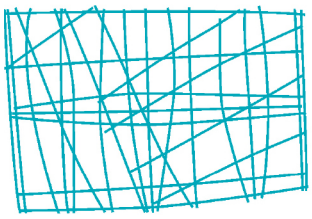

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Núcleo de Economia Regional e Urbana
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The University of São Paulo
Regional and Urban Economics Lab

SHADES OF BLUE: THE GEOGRAPHY OF THE OCEAN ECONOMY IN BRAZIL

Eduardo A. Haddad
Inácio F. Araújo

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Shades of Blue: The Geography of the Ocean Economy in Brazil

Eduardo A. Haddad and Inácio F. Araújo

Abstract. We quantify blue economy contributions and analyze coast-hinterland economic interdependence through interregional linkages The study advances by adopting a multi-level approach, analyzing municipality and state-level data of ocean-related activities. Using an interstate input-output model, we estimate the blue economy's value chains, enhancing our understanding of its systemic impacts. We address gaps in national, regional, and local blue economy assessments, providing insights for tailored policies in Brazil's diverse coastal regions as Brazil aims for UN Sustainable Development Goal 14 by 2030. Our analysis underscores the diverse blue economy structure and regional disparities, advocating for the coordination of sector and region-specific policies. Embracing an integrated regional approach acknowledges the interconnectedness of coastal economies to address shared challenges and capitalize on regional strengths effectively.

1. Introduction

The "blue economy" has been attracting increasing attention from policymakers and the research community. Broadly speaking, the blue economy refers to the sustainable use of ocean resources for economic growth, improved livelihoods, and environmental sustainability. It encompasses various sectors, including fisheries, aquaculture, tourism, shipping, renewable and non-renewable energy, and marine biotechnology.[1]

Special interest in quantifying its economic contribution has generated a strand of research in the last few years. Initial efforts provided opportunities to test and adapt different methodologies anchored in national accounting frameworks, attempting to measure the contribution of individual blue economy industries to domestic economic activity. The emergence of Sea Satellite Accounts embedded in countries' Systems of National Accounts (SNA) statistics (Ram et al., 2019; Statistics Portugal, 2016; Nicolls et al., 2020) contributes to a movement towards

[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).

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 attempts to isolate the contribution of the blue economy to a country or region have been made using approaches with different methodological twists and include examples for 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), European Union (European Commission, 2021), Philippines (Philippine Statistics Authority, 2022), and Poland (Kwiatkowski and Zaucha, 2023), among others. The lack of standardizing and harmonizing practices still makes it imperfect a comprehensive comparability of the results (Graziano et al., 2022). Given this caveat, the focus on estimating aggregate contributions to national economies has generated a plethora of figures showing the blue economy's share in GDP for different 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, to our knowledge, Carvalho (2018), and Carvalho and Moraes (2021) provide a first attempt to quantify the blue economy from a sectoral perspective. According to their estimates, based on the isolation of marine sectors embedded in a national input-output table, Brazilian marine economies[2] generated 2.6% of the national GDP in 2015. The authors also included in their estimates the broader coastal economies, defined by the total GRP of all other non-marine activities for each municipality facing the ocean. Altogether, marine and coastal economies contributed 19.0% to national GDP in that year. Nonetheless, from a regional policy perspective, the aggregate nature of the estimates constrains their usefulness for the design of blue economy strategies tailored to address specific needs and challenges of economically diverse coastal areas in the country. Understanding local and regional differences improves the implementation of targeted interventions.

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

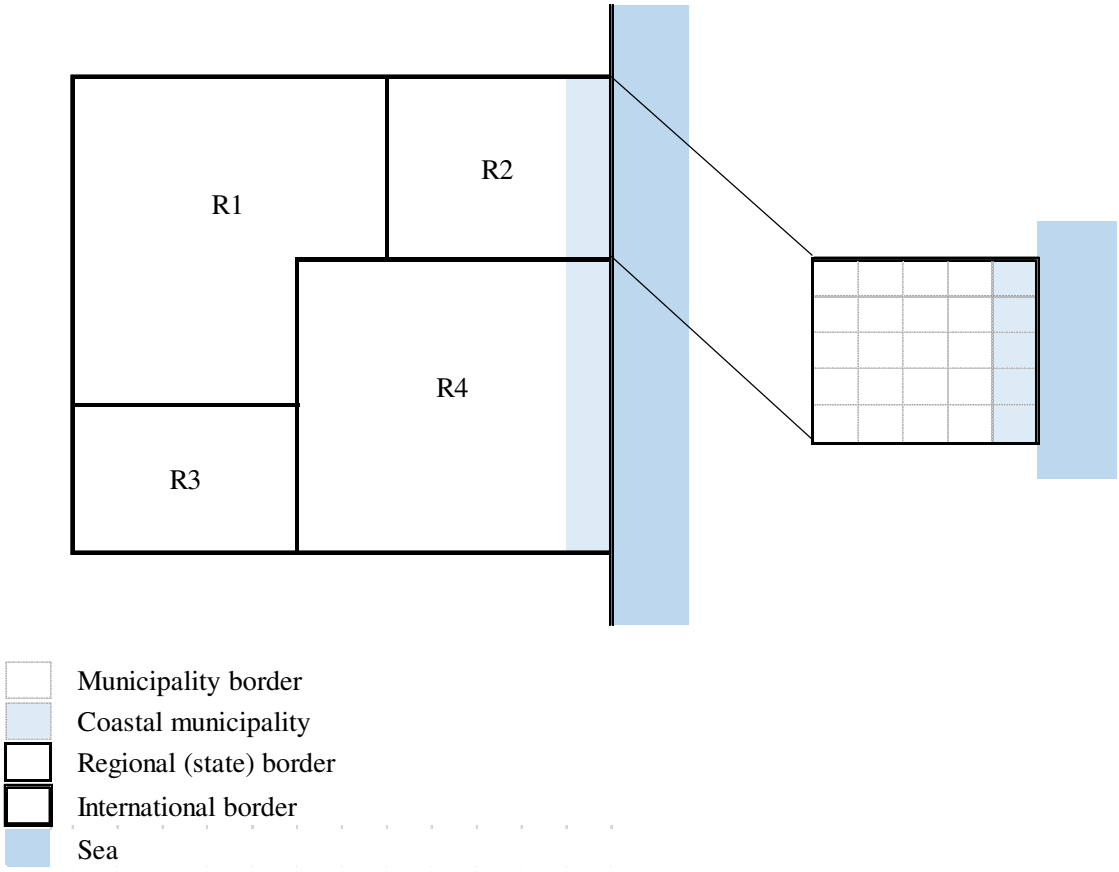
Adding to the pioneering efforts by Carvalho (2018), we give a step forward in the quantification of the blue economy in Brazil from a geographical perspective. We adopt a multi-level approach, relying on information at the municipality and state levels, and different levels of classification of economic activities. We provide estimates of the size and economic structure of the blue economy in Brazilian municipalities and states. Moreover, we also consider a value-chain perspective by estimating the indirect effects of the blue economy at the state level through the partial extraction method applied to an interstate input-output (IIO) model for the country. Our approach benefits from rich geographical and sectoral data, and the availability of an IIO table that serves as the basis for the assessment of the blue economy's systemic effects incorporating backward and forward linkages. By measuring how the blue economy affects other sectors and regions through indirect channels, policymakers gain a deeper understanding of the economy's complexity and interconnectedness. Thus, this paper adds to the current literature on the measurement of the blue economy by offering an alternative systemic approach to quantify the different shades of blue in a big country's economy with a long coastline hosting diverse local and regional economies.

2. Methodology

We consider a country divided into different regions (e.g. states). In our stylized example (Figure 1), there are four regions in the country (R1, R2, R3 and R4). There are two landlocked regions (R1 and R3), and two coastal regions (R2 and R4). We can divide each region into several sub-regions (e.g. municipalities). For instance, R2 is divided into 25 subregions, five of them facing the sea. Given data availability, we have richer information at the regional level compared to the sub-regional level. Likewise, we have richer information at higher levels of classification of economic activities. The challenge is twofold. First, we need to define and isolate the contribution of activities related to the sea, specified at a lower level of sectoral aggregation, which, according to our framework, are located only in coastal, sea-shore adjacent sub-regions. It will allow us to quantify the magnitude of the blue economy in each sub-region/region. In our definition, we consider direct activities that either are developed in the sea or yield products that are used in the

sea. Second, after moving to a higher level of regional and sectoral aggregation due to the availability of interregional input-output information, we need to calculate the systemic economic contribution of the blue economy, estimating its multiplier effects.

Figure 1. Schematic Representation of the Multi-Level Geographical Setting



2.1. General Framework

Regional setting

Consider there are R regions, r = 1, ..., R, which exhaust the space of a country's economy. Each region is further divided into a finite number of sub-regions, M^r, $m^r = 1, \dots, M^r$, for all r = 1, ..., R. Notice that the number of sub-regions can vary across regions.

Production setting

There are C firms in the country, c = 1, ..., C, allocated to J sectors, j = 1, ..., J. Firms are characterized by a production set Y^c contained in the sectoral production set Y^j they belong, and they are spatially distributed in M^r sub-regions in each of the R regions. Moreover, firms can be allocated to a sub-sector within j based on its main output characteristics. Thus, within a given sector j, there may be Q^j different sub-sectors, $q^j = 1, \dots, Q^j$, for all j = 1, ..., J. Each firm produces one unit of output irrespective of its sub-sector and location.

Blue economy setting

We consider two dimensions associated with the blue economy. The spatial dimension is related to identifying the subset of sub-regions facing the sea. We define $\breve{M}^r$ as a subset of coastal sub-regions in r, $\breve{m}^r = 1, \dots, \breve{M}^r$. 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 $\breve{m}^r$), that are directly associated with the presence of the sea, with $\breve{q}^j = 1, \dots, \breve{Q}^j$, for all j = 1, ..., J. In sum, the blue economy universe includes activities directly related to the sea ($\breve{q}^j$) that take place in the coastal territory 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 $0 \leq C_{(q^j)}^{(m^r)} \ll C$ 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 $q^j = 1, \dots, Q^j$, 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, $\breve{m}^r = 1, \ldots, \breve{M}^r$, 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 $q^j = 1, \ldots, Q^j$, 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:

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

2.2. 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 taken into consideration through the explicit specification of interregional trade linkages.

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

Figure 2. Interregional Input-Output Flows

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

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

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

l_j^s and n_j^s, with $j = 1, \dots, J$ and $s = 1, \dots, R$ 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 $i = 1, \dots, J$ and $r = 1, \dots, R$ represent the regional components of final demand, $f_i^{r\bullet}$, respectively, household purchases, investment purchases, government purchases, and exports from region *r*

x_i^r, with $i = 1, \dots, J$ and $r = 1, \dots, R$ 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 $j = 1, \dots, J$ and $r = 1, \dots, R$, is the total sectoral output related to the sea in region *r*.

Thus, we define *j*x*s* factors (F_j^s) where $0 < F_j^s < 1$, specifying the share of output in each sector in each region that is not directly related to the sea economy. This allows the model to be responsive to sector-region specific characteristic. For instance, in a landlocked region, we set the factor to unity; for activities in coastal regions that would face stronger relation with the sea, such as seawater fishing, marine salt and gem salt extraction and refine, or offshore oil and natural gas extraction, we set the factor closer to zero. Once we have computed the factors, F_j^s, the next step is to use this set of information to partially extract some of the sectoral flows in the interregional input-output table, considering both demand and supply reductions.

Interindustry demand:

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

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

Final demand:

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

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

F_c^s is calculated based on total aggregate earnings in region *s*, excluding earnings by workers in region *s* employed in those activities related to the sea economy. Total labor income earned by informal and formal workers in blue economy activities is, thus, deduced from total labor income in the region, such that F_c^s defines the share of income that is not directly related to the sea. We then assume aggregate labor income is fully translated into household demand changes. Other possible income-related changes, such as government transfers to specific groups of workers would also affect F_c^s after properly mapped into household purchases.

F_i^s is calculated based on the share of total regional gross operational surplus that is unrelated to blue economy activities. Analogously, F_g^s is calculated based on the allocation of net indirect taxes and production taxes between the two groups of activities, namely, those directly related and those unrelated to the sea. F_g^s will include only the share of government revenue raised in region *s* from taxes levied on non-marine activities.

$F_e^\bullet$ is set to unity. The implicit assumption is that export demand is fully exogenous.

Thus, considering 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 the diminished sectoral flows, we have now two matrices of interindustry flows, $\mathbf{Z}$ and $\overline{\mathbf{Z}}$, and 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 consists of the hypothetical extraction of a sector in the input-output matrix.[4] The purpose is to quantify how much the total output of an economy with

[4] The regional approach to the extraction method, applied in Dietzenbacher et al. (1993), was originated by Miller (1966, 1969).

J sectors and *R* regions could change (or reduce) if a particular sector were removed from this economy. This enables the analysis of sector and region economic relevance, within a given economic structure; given its extraction and consequent reduction in the level of activity in the economy. Note that greater the level of interdependence of such a sector in relation to other sectors, greater the systemic impact.

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

In the complete interregional input-output model, with 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:

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

Therefore, after the partial extraction:

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

where **T** is the aggregate measure of annual loss in the economy – decrease in total output if the output associated with the ocean-related activities "disappears". In other words, it is a measure of the relative importance of activities related to the existence of the sea, or the total linkages with which such activities are associated.

We can translate sectoral gross output outcomes in other variable outcomes. To do so we multiply the vector of gross output, $\mathbf{x}$ or $\bar{\mathbf{x}}$, by a diagonal matrix, $\hat{\mathbf{v}}$, whose main diagonal contains the variable's coefficients, i.e. the ratios of the variable values by sector-region divided by the respective sectoral-regional gross output.

3. Results

Brazil has a land area of approximately 8.5 million square kilometers (3.2 million square miles) with a coastline that spans approximately 7,491 kilometers (4,655 miles) along the Atlantic Ocean. The country is divided into 26 states and one federal district. Each state has its own government and is further divided into municipalities. Brazil has a total of 5,570 municipalities, out of which 280 face the Atlantic Ocean directly. They are located in 17 different states (Map 1).

Map 1. Brazilian Coastal Municipalities

Brazilian coastal municipalities cover an area of 251 thousand square kilometers and hosted, in 2019, a population of 39 million inhabitants (18.5% of the national total). Altogether, they generated 19.5% of Brazil's GDP and 18.2% of the national gross output in 2019.

We collected production data at the municipality level. We anchored our estimates in 2019 gross output information from Haddad et al. (2023) for 128 commodities (products) that span the whole economy, classified according to Brazil's National Account System.

The process of generating the municipality-level product information is fully consistent with Brazilian regional and national accounts.

We also collected 2019 employment and labor income data for all Brazilian municipalities at a finer level of activity disaggregation. Data from RAIS (Brazilian Ministry of Labor) are available for 1,331 different categories (subsectors). We identified 83 subsectors that either operate on the ocean (e.g. sea fishing, prospection of conventional energy resources – oil and gas; maritime freight transport), or do not operate on the ocean but depend on it (e.g. processing of fishing; sea salt extraction and refining; coastal tourism; imputed rents for second home), or both (e.g. shipbuilding; port infrastructure and operations; coastal defence). By allocating 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 generation in each coastal municipality using employment and labor income shares. For some products, though, we relied on complementary information (e.g. share of residential units for occasional use; share of leisure tourism in total tourism; navy expenditures).

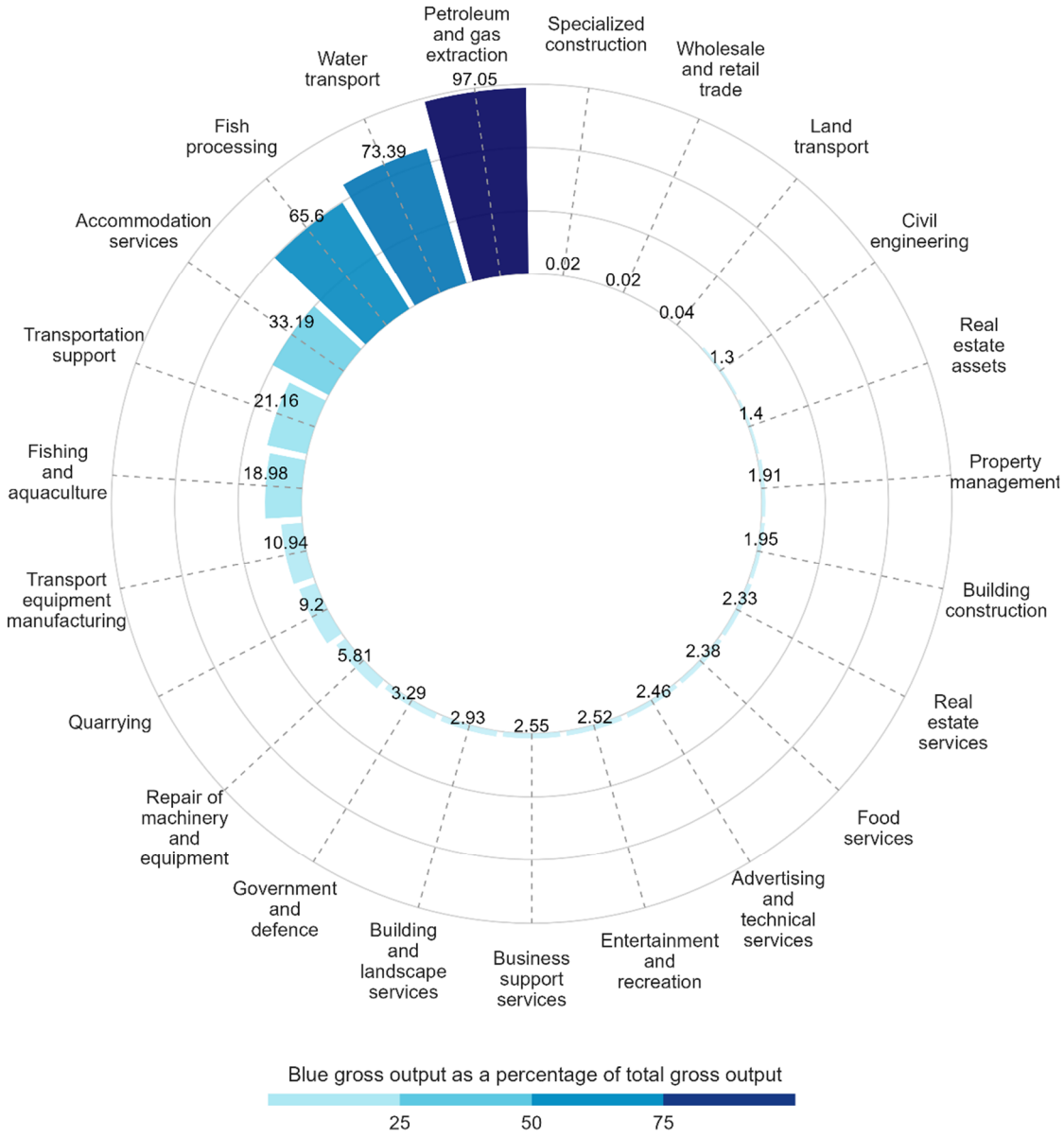
3.1. Direct Contribution

According to our estimates, in 2019 the blue economy was responsible for 2.90% of Brazil' 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 for the gross output of different products, aggregated across municipalities. Overall, petroleum and gas extraction (97.0%), water transport (73.4%), and fishing processing (65.6%) stand out as the blue economy generates over 50% of their national gross output. Accommodation services (33.2%), transportation support (21.2%), and fishing and aquaculture (19.0%) also are relatively concentrated in coastal municipalities, since the respective shares allocated to the blue economy are greater than their "fair" share, given by the contribution of those municipalities to the national gross output (18.2%)

Table 1. The 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 for the gross output of each coastal municipality, aggregating our base estimates across products. Table 2 presents the results for the largest "blue local economies". Municipalities are ranked according to their total output directly associated with blue economy activities. The top 10 – eight of them oil-producing municipalities located in the state of Rio de Janeiro – account for 60% of the blue 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 information at the state-level to be used in our model calibrated with data from the 2019 interstate input-output system for Brazil. Table 3 presents aggregated estimates for each state. Rio de Janeiro (63.5%), São Paulo (10.3%), and Espírito Santo (8.6%) are the three largest blue state-economies, concentrating 82.4% of the total gross output, heavily influenced by the presence of offshore oil and natural gas extraction. However, the relative importance of the blue economy for each state (Table 3 and Figure 4) is more prominent 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 its share in total regional output is at least as large as its share in the national economy (2.9%).

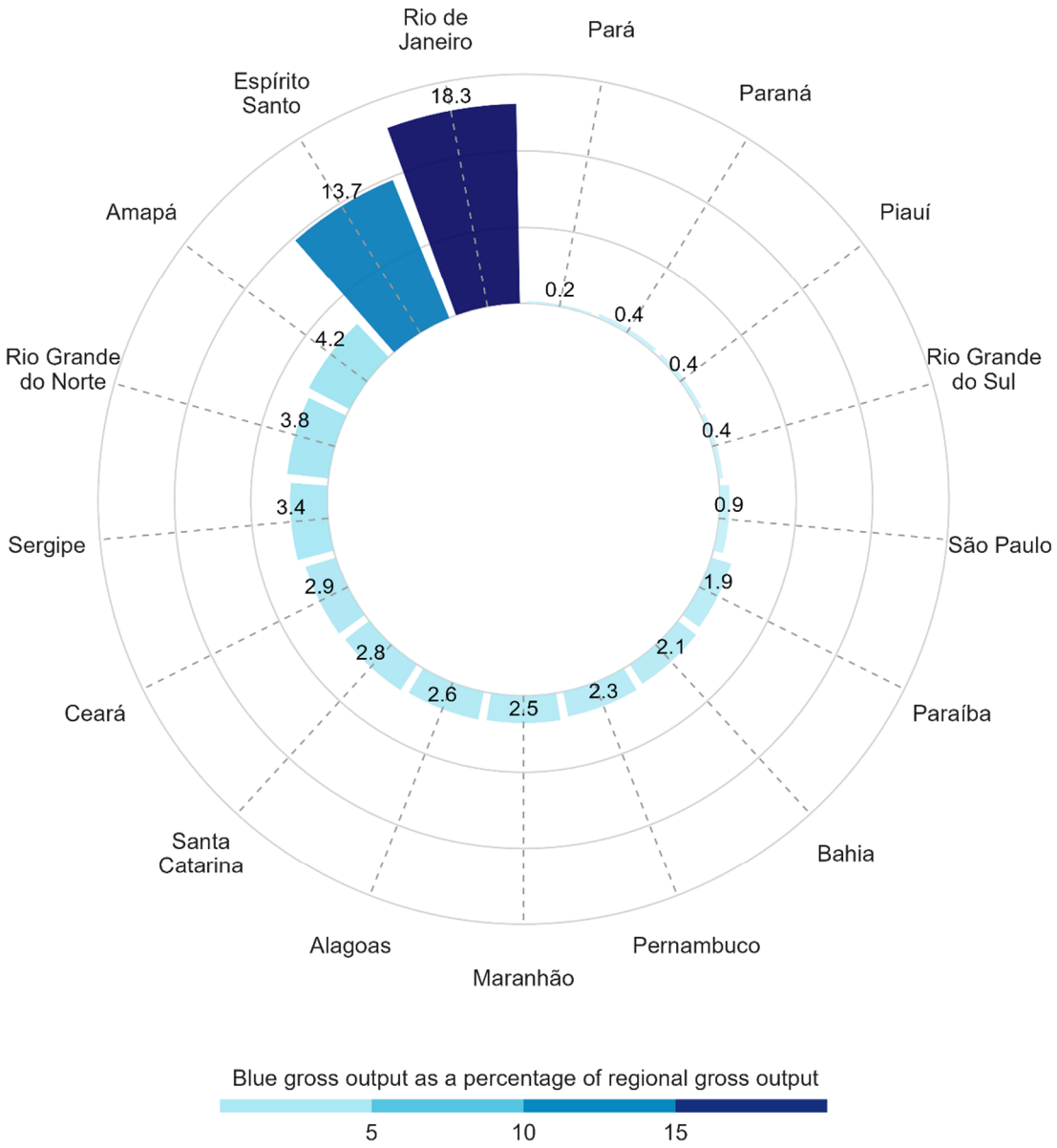
Table 2. The Geography of the Blue Economy in Brazil: Gross Output in 2019, by Municipality (Top 50)

#	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. The 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%**

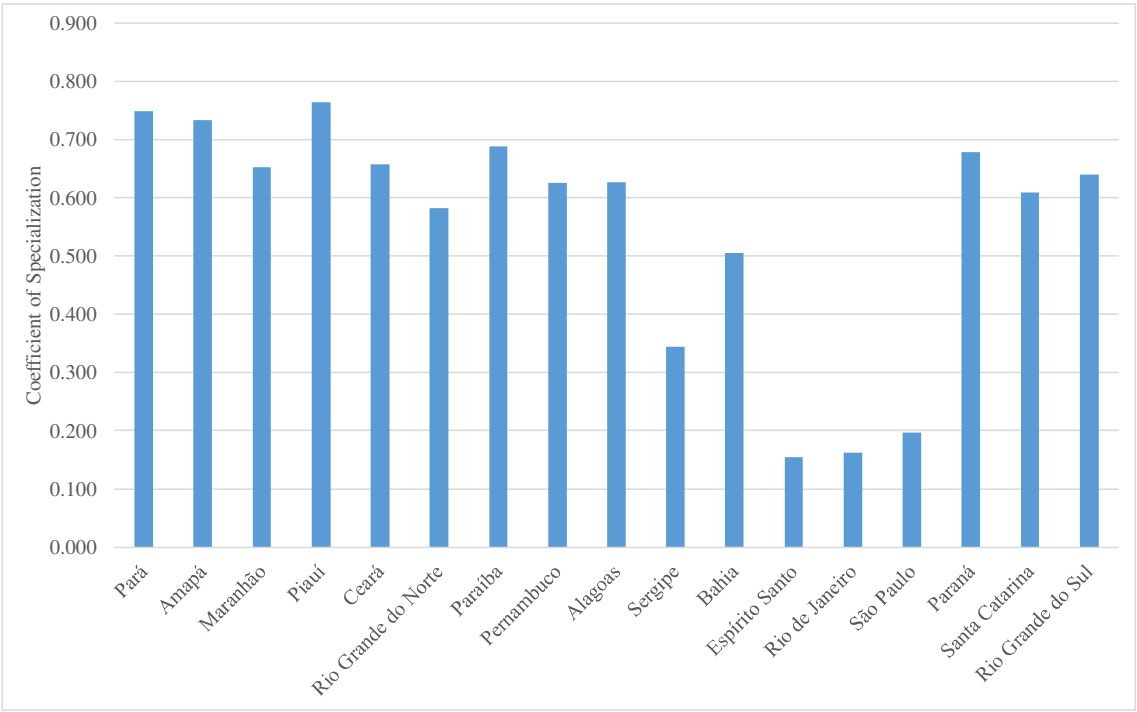
Figure 4. Share of the Blue Economy in Regional Gross Output, by State



3.2. Regional Heterogeneity

The Brazilian blue economy is not homogeneous internally, presenting variations across regional blue economies. At the state level, Table 4 relates blue economy gross output by product viewed as a system of coastal states showing their respective contribution for each product' output. At the bottom of the table, one finds the structure of the national blue economy. One way of comparing the regional structures with the national structure is the use of the coefficient of specialization, which measures the diversity in a region in reference to the aggregate distribution. Its lowest possible value is 0, which means gross output is distributed in the state in the same proportion as the nation; the highest possible is 1 (Hoover and Giarratani, 1971). Thus, the more similar is the regional structure to the national, the closer to 0 the value is. Figure 5 plots the values of the coefficient of specialization for the 17 state economies revealing important 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 shows, for instance, that P018 (Extraction of crude petroleum and natural gas) represents 60.4% of Brazil's total, being relatively more concentrated in Rio de Janeiro (75.5% of the state total) and Espírito Santo (71.3%). On the other hand, P101 (Accommodation), with an overall contribution of 2.9%, presents

much higher importance to states in Brazil's northeast, such as Ceará (20.8% of the state total), Bahia (16.9%), Alagoas (13.8%), and Pernambuco (13.6%). We can adopt the concept of relative concentration of economic activities to create a typology of state blue economies. We used the location quotient (LQ), a statistical measure widely 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 levels 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, grouping related products in four clusters of similar activities in a region: (i) fishing, (ii) maritime transport, (iii) coastal tourism, and (iv) defence. We calculated the LQ for each clustering of products in each state, revealing their specific relative concentration. We then used the LQ information to generate a hinge-based circle (HBC) figure that further reveals structural differences across regional blue economies in Brazil. To do that, we had to limit the LQ estimates in the range [-1, 1] redistributing, for each cluster, values above 1 between [0, 1] and values smaller than 1 between [-1, 0]. Figure 5 presents the resulting HBC figure including the four variables based on these vectors.

Figure 6 summarizes the LQ results focusing on the structural regional specialization in blue economic clusters in Brazilian states. We use a visualization technique that provides an opportunity to explore regional characteristics of the country's blue economy, reflecting the spatial economic phenomena of sectoral specialization. The results are presented in a way that helps identify the different configurations of economic structures from a region's perspective.

The normalized vectors for the first two clusters (coastal tourism and maritime transport) in a Cartesian plan, over their respective axes (coastal tourism is represented in the x-axis and maritime transport is in the y-axis), and their vector sum results in a vector that defines the direction and the sense in which the point will be plotted. The following step is to take the intersection of this resultant vector and a circumference with radius one and center in the origin of the Cartesian plan defined before. Departing from this so-defined point, we plot the normalized vector of the "fishing" cluster (with the same direction of the resultant vector mentioned above). Positive values (high relative specialization) for

the third clusters are represented as pointing to the center of the circumference and, thus, falling inside the circle. Negative values (low relative specialization), on the other hand, fall outside the circle. This is so that the states less specialized in fishing are located outside the circle.

Figure 6 considers all kinds of signs combinations among the three clusters. Thus, taking the results from the three (transformed) LQs, we compare the importance of each cluster to the Brazilian states, which allows us to understand relative differences in structural characteristics in the country's state blue economies. One last piece of information represented in Figure 6 refers to the fourth cluster, "defence": for above-average values (high relative specialization), the symbol representing the state is a blue triangle turned up, and in the opposite case, it is an upside-down brown triangle.

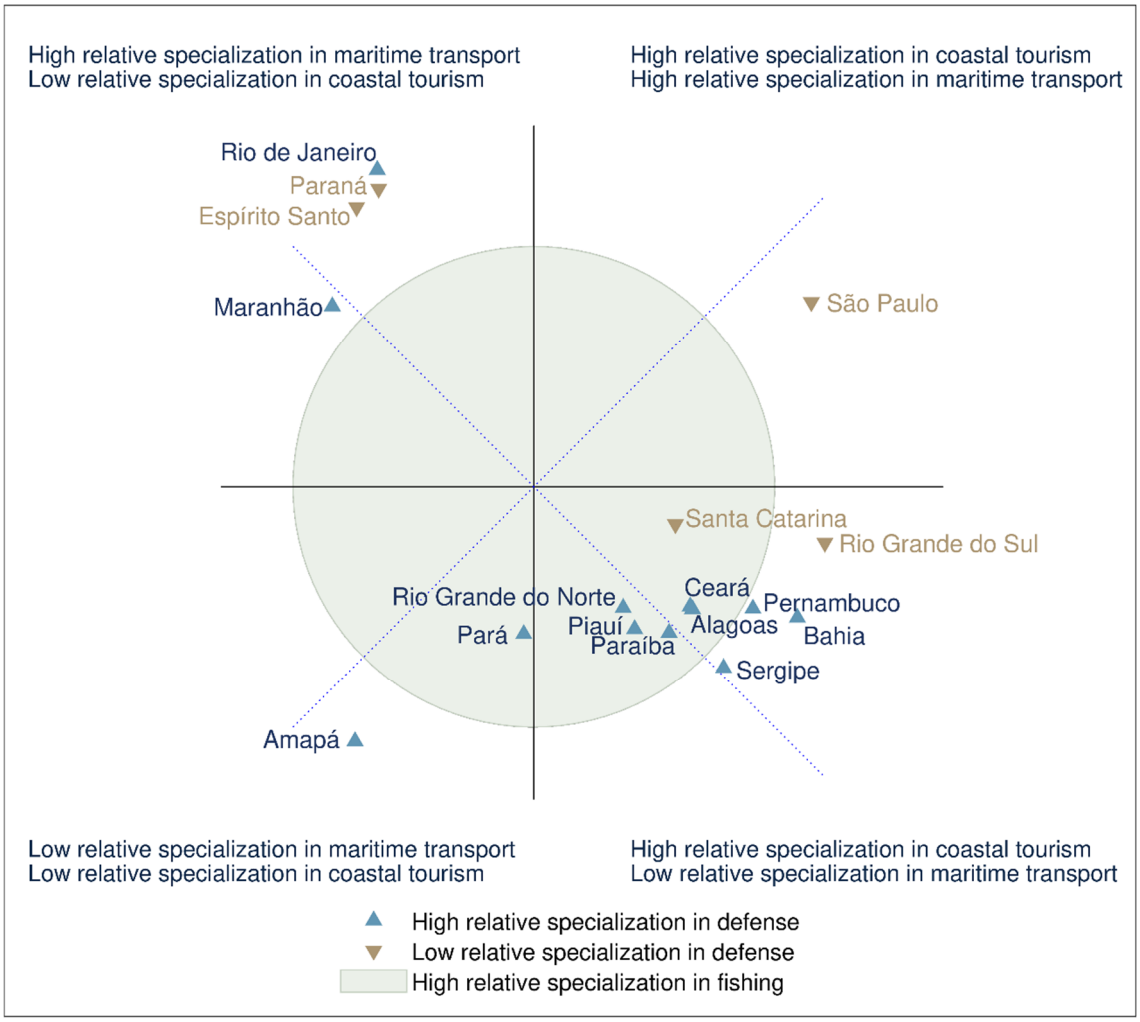
With the exception of Maranhão, states in Brazil's northeast (Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe and Bahia) located in the southeast quadrant of Figure 6), present evidence of specialization in coastal tourism activities with lower values for the LQ related to maritime transport activities. Coastal states in Brazil's southeast (Espírito Santo, Rio de Janeiro, and São Paulo), extending to the southern state of Paraná, show relative specialization in maritime transport – two upper quadrants. Different geographical patterns emerge for the other two clusters. Fishing is relatively concentrated in the northern portion of the Atlantic Ocean (located inside the circle), covering state economies from Pará to Rio Grande do Norte, and the states of Paraíba and Alagoas, while defence is relatively more concentrated from Rio de Janeiro northwards along the coast, excluding only Espírito Santo (blue triangles). Two important exceptions are Santa Catarina, located in Brazil's south, which stands out in the fishing cluster, and Maranhão, in the northeast, whose blue economy is more heavily 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 defence; P124 Arts, entertainment and recreation

Figure 6. Typology of States According to the Relative Importance of Product Clusters to their Overall Blue Economic Structure



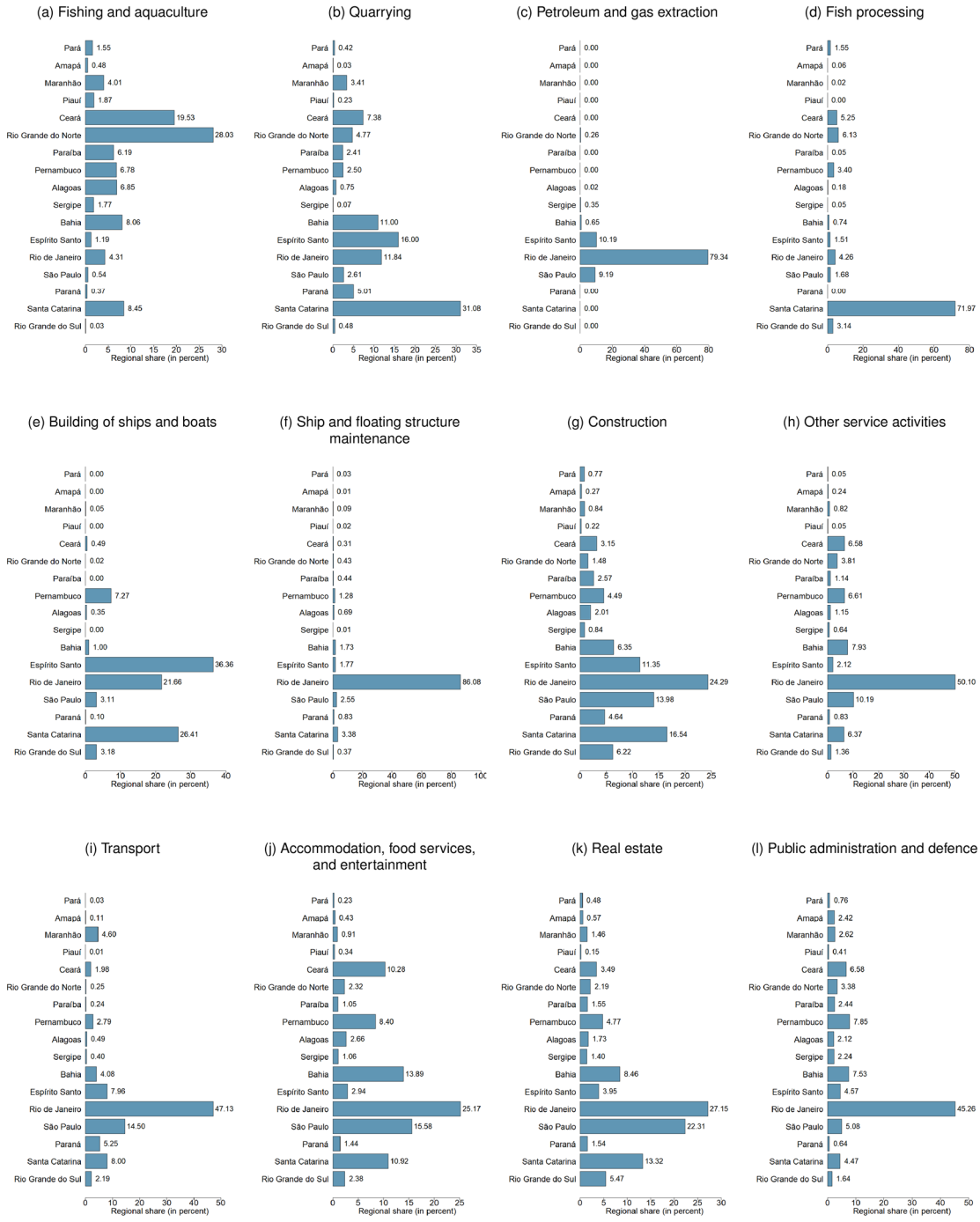
Clusters: fishing (P015, P024), maritime transport (P084, P087, P094, P097, P099), coastal tourism (P090, P091, P092, P096, P101, P102, P108, P109, P113, P114, P115, P116, P124), security (P118).

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 defence; P124 Arts, entertainment and recreation

Figure 7 presents the regional distribution of different blue economy activities[5], reinforcing structural differences in the Brazilian blue economy. In this case, the focus on the spatial patterns of such activities highlights differences related to location preferences. Sectoral location patterns can differ due to a variety of factors that influence the spatial distribution of economic activities across different sectors. Thus, for instance, the concentration of the petroleum and gas extraction in Rio de Janeiro, Espírito Santo and São Paulo is defined by the availability of offshore natural resources along the states' coast. The apparent co-location of accommodation, food services and entertainment with real state reveals agglomerations of coastal tourism activities, benefitted by cluster effects, where related industries and supporting services cluster together to gain efficiency, knowledge spillovers, collaborative opportunities, and shared resources. Another example is the availability of better transport infrastructure and network effects in the southern part of the country, and dedicated ports connected to export corridors in Maranhão and Espírito Santo shaping the concentration of the transport sector in these areas.

[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



3.3. Systemic Contribution

The next step was to use the state make matrices to transform 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. We could then calculate the share of the blue economy in each sector j in each state r, $BLUESH_j^r$, for all j = 1, ..., 68, and r = 1, ..., 27. With this information we define the factors *F* used 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 each of the 23 products related to blue economy activities. F-factors for the domestic absorption components (Table 5) were also estimated 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) present the lowest factors with a higher share of ocean-related components equal, on average, to 97.1%, 65.6%, and 73.4%, respectively. P099 (Warehousing and support activities for transportation) and P101 (Accommodation) also present sizeable shares of blue economy content, above 20% of total gross output, reflected in lower *F* factors. All remaining 105 products, with no direct relation to the sea economy, receive an F factor equal to unity.

Tables 7-10 present the systemic economic impacts generated by the extraction of blue economy related flows in the interstate input-output system. The size of the estimated effects depends on three main elements. First, the adjustment factors *F*s, which excludes the flows directly related to the sea economy. Second, the interregional and intersectoral linkages of the economy[6], which allows sectors with no direct relation to the ocean and landlocked states to be affected. Finally, given the assumption that components of domestic absorption are directly influenced by income (i.e. labor income, capital income and tax revenue) generation in blue economy activities, the higher participation of such activities in the state economies could imply a higher effect on household demand, investment demand and government consumption and, as a consequence, in regional economic activity as a whole.

[6] Productive linkages are measures that allow to establish the impact of one sector on another. On the one hand, backward linkages refer to measures of how much a sector demands from others, while forward linkages measure the importance of a sector as a supplier of goods and services to the others.

The common structure of Tables 7-10 considers the direct, indirect and total effects of the blue economy across states and across sectors, considering the outcomes in terms of GDP (Tables 7 and 9) and employment (Tables 8 and 10). They show the results in levels (R$ millions and workers), and as a percentage of the national and regional blue economy GDP (GRP). Overall, the systemic contribution of the blue economy accounts for 6.39% of Brazil's GDP, 2.91% of which directly related to the ocean, with an implicit multiplier of 2.20. In terms of employment, 1,136,111 workers (1.07% of the national employed workforce) are allocated to blue economy activities that generate 3,585,613 additional jobs (3.38% of the total) – multiplier equivalent to 4.16.

Considering the regional distribution of the impacts of the blue economy in Brazil, one insightful result refers to the distinct geographies 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 (80.0% of the blue economy GDP, and 51.29% of employment[7]), indirect effects are less concentrated. The three largest shares amount to less than two thirds of total GDP (62.94%). More interestingly, Minas Gerais, a landlocked state in Brazil's Southeast, which shares common borders with Rio de Janeiro, São Paulo, and Espírito Santo (also Bahia), ranks third in terms of indirect effect. As a general result, it is noticeable that the ocean reaches all landlocked Brazilian states through production and income linkages (see Figure 8).

From a sectoral perspective (Tables 9 and 10), the dominance of the Extraction of crude petroleum and natural gas in terms of GDP (55.16% of the total) is not reflected in employment terms (only 3.74%) given the sectoral very high capital-labor ratio. Direct contribution of blue economy activities for job creation in Brazil is more spread across different sectors, with more relevance for the coastal tourism cluster and defence. Indirect effects in GDP and employment present another structural pattern, with higher-order contributions concentrated in non-blue manufacturing (other industrial activities) and services activities (trade and other service activities). Indirect effects in agriculture employment is also noticeable, as the sector ranks fourth in the number of indirect jobs.

[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 the 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.

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; 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 defence; P124 Arts, entertainment and recreation

Table 7. Systemic Impacts of the Blue Economy in Brazil: GDP by State

State	*GDP*	*Blue economy (R$ million)*			*Blue economy (% of BE total)*			*Blue economy (% of regional total)*		
	(R$ million)	*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**

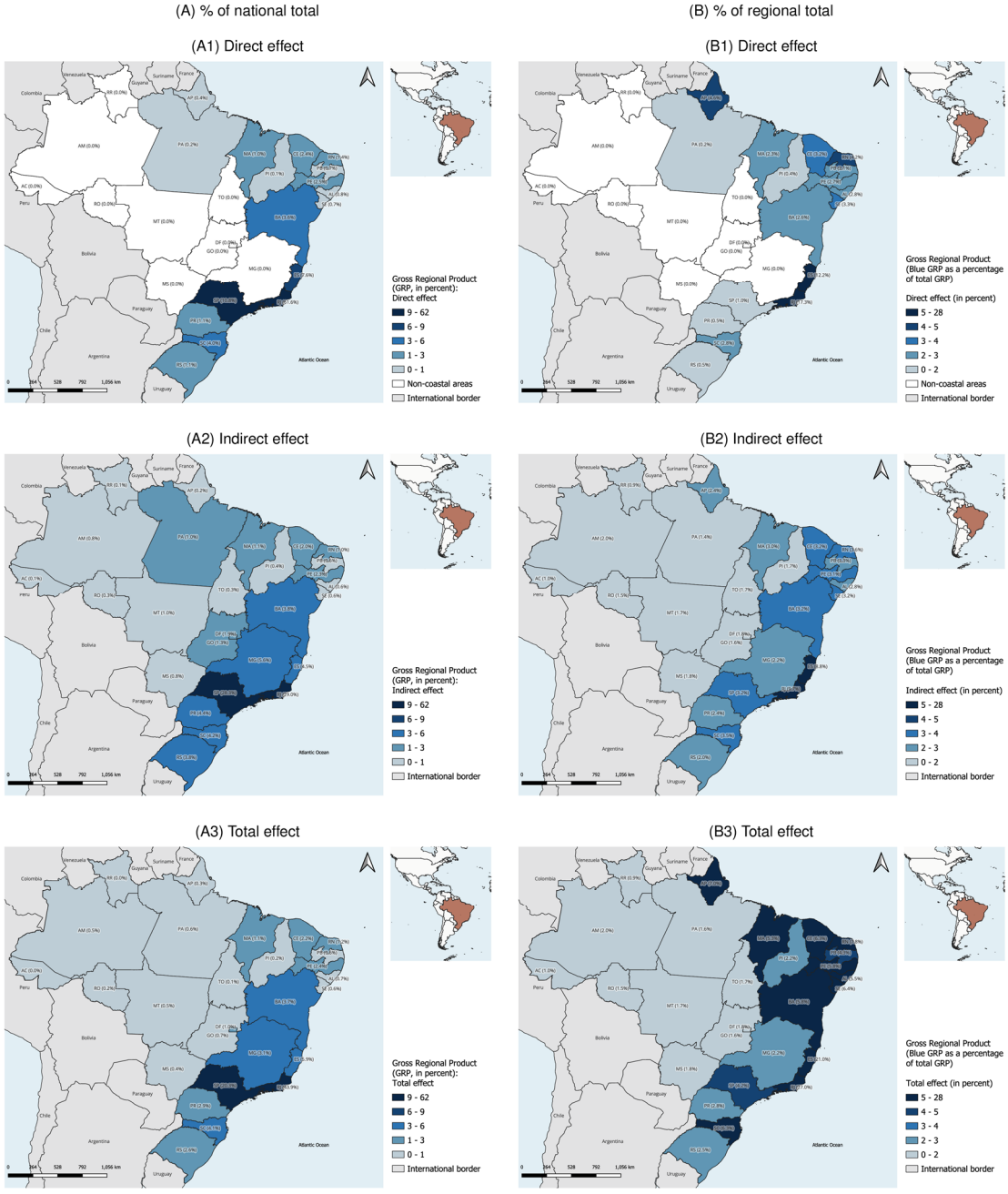
Table 9. Systemic Impacts of the Blue Economy in Brazil: GDP by Sector

Sector	*GDP*	*Blue economy (million, BRL)*			*Blue economy (sectoral share)*			*Blue economy (%GDP)*		
	(million, BRL)	*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



4. Final Remarks

Measurement provides the foundation of reliable evidence needed for informed, effective, and accountable policymaking (Head, 2016). In this paper, we faced the challenge of quantifying the contribution of blue economy activities to national, regional and local output and employment in Brazil, and assessing the coast-hinterland economic interconnectedness through interregional input-output linkages that reveal the interdependencies between different sectors of the economy. The picture that emerged is one of a structural diverse blue economy, with strong geographical variations across sectors and within regions. Thus, it is expected national sectoral policies targeted to specific blue economy activities will have differential impacts across space.

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

As the country moves forward taking actions to achieve the UN Sustainable Development Goal 14 ("Oceans") by 2030, considering local shades of blue in the design of economic policies for coastal areas is important for policymakers to tailor interventions to address specific regional needs and capitalize on local strengths more effectively. Natural resources (e.g. oil and gas, fisheries, climate) and man-made local resources (e.g. human capital, cultural heritage, infrastructure) are unevenly distributed along the coast, creating an intricate pattern of locational advantages for blue economy activities, revealed in our estimates. Moreover, the analysis of blue *economies* in the context of integrated regional systems – given the severe limitations of analyzes in which a single region or activity is studied in isolation from others (Batey and Madden, 1986) – recognizes the interconnectedness of regional economies and the need for coordinated approaches to address shared challenges and opportunities.

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