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A macroeconomic definition of the contribution of the South African ocean economy

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Abstract

This study is structured around the objective of developing a macroeconomic definition of the sustainable welfare contribution of the South African ocean economy that is both feasible to evaluate and to track. It provides a rationale for developing this definition, discusses the concept and parts of an ocean economy and identifies three models through which this macroeconomic contribution can be assessed; one conventional model and two alternatives. The two alternative models are based respectively on the enhancement effect provided by access to the ocean and the value added to a regional economy by enterprises that locate near the ocean to take advantage of its economic benefits. The study defines the sustainable macroeconomic contribution of the South African ocean economy with reference to these models and to welfare-related criteria. For evaluating and monitoring the welfare-sustaining contribution of the South African ocean economy it recommends applying a combination of the two alternative models, rather than the conventional one, because they incorporate more of the contribution.

Keywords: Ocean economic importance, welfare sustaining ocean economy contribution, South Africa.

Introduction

Against a global backdrop of *'population growth, rising incomes, dwindling natural resources, responses to climate change, and pioneering technologies'* (OECD, 2016), an international optimism emerged during the twenty-first century that the ocean *'holds the promise of immense resource wealth and great potential for boosting economic growth, employment, and innovation'* (OECD, 2016; World Economic Forum, 2025). This optimism has philosophical roots (Simon, 1981). The underlying philosophy is that a changing and diminishing global land-based natural resource base does not constrain economic growth or improvements in social welfare. The argument is that the declining availability of land-based natural resources acts as an incentive for exploring new sources of natural wealth, increasing the efficiency of resource use and investing in technologies that substitute for scarce production inputs. In this way, even in the face of dwindling terrestrial natural

resources, the door remains open to sustainable economic development and improved social welfare.

This optimism is shared by many in Africa (Sparks, 2023). It has generated growing academic interest across the continent in distinguishing between the economic contributions of land-based and ocean-based natural resources. The African Union has formulated a strategy specifically aimed at managing maritime-linked sustainable economic development — **Africa's Integrated Maritime Strategy 2050** (2050 AIM Strategy, 2012). In addition, an **African Community of Practice** has been established under the auspices of the **Global Ocean Accounts Partnership (GOAP)** to promote ocean accounting in support of sustainable development, a key component of which is macroeconomic measurement (GOAP, 2025). South Africa has articulated its own plan to develop the ocean economy sustainably - the **South African**

Oceans Economy Master Plan (OEMP)¹. Master-plans are at best described as action-oriented policy instruments that are focused on the development of local value-chains and the promotion of local jobs. The OEMP currently sits alongside **Operation Phakisa** (DFFE, 2016)², a comprehensive and coordinated plan of action across a range of industries aimed at facilitating rapid growth in ocean-linked industrial sectors.

For ocean policymaking to act effectively upon this international and African optimism, a clear definition of the ocean economy's contribution is required. This paper aims to provide that definition – one that facilitates the evaluation and tracking of the welfare-sustaining macroeconomic contribution of the South African ocean economy. The paper is structured as follows: it first presents the rationale and background for developing this definition, then discusses the concept and parts of the ocean economy as used in common discourse, outlines three models of a welfare-sustaining macroeconomic contribution aligned with this concept, examines selected challenges to evaluating the ocean economy in terms of these models, and concludes with a proposed definition.

The backdrop and rationale for generating information about South Africa's ocean economy contribution

The international backdrop for South African ocean economy optimism

The backdrop for optimism regarding the growth prospects of industries that utilize ocean natural resources includes several global trends: an increasing dependence on ocean-based trade to sustain welfare; improvements in cost-effectiveness that have enhanced the profitability of exploiting many marine resources, and United Nations agreements defining criteria for the sustainable use of the ocean and clarifying the role national governments can play in implementing these guidelines.

The global economy has evolved to a point where the people of both developed and developing nations can no longer maintain or enhance their well-being through increased self-sufficiency. Sustaining their welfare has become dependent on international trade (Lane and Pretes, 2020). This trade is conducted through digital markets, within a framework defined by a web of international financial arrangements, laws, and agreements, involving multiple global actors rather than any single national government.

Most commercial shipping operates on vessels that are built or recycled in countries other than those of their owners, registered under flags of convenience (such as Liberia, the Marshall Islands, or Panama), and manned by multinational crews who may change during transit (UNCTAD, 2024). Cargo ownership may also change hands while in transit. National navies contribute to safeguarding international sea-borne trade, often in formal or informal collaboration with the naval forces of other countries.

Several indicators highlight the economic importance of sea-borne goods transport. Due to the considerable cost advantage that ocean transport has maintained over centuries compared with land transport, about 80 % of all goods by value traded globally are shipped by sea (Statista, 2024). The volume of goods transported across the oceans increased from 4 to 11 billion tons between 1990 and 2021 (Statista, 2024). Disruptions to shipping have immediate and significant global economic effects (UNCTAD, 2024), as most industrial supply chains rely on maritime transport or undersea communication infrastructure.

In a study of 129 countries, Lane and Pretes (2020) found that Gross Domestic Product (GDP) per capita is significantly associated with the number of ports, the merchandise trade ratio, and shipping liner connectivity. By inference, the better a country's access to the ocean, the greater its capacity to leverage trade dependency for economic growth and improved national welfare. There are also numerous other indicators of the ocean's economic significance beyond shipping. Since 2010, there has been a steady increase in the proportion of global data and voice transmission carried by high-capacity undersea cables (Illidge, 2024). Most of the world's fish supply comes from marine sources, and more than half of global tourism expenditure—an indicator of recreational value—is linked to the ocean (World Economic Forum, 2023). Alongside the growth in cargo, data communication, and tourism volumes, demand for related goods and services has also risen steadily (OECD, 2016).

Before the twentieth century, ocean mining was minimal, as seabed mineral and hydrocarbon extraction was technically difficult and prohibitively costly. Similar limitations applied to the production of potable water, electricity, and food from marine resources. However, during the twentieth and twenty-first centuries, technological innovation and investment have expanded the range of ocean resources that can be commercially

exploited³, driven largely by the depletion of known terrestrial reserves (Etzioni, 2014; OECD, 2016; Hosking and Mtati, 2022). The cost gap between exploiting non-renewable natural resources on land and in the ocean has narrowed, as has the cost differential for producing renewable resources such as desalinated water, marine-derived electricity, and ocean-grown food (World Ocean Review, 2014). By the twenty-first century, seabed mining had become a substantial and rapidly growing global industry (Muttitt, 2024), marking the opening of a new frontier for economic activity.

Responding to growing international demand for the orderly and sustainable exploitation of marine resources, the United Nations Convention on the Law of the Sea (UNCLOS) was adopted in 1982. It established an international framework for regulating ocean use and resource extraction, granting coastal nations rights to exploit marine resources within and beyond their Exclusive Economic Zones (EEZs). Article 76 of UNCLOS allows nations to claim extended continental shelves - and the associated rights to exploit resources on or beneath them - if they can demonstrate geological continuity beyond the 200-nautical-mile EEZ limit⁴.

In partial response to rising interest in seabed mining in Areas Beyond National Jurisdiction (ABNJ), the United Nations adopted the High Seas Treaty in June 2023 (United Nations, 2023). This agreement seeks to safeguard the ecological integrity of the high seas by extending environmental protections comparable to those within national jurisdictions (United Nations Environment Programme, 2025). However, its relevance has been challenged by the United States, whose official statements and actions suggest a reluctance to limit its deep-sea mining activities to the treaty's provisions (Cusick, 2025).

The United Nations' agreements and initiatives promoting the sustainable use of marine resources are primarily conservation oriented. Their goal is not to facilitate exploitation, but to preserve marine biodiversity and ecosystem functionality in the face of increasing demand. This sustainability focus is reflected in both the High Seas Treaty and the 2030 Agenda for Sustainable Development. The latter was adopted by all member states of the United Nations. It called for a global partnership to address 17 sustainable development goals (SDGs).⁵

These international frameworks have coincided with national law-making efforts in various countries aimed

at facilitating increased ocean resource exploitation - not only in the United States. For example, the South African Parliament approved the Upstream Petroleum Resources Development Bill, one of whose stated purposes is 'to create an enabling environment for the acceleration of exploration and production of the nation's petroleum resources'. Most of South Africa's known petroleum resources are located offshore.

The rationale for generating information about the Contribution of the South African Ocean Economy

Driven by optimism regarding the ocean economy, many countries - including South Africa - have expressed a policy demand for improved information about this sector (Jolliffe and Jolly, 2024; Hosking and Mtati, 2022). To meet this demand, it is necessary to evaluate and track the ocean economy's contribution to GDP, and to identify industries and regions with the potential to "unlock" sustainable economic development using marine natural resources⁶.

In South Africa, this demand became prominent in 2014 when the government formally launched Operation Phakisa, an initiative to accelerate sustainable ocean-based economic development (DFFE, 2016; Findlay, 2018). The focus broadened in 2015 with South Africa's endorsement of the United Nations Sustainable Development Goals (SDGs) - particularly SDG 14, 'to conserve and sustainably use the oceans, seas, and marine resources for sustainable development', and SDG 8, 'to promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all' (United Nations, 2024).

After 2020, attention shifted more specifically toward information supporting economic growth and job creation:

- Under the South African Oceans Economy Master Plan (OEMP), the objective is 'to advance stabilisation, revival, and growth of the sub-sectors within the ocean economy to ensure increased contributions to job creation, GDP, economic recovery, and potential growth' (Parliamentary Monitoring Group, 2023).
- South African academics have also called for 'putting a value on ocean-based industries', enabling 'their contributions to be tracked in both monetary and employment terms' (Struwig *et al.*, 2024).

Concurrently, personnel from Statistics South Africa have called for a macroeconomic definition that

would facilitate both the evaluation of the sustainable ocean economy and the construction of a South African Ocean Economy Satellite Account (Grobler, 2023). In 2025, Hosking and Mtati (2025) demonstrated the policy advantages of measuring selected sustainable ocean-related primary sector contributions to GDP. Achieving the broader objective - tracking the contribution of the entire sustainable ocean economy to GDP within a satellite account of the national accounts system - requires a clear and functional definition of that contribution (Grobler, 2023). This objective is addressed by this paper in two parts: a discussion of the concept of the ocean economy as it is commonly understood, and a modelling of its GDP contribution consistent with that concept.

The concept and parts of an ocean economy as the term is used colloquially

The parts to an Ocean Economy

The concept of an ocean economy entered international discourse at the United Nations Conference on Sustainable Development held in Rio de Janeiro in 2012 (Smith-Godfrey, 2016). Initially, the term *ocean economy* was associated with island nations perceived as being entirely dependent on the ocean. However, it has since evolved to include all economic activities - across all types of countries - that depend directly or indirectly on the natural resources found in, above, or below the ocean (Hosking and Mtati, 2022). The term was not precisely defined in 2012, and since then its meaning has often been blurred through conflation with related terms such as *marine economy*, *maritime economy*, and *blue economy*. Although these concepts are often treated as synonymous (Park and Kidlow, 2014), they can also be differentiated (Potgieter, 2018) and viewed as parts of the ocean economy (according to their main industrial focus) or as an ideal form of an ocean economy, as reflected in the way they are commonly used.

When the term *marine* is applied to an industry, it refers to economic activities directly connected with the physical body of seawater and its natural resources (Merriam-Webster, 2024). These are industries with a tangible and spatial link to the ocean itself, rather than land-based upstream or downstream activities that are only indirectly related. For this reason, the term *marine economy* is taken by this paper to cover industries built on the extraction or direct use of marine natural resources - such as harvesting marine living organisms, mining seabed minerals, generating electricity from marine resources, producing potable

water through desalination, or discharging wastewater into the sea. There are many downstream secondary industries dependent on the marine economy that add value and many downstream tertiary industries that add value, such as retail and logistics that further process or distribute those outputs.

The term *maritime economy* may be said to be mainly directed at commerce and support services directly or indirectly related to navigation in or over the ocean. Maritime activities are typically organised and managed by enterprises located in coastal regions (Merriam-Webster, 2024)⁷. Many exporters and importers cluster near the sea to take advantage of the cost efficiencies of sea-borne transport. For this reason, the term *maritime economy* is taken by this paper to cover a wide range of ocean transport services, including the import and export of goods, naval and commercial shipping, and various forms of support for ocean transport such as military, communications, and safety services. There are many upstream and secondary industries supporting (depending on) sea-borne trade, such as shipbuilding. There are also many other tertiary industries supporting (depending on) the maritime economy, such as freight and ship insurance.

Boat-based recreation could also be viewed as part of the maritime economy, but a better category in which to capture such activity is the ocean tourism economy, which this paper takes to include ocean-related the recreation and lifestyle sectors, as is typical in tourism satellite accounts (STATSSA, 2023).

The ocean economy thus encompasses marine, maritime and ocean tourism economic activities, as well as a broader range of interconnected industries, including non-observed marine, maritime and ocean tourism economic activities. In short, it covers all economic activities related to the ocean across a wide range of interlinked and emerging sectors.

The prescriptive purpose of the Blue Economy term vs the descriptive purpose of the Sustainable Ocean Economy term

The African Union's Integrated Maritime Strategy (2050 AIM Strategy, 2012) defines the *blue economy* as activities that sustainably use ocean resources for economic growth, social inclusion, and improved livelihoods - a definition nearly indistinguishable from that of the ocean economy, except it is taken to include activities on fresh waters⁸. Similarly, the World Bank defines the blue economy as the 'sustainable use of

ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of the ocean ecosystem' (United Nations, 2022). However, the blue economy differs from the ocean economy in two important respects. First, it is sometimes used to include economic activities related to both freshwater and marine bodies. Second, it often carries a normative or "virtuous" connotation, implying a form of ocean-based economic management that upholds environmental or ecosystem sustainability (Sparks, 2023; United Nations, 2024). In this sense it is a prescriptive term.

The Commonwealth of Nations describes the blue economy as 'an emerging concept which encourages better stewardship of our ocean or 'blue' resources' (United Nations, 2022). This framing suggests that being "blue" implies a higher, more virtuous standard of ocean resource management. The notion aligns with the concept of the "blue flag beach," where the "blue" designation signifies adherence to specific quality criteria such as water quality, safety standards, and environmental management. For this reason, this paper treats the blue economy as conceptually distinct from the broader ocean economy.

The ocean economy, as used in this paper, does not inherently include a sustainability constraint or moral dimension. The qualifier *sustainable* can be added to denote a sustainable ocean economy, but this remains conceptually distinct from the blue economy for two reasons:

- A blue economy implies virtuous management by definition, whereas a sustainable ocean economy does not.
- The blue economy references the sustainability of ecosystem services and biodiversity, while the sustainable ocean economy references the achievement of a particular level of social welfare - and therefore relates to welfare values rather than ecological virtue.

Industrial and consumption activities that generate negative environmental outcomes—such as higher concentrations of greenhouse gases, acids, toxic chemicals, or hazardous waste—fit poorly within the blue economy concept, as they are not inherently virtuous and often compromise ecosystem services (United Nations, 2022). However, these same activities can fall within the broader ocean economy and may even be regarded as sustainable in welfare terms if their aggregate contribution to social well-being is positive

overall, despite environmental trade-offs. A sustainable ocean economy may be regarded by some as a blue economy if its management produces environmentally positive effects (Findlay, 2018) - for example, by reducing overall greenhouse gas emissions.

The following section will model the welfare-sustaining contribution of the ocean economy (concept) with a view to enabling its evaluation.

A model of a welfare sustaining industrial contribution by the ocean economy

Theoretical framework

Allowing for cyclical fluctuations, the objective of sustaining welfare through industrial contributions can be said to be achieved if the following condition is satisfied over the time horizon of interest:

$$W_{t+3} - W_t \geq 0 \quad (1)$$

where

$$W_t = f\left[\frac{(Y-R)_t}{P_t}; ED_t\right] \quad (2)$$

given:

- W_t is a measure of social welfare in any given year,
- Y_t is the value of aggregate output, measured by Gross Domestic Product (GDP) over a given year,
- R_t is the total negative (reducing or depreciating) effect on produced and natural capital resulting from production and consumption activities over a given year, net of any increase in known available natural resource stocks through exploration, $R = f(Y)$,
- P_t is the population in a given year, and
- ED_t represents the equitable distribution of products across the population in a given year.

The aim of sustainable development is a *satisficing* rather than a *maximising* challenge with respect to industrial value added. Condition (1) and Equation (2) reflect this. They describe the net positive industrial value added per capita over a three-year period, conditioned by the requirements welfare increases over time and there be equity among members of the population (inclusivity). The inclusion of equity as a determinant of welfare reflects the observation that social welfare cannot be said to increase if some people benefit while others bear the costs. This principle - ensuring that no one is "left out or left behind" - is embedded in Sustainable Development Goal 10 (United Nations, 2024).

The net industrial value-added per capita component of this welfare function can be considered within the framework of conventional growth accounting theory. According to this theory, aggregate output is a function of two categories of production inputs - human resources and physical capital - and their productivity (Solow, 1957). Such models explain GDP growth in terms of increases in produced capital and employment, and changes in total factor productivity, weighted by each factor's share of GDP (Solow, 1956; Lange, Wodon, and Carey, 2018). The theory can be extended to include the physical quantities of natural resources used (Lange *et al.* 2018), which can, in turn, be distinguished between those drawn from the ocean space and those from the land space (Hosking and Mtati, 2022).

Distinguishing between factors of production derived from the ocean and those from the land is not straightforward, as the natural boundary between these spaces is blurred. Some land areas are intermittently covered by the ocean (e.g., intertidal zones), and seawater mixes with freshwater in estuaries⁹. Some natural resources, such as fish and birds, migrate seasonally between ocean and land environments.

For economic purposes, this physical ambiguity can be resolved by defining ocean space both horizontally and vertically.

- Horizontally, ocean space refers to the area below the high-water mark, defined as the level on land routinely occupied by seawater.
- Vertically, it comprises the seawater column, the seabed beneath it, and the atmosphere above it.

By contrast, land space is the area above and below the Earth's surface that is not routinely covered by, or mixed with, seawater. Under this definition, distinctions can be drawn between freshwater and seawater shipping routes - for example, between the St. Lawrence Lakes and the Atlantic Ocean pathways - where only the latter qualify as ocean space.

A sustainable aggregate output function for South Africa can therefore be adjusted for factor inputs distinguished by their use of natural resources from the land and ocean spaces (Hosking and Mtati, 2022). Net Domestic Product (NDP) is a more accurate measure of sustainable aggregate output than GDP, as it accounts for the replacement of produced capital and thus preserves production capacity. NDP is further refined by deducting the depreciation of natural

capital resulting from production and consumption (Equation 3):

$$(Y-R)_t = GDP_t - R_t = NDP_t - (R_{NRL} + R_{NR_{OSA}})_t \quad (3)$$

$$Y_t = Af\{(HR_L, K_L, NR_L); (HR_O, K_O, NR_{OSA} + NR_{OI}), t\} \quad (4)$$

where:

- A represents technological progress incorporated into production,
- HR denotes human resources employed (subscript O = ocean-linked; L = land-linked),
- K represents physical capital (subscript O = ocean-linked; L = land-linked),
- NR_L is the known available renewable and non-renewable natural resource utilised from land space,
- NR_{OSA} refers to known renewable and non-renewable natural resources exploited from South Africa's two Exclusive Economic Zones (EEZs) - the mainland EEZ and that around the Prince Edward Island group¹⁰,
- NR_{OI} denotes renewable and non-renewable ocean resources utilised from international waters¹¹,
- $NDP_t = (Y - R_{KL} - R_{KO})_t$ is the net domestic product,
- $R = (R_{KL} + R_{NRL}) + (R_{KO} - R_{NR_{OSA}})$,
- R_{KL} and R_{KO} represent depreciation on produced capital used with land and ocean natural resources, respectively, and
- R_{NRL} and $R_{NR_{OSA}}$ are depreciation on natural resources from the land and ocean spaces, net of exploration-based increases in known reserves.

The conventional Two-Economies Model basis for evaluating the Sustainable Welfare Contribution of the Ocean Economy

The conventional approach to evaluating the ocean economy (Colgan, 2016) is, in effect, a two-economies model. This model is based on two constructs:

- (1) a distinguishable land economy, dependent on natural resources from the land space; and
- (2) a distinguishable ocean economy, dependent on natural resources from the ocean space.

In this framework, the evaluation of the ocean economy requires factor inputs to be apportioned between those linked to the land and those linked to the ocean, as represented in Equations (5) and (6). The contribution of the ocean economy to GDP under this model is expressed in Equation (7):

$$(Y-R)_t = Af\{I_L, I_O, t\} - R_t \quad (5)$$

or, excluding R_t for simplicity,

$$Y_t = Af\{I_L, I_O, t\} \quad (6)$$

$$\frac{(dY_t/dI_O)I_O}{Y_t} = 1 - \frac{\left(\frac{dY_t}{dI_L}\right)I_L}{Y_t} \quad (7)$$

In these equations, I_L and I_O represent the aggregated bundles of land-linked (HR_L, K_L, NR_L) and ocean-linked ($HR_O, K_O, NR_{OSA} + NR_{OL}$) factor inputs, respectively. The share of GDP accounted for by ocean-based activities is given by $\frac{(dY_t/dI_O)I_O}{Y_t}$, with the balance representing land-based activities. The contribution of the ocean economy is determined through disaggregation of industrial value added across ISIC sectors by the proportion of natural resource inputs from ocean versus land spaces. These proportions are termed *partials* (Colgan, 2016). An ocean economy is mostly embedded in an economy based on factor inputs drawn from the land space. The evaluation of the ocean economy requires the separating out of value added due to factor inputs linked to the land and ocean spaces.

One advantage of the two-economies model is its conventional use, allowing for international comparability. Estimates of the ocean's contribution to GDP using this model include: 4.4 % for the United States (2010), 9.6 % for China (2012), 5.5 % for South Korea (2005) (Park and Kidlow, 2014:2)¹², and 4.5 % for South Africa (2010) (Hosking *et al.*, 2014). A disadvantage, however,

is the high level of subjectivity involved in estimating the *partials*. The South African Government's Oceans Economy Master Plan (OEMP) - an unpublished work in progress (during 2025) led by the Department of Forestry, Fisheries and the Environment - refers to a "meaningful degree of dependence" of industries on the use of ocean resources - a concept that aligns closely with the two-economies model approach.

The Ocean Access Enhanced Economy Model

An alternative approach, arguably with requiring less subjectivity in evaluation, defines the industrial value added contribution of the ocean economy using Equation (8):

$$(dY_t/dI_O)I_O = [Af(HR, K, NR, t) - Af(I_L, t)]/Y_t \quad (8)$$

This model is termed by this paper as the ocean access enhanced economy model. It defines the aggregate output gained (or enhanced) by the national economy through restored access to the use of ocean resources, as a difference between two production functions: $Af(HR, K, NR, t)$ which incorporates all factors of production and $Af(I_L, t)$ which includes only land-based factors. Their difference represents the aggregate output that would be lost if access to ocean resources were denied.

Under this model:

- Virtually all economic activity depends on resources drawn from the land space; and

Table 1. The types of industrial dependence on the ocean that define the ocean economy.

Ocean economy dependence theme	Direct dependence elements to the theme	Indirect dependence theme elements	
		Downstream elements (from sales)	Upstream elements (from purchases)
Production dependence on abstraction from and disposal into ocean = Marine Economy	-Marine fishing -Seabed mining -Potable water supply -Electricity supply	-Further processing -Wholesale and Retail	Purchases of products by industries directly dependent on the ocean from other industries
Trade dependence on transport through ocean space = Maritime Economy	-In ocean goods cargo transport and communication services -Near ocean cargo transport and management pre onloading and post offloading -Above ocean goods cargo transport (less dependence)	Industry based on Import-Export via ocean space, e.g., vehicle manufacture	Purchases of products by industries directly dependent on the ocean from other industries
Tourism and recreation dependence on access to the ocean space = Ocean Tourism Economy	Ocean tourism characteristic industries	Ocean tourism connected industries, such as wholesale and retail (sales to tourists)	Ocean tourism connected industries (Purchases of products by tourism characteristic industries)

- The ocean economy contribution is the enhancement to land-based economic activity made possible by access to ocean resources.

The ocean economy is an add on or enhancement to a national economy that access to the ocean enables. Under the ocean access enhanced economy model the evaluation of the sustained ocean economy contribution is based on either:

- The theoretical industrial value added at all supply-chain stages and across all sectors resulting from access to ocean resources (such as analysed in Table 1); or
- The final product expenditure dependent on such access.

The left-hand column of Table 1 identifies 3 broad groupings (themes) of industry by which such value would be added based on the concepts of a distinct marine economy, a distinct maritime economy and a distinct ocean tourism economy. Industries identified as directly dependent on ocean inputs are listed in the second column and the industries identified as indirectly dependent are listed in the third and fourth columns. A maritime economy connection to many goods exports qualifies them as dependent on the use of the natural resources of the ocean.

A reason for favouring the enhanced economy model over the two-economy model is it includes more of the contribution of the ocean economy. It includes upstream and downstream value added in the land space that is dependent on inputs (intermediate or direct) from the ocean space. Consequently, the enhanced model will yield a substantially higher measure of the ocean economy's contribution than the two-economies model. It eliminates the *partials* estimation problem but has its own evaluation challenges¹³.

The differences between the two models may be shown through two examples, one relating to the ocean connected value added in the production of fish food and a second relating to the ocean connected value added to sea-borne goods exports. Under the two-economies model, the ocean contribution to the fish food industry is confined to value created within the ocean space (fishing vessels, labour, and fish stocks). Under the enhanced economy model, however, all upstream and downstream activities dependent on fish extraction - processing, packaging, retailing - are also included as part of the ocean economy. Similarly, in goods exports, sea-borne transport adds value

not only through ships and crews (ocean factors) but also through land-based logistics, storage, and port services. Under the enhanced model, all value added that depends on ocean access, even indirectly, is included as an ocean economy contribution¹⁴.

A model of the ocean economy based on the economic advantage of locating an economic activity near the ocean

A distinct model, in addition to the two industrial-based value-added models (the two-economies and ocean access enhanced economy models), is one based on the economic advantage of locating an economic activity (enterprise) near the ocean. There is good reason to also model the ocean economy in this way - as part of the value added of a geographically defined land region. An analysis of where land-based enterprises are located corresponds with the way official statistical organisations collect and report economic data.

There are two elements to the statistical classification of the economic activity of an establishment: the industry in which it is engaged and the location at which it takes place (paragraph 67, Seventh Edition of the Standard Industrial Classification, STATSSA, 2012). Park and Kidlow (2014) observe that “to define (an) ocean economy, a combination of industrial and geographical perspectives is required.” All enterprises are classified as being based in some land space.

A part of the land-based economy was clearly envisaged as constituting the ocean economy by the Organisation for Economic Co-operation and Development (OECD, 2016; Jolliffe *et al.*, 2021), when it included criteria *f* and *g* among those that would qualify an economic activity as being part of the ocean economy. The OECD argues that an economic activity qualifies as part of the ocean economy if it:

- a) takes place on or in the ocean,
- b) produces goods and services primarily for use on or in the ocean,
- c) extracts non-living resources from the marine environment,
- d) harvests living resources from the marine environment,
- e) uses living resources harvested from the marine environment as intermediate inputs¹⁵,
- f) would likely not take place were it not located in proximity to the ocean, or
- g) gains a particular advantage by being in proximity to the ocean.

The OECD criteria f and g are founded on an ocean economy model that incorporates land-based enterprises located geographically close to the ocean because of the economic advantage this proximity affords them.

Equation 9 describes a model of the ocean economy's contribution founded on value added per geographically defined land region. In this model, the ocean economy regional contribution $Y-R_{tO}$ is the sum of all enterprise value added within all land regions based on the economic (locational) advantage of nearness to the ocean:

$$Y-R_{tO} = \sum a_j O_j + \sum a_k L_k - R_t \quad (9)$$

where:

$\sum O_j$ is the gross geographic product of the sum of the output of $j = 1, \dots, m$ geographically defined ocean economy regions,

$\sum L_k$ is the gross geographic product of the sum of the output of $k = m+1, \dots, n$ geographically defined land regions, and a_j and a_k are, respectively, the proportions to which enterprise location choice is dominated by the economic advantage of nearness to the ocean.

It may be assumed that:

$$a_k = 0,$$

because firms and people choosing to locate in inland (non-maritime) regions may reasonably be assumed to have been attracted there by the cost and benefit advantages of those inland regions. The commerce (value adding) they bring to inland regions may therefore be deemed to be dominated by inland regional advantages.

By similar reasoning:

$$1 > a_j > 0,$$

because proximity to the ocean affords enterprises in those land regions potential transport, climatic, visual, and other economic advantages. To the extent that these advantages influence the decisions of people and enterprises to locate in maritime regions, the commerce (value adding) they bring to such regions may be deemed to result from the economic advantage of that location relative to inland regions. Evaluating the ocean economy with reference to a model that predicts enterprise proximity based on this locational advantage shares a key benefit with the ocean access enhanced economy model: it can incorporate indirect effects - upstream and downstream effects of enterprise location choice can be captured.

When an enterprise induces additional enterprises and people to locate in the same region, it may be called an *anchor* or *core* enterprise. The additional enterprises and people who locate there may be considered upstream and downstream entities. These upstream and downstream enterprises and human resources may not themselves have located near the ocean because of a direct need to use ocean natural resource inputs in production, but because of their need to supply services to, or receive supply from, core enterprise(s) - that is, due to an indirect motive to locate near the ocean¹⁶.

Under this model of the ocean economy—based on the economic advantage of locating an activity near the ocean—a method is required to determine the degree to which enterprises in maritime regions are dominated by the economic advantage of nearness to the ocean, i.e., to determine the extent to which a_j exceeds 0. All maritime regions will house a mixture of:

- i. enterprises located there directly or indirectly because of the economic advantage of proximity to the ocean, and
- ii. enterprises located there for other reasons.

The preferred method for making this determination is by region. A simple approach is to assign region-by-region values where $a_j = 0$ or $a_j = 1$, under the assumption that errors of inclusion in the ocean economy are balanced by errors of omission. Under this approach, if there is no dominant or very significant discernible economic advantage influencing enterprise and population location decisions near the ocean, the output of that region should not be considered part of the ocean economy - even if the region borders the sea or if, at some previous time, there was such an advantage.

Under this model, the South African region qualifying as part of the ocean economy could be expected to be smaller in area than the sum of maritime (sea-bordering) municipalities - these being the smallest politically defined regions - because of the absence of a dominant nearness-to-the-ocean motive for enterprise location in many of these municipalities.

The challenge of evaluating welfare effects

The welfare implications of any intervention in the ocean economy are pivotal to the *satisficing* problem (sustainability) that the models in this paper seek to address. However, evaluating welfare remains a challenging task.

- The evaluation of reductions in production possibilities resulting from the non-replacement of produced physical capital is required, since Net Domestic Product (NDP) is the reference point for production sustainability. However, South Africa's NDP is not an officially reported figure and must therefore be estimated.
- The evaluation of reductions in ecosystem product yields caused by the current use of ocean natural resources (Rn_{rosa}), including the resulting shift in consumption options toward inferior products, is also required. Such welfare evaluations must take place in a dynamic rather than static context. Welfare reference points for recreation and lifestyle attractiveness may change significantly over time and across populations (Dugstad *et al.*, 2020). What may initially cause intense dissatisfaction (for example, the introduction of wind turbines into a coastal region) often becomes more tolerable later, particularly when perceived positive welfare trade-offs - such as reductions in greenhouse gas emissions - are recognised.

There are very few industrial uses of the ocean that occur within the ocean itself which could credibly claim to leave its natural resources (and therefore ocean natural capital) unchanged in any detectable way. In some cases, the change may be very small and perhaps insignificant, but in many cases, it will be substantial and contribute to a significant welfare effect - potentially reducing the welfare possibilities of both current and future generations.

When an industrial use of the ocean has such a (significant) negative impact on production possibilities, its welfare effect must be evaluated alongside the positive impacts on production possibilities and equitable distribution (ED). Inevitably, there will also be a trade-off between expanding the ocean economy and equitably distributing the associated benefits and costs from a welfare perspective.

Conclusion on the definition

Ideally, a macroeconomic definition of the welfare-sustaining contribution of the South African ocean economy should be extensive if it is to serve as a broad guide to sustainable development. Moreover, if it is to align with the objective of sustaining welfare, it must reference several key elements, including:

- Net Domestic Product (NDP)
- Evaluation options, such as the value added by industries dependent on the use of the natural

resources of the ocean space; the value added by enterprises whose locations depend on proximity to these resources; or the final product expenditure dependent on the use of the natural resources of the ocean

- The definition of ocean space
- Welfare-influencing effects not accounted for in the NDP measure.

A definition that references these elements follows:

The welfare-sustaining contribution of the ocean economy is either

- i. the value added to NDP that is dependent on the use of the natural resources of the ocean space or on proximity to those resources, or
- ii. the final product expenditure dependent on the use of the natural resources of the ocean, adjusted for unaccounted welfare-changing effects, where *ocean space* refers to the land and sea below the high-water mark, as well as the exploitable seabed and the atmosphere above the ocean surface.

Based on the criterion of comprehensiveness, it is recommended that the evaluation and tracking of the South African ocean economy be based on the two alternative models proposed in this paper - namely, the **ocean-access enhancement model** and the **economic advantage of ocean proximity model**. These models define the ocean economy's contribution in different ways and will therefore yield different magnitudes in estimation. However, if properly applied, the differences should not be excessively large, as both are grounded in the economic advantages arising from the exploitation or proximity-based use of the ocean's natural resources.

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References

- 2050 AIM Strategy (2012) Africa's Integrated Maritime Strategy: 2050. African Union. First conference of African ministers in charge of maritime related affairs, Addis Ababa-Ethiopia, 21 April 2012. 32 pp [https://cggrps.com/wp-content/uploads/2050-AIM-Strategy_EN.pdf]
- Alleyne T, Subramanian A (2001) What does South Africa's pattern of trade say about its labour market? International Monetary Fund, Working Paper, WP/01/148. 24 pp

- Colgan CS (2016) Measurement of the ocean economy from national income accounts to the sustainable blue economy. *Journal of Ocean and Coastal Economics* 2 (2) Article 12. 45 pp [doi.org/10.15351/2373-8456.1061]
- Cusick D (2025) High Seas Treaty to protect oceans ratified as Trump pushes mining. *E&E News by Politico*. 2 pp [https://www.eenews.net/articles/high-seas-treaty-to-protect-oceans-ratified-as-trump-pushes-mining/#:~:text=High%20Seas%20Treaty%20to%20protect,mining%20%2D%20E&E%20News%20by%20POLITICO]
- DFFE (2016) South Africa's oceans economy. Department of Forestry, Fishing and the Environment. 60 pp [https://www.dffe.gov.za/sites/default/files/docs/publications/southafricas_oceaneconomy__for-investment.pdf]
- Dugstad A, Grimsrud K, Kipperberg G, Lindhjem H, Navrud S (2020) Acceptance of wind power development and exposure – Not-in-anybody's-backyard. *Energy Policy* 147 (December 2020): 111780 [doi.org/10.1016/j.enpol.2020.111780]
- Etzioni A (2014) Final frontier vs. fruitful frontier: The case for increasing ocean exploration. *Issues in Science and Technology* 30 (4). 10 pp [https://issues.org/final-frontier-vs-fruitful-frontier-the-case-for-increasing-ocean-exploration/]
- Findlay K (2018) Operation Phakisa and unlocking South Africa's ocean economy. *Journal of the Indian Ocean Region* 14 (2): 248-254
- GOAP (2025) Global Ocean Accounts Partnership, Africa Community of Practice. [https://www.oceanaccounts.org/ocean-accounts/]
- Grobler R (2023) Personal communication, Ocean economy working group meeting, June 2023
- Hosking SG, Du Preez D, Kaczynsky V, Hosking J, Du Preez M, Haines R (2014) The economic contribution of the ocean sector in South Africa. *Studies in Economics and Econometrics* 38 (2): 65-81
- Hosking SG, Mtati O (2022) Why and how to measure the contribution of South Africa's ocean economy. *Economic Research Southern Africa. Working Paper number 883*. 25 pp [doi.org/10.71587/s4njw7]
- Hosking SG, Mtati O (2025) The feasibility and advantage of measuring the GDP contribution over time of the South African ocean economy. *Studies in Economics and Econometrics*: 1–16 [doi.org/10.1080/03796205.2025.2582100]
- Illidge M (2024) These undersea cables connect South Africa to the world. *My Broadband*. 10 pp [https://my-broadband.co.za/news/internet/521329-these-undersea-cables-connect-south-africa-to-the-world.html]
- Jolliffe J, Jolly C, Stevens B (2021) Blueprint for improved measurement of the international ocean economy: An exploration of satellite accounting for ocean economic activity, OECD Science, Technology and Industry Working Papers, No. 2021/04. Paris: Organisation for Economic Co-operation and Development Publishing. 67 pp [doi.org/10.1787/aff5375b-en]
- Jolliffe J, Jolly C (2024) Eight lessons learned for comparing ocean economy measurement strategies across countries. OECD Science, Technology and Industry Working Papers 2024/01. 50 pp [doi.org/10.1787/1c-b42a67-en.]
- Lane JM, Pretes M (2020) Maritime dependency and economic prosperity: Why access to oceanic trade matters. *Marine Policy* 121. 9 pp [doi.org/10.1016/j.marpol.2020.104180]
- Lange G, Wodon Q, Carey K (2018) The changing wealth of nations 2018: Building a sustainable future. Washington, DC: World Bank. 255 pp [doi:10.1596/978-1-4648-1046-6] [License: Creative Commons Attribution CC BY 3.0 IGO]
- Merriam-Webster (2024) Maritime adjective. *Marine adjective*. 2 pp [https://www.merriam-webster.com/dictionary/maritime#:~:text=%3A%20of%20or%20relating%20to%20navigation%20or%20commerce%20on%20the%20sea and https://www.merriam-webster.com/dictionary/marine]
- Muttitt G (2024) No new fossil fuel projects: The logical first step in a transition to clean energy. *International Institute for Sustainable Development*. 3 pp [https://www.iisd.org/articles/insight/no-new-fossil-fuel-projects-logical-first-step-transition-clean-energy]
- National Geographic (2024) Ecosystem. 7 pp [https://education.nationalgeographic.org/resource/ecosystem/]
- OECD (2016) The ocean economy in 2030. Paris: Organisation for Economic Co-operation and Development Publishing. 256 pp [https://read.oecd-ilibrary.org/economics/the-ocean-economy-in-2030_9789264251724-en#page1]
- Oxford Reference (2024) Maritime state. 1 pp [https://www.oxfordreference.com/display/10.1093/oi/authority.20110803100134692#:~:text=A%20maritime%20State%20is%20a,Encyclopaedic%20Dictionary%20of%20International%20Law%20%C2%BB]
- Park KS, Kildow JT (2014) Rebuilding the classification system of the ocean economy. *Journal of Ocean and Coastal Economics* 2014 (1). 39 pp [doi.org/10.15351/2373-8456.1001]

- Parliamentary Monitoring Group (2023) Update on the ocean economy master plan and Operation Phakisa programmes, with Minister. 4 pp [<https://pmg.org.za/committee-meeting/36358/>]
- Potgieter T (2018) Oceans economy, blue economy, and security: notes on the South African potential and developments. *Journal of the Indian Ocean Region* 14 (1): 49-70
- Simon J (1981) *The ultimate resource*. Princeton University Press, Princeton. 432 pp
- Smith-Godfrey S (2016) Defining the blue economy. *Maritime Affairs: Journal of the National Maritime Foundation of India* 12 (1): 58-64
- Solow RM (1956) A contribution to the theory of economic growth. *Quarterly Journal of Economics* 70 (1): 65-94
- Solow RM (1957) Technical change and aggregate production function. *The Review of Economics and Statistics* 39: 312-320 [<http://dx.doi.org/10.2307/1926047>]
- Statista (2024) Ocean shipping worldwide - statistics & facts. 5 pp [<https://www.statista.com/topics/1728/ocean-shipping/#topicOverview>]
- Struwig M, Van den Berg A, Hadi N (2024) Challenges in the ocean economy of South Africa. *Development Southern Africa* 41 (1): 1-15
- Sparks D (2023) *Southern Africa's blue economy*. Routledge, New Yprk. 110 pp
- STATSSA (2012) *Standard industrial classification of all economic activities*, 7th edition. Statistics South Africa. Report No. 09-90-02. 266 pp
- STATSSA (2023) *Tourism satellite account for South Africa, final 2019 and provisional 2020 and 2021*. Statistics South Africa. Report No. 04-05-07(2023). 71 pp [<https://www.statssa.gov.za/publications/Report-04-05-07/Report-04-05-072021.pdf>]
- UNCTAD (2024) *Navigating troubled waters: Impact to global trade of disruption of shipping routes in the Red Sea, Black Sea and Panama Canal*. Unctad rapid assessment, February 2024. United Nations Trade and Development. 17 pp [<https://unctad.org/publication/navigating-troubled-waters-impact-global-trade-disruption-shipping-routes-red-sea-black>]
- United Nations (2022) *Blue economy definitions*. 1 pp [https://www.un.org/regularprocess/sites/www.un.org.regularprocess/files/rok_part_2.pdf]
- United Nations (2023) *Agreement under the United Nations Convention of the Law of the Sea on the conservation and sustainable use of marine biological diversity in areas beyond national jurisdiction*. 432 pp [https://treaties.un.org/doc/Treaties/2023/06/20230620%2004-28%20PM/Ch_XXI_10.pdf]
- United Nations (2024) *Sustainable development: The 17 goals*. Department of Economic and Social Affairs. 6 pp [<https://sdgs.un.org/goals>]
- United Nations (2025) *Sustainability*. 1 pp [<https://www.un.org/en/academic-impact/sustainability>]
- United Nations Environmental Programme (2025) *What is the international agreement to protect the high seas and why is it important*. 2 pp [<https://www.unep.org/news-and-stories/story/what-international-agreement-protect-high-seas-and-why-it-important>]
- World Economic Forum (2023) *Why the travel and tourism industry should care about the state of the ocean*. 10 pp [<https://www.weforum.org/agenda/2023/10/why-the-tourism-industry-should-care-about-the-state-of-the-ocean/>]
- World Economic Forum (2025) *How the ocean economy can catalyse sustainable growth*. 3 pp [<https://www.weforum.org/stories/2025/10/how-the-ocean-economy-can-catalyze-sustainable-growth/>]
- World Ocean Review 3 (2014) *Marine resources – Opportunities and risks*. Maribus gGmbH., Hamburg. 165 pp

Appendix I

Supplementary notes:

- ¹ The OEMP is drawn up by the Department of Trade, Industry and Competition and incorporated in the Industrial Action Plan.
- ² *Operation Phakisa* is a framework purposed at achieving significant and fast economic growth results. It is coordinated by the Presidency and the Department of Forestry, Fisheries and the Environment (DFFE).
- ³ The technological improvement is broadly based – in underwater mining, in the processing of natural resources of the ocean and in cultivating output in the ocean (marine aquaculture).
- ⁴ This provision may be considered an arbitrary arrangement because the natural resources of the ocean space fit the criteria of a global rather than national public good. The fluidity of the natural resources of the ocean makes them like the natural resources of the atmosphere – a global rather than national asset. This provision (riparian land jurisdiction with respect to the ocean) is also inconsistent with rights allocation bases in many countries, where riparian land ownership is not recognised as the basis for a right to exploit water resources.
- ⁵ Its 1987 report, *Our Common Future*, the Brundtland Commission defined sustainable development as “meeting the needs of the present without compromising the ability of future generations to meet their own needs” (United Nations, 2025).
- ⁶ Recognising that policymakers in many countries have insufficient information on their ocean economy and applicable measures to compare with other countries, the Organisation of Economic Cooperation and Development is measuring the ocean economy contribution of Belgium (Flanders), Canada, Ireland, Italy, Norway, Portugal, Korea and the United States) alongside national-level efforts (Jolliffe and Jolly, 2024)
- ⁷ The land area bordering the sea in which activity related to the sea takes place is defined as a maritime region, irrespective of the length of the coastline (Oxford Reference, 2024). Maritime regions are distinguished from land-locked ones, i.e. ones with no seacoast, or ones in which the activity taking place in them is not related to the sea.
- ⁸ The African Union has incorporated commerce activities related to transport over fresh inland waters as part of the blue economy, which they conflate with the term ocean economy (2050 AIM Strategy, 2012).
- ⁹ The fact that the natural resource yields of the oceanic and terrestrial spaces are products of multiple and complex Earth systems, in which components of the land space (including freshwater) and ocean space inter-act (National Geographic, 2024), is irrelevant to the feasibility of determining from which space they are sourced.
- ¹⁰ ‘In the Exclusive Economic Zone, the coastal State has: (a) sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or non-living, of the waters superjacent to the seabed and of the seabed and its subsoil, and with regard to other activities for the economic exploitation and exploration of the zone, such as the production of energy from the water, currents and winds; (b) jurisdiction as provided for in the relevant provisions of this Convention with regard to: (i) the establishment and use of artificial islands, installations and structures; (ii) marine scientific research; (iii) the protection and preservation of the marine environment; (c) other rights and duties provided for in this Convention.’ (United Nations, n.d., pp. 43-44). The value of natural capital is the discounted sum of the rents generated over the lifetime of the known natural resource available (Lange, Wodon and Carey, 2018).
- ¹¹ The international water space is used in the production of South African transport and communication services. The living marine resources and non-renewable resources in international waters South Africa uses in production is that to which South Africa has negotiated access through international agreements.
- ¹² The problem with these estimates is that they were not benchmarked against a standard definition of the ocean economy. They reference to different concepts of what constitutes the ocean’s contribution to GDP (Park and Kidlow, 2014: 5-6).
- ¹³ An anonymous referee to an earlier draft of this paper commented that ‘The challenge would be to isolate the component of its value provided by the sea, i.e., port services, from the value determined by the existence of railway lines, electricity services, inland coal mines etc. If these last services didn’t exist neither the harbour, nor the sea routes to it, would have value.’
- ¹⁴ About 80 % of South Africa’s export and import trade is with countries in the European Union, East Asia and the Pacific, and North America (Alleyne and Subramanian, 2001), i.e., to markets a great distance from South Africa and separated by considerable ocean surface.
- ¹⁵ The OECD criteria a, c, d are consistent with the two-economy model, while the criteria a, b, c, d and e are consistent

with the ocean access enhanced economy model (as they include land-based upstream and downstream industries), i.e., the OECD criteria are based on a hybrid model – partly two-economy and partly the dependent on ocean use.

¹⁶ A South African example of such a core enterprise is that of Mercedes-Benz South Africa. It is an automotive manufacturing enterprise in the Buffalo City Metropolitan Municipality. In 1958 this enterprise chose to locate a plant to assemble Mercedes-Benz vehicles on the West Bank of the Buffalo River, close to the port of East London. The locational attraction to the assembly of Mercedes-Benz vehicles was the transport cost

advantage of the factory's nearness to the East London harbour and sea-borne transport. Currently Mercedes-Benz South Africa manufacture C-Class sedan cars for right and left-hand drive markets from this location. They import and purchase local vehicle parts, assemble them and supply the assembled products to domestic and foreign markets. Many other enterprises and human resources have established themselves in the same municipality to supply goods and services to the Mercedes-Benz South Africa manufacturing plant or to receive supply from it. They are upstream and downstream industries to Mercedes-Benz South Africa.