9958	0.9966
Mato Grosso do Sul	1.0000	1.0000	1.0000
Mato Grosso	1.0000	1.0000	1.0000
Goiás	1.0000	1.0000	1.0000
Distrito Federal	1.0000	1.0000	1.0000

Table 6

F-Factor for Product Output, by State

State	P015	P017	P018	P024	P084	P087	P090	P091	P092	P094	P096	P097	P099	P101	P102	P108	P109	P113	P114	P115	P116	P118	P124
Rondônia	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Acre	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Amazonas	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Roraima	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Pará	0.9183	0.9783	1.0000	0.4447	0.9969	0.9983	0.9937	1.0000	1.0000	1.0000	1.0000	0.9978	0.9949	0.9492	0.9963	0.9894	0.9970	0.9997	0.9992	0.9968	0.9992	0.9902	0.9984
Amapá	0.3375	0.7810	1.0000	0.0000	1.0000	0.8995	0.9716	0.9837	0.9996	0.9991	0.9992	0.7409	0.6667	0.4167	0.9678	0.9679	0.9580	0.9171	0.9500	0.9528	0.9130	0.8851	0.8738
Tocantins	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Maranhão	0.8204	0.6584	0.9987	0.3476	0.8992	0.9789	0.9906	0.9915	0.9998	0.9998	0.9995	0.2417	0.5755	0.5824	0.9838	0.9776	0.9769	0.9591	0.9861	0.9696	0.9526	0.9462	0.9578
Piauí	0.7959	0.9817	1.0000	0.9992	1.0000	0.9995	0.9952	0.9999	1.0000	0.9999	0.9999	0.9764	0.9722	0.8281	0.9812	0.9946	0.9953	0.9989	0.9967	0.9954	0.9985	0.9893	0.9955
Ceará	0.3602	0.8606	0.0000	0.0023	0.7307	0.9840	0.9747	0.9978	0.9996	0.9998	0.9994	0.0563	0.5780	0.1984	0.9721	0.9683	0.9711	0.9189	0.9857	0.9631	0.9039	0.9197	0.8604
Rio Grande do Norte	0.4529	0.8966	0.8025	0.0137	0.1264	0.9761	0.9633	0.9945	0.9997	0.9998	0.9996	0.5641	0.9193	0.3183	0.9621	0.9459	0.9596	0.9231	0.9949	0.9560	0.7420	0.9251	0.9677
Paraíba	0.6974	0.7984	1.0000	0.6311	0.9049	0.8899	0.9502	0.9869	0.9996	0.9998	0.9995	0.0855	0.8253	0.3960	0.9628	0.9713	0.9608	0.9515	0.9834	0.9321	0.9675	0.9497	0.9731
Pernambuco	0.4854	0.8074	0.0000	0.1373	0.0331	0.9346	0.9653	0.9854	0.9996	0.9997	0.9995	0.0190	0.5912	0.1615	0.9544	0.9671	0.9638	0.9391	0.9779	0.9599	0.8676	0.9264	0.8854
Alagoas	0.8426	0.9155	0.4117	0.1934	0.0150	0.8657	0.9478	0.9885	0.9995	0.9999	0.9994	0.3854	0.6292	0.1499	0.9372	0.9547	0.9565	0.9730	0.9831	0.9455	0.9205	0.9361	0.9625
Sergipe	0.6217	0.9411	0.3934	0.1481	1.0000	0.9965	0.9664	0.9991	0.9997	0.9999	0.9999	0.2303	0.6216	0.2781	0.9718	0.9489	0.9543	0.9907	0.9973	0.9504	0.9467	0.9270	0.9801
Bahia	0.6552	0.8862	0.5133	0.8167	0.8017	0.9750	0.9712	0.9964	0.9998	0.9997	0.9995	0.2058	0.7873	0.2561	0.9634	0.9459	0.9549	0.9790	0.9931	0.9400	0.8718	0.9443	0.9808
Minas Gerais	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Espírito Santo	0.6593	0.8154	0.0000	0.0000	0.0295	0.9687	0.9034	0.9003	0.9995	0.9996	0.9993	0.0012	0.4690	0.3174	0.9463	0.9493	0.9548	0.9505	0.9885	0.9424	0.9460	0.9093	0.9218
Rio de Janeiro	0.5844	0.6416	0.0000	0.0528	0.1299	0.8619	0.9558	0.9660	0.9982	0.9988	0.9993	0.0002	0.5728	0.2933	0.9527	0.9548	0.9451	0.8183	0.8964	0.9450	0.8935	0.8781	0.9574
São Paulo	0.9729	0.9790	0.0000	0.9244	0.9902	0.9931	0.9882	0.9954	1.0000	0.9999	0.9998	0.4473	0.8796	0.8316	0.9826	0.9810	0.9906	0.9979	0.9996	0.9806	0.9988	0.9896	0.9946
Paraná	0.9895	0.9211	1.0000	0.9998	0.9934	0.9866	0.9916	0.9703	1.0000	1.0000	1.0000	0.2343	0.7784	0.9606	0.9899	0.9962	0.9941	0.9938	0.9994	0.9895	0.9993	0.9958	0.9964
Santa Catarina	0.7174	0.6348	1.0000	0.0286	0.1680	0.9209	0.9281	0.9891	0.9998	0.9992	0.9928	0.0079	0.5401	0.5230	0.9230	0.9251	0.9411	0.9486	0.9843	0.9118	0.9629	0.9552	0.8856
Rio Grande do Sul	0.9986	0.9893	1.0000	0.0915	0.6621	0.9951	0.9810	0.9942	0.9999	1.0000	1.0000	0.5904	0.8365	0.9445	0.9831	0.9785	0.9826	0.9957	0.9984	0.9800	0.9987	0.9906	0.9920
Mato Grosso do Sul	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Mato Grosso	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Goiás	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Distrito Federal	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Note: P015 Marine fishing and aquaculture; P017Quarrying of stone, sand and clay; P018 Extraction of crude petroleum and natural gas; P024 Processing and preserving of fish; P084 Building of ships and boats; P087 Maintenance and repair of ships, boats and floating structures; P090 Construction of buildings; P091Civil engineering; P092 Specialized construction activities; P094 Wholesale and retail trade of boats and floating structures; P096 Urban passenger land transport; P097 Water transport; P099 Warehousing and support activities for transportation; P101 Accommodation; P102 Food and beverage service activities; P108 Real estate activities on a fee or contract basis; P109 Real estate activities with own or leased property; P113 Advertising and other technical activities; P114 Rental and leasing of non-real estate assets; P115 Services to buildings and landscape activities; P116 Other business support activities; P118 Public administration and defense; P124 Arts, entertainment and recreation.

Table 7

Systemic Impacts of the Blue Economy in Brazil: GDP by State

State	*GDP (R$ million)*	*Blue economy (R$ million)*			*Blue economy (% of BE total)*			*Blue economy (% of regional total)*		
		Direct effect	*Indirect effect*	*Total effect*	*Direct effect*	*Indirect effect*	*Total effect*	*Direct effect*	*Indirect effect*	*Total effect*
Rondônia	44,314	0	655	655	0.00	0.28	0.15	0.00	1.48	1.48
Acre	14,531	0	139	139	0.00	0.06	0.03	0.00	0.96	0.96
Amazonas	100,768	0	2,002	2,002	0.00	0.84	0.46	0.00	1.99	1.99
Roraima	13,454	0	121	121	0.00	0.05	0.03	0.00	0.90	0.90
Pará	169,957	341	2,424	2,765	0.17	1.02	0.63	0.20	1.43	1.63
Amapá	16,794	780	403	1,183	0.39	0.17	0.27	4.65	2.40	7.05
Tocantins	37,278	0	627	627	0.00	0.26	0.14	0.00	1.68	1.68
Maranhão	88,683	2,079	2,639	4,718	1.05	1.11	1.08	2.34	2.98	5.32
Piauí	49,477	203	862	1,065	0.10	0.36	0.24	0.41	1.74	2.15
Ceará	151,075	4,780	4,791	9,571	2.41	2.02	2.20	3.16	3.17	6.34
Rio Grande do Norte	67,500	2,857	2,418	5,275	1.44	1.02	1.21	4.23	3.58	7.81
Paraíba	62,901	1,307	1,422	2,730	0.66	0.60	0.63	2.08	2.26	4.34
Pernambuco	181,222	4,958	5,539	10,497	2.50	2.33	2.41	2.74	3.06	5.79
Alagoas	55,304	1,522	1,535	3,057	0.77	0.65	0.70	2.75	2.77	5.53
Sergipe	41,767	1,371	1,320	2,691	0.69	0.56	0.62	3.28	3.16	6.44
Bahia	278,752	7,123	9,050	16,174	3.59	3.81	3.71	2.56	3.25	5.80
Minas Gerais	611,831	0	13,342	13,342	0.00	5.62	3.06	0.00	2.18	2.18
Espírito Santo	122,541	15,004	10,741	25,744	7.56	4.52	5.91	12.24	8.76	21.01
Rio de Janeiro	707,612	122,221	68,955	191,175	61.62	29.05	43.88	17.27	9.74	27.02
São Paulo	2,126,529	21,447	67,099	88,547	10.81	28.27	20.32	1.01	3.16	4.16
Paraná	438,071	2,086	10,396	12,482	1.05	4.38	2.86	0.48	2.37	2.85
Santa Catarina	287,136	7,987	9,971	17,959	4.03	4.20	4.12	2.78	3.47	6.25
Rio Grande do Sul	452,720	2,265	9,112	11,377	1.14	3.84	2.61	0.50	2.01	2.51
Mato Grosso do Sul	101,920	0	1,808	1,808	0.00	0.76	0.41	0.00	1.77	1.77
Mato Grosso	138,835	0	2,356	2,356	0.00	0.99	0.54	0.00	1.70	1.70
Goiás	198,357	0	3,093	3,093	0.00	1.30	0.71	0.00	1.56	1.56
Distrito Federal	255,075	0	4,547	4,547	0.00	1.92	1.04	0.00	1.78	1.78
Brazil	**6,814,405**	**198,332**	**237,367**	**435,699**	**100.00**	**100.00**	**100.00**	**2.91**	**3.48**	**6.39**

Table 8

Systemic Impacts of the Blue Economy in Brazil: Employment by State

State	*Employment*	*Blue economy (workers)*			*Blue economy (% of BE total)*			*Blue economy (% of regional total)*		
		Direct effect	*Indirect effect*	*Total effect*	*Direct effect*	*Indirect effect*	*Total effect*	*Direct effect*	*Indirect effect*	*Total effect*
Rondônia	899,233	0	14,678	14,678	0.00	0.41	0.31	0.00	1.63	1.63
Acre	337,851	0	5,309	5,309	0.00	0.15	0.11	0.00	1.57	1.57
Amazonas	1,835,105	0	31,236	31,236	0.00	0.87	0.66	0.00	1.70	1.70
Roraima	241,170	0	2,994	2,994	0.00	0.08	0.06	0.00	1.24	1.24
Pará	3,907,104	7,612	69,055	76,667	0.67	1.93	1.62	0.19	1.77	1.96
Amapá	367,399	8,315	13,111	21,426	0.73	0.37	0.45	2.26	3.57	5.83
Tocantins	727,768	0	13,259	13,259	0.00	0.37	0.28	0.00	1.82	1.82
Maranhão	2,585,295	28,157	78,951	107,109	2.48	2.20	2.27	1.09	3.05	4.14
Piauí	1,445,975	8,770	28,422	37,193	0.77	0.79	0.79	0.61	1.97	2.57
Ceará	4,206,292	100,169	140,010	240,179	8.82	3.90	5.09	2.38	3.33	5.71
Rio Grande do Norte	1,481,915	41,600	59,682	101,282	3.66	1.66	2.15	2.81	4.03	6.83
Paraíba	1,651,876	24,311	47,152	71,463	2.14	1.32	1.51	1.47	2.85	4.33
Pernambuco	4,046,333	89,218	131,350	220,568	7.85	3.66	4.67	2.20	3.25	5.45
Alagoas	1,140,538	24,211	34,351	58,561	2.13	0.96	1.24	2.12	3.01	5.13
Sergipe	1,061,920	16,009	37,281	53,290	1.41	1.04	1.13	1.51	3.51	5.02
Bahia	6,510,326	104,030	204,428	308,459	9.16	5.70	6.53	1.60	3.14	4.74
Minas Gerais	11,499,544	0	216,739	216,739	0.00	6.04	4.59	0.00	1.88	1.88
Espírito Santo	2,162,045	61,868	185,992	247,860	5.45	5.19	5.25	2.86	8.60	11.46
Rio de Janeiro	8,612,945	351,544	963,034	1,314,578	30.94	26.86	27.84	4.08	11.18	15.26
São Paulo	25,538,967	127,110	728,341	855,451	11.19	20.31	18.12	0.50	2.85	3.35
Paraná	6,293,540	24,605	143,434	168,038	2.17	4.00	3.56	0.39	2.28	2.67
Santa Catarina	4,180,150	93,410	156,212	249,622	8.22	4.36	5.29	2.23	3.74	5.97
Rio Grande do Sul	6,457,951	25,173	129,065	154,238	2.22	3.60	3.27	0.39	2.00	2.39
Mato Grosso do Sul	1,483,170	0	25,991	25,991	0.00	0.72	0.55	0.00	1.75	1.75
Mato Grosso	1,889,917	0	34,721	34,721	0.00	0.97	0.74	0.00	1.84	1.84
Goiás	3,807,675	0	61,102	61,102	0.00	1.70	1.29	0.00	1.60	1.60
Distrito Federal	1,623,755	0	29,712	29,712	0.00	0.83	0.63	0.00	1.83	1.83
Brazil	**105,995,759**	**1,136,111**	**3,585,613**	**4,721,723**	**100.00**	**100.00**	**100.00**	**1.07**	**3.38**	**4.45**

Table 9

Systemic Impacts of the Blue Economy in Brazil: GDP by Sector

Sector	*GDP (million, BRL)*	*Blue economy (million, BRL)*			*Blue economy (sectoral share)*			*Blue economy (%GDP)*		
		Direct effect	*Indirect effect*	*Total effect*	*Direct effect*	*Indirect effect*	*Total effect*	*Direct effect*	*Indirect effect*	*Total effect*
Agriculture	304,614	211	7,437	7,648	0.11	3.13	1.76	0.07	2.44	2.51
Marine fishing and aquaculture	28,359	2,029	848	2,877	1.02	0.36	0.66	7.15	2.99	10.15
Quarrying of stone, sand and clay	9,014	557	659	1,216	0.28	0.28	0.28	6.18	7.31	13.49
Extraction of crude petroleum and natural gas	125,652	109,399	1,259	110,658	55.16	0.53	25.40	87.07	1.00	88.07
Manufacture of food products	61,281	679	1,338	2,017	0.34	0.56	0.46	1.11	2.18	3.29
Manufacture of other transport equipment	10,688	1,027	113	1,140	0.52	0.05	0.26	9.61	1.06	10.67
Repair and installation of machinery and equipment	33,595	1,658	3,505	5,163	0.84	1.48	1.18	4.94	10.43	15.37
Other industrial activities	1,116,309	394	46,401	46,795	0.20	19.55	10.74	0.04	4.16	4.19
Construction	270,889	3,537	8,927	12,463	1.78	3.76	2.86	1.31	3.30	4.60
Wholesale and retail trade	746,396	847	27,197	28,044	0.43	11.46	6.44	0.11	3.64	3.76
Water transport	11,435	8,374	429	8,803	4.22	0.18	2.02	73.23	3.75	76.98
Warehousing and support activities for transportation	88,984	16,343	5,481	21,825	8.24	2.31	5.01	18.37	6.16	24.53
Accommodation	18,140	5,941	305	6,246	3.00	0.13	1.43	32.75	1.68	34.43
Food and beverage service activities	158,644	3,745	2,012	5,758	1.89	0.85	1.32	2.36	1.27	3.63
Real estate activities	624,578	12,693	8,565	21,258	6.40	3.61	4.88	2.03	1.37	3.40
Professional, scientific and technical activities	45,479	1,075	2,400	3,475	0.54	1.01	0.80	2.36	5.28	7.64
Administrative and support service activities	196,691	5,277	8,721	13,998	2.66	3.67	3.21	2.68	4.43	7.12
Public administration and defence	666,202	21,950	8,285	30,235	11.07	3.49	6.94	3.29	1.24	4.54
Arts, entertainment and recreation	27,467	674	479	1,153	0.34	0.20	0.26	2.45	1.74	4.20
Other service activities	2,269,988	1,922	103,005	104,927	0.97	43.39	24.08	0.08	4.54	4.62
Total	**6,814,405**	**198,332**	**237,367**	**435,699**	**100.00**	**100.00**	**100.00**	**2.91**	**3.48**	**6.39**

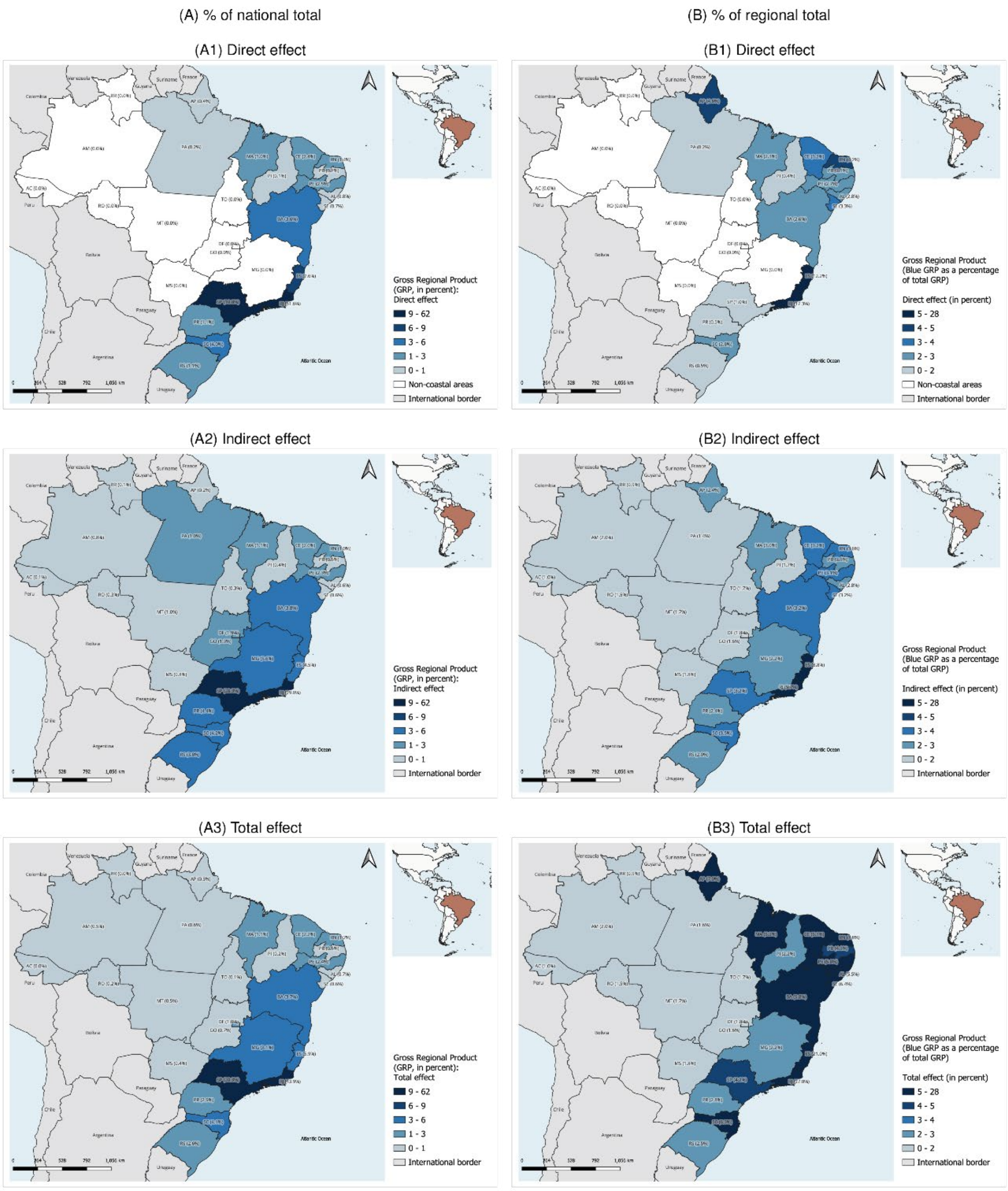
Table 10

Systemic Impacts of the Blue Economy in Brazil: Employment by Sector

Sector	*Employment*	*Blue economy (workers)*			*Blue economy (sectoral share)*			*Blue economy (%employment)*		
		Direct effect	*Indirect effect*	*Total effect*	*Direct effect*	*Indirect effect*	*Total effect*	*Direct effect*	*Indirect effect*	*Total effect*
Agriculture	12,340,622	20,620	366,083	386,703	1.81	10.21	8.19	0.17	2.97	3.13
Marine fishing and aquaculture	847,266	68,469	26,790	95,259	6.03	0.75	2.02	8.08	3.16	11.24
Quarrying of stone, sand and clay	111,278	8,326	9,165	17,491	0.73	0.26	0.37	7.48	8.24	15.72
Extraction of crude petroleum and natural gas	52,669	42,470	700	43,170	3.74	0.02	0.91	80.64	1.33	81.97
Manufacture of food products	784,540	10,045	17,344	27,389	0.88	0.48	0.58	1.28	2.21	3.49
Manufacture of other transport equipment	80,570	9,563	1,104	10,667	0.84	0.03	0.23	11.87	1.37	13.24
Repair and installation of machinery and equipment	549,899	17,702	52,544	70,246	1.56	1.47	1.49	3.22	9.56	12.77
Other industrial activities	10,383,345	4,784	384,759	389,543	0.42	10.73	8.25	0.05	3.71	3.75
Construction	7,745,390	101,700	260,748	362,448	8.95	7.27	7.68	1.31	3.37	4.68
Wholesale and retail trade	15,985,827	18,472	583,388	601,860	1.63	16.27	12.75	0.12	3.65	3.76
Water transport	52,972	33,618	2,935	36,553	2.96	0.08	0.77	63.46	5.54	69.00
Warehousing and support activities for transportation	832,617	135,729	44,651	180,381	11.95	1.25	3.82	16.30	5.36	21.66
Accommodation	445,384	152,626	7,272	159,899	13.43	0.20	3.39	34.27	1.63	35.90
Food and beverage service activities	5,884,294	128,419	71,650	200,069	11.30	2.00	4.24	2.18	1.22	3.40
Real estate activities	479,340	10,007	6,667	16,674	0.88	0.19	0.35	2.09	1.39	3.48
Professional, scientific and technical activities	676,741	18,610	36,261	54,871	1.64	1.01	1.16	2.75	5.36	8.11
Administrative and support service activities	4,262,858	117,352	181,357	298,709	10.33	5.06	6.33	2.75	4.25	7.01
Public administration and defence	4,793,630	168,400	53,745	222,145	14.82	1.50	4.70	3.51	1.12	4.63
Arts, entertainment and recreation	1,187,141	32,792	19,929	52,721	2.89	0.56	1.12	2.76	1.68	4.44
Other service activities	38,499,376	36,406	1,458,521	1,494,926	3.20	40.68	31.66	0.09	3.79	3.88
Total	**105,995,759**	**1,136,111**	**3,585,613**	**4,721,723**	**100.00**	**100.00**	**100.00**	**1.07**	**3.38**	**4.45**

Figure 8

Decomposition of the Systemic Impacts of the Blue Economy in Brazil



IV. FINAL REMARKS

Measurement is the cornerstone of reliable evidence that informs effective, accountable policymaking (Head, 2016). In this paper, we tackled the challenge of quantifying the contribution of blue economy activities to national, regional and local output and employment in Brazil, while also assessing the economic interconnectedness between coastal and hinterland areas through interregional input-output linkages. These linkages reveal the interdependencies between various sectors of the economy. What emerged is a structurally diverse blue economy with strong geographical variations across sectors and regions. Therefore, national sectoral policies targeting specific blue economy activities are expected to have differential spatial impacts.

Brazil has been slow to implement coordinated policies for the sustainable use of its marine resources. Despite having a National Policy for Sea Resources ("Política Nacional para os Recursos do Mar – PNRM") and a broader National Maritime Policy (Política Marítima Nacional – PMN), the country is still in its infancy regarding public policies aimed at the sustainable utilization of ocean resources for economic growth, improved livelihoods, and environmental sustainability (Andrade *et al.*, 2022).

As Brazil moves forward with actions to achieve the UN Sustainable Development Goal 14 ("Life Below Water") by 2030, it is crucial to consider local nuances when designing economic policies for coastal areas. Policymakers need to tailor interventions to address specific regional needs and leverage on local strengths more effectively. Natural resources (such as oil, gas, fisheries, and climate) and man-made resources (including human capital, cultural heritage, and infrastructure) are unevenly distributed along the coast, creating a complex pattern of locational advantages for blue economy activities, as revealed in our estimates. Moreover, analyzing the blue economies within the context of integrated regional systems—given the limitations of studies that examine a single region or activity in isolation (Batey and Madden, 1986)—emphasizes the interconnectedness of regional economies and the need for coordinated approaches to address shared challenges and opportunities.

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