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Eight lessons learned from comparing ocean economy measurement strategies across countries

Many ocean economic activities are not readily visible in official statistics, hindering policymakers' access to crucial information for decision making. The OECD ocean economy measurement project aims to address this by aligning ocean economy statistics with broader economic data and ensuring international consistency. This paper compares the measurement strategies of eight OECD member countries using principles from the system of national accounts. It also highlights the ocean economy thematic accounts of four countries and summarises their methods. The paper concludes with recommendations for integrating ocean economy measurements with national accounting standards, a vital step for improving the evidence base for ocean policymaking.

Acknowledgements

Executive summary

The OECD is supporting countries as they work to pursue sophisticated measurements of the ocean economy. This paper reviews the methods used to measure national-level ocean economic activity in multiple OECD member countries and outlines lessons learned from the analysis for the future measurement strategies of all countries.

The ocean economy – a concept capturing the interlinkages between ocean economic activities and the marine environment upon which they rely – is attracting much interest around the world for its potential contribution to sustainable economic growth. Concurrently, the effects of poor marine environmental management and the twin environmental crises of climate change and marine biodiversity loss are gathering momentum. Effective evidence-based decision making is required if the ocean economy is to prosper in the face of these challenges.

But policymakers in many countries currently have little in the way of accurate, organised and comprehensive ocean economy information. To improve the evidence base, the OECD is complementing national-level efforts by conducting an ocean economy measurement project alongside eight participating countries (Belgium (Flanders), Canada, Ireland, Italy, Norway, Portugal, Korea and the United States).

The OECD ocean economy measurement project targets better information for policymakers in three ways. First, it highlights approaches to measuring ocean economic activity that result in statistics comparable with those on the overall economy and across countries. A second objective is to estimate detailed internationally comparable statistics with global coverage. Finally, the project explores how ocean economic activity measures could be used as a foundation for marine environmental-economic accounts.

This paper builds upon OECD (2021) *Blueprint for improved measurement of the ocean economy* **and answers the first element of the OECD project.** The OECD has distilled relevant guidelines from the system of national accounts that are particularly relevant to producing comparable ocean economy measures. Different participating country approaches are then compared to this benchmark to illustrate a way forward for countries looking to improve the coherence of their estimates with the national accounts.

All participating countries currently focus on ocean economic activity as contained within the traditional production boundary of the system of national accounts – the framework used by national statistical offices to compile important economic statistics such as gross domestic product. But most ocean economic activity is not readily visible in official statistics due in part to a lack of coverage by existing statistical classification systems.

The central challenge faced by participating countries is to estimate the proportion of official statistics on broader economic activity that can be attributed to the ocean economy. In general, complementary information is required to generate partials of established categories and adjustments must be made to ensure the appropriate accounting standards. Each country introduces complementary information differently, although similarities in the

sources, processes and methods adopted – such as the use of thematic accounting frameworks – are expanded upon in the paper.

A comparison of approaches is then used as the basis for recommendations to countries looking to align their measurement strategies with the concepts and standards of the system national accounts. Doing so would accelerate progress towards the realisation of statistics on ocean economic activity that are highly comparable with statistics on overall economies and across countries. The recommendations are summarised as follows:

- *Consult user communities early-on to co-decide what can be measured given standard definitions of the ocean economy.* Good definitions help focus compilation efforts on the areas that cannot effectively be left unmeasured. The OECD definition of ocean economic activities can be used as a starting point by countries prioritising international comparability.

- *Curate a list of economic units in-scope of the ocean economy and keep it up-to-date.* Satellite business registers of ocean economy establishments could be developed if the resources are available. If they are not, regularly updated lists of the most important ocean economy units in each industry would assist compilers generate statistics.

- *Use existing classification systems to categorise ocean economy statistics even if they only partially match.* Existing statistical classification systems rarely provide satisfactory coverage of the ocean economy in isolation from other areas of economic activity. An effective solution is to create concordance between existing classifications and bespoke ocean economy specific categories.

- *Formalise and maintain collaborations between ocean economy domain experts and national accountants.* Ocean experts have information on the activities that should be measured but national accountants are best placed to understand the conventions of official statistics. A combination of the two is necessary for achieving accurate measures of ocean economic activity.

- *Prioritise the application of thematic accounting frameworks for combining official statistics with complementary ocean economy information.* Highlighting invisible areas in the core national accounts requires blending data from different sources. Statistics from thematic accounts should accurately isolate ocean economic activity and help ensure overall comparability.

- *Record methodically all adjustments made to both official statistics and any complementary information used and clearly explain the method adopted.* The adjustments required can be substantial, difficult to achieve and resort to strong assumptions. Transparently clarifying all adjustments made is therefore of primary importance for analytical user groups.

- *Ensure any statistics produced are consistent over time and, in addition to current value time series, provide monetary variables in volume terms.* To be useful for policy analysis, measurements should be regular and published in time series. Compiling time series in value and volume terms helps to improve accuracy and improves their utility for analysis.

- *Develop a strategy for building-upon regular measurements of ocean economic activity so that they may be used effectively in environmental-economic decision making.* Embedding comparable environmental information in ocean economy measures is a substantial and challenging task. A pragmatic strategy that starts with what is currently possible in each country is therefore required.

The OECD stands ready to support all countries as they develop their measurement strategies in line with these recommendations. The next phase in the project will involve expanding the OECD's experimental international statistics and conducting preliminary analysis of methods to introduce comparable measures of marine environmental-economic linkages.

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1 An OECD contribution to improving ocean economy measurement

What is the OECD ocean economy measurement project?

The motivation behind the OECD's ocean economy measurement project is to support and complement efforts by OECD member countries to better measure national-level ocean economies. It involves the participation of experts from Belgium (Flanders), Canada, Ireland, Italy, Norway, Portugal, Korea and the United States. The first objective of the project is to highlight ways in which national statistics on ocean economic activity can be made comparable with statistics on the overall economy and across countries. A second objective is to use information from national ocean economy studies as the basis for estimates of detailed internationally comparable statistics on ocean economic activity with global coverage. Finally, the project explores ways in which measures of ocean economic activity can be used as the foundation from which ocean economy environmental-economic linkages can be accounted for.

What are the objectives of this paper?

This paper relates to the first project objective by highlighting ways in which measures of ocean economic activity can be made more coherent with official statistics. An in-depth analysis of participating countries measurement approaches is conducted by comparing them to internationally agreed guidance for the system of national accounts (SNA). Then the results of the comparative analysis are used to outline recommendations for all countries looking to improve their ocean economy measurement strategies. A definition of ocean economic activity is provided on page 14.

National accounting principles selected by the OECD for their relevance to ensuring comparable data in studies of the ocean economy are used as the framework by which the measurement approaches of participating countries are analysed. Given national approaches provide the information by which different methods and datasets are reconciled for international statistics, eight lessons learned for improving the coherence of ocean economy measurement strategies are drawn out from the analysis. The paper therefore follows-on from the OECD *Blueprint for improved measurement of the international ocean economy: An exploration of satellite accounting for ocean economic activity* (Jolliffe, Jolly and Stevens, 2021[1]).

Why should ocean economy statistics be coherent with the national accounts?

The national accounts can be viewed as the ultimate aggregator of economic information available to policymakers for guiding their decisions. The SNA ensures important economic statistics such as gross domestic product (GDP) are accurate and are calculated in a manner

that remains consistent over time. The data produced are considered to be reliable for many types of important economic analysis and are the primary statistical resource used by governments and civil society to track economic development and analyse policy outcomes. Most countries construct their national accounts according to internationally agreed guidelines so that the economic statistics produced can be compared across countries as well as over time. Countries that ensure measures of ocean economic activity meet to a reasonable degree the high standards of the SNA can therefore be confident in the evidence base of the analyses conducted using them.

In addition to improving the accuracy and comparability of ocean economy statistics, using the SNA as the basis for measurement of ocean economic activity expands the types of analysis that may be conducted with the results. For example, constructing supply and use tables (SUTs) that balance the supply of products with their uses provides a snapshot of the flows of goods and services across the economy. SUTs display the structure of the economy but can also be converted to input-output tables, which indicate the cross-dependencies between industries (or products) and provide the basis for assessments of the impact of particular industries (or products) on the overall economy in a given year. Such analysis can be used to better understand the implications of proposed policies on the ocean economy and lead to more effective decisions that consider a broad range of potential effects on economic activity.

Furthermore, while the core SNA measures economic activity only, extensions have been created that enable environmental and social variables to also be measured in a manner consistent with official economic statistics. Environmental-economic accounts offer particular promise for analysis of the whole ocean economy which includes many crucial linkages with the services and assets of the marine environment. To prepare for fully integrated environmental-economic accounts for the ocean economy (sometimes called "ocean accounts"), there is a need to ensure that the statistics currently produced on ocean economic activity meet national accounting principles and are thereby comparable with the broader estimates in the national accounts.

Who is this paper targeted at?

The analysis is written to be accessible to any interested person, no matter their previous exposure to the technical details of national accounting. It is intended for three broad groups of readers. *Ocean economy domain experts* who are keen to measure their ocean economies in a manner comparable with official economic statistics and who want to understand how countries approach the task. The *community of national accountants* that are increasingly called upon to enable the development of thematic accounts for ocean economic activity and require an introduction to the key issues concerned with ocean economy measurement. And *users of ocean economy statistics* seeking to know more about the arrangements required for comparable economic statistics to be produced.

How is this paper structured?

The paper is split into four additional sections. In Section 2, the institutional arrangements for conducting measurements of ocean economic activity in participating countries are discussed as well as their approaches to defining the boundaries of what should be measured. Section 3 contains brief non-technical descriptions of ten areas of the SNA that are particularly relevant to measuring ocean economic activity alongside introductions to how each area is tackled in the ocean economy studies of the participating countries. In Section 4, an introduction to

thematic accounting is provided in addition to summaries of accounts for ocean economic activity produced by four participating countries. A definition of the term thematic accounts is provided on page 13. Finally, in Section 5, eight key lessons learned drawn from the comparison of the participating country studies and several suggested areas for future OECD work are outlined.

2 Measurement of ocean economic activity in participating countries

The ocean economy studies analysed in this paper target the measurement of ocean economic activity as contained within the traditional production boundary of the system of national accounts (SNA) (Box 1). Accounting for such activities in a consistent manner enables policymakers to understand their performance relative to other areas of the economy and over time. If international accounting standards are met, the performance of ocean economic activities can be assessed across countries with confidence. The resulting statistics are used by policymakers to inform their decisions, including during the development of evidence-based national ocean strategies and in ocean governance frameworks such as marine spatial planning.

The participating country studies are given in Table 1. In general, the key variables of focus are gross value added and employment both for industry-level aggregations and as percentages of gross domestic product and national employment respectively. Of the participating countries, four have developed thematic accounts for ocean economic activity (Korea, Norway, Portugal and the United States) and four have adopted an alternative approach (Belgium (Flanders), Canada, Ireland and Italy).

Box 1. Definition of the traditional production boundary of the system of national accounts

Countries participating in the OECD ocean economy measurement project measure ocean economic activity that would be included in the traditional production boundary of the system of national accounts (SNA). The production boundary of the SNA includes the following activities:

a) The production of all goods or services that are supplied to units other than their producers, or intended to be so supplied, including the production of goods or services used up in the process of producing such goods or services;

b) The own-account production of all goods that are retained by their producers for their own final consumption or gross capital formation;

c) The own-account production of knowledge-capturing products that are retained by their producers for their own final consumption or gross capital formation but excluding (by convention) such products produced by households for their own use;

d) The own-account production of housing services by owner occupiers; and

e) The production of domestic and personal services by employing paid domestic staff.

Activities undertaken by households that produce services for their own use are excluded from the concept of production in the SNA, except for services provided by owner-occupied dwellings and services produced by employing paid domestic staff.

Source: EC, IMF, OECD, UN, WB (2009[2]) *System of National Accounts 2008*

Table 1. Recent approaches to ocean economy measurement in participating countries

Basic information on ocean economy publications in participating countries

Country	Thematic account?	Name of study	Latest methodology reference
Belgium (Flanders)	No	Mapping the Economic and Social Importance of the Blue Economy for Flanders	No publicly available reference document
Canada	No	Marine Sectors in Canada	(Fisheries and Oceans Canada, 2023[3])
Ireland	No	Ireland's Ocean Economy	(Norton et al., 2022[4])
Italy	No	Report on Economy of the Sea	(Informare & OsserMare, 2023[5])
Norway	Yes	Ocean Satellite Account	(Statistics Norway, 2022[6])
Portugal	Yes	Ocean Satellite Account	(Statistics Portugal, 2021[7])
Korea	Yes	Ocean Economy Satellite Account	(Korea Maritime Institute, 2022[8])
United States	Yes	Marine Economy Satellite Account	(Nicolls et al., 2020[9])

Note: Countries that do not produce thematic accounts have developed specific methods for achieving their objectives and, in general, produce measures based on ad-hoc industry categories. For Belgium (Flanders), information on the methodology pursued was shared with the OECD via bilateral communication.

The term *thematic account* refers to accounts that provide more detail on economic activity already measured in gross domestic product and other aggregates of the SNA. The national accounts are categorised by statistical classification systems that provide the required detail for tracking entire economies and for most analytical use cases. However, the categories used are for the most part not detailed enough for accurate and exhaustive measures of the ocean economy to be lifted directly from published statistics.

In order to highlight areas of overall economies such as the ocean economy that are not readily visible in published statistics, the SNA provides for the opportunity to expand upon the existing framework through the creation of what in the past were referred to as satellite accounts. To remove the potential for the term satellite to imply such accounts are of secondary importance to the central accounts, alternative terminology has been proposed by the national accounting community that distinguishes between thematic accounts and extended accounts.

The first type of accounts – *thematic accounts* – enable more granular statistics on particular productive activities to be calculated. They allow for this through the use of more detailed categories from existing statistical classification systems or through the calculation of partial categories. Although new information can be introduced in order to achieve the additional detail, accounts of this type do not change the other central concepts of the SNA. Thematic accounts include, for example, accounts on tourism and culture.

The second type of accounts – *extended accounts* – enable the concepts and accounting rules of the SNA to be altered. This type extends the traditional production boundary to include the production of goods and services that would not normally be measured in gross domestic product (GDP). A well-known example of extended accounts measures unpaid household service work for inclusion in estimates of GDP that include the value of these services that are not normally counted in traditional GDP measures (referred to as extended GDP).

While all four participating countries that have produced accounts for the ocean economy (Korea, Norway, Portugal and the United States) differ in the methodology adopted, they all attempt to provide more precise statistics on productive activities that can be attributed to the ocean economy and count towards traditional measures of GDP and other aggregates of the SNA. Following the taxonomy outlined above, they can be considered to have produced thematic accounts for ocean economic activity.

Although they are not the focus of this paper, coherent measures of ocean economic activity should be considered a first step towards more comprehensive accounts that include measures of the goods and services provided by the marine environment that are not usually included in accounts for productive economic activities. The physical flows of natural resources such as fish or minerals from the marine environment to the economy, for example, or the asset values of marine fish stocks or marine mineral reserves contained within a country's exclusive economic zone. Approaches to estimates of environmental-economic linkages and other elements of importance to analysis of the ocean are areas for future research suggested in Section 5 below.

Definitions of ocean economic activity

All participating countries attempt to measure the aggregate value of production from all economic activities that are related to the ocean in some way. Some countries have produced lists of economic units that conduct important ocean economic activities. However, most countries do not have access to detailed lists of units that fall into this category in part because there is no obvious way of delineating those operating in the ocean economy from those that are not. This is true of all areas of the economy that are not easily described by existing statistical classification systems.

What counts as the ocean economy in each participating country is governed by definitions outlined in each national study. Some countries choose to define the ocean economy tightly and reduce the number of activities measured to a few key industries. Others chose a more maximalist approach and want to include all activities that may be justified as belonging to the ocean economy.

Differences in definitions of the ocean economy between countries mean that the activities conducted by economic units that are considered to be in-scope of the ocean economy also differ between countries. In turn, differences in the value of production associated with industries conducting a particular ocean economic activity will be in part the result of differences in definition.

In the United States, for example, the definition adopted includes "production that takes place on the ocean or receives essential inputs from the ocean", "production that, by necessity, takes place near the ocean", and "commodities purchased for use on the ocean, no matter where production takes place". The United States differs somewhat from other countries approaches in that it counts economic activity occurring on the freshwater Great Lakes and other major bodies. Estimates of economic activity conducted through the United States Marine Economy Satellite Account are therefore not specific to the ocean.

OECD working definition of ocean economic activity

The OECD has adopted an approach to summarising statistics on ocean economic activity based on industrial activities that fall within the traditional production boundary of the SNA (Jolliffe, Jolly and Stevens, 2021[1]). Following a consensus among the countries participating in the OECD ocean economy measurement project, it has proposed a working definition of ocean economic activity for international statistics. The definition contains seven parts describing relationships and dependencies between economic activity and the ocean. Compilers of statistics on ocean economic activity can use the definition to help decide the boundaries between ocean economic activities and all others by measuring activities that meet any or all of the following requirements:

- They take place on or in the ocean;

- They produce goods and services primarily for use on or in the ocean;

- They extract non-living resources from the marine environment;

- They harvest living resources from the marine environment;

- They use living resources harvested from the marine environment as intermediate inputs;

- They would likely not take place were they not located in proximity to the ocean; and/or

- They gain a particular advantage by being located in proximity to the ocean.

Justifications for the inclusion of each element of the definition and examples of economic activities what would and would not be included are provided in Jolliffe, Jolly and Stevens (2021[1]). The elements are not mutually exclusive and an activity may satisfy multiple parts of the definition. The OECD uses the United Nations' International Standard Industrial Classification of All Economic Activities Revision 4 (ISIC Rev.4) as its reference classification system for describing the industries that make up ocean economic activities (each OECD ocean economic activity is based on one or more industries that can be at least partially described by an existing statistical classification code). A list of concordant ISIC Rev.4 codes is also provided in Jolliffe, Jolly and Stevens (2021[1]).

National arrangements for measuring ocean economic activity

Each country participating in the OECD ocean economy measurement project has a different way of organising and conducting measurements of ocean economic activity, but all approaches involve collaboration between national statistical authorities and ocean economy domain experts. The level of collaboration between the different producers of statistics differs between countries. In Ireland, for example, an arrangement between the national statistical office and the ocean economy domain experts results in specific statistics being sent between the two organisations upon request. For the countries producing ocean economy thematic accounts, national statistical offices perform a much more prominent role in the compilation process. The arrangements for ocean economy measurement at national level must therefore take into account the various processes of the institutions involved.

In the countries that pursue close collaboration between national accountants and ocean economy domain experts, national studies of ocean economic activity must fit into the standard work programmes of national statistical offices (so-called "statistical business process"). If official statistics are being produced, quality assurance represents a crucial consideration. Assuring the quality of official statistics, particularly at the level of the SNA, is a complex and time-consuming process. In order to organise their work effectively and ensure regular and predictable outputs, national statistical offices follow detailed procedures set against strict timelines.

The statistical business process for the production of the United States' ocean economy thematic account – the United States Marine Economy Satellite Account (US MESA) – begins in September of each year, when the core national annual supply and use tables (SUTs) are updated (Franks, 2022[10]). Between October and December, the SUTs are used to update the coefficients relied upon to isolate ocean economic activity from the rest throughout the timeseries. Any new methodologies for estimating coefficients that may have been proposed since the previous edition are also reviewed during this period. In January and February of the following year, the first set of estimates are produced and an initial review is conducted by the United States Bureau of Economic Analysis (BEA) and the National Oceanic and Atmospheric Administration (NOAA). Between March and May, the estimates are finalised through an official

review and the publication materials are produced, reviewed and prepared for dissemination by both agencies. In June, the results from the US MESA are released publicly.

For countries where national statistical offices are not directly involved in the measurement process, timelines depend more on the institution with ocean economy domain expertise that is carrying out the measurement and the needs of the main user groups of ocean economy statistics. The Korea Maritime Institute, for example, releases annual measurements of ocean economic activity in accordance with a scheduled release date. While Ireland's Marine Institute and the Socioeconomic Marine Research Unit (SEMRU) at the National University of Ireland at Galway have committed since 2022 to produce a joint annual update of their statistics on ocean economic activity.

The funding mechanisms in place for ocean economy measurement projects and programmes differ between each country. In the United States, the BEA is under contract from NOAA to produce its annual US MESA. In Ireland, the Marine Institute receives funding from the Irish Government to provide economic statistics and other services that support its maritime spatial planning activities. This has allowed the Marine Institute to set up an economics unit. In Korea, some initial research into an ocean economy thematic account was funded by the Korean National Research Council for Economics, Humanities, and Social Sciences while the Ministry of Oceans and Fisheries (MOF) has committed to funding a full pilot project for potential development of official statistics. A summary of the national arrangements for ocean economy measurement in all of the participating countries is provided below.

Arrangements in Belgium (Flanders)

There are no regular measurements of ocean economic activity in Belgium. However, the Flanders Blue Cluster commissioned the production of a report published in 2020 entitled *Mapping the Economic and Social Importance of the Blue Economy for Flanders*. The analysis contains information on employment in in number of full-time jobs and gross value added in ocean economic activities such as marine aquaculture, marine extraction of oil and gas, and water transport and port infrastructure. The results of the assessment are model based and include estimates of the indirect and induced effects of certain ocean economic activities on the wider economy. An update to the 2020 report is scheduled for release in 2024.

Arrangements in Canada

In Canada, Fisheries and Oceans Canada (DFO) has been responsible for the production and publication of regular and systematic measurements of ocean economic activity on behalf of the Government of Canada for at least the past decade. The key national resource for statistics on Canada's ocean economic activities is DFO's *Marine Sectors in Canada Summary Tables*. The series contains breakdowns of gross domestic product and employment categorised into fourteen activity groupings split across the public and private sectors. The publication also gives estimates of the indirect effects of multiple ocean economic activities on activity in the rest of the Canadian economy. More recently, DFO has partnered with the national statistical authority, Statistics Canada, to develop marine natural capital accounts. The first set of accounts are likely to focus on seagrasses, kelps, and salt marshes.

Arrangements in Ireland

In Ireland, the Marine Institute and the National University of Ireland at Galway's Socioeconomic Marine Research Unit (SEMRU) play key roles in the measurement of ocean economic activity. Among many ocean economy related programmes, the Marine Institute keeps a record of

enterprises operating in the Irish ocean economy. It publishes data on research and development grants awarded in Ireland from both national and international sources through the National Marine Research Database. It also funds socio-economic research through its competitive funding programmes for doctoral positions, postdoctoral fellowships and other economic research projects.

Between 2006 and 2020, the Marine Institute worked to improve national capacities in the study of the ocean economy including through funding the establishment of SEMRU in 2008. In 2021, the Marine Institute entered a five-year partnership with SEMRU to achieve common objectives for delivering public services such as implementing maritime spatial planning in Ireland. In parallel, the Marine Institute has an agreement with the Marine Planning and Policy Unit in the Irish Government's Department of Housing, Local Government and Heritage on the provision of marine scientific and technical advisory services. Such services help to deliver national legislative responsibilities through monitoring, analysis, and data acquisition and management. In addition in 2021, the Marine Institute funded a doctoral position to work with the environmental accounts division of the national statistics office to develop a framework for the establishment of marine ecosystem accounts for Ireland.

The Marine Institute and SEMRU are responsible for the production and publication of measurements of ocean economic activity in Ireland through the *Ireland's Ocean Economy* publication series. The reports aim to provide a regular summary of the contribution of the ocean economy to Ireland's economy overall and highlight particular developments in the policy environment surrounding ocean economic activities. A core objective of the series is to provide a repeatable methodology for measuring turnover, gross value added, and employment generated by ocean economic activity over time. The latest report was released in 2022 and represents the sixth in the series. From 2022 onwards, the report will be released annually.

Arrangements in Italy

In Italy, regular statistics on ocean economic activity are published by the Chamber of Commerce Frosinone-Latina. The statistics are produced by the Study Centre of the Chambers of Commerce Guglielmo Tagliacarne which conducts socioeconomic research and policy analysis for public administrations and other relevant institutions in collaboration with different Chambers of Commerce in different parts of Italy. The annual *Report on the Economy of the Sea* is produced on behalf of the Special Agency of the Chambers of Commerce Frosinone Latina (Informare) and the National Observatory of the Economy of the Sea (OsserMare) and is used by the business community and public policymakers alike. The latest version, released in 2023, represents the 11th edition of the report.

Arrangements in Korea

The Korea Maritime Institute (KMI) is responsible for the production and publication of measurements of ocean economic activity in Korea. Established in 1997, KMI is a government funded research institute contributing to the development of maritime and fisheries policies that foster national economic growth. In addition to a wide range of maritime and fisheries research, KMI's Ocean Economy Research Division produces the *Korea's Ocean Economy* publication series. The series "aims to diagnose the size and status of Korea's ocean economy… and look into the recent trends of individual industries" in order to improve decision making surrounding relevant policies.

KMI's Ocean Economy Research Division conducts further work on economic statistics and analysis of relevance to the measurement of ocean economic activity in Korea. These include

the delivery of an annual National Ocean Economy Statistics Survey alongside the national statistical office (Statistics Korea) and a developmental project on a national ocean economy thematic account. The data from the measurement programme are used in impact analyses and simulations relying upon both elaborations of the Bank of Korea's analytical input-output tables and computable general equilibrium (CGE) models. The statistics are also fed into forecasts of changes in the value added generated in maritime and fisheries industries using econometric and machine learning methods.

Arrangements in Norway

The Government of Norway's 2020 Ocean Strategy details Norway's history as an ocean-faring country with a history of ocean economic development. Multiple ocean economic activities such as the offshore extraction of oil and gas, marine fishing and aquaculture and maritime transport have been major contributors to Norway's economy overall. The 2020 Ocean Strategy contains estimates of value added and employment generated in the Norwegian ocean economy conducted by an economic consultancy (Menon Economics). The methods used to develop the statistics are not publicly available, but the report suggests that the three aforementioned industries "account for more than 30% of all value-creation of the private sector" in Norway.

In 2020, the Prime Minister of Norway spearheaded the High Level Panel for a Sustainable Ocean Economy. The "Ocean Panel" brought together the heads of state and government of 14 different countries to consider policy actions that would lead to a future ocean economy that is more sustainable and equitable than at present. The Ocean Panel resulted in commitments from multiple countries to "build ocean knowledge", including through the development of statistical information systems that measure productive activities in the ocean economy as well as marine natural capital and ecosystem services.

Until recently, no single organisation has been responsible for the production and publication of regular and systematic measurements of ocean economic activity in Norway. In 2021, the Research Council of Norway invited Statistics Norway to begin work on building the statistical infrastructure required to produce a thematic account for ocean economic activity. The thematic account was to provide a summary of ocean economic activity in Norway through the supply and use framework. The statistics produced are consistent with the Norwegian national accounts and comparable with other parts of the Norwegian economy.

Arrangements in Portugal

Portugal is a pioneering ocean economy measurement country having been the first country to produce a thematic account for ocean economic activity. Responsibility for the production and publication of measurements of ocean economic activity in Portugal lies with Statistics Portugal (INE). The Portuguese ocean economy thematic account makes use of the core national accounts and involves the construction of dedicated ocean economy SUTs. At present, the thematic account maintains the production boundary of the national accounts and measures ocean economic activities only.

The first ocean economy thematic account was produced by INE under request from the Government of Portugal's Directorate General for Maritime Policy (DGPM). It was released in 2016 and covered the years 2010 to 2013. Measurements of ocean economic activity have since become a priority area for the Government of Portugal and a Ministerial Resolution mandates that the thematic account estimates are to become official statistics updated by INE every three years. The second version, completed in 2020, contains various developments from the initial account including more refined source data and additional estimations for the

Autonomous Regions of Azores and Madeira. It covers the years 2016 to 2018. DGPM and the Portuguese Science and Technology Foundation (FCT) continue to provide technical inputs to the process, including through the scoping of the productive units to be included in the account and the provision of the results of a survey of ocean-related research and development activities.

Arrangements in the United States

The National Oceanic and Atmospheric Administration (NOAA) conducted the first measurements of the ocean economy by an official statistical organisation in the United States (US) through the development of the Economics: National Ocean Watch (ENOW) programme. In recent years, the United States has pursued the development of the United States Marine Economy Satellite Account (US MESA). Responsibility for the production and publication of the US MESA lies with the Bureau of Economic Analysis (BEA) in collaboration with NOAA.

The US MESA makes use of the core national accounts and the BEA's SUTs in particular. At present, the thematic account maintains the production boundary of the national accounts and measures ocean economic activity only. The first prototype version of the ocean economy satellite was produced by BEA in 2020 and covered the years 2014 to 2018. The latest version – released in 2023 for the years 2014 to 2021 – contains various developments from the initial account and the statistics produced are now considered official, rather than experimental, estimates.

3 Comparing measurements of ocean economic activity to national accounting principles

This section compares the methods used by countries participating in the OECD ocean economy measurement project to generate statistics on ocean economic activity with ten national accounting principles. Each principle refers to a technical area of the system of national accounts (SNA) that has been deemed by the OECD to be important for producing comparable measures and for consideration in future national studies of the ocean economy. Each principle introduced includes a description of how the topic is reflected in the ocean economy studies of the participating countries.

The principles are summarised in non-technical language based on the internationally agreed guidelines. The national statistical offices of all OECD member countries compile their national accounts using methods that meet the guidance outlined in the United Nations Statistical Commission (UNSC) approved System of National Accounts 2008 (2008 SNA) (EC; IMF; OECD; UN; WB[2]). The concepts from the 2008 SNA are therefore important for producing comparable international statistics on ocean economic activities. The main sources for the information below regarding the national accounts are the 2008 SNA and the *UN Handbook on Supply and Use Tables and Input-Output Tables with Extensions and Applications* (United Nations, 2018[11]). Methodological sources for the ocean economy studies of the participating countries are referred to in Table 1.

Institutional units and their categorisation by sector

A complete measurement of ocean economic activity would account for all economic entities operating in the ocean economy from all institutional sectors. The most basic economic entity considered in the SNA is the *institutional unit*. An institutional unit is an economic entity that is capable, in its own right, of owning assets, incurring liabilities and engaging in economic activities and in transactions with other entities. An institutional unit can be a person, a group of persons such as a household or a legal entity recognised in society independently of any person such as a business corporation or government agency. Institutional units conduct three broad types of economic activity: production of goods and services, consumption of goods and services, and the accumulation of capital. An individual institutional unit partakes in the economic activity or activities that realise its economic objectives and functions.

Of the eight participating countries, Portugal provides a good example of a method to count the number of units operating in the ocean economy. To do so, details on units are collected from business registers and other sources that are classified under statistical codes deemed in-scope of their definition of the ocean economy (see sections on 'Statistical business registers' and 'Establishments and their aggregation into industries' below). The details of units not

captured by this process but considered by authorities to be in-scope of the ocean economy are added manually to the list. Those known to be operating in the ocean economy due to disclosures in public documents such as company reports, for example. Or units that advertise their activities at ocean conferences and in industry newsletters. The final list contains around 45 700 units on mainland Portugal, around 3 300 in the Autonomous Region of the Azores, and around 3 500 in the Autonomous Regions of Madeira.

Portugal then links the units deemed in-scope of the ocean economy to the institutional sectors with which they are associated. In the SNA, institutional units are categorised into different *institutional sectors* based in part on the economic activity they typically engage with. Institutional sectors are mutually exclusive in that the part of an institutional unit measured in statistics cannot belong to more than one institutional sector (usually the sector that best describes its economic activity).

Portugal finds in-scope units operating across three of the five primary institutional sectors defined in the SNA: 'General Government' institutions, 'Non-profit institutions serving households (NPISH)' and 'Financial corporations'. The five primary resident institutional sectors are defined in the SNA as follows:

- *Households* are groups of persons who share the same living accommodation, who pool some, or all, of their income and wealth and who consume certain types of goods and services collectively, mainly housing and food
- *Non-profit institutions serving households (NPISHs)* are legal entities that are principally engaged in the production of non-market services for households or the community at large and whose main resources are voluntary contributions
- *General government* consists of institutional units that, in addition to fulfilling their political responsibilities and their role of economic regulation, produce services (and possibly goods) for individual or collective consumption mainly on a non-market basis and redistribute income and wealth
- *Financial corporations* are resident corporations that are principally engaged in providing financial services, including insurance and pension funding services, to other institutional units
- *Non-financial corporations* are corporations whose principal activity is the production of market goods or non-financial services

An additional grouping – *rest of the world* – consists of all non-resident institutional units that enter into transactions with resident units or have other economic links with resident units.

Although the terms *public sector* and *private sector* do not describe institutional sectors as defined in the SNA, Canada provides estimates of the output of the "public sector" in its statistics on ocean economic activity. To achieve this, specific institutional units in each institutional sector are delineated between "public" and "private" units. In this view of the ocean economy, all institutional units controlled by government, whether they be a part of the government institutional sector, a financial or a non-financial corporation, make up the public sector. Conversely, the private sector consists of all other units from any institutional sector other than government.

Economic territory and the total economy

A complete measurement of a country's ocean economic activity would account for all institutional units from all institutional sectors resident in an economic territory regardless of

where their interaction with the ocean takes place. *Economic territory* refers to the geographic area or legal jurisdiction for which economic statistics are being compiled (typically nation states and their subdivisions). Economic territories include the land area, airspace, territorial waters and overseas territorial enclaves such as embassies controlled by a single government, but official economic territories based on international economic unions also exist.

Given a substantial portion of ocean economic activity regularly shifts between legal jurisdictions, territory represents an important aspect in ocean economy measurement. International maritime transport activities, for example, move goods between ports in one economic territory to ports in other economic territories. Under which economic territory should such activities be accounted for?

In the SNA, the complete set of institutional units that are *resident* in an economic territory across the five institutional sectors constitute the *total economy*. Complex institutional units that operate in multiple areas and jurisdictions are considered to be resident in the economic territory containing their dominant economic interest. This ensures, by rule, that an institutional unit is resident in only one economic territory. Where this is not the case and it is not possible to assign the predominant economic interest of an institutional unit to a single economic territory, special methods enable operations to be split between economic territories. The productive activities of international maritime transport operators are therefore accounted for in the country in which units operating these activities are resident.

Theoretically, delineating resident units operating in the ocean economy of an economic territory from those that are not is governed by definitions outlined in the study of each participating country. For the majority of participating countries, the ocean represents the only water body of interest. In the United States, the inland freshwater bodies of the Great Lakes are included. Any resident unit active in relation to the Great Lakes is therefore also counted in its measurements of ocean economic activity.

The measures of ocean economic activity conducted by the participating countries are compiled for economic territories representing whole countries. This is also true of the national accounts in general. However, the SNA can be elaborated in several different ways including through more granular geographical areas. That much of the ocean economy takes place in or near coastal areas suggests that regional accounts could be a useful tool for policy analysis in large countries with strong discrepancies in ocean economic activity between regions.

Regional accounts for ocean economic activity are perhaps most relevant in federal states where state-level governance plays a substantial role in the development of the ocean economy. In Belgium, for example, the entire coastline and the important logistical hub of the Port of Antwerp are located in the Flemish Region of Belgium (Flanders). Much of Belgium's ocean economic activity therefore takes place in Flanders but this nuance is not reflected in national-level statistics. Similar issues occur in the United States, where the coastal states play a more important role in the generation of ocean economic activity than inland states. The National Oceanic and Atmospheric Administration (NOAA) and the Bureau of Economic Analysis (BEA) have highlighted state-level estimates as a potential next step in the development of their Marine Economy Satellite Account as a result.

Statistical business registers

Some participating countries are beginning to curate lists of economic units operating in the ocean economy. Many governments keep information on resident institutional units in centralised repositories. *Statistical business registers* collect this information and attempt to

organise data on the population of institutional units from all institutional sectors in an economic territory, whether they produce market or non-market output. One of the pieces of information collected in submissions to business registers is the *nature of business* that is conducted. In general, the options available to describe business nature are taken from the industrial classification systems managed by national statistical offices (see section on 'Establishments and their aggregation into industries' below).

An up-to-date statistical business register is considered essential for the statistical surveys used for SNA estimates (see section on 'Key data sources' below). In practise, national statistical offices will sometimes keep their own business registers to supplement the information stored in central statistical business registers. In addition, satellite business registers can be created that contain details on the population of institutional units operating in a particular economic area.

Given their centrality to understanding the institutional units operating in a particular economic area of a country, ocean economy measurements would benefit from the development of satellite registers specific to ocean economic activity. However, developing a satellite business register for the ocean economy requires a commitment to quality assurance and regular updates that make the costs of doing so significant. The resources required for such a programme are not insubstantial and therefore currently unavailable to most organisations seeking to better measure the ocean economy.

An alternative starting point used by participating countries are analyses of business registers held by organisations such as businesses associations and industry networks. In Italy, for example, the Chamber of Commerce Frosinone-Latina identified 228 190 enterprises operating in Italy's ocean economy in 2022 which make up just under 4% of the enterprises in the overall economy in the same year. The statistics on the number of enterprises are broken down by industry aggregation, territory, region and province. Demographic details – gender and age seniority – are also included. For example, around half (47.8%) of the total number of ocean economy enterprises operate in the 'Accommodation and catering services' industry, 10.5% are located in Liguria, and 22.1% of the total number persons employed by all ocean economy enterprises are female.

Another accessible form of business register pursued by participating countries is curated lists of businesses used for administrative purposes such as governing particular ocean economic activities. Ireland, for example, maps the concentration of business in electoral districts based on entries into the Marine Institute of Ireland's Marine Business Directory. Korea counts the number of businesses responding to an annual survey targeted at a sample of units owning fishing license registrations among other administrative data.

Measuring production

All participating countries attempt to measure the production associated with ocean economic activities. *Production* is the act of using capital, labour and goods and services as inputs to a process that results in outputs of goods and services. Collectively, goods and services are called *products*. In the SNA. institutional units that engage in productive activities and own or have the right to be paid for the products resulting from them are called *enterprises*. Enterprises can originate in any institutional sector.

Most participating countries begin their measurements of the productive activities of enterprises in-scope of the ocean economy in terms of domestic output. *Output* refers to the goods and services created by enterprises through the process of production. Output can be produced for

sale at economically significant prices or bartered in markets. *Market producers* sell their output at economically significant prices. *Non-market producers* provide their output to other institutional units or to society more generally without charge or at economically insignificant prices. Some output is used by producers for investments in fixed assets and some may be used for own final consumption. Measures of output therefore differ from measures of sales in a given year.

Uniquely among the participating countries, Ireland measures the turnover associated with ocean economic activities. *Turnover* refers to actual sales in a given year and differs from domestic output in that some output may either: be produced and added to inventories rather than be sold, or, vice versa, be taken out of inventories created from products produced in previous periods.

In their thematic accounts, Norway and Portugal publish estimates of the intermediate consumption required by ocean economic activities to produce domestic output. Products used in the process of producing other goods and services are called *intermediate inputs*. The total value of the use of intermediate inputs among enterprises is called *intermediate consumption*. The United States publishes statistics on the intermediate inputs used in the production of ocean economy goods and services rather than the aggregate intermediate consumption associated with particular ocean economic activities.

Table 2. Countries differ in the economic variables measured in their national studies of the ocean economy

Economic variables measured by each participating country

	BEL	CAN	IRL	ITA	NOR	PRT	KOR	USA
Production by industry								
Number of units			X	X		X		
Turnover			X	X				
Gross output		X			X	X	X	X
Intermediate inputs					X	X	X	X
Value added	X	X	X	X	X	X	X	X
Value added components by industry								
Compensation of employees					X	X	X	X
Taxes and subsidies on production					X	X	X	
Operating surplus and mixed income						X	X	
Consumption of products								
Final consumption expenditure					X	X	X	
Gross fixed capital formation				X	X	X	X	
Gross capital stock								
Trade in products								
Imports				X	X	X	X	
Exports				X	X	X	X	
Employment by industry								
Persons' employed		X		X				X
Full-time equivalents	X		X		X	X	X	

Note: The United States measure intermediate inputs to the production of ocean economy products rather than the intermediate consumption of ocean economy industries. Norway's ocean economy thematic account refers to gross value added as gross product. Canada measures gross output but does not publish the estimates publicly due to previous issues linked to interpretation of the results.
Source: See Table 1 for references to the relevant national studies

All participating countries then measure production in terms of *gross value added* – defined as the difference between the value of domestic output and intermediate consumption. Ireland, Italy and Canada take estimates of gross value added directly from official statistical sources and split them to isolate the portion attributable to ocean economic activity using complementary information from alternative sources. The United States applies the ratio of ocean economic activity gross output to overall gross output to estimate gross value added by ocean economic activities. The remaining participating countries subtract estimates of intermediate consumption from their estimates of gross output. In the SNA, the productive activity that generates the majority of the total value added resulting from an enterprise's activities is considered its *principle activity*. Minority value added productive activities are called *secondary activities* if they result in products delivered to other institutional units. They are called *ancillary activities* if they are produced for use as intermediate inputs by the enterprise itself.

All participating countries then attempt to estimate the contribution of production in ocean economic activity to their overall economies. One way of doing so is to calculate the percentage of *gross domestic product* (GDP) – a measure of the total value of production in an economic territory – that can be attributed to ocean economic activity. The SNA allows for three ways of measuring GDP. The approach derived from production accounts is known as the *output approach* and is achieved by summing the gross values added of all establishments operating in all industries of the economy (see section below on 'Establishments and their aggregation into industries'). GDP calculated according to the *expenditure approach* is equal to the sum total of final consumption, investment and net exports. The *income approach* involves summing compensation of employees, gross operating surplus and gross mixed income. A consistent set of national accounts will result in estimates of GDP that are equal across the three approaches once taxes less subsidies are taken into account.

Components of gross value added

As already outlined, gross value added is equal to the difference between the value of domestic output and intermediate consumption. Gross value added is used by enterprises to pay their workers, meet interest payments on loans, pay the taxes on production they face, and replace or purchase new forms of the capital they use up in the process. In SNA terms, gross value added is equal to the sum of the compensation of employees, (other) taxes less subsidies on production, and operating surplus/mixed income.

Some participating countries provide estimates of these components of gross value added for ocean economic activity. Norway and Portugal calculate the compensation of employees in ocean economic activities. In the SNA, the total cost of labour to an employer is captured in *compensation of employees* which refers to both the wages and salaries received by workers plus any additional benefits and social contributions that employers are liable for. The United States measures wages and salaries paid to the employees of enterprises conducting ocean economic activities.

In addition to the compensation of employees, Portugal measures (other) taxes and subsidies on production. Any taxes on products or on the factors of production are considered *taxes on production*. Taxes on products includes taxes paid by the producer on their output, taxes and duties on imports, export taxes, and any other taxes on products. Taxes on production also includes those paid regardless of the profitability of the enterprise that are related to the ownership of capital such as land and buildings as well as taxes paid due to the employment of labour. *Subsidies on production* are usually deducted from the value of taxes on production to make *taxes less subsidies on production*. *Subsidies on products* are receipts of enterprises from

the general government sector based on the level of goods and services produced by a particular enterprise. Other subsidies on production can be received as a reward for generating positive externalities such as reducing the environmental effects of polluting production processes.

Portugal also measures *operating surplus* and *mixed income* in ocean economic activities Anything left over after employee compensation and taxes (less subsidies) have been paid accrues to the enterprise in the form of *operating surplus* and *mixed income*. Operating surplus is a measure of the returns to capital and can be used to assess the performance of enterprises. It is not however equivalent to profit in company accounts mainly because some revenues and expenditures, such as interest and rent paid and received as well as dividends received, have not yet been taken into account. But also due to the multiple adjustments to the value of output and inputs and differing methods of valuation in the SNA. Mixed income is a similar concept but is applied when it is difficult to separate the returns to capital from the returns from labour such as in the case of *unincorporated enterprises* where the labour input of the owner or other family members is not directly remunerated.

Establishments and their aggregation into industries

All participating countries calculate statistics on ocean economic activity by industry. Compiling a coherent industry view of the ocean economy requires careful accounting for specific statistical units, but the enterprises carrying out ocean economic activities range in type, size and structure.

Individual enterprises can be small and simple organisations conducting just one or a few activities. They can also be large and complex organisations spread over distant geographical areas conducting many different activities that are vertically and/or horizontally integrated with each other. While small ocean economy enterprises generally coincide with one statistical unit, large and complex ocean economy organisations may consist of several units. It may also be the case that only one part of a large and complex enterprise conducts activity considered in-scope of the ocean economy while all other parts do not.

In the SNA, whole enterprises or the parts of large and diverse enterprises that conduct the same primary activity are considered part of the same *kind-of-activity unit*. Kind-of-activity units that operate from one location (or *local unit*) are called *establishments*. Production in the SNA is generally measured at the level of establishments. Groups of establishments engaged in similar kinds-of-activity are considered to belong to the same *industry*. Industries contain both market producing establishments and non-market producing establishments. Many government services, for example, are classified under the industry which best describes the activities that take place.

All participating countries rely to an extent on existing official statistics classified according to nomenclatures such as the United Nations' International Standard Industrial Classification of All Economic Activities (ISIC) and the classification systems related to it. The goods and services produced by industries are classified by nomenclatures such as the United Nations' Central Product Classification (CPC) and the national classification systems related to it.

Classifications of industries and products such as ISIC and CPC have a hierarchical structure with multiple layers of mutually exclusive categories. The hierarchy in the current ISIC has four levels of detail. In general, an establishment will be assigned to one ISIC code at the most detailed ISIC level (four-digit classes) and thereby counted under the categories in the three levels above it in the hierarchy. At four-digit class level, the processes and technologies used

by establishments in their productive activities are described. At higher-levels of detail, the categories describe more aggregated activities that are useful in analysis rather than the processes and technologies relied upon.

In order to remain relevant to economic reality and analytical needs, both ISIC and CPC are updated and revised when required. New categories are added, obsolete ones removed, and the alignment between related systems improved. The first ISIC was established in 1948, the current Revision 4 of ISIC was agreed in 2006 and the latest version – ISIC Rev.5 – was submitted to the United Nations Statistical Commission for approval in 2023. During updates and revisions, a compromise is struck between the theoretical underpinnings of the classification, its utility for analysis and the amount of detail it provides. Too little detail and analysts are unable to use data that is structured by the classification system in their work. Too much detail and the classification becomes too complex for accurate data to be collected or for confidentiality concerns to preclude the publication of statistics.

Practical considerations such as these sometimes mean that specific areas of the economy are not readily categorised by statistical classification systems. The ocean economy is a good example of this. The industry categories in ISIC, for example, don't for the most part delineate establishments operating in the ocean economy from those operating in the same industry but with no relevance to the ocean economy. With the exception of the four-digit ISIC Rev.4 classes marine fishing, marine aquaculture, sea and coastal passenger water transport, and sea and coastal freight water transport, all other four-digit classes contain activity that might not be included in analysis of the ocean economy. A similar combination of establishments conducting activities that would be counted under the ocean economy with those that would not is also apparent in the definitions given in national industry classifications.

Analyses of the ocean economy that rely upon statistics aggregated under industrial classification systems therefore require additional information to split existing industry categories in order to isolate the activity taking place in ocean economy establishments from the rest. Statistics on ocean economic activity calculated in this manner can then be aggregated into the existing classification structure and compared with the broader aggregations apparent in the original statistics. Alternatively, an entirely bespoke classification of ocean economy specific industry descriptions can be created and economic statistics calculated based on methods unrelated to the SNA. While the first approach can achieve coherence with SNA aggregates, the second reduces comparability in most cases.

The participating countries pursue either the first or a mix of the two approaches to producing statistics on ocean economic activity by industry. Portugal and the United States publish partials of existing categories using information from outside of the national accounts. Both also provide statistics aggregated under bespoke ocean economy labels to ease direct access to relevant statistics among user groups. The United States publishes statistics aggregated according to ten "marine economy activities" that reflect important ocean economy areas. Portugal also publishes statistics according to bespoke aggregations (nine different "groups" of established and emerging ocean economic activities) in addition to those classified under established industry categories.

Canada, Norway and Korea calculate partials of established industry categories but do not aggregate statistics under them. Instead, they publish their results under bespoke combinations of detailed categories with bespoke labels. To assist this process, Korea and Norway have created concordance tables with the industry classification systems used in each country. In addition, Korea has created a detailed ocean economy specific classification system that concords to both the Korean national industry classification system (KSIC) and ISIC (Box 2). The Korean National Classification for Marine and Fisheries Industries enables detailed

comparisons of ocean economy statistics with the broader values published in Korean national accounts as well as internationally.

Ireland creates a bespoke set of industry categories. Activity categories are either associated with one or more four-digit industry category or are defined by ocean economy experts in the country. Using formal industry codes enables the use of statistics published by the national statistical office for categories where granular data are available. The bespoke categories aggregate data from a range of alternative sources including special surveys designed to understand particular facets such as marine and coastal tourism arrivals and new emerging activities such as marine renewable energies and marine biotechnology.

Box 2. The Korean National Classification for Marine and Fisheries Industries

The Korea Maritime Institute (KMI) has developed an ocean economy measurement infrastructure that includes a bespoke classification system for ocean economic activities. The 2018 Korean Classification System of Marine and Fisheries Industries is built upon the Korean Standard Industrial Classification (KSIC) Version 10 and adds extra detail where required. (KSIC is fully concordant with the International Standard Industrial Classification Revision 4.) Two more refined classifications developed in 2015 for marine industries and, separately, fisheries industries are used by KMI. The 2018 Korean Classification System of Marine and Fisheries Industries is a combination of the two refined classifications.

The 2018 classification is hierarchical in nature and contains four layers of detail. At the most aggregated level of activity, there are nine categories. The nine major categories are: marine resources development and construction; shipping and port industry; building and repair of ship and offshore plant; fisheries production; fish processing; fishery products distribution; ocean and fisheries leisure and tourism; ocean and fisheries equipment manufacturing; and, ocean and fisheries related services. These are broken down into finer detail by 29 medium, 68 small, and, at the most detailed level, 143 sub categories.

For example, the fishery processing industry is broken down into four small categories: fish processing and preservation; seaweed processing and preservation; salt processing; and, other fish processing. The fish processing and preservation industry is further broken down into five sub categories: manufacture of smoked, seasoned and similar prepared aquatic animal products; manufacture of dried, salted aquatic animal products; manufacture of frozen aquatic animal products; processing and preserving of other aquatic animals; and, manufacture of animal oils and fats. The other fish processing industry is further broken down into three sub categories: manufacture of organic fertilizers and bed soils; manufacture of jewellery and related articles; and, manufacture of imitation jewellery and costume jewellery. (No further detail are provided for the other small categories: seaweed processing and preservation; and, salt processing.)

Balancing the supply of products with their use

All participating countries pursue a quality assurance process that seeks to verify the statistics produced on ocean economic activity are consistent with previous editions of their measurement publications. Where this is not the case and a break in methods is necessary, the resulting changes are documented and the effects of these changes explained. Ensuring coherence with statistics on the overall economy and across countries also requires ensuring the standards of the SNA are satisfied.

Central to the checks and balances built into the SNA is the convention that the products supplied to an economy in an accounting period must all be used in some way during the accounting period. The supply of products originates in the output of domestic establishments as well as imports from the rest of the world. All products supplied must then be used by institutional units from any sector as intermediate inputs, in capital formation, including changes in inventories, through final consumption and as exports to the rest of the world. This equation is known as the *product balance* and holds for all goods and services in an economy. The aggregate product balance can be stated as: Output plus Imports equals Intermediate consumption plus Final consumption plus Capital formation plus Exports.

Product balances for all goods and services in an economy are made explicit in the SNA through a set of interlinked tables known as *supply and use tables* (SUTs). SNA principles apply in SUTs just as they do for the rest of the accounting tables. But the accounting entries are organised in such a way that the processes of production and consumption become clearer. The SUTs are structured as a series of joined matrices showing different elements of the product balance. The SUTs depicted in Figure 1 are based on an internationally agreed structure collected by the OECD for cross country comparisons and published in the OECD's SUT Database. A detailed summary of SUTs and the different matrices they contain in the context of the measurement of ocean economic activity is provided in Jolliffe, Jolly and Stevens (2021[12]).

SUTs for ocean economic activity are estimated by Korea, Norway, Portugal and the United States – the participating countries that have developed thematic accounts. In doing so, they combine the domestic output of ocean economy products produced by resident establishments with the imports of ocean economy products. They then add taxes less subsidies on ocean economy products, the costs of transporting them from the producer to the purchaser and the mark-ups added by traders selling them (the latter two are *trade and transport margins*). This gives estimates of the total domestic supply of ocean economy products at purchasers' prices which, according to the SNA product balance, must be equivalent to the total use of ocean economy products. To check for this condition, they then calculate the total use of ocean economy products valued in purchasers' prices by adding the ocean economy products used in intermediate consumption by domestic industries to those used in gross capital formation to those that are exported.

SUTs are therefore a tool used by the compilers of economic statistics to ensure the accuracy of their estimates. When total supply at purchasers' prices is equal to total use at purchasers' prices, the SUTs are considered to be balanced. A balanced set of SUTs suggests that the data used to compile them are consistent. If there is an imbalance and total supply does not equal total use for a particular product then the compiler must check the reliability of the estimates in each area of the SUTs and correct any errors that may arise. The product balance can also be used by compilers to fill in gaps by enabling missing variables to be calculated residually. In reality, the source data used in measures of ocean economic activity regularly result in imbalanced SUTs and the process of balancing the SUTs is a fundamental step in producing reliable and consistent estimates.

Figure 1. Structure of the supply and use tables presented in the OECD SUT Database

Supply at basic prices and its transformation into purchasers' prices

| | | Output by domestic industry | | | Total domestic supply at basic prices | | Valuation layers | | | | Total domestic supply at purchasers' prices |
| | | | | | | | Trade and transport margins | | Taxes less subsidies | | |
		Activity hierarchy up to 88 industry categories			Total output at basic prices	Imports	Trade margins	Transport margins	Taxes on products	Subsidies on products	
Supply of products	Product hierarchy up to 88 product categories										
	Total										

Use at purchasers' prices

| | | Intermediate uses | | | Intermediate consumption at purchasers' prices | Final uses | | | | Exports | Total use at purchasers' prices |
| | | Intermediate consumption by domestic industry | | | | Final consumption | | Gross capital formation | | | |
		Activity hierarchy up to 88 industries				Final consumption by households	Final consumption by government	Gross fixed capital formation	Change in inventories		
Use of products	Product hierarchy up to 88 products										
	Total										
	Gross output (basic prices)										
	Gross value added										

Note: The OECD SUT Database also includes a table not depicted here that is usually presented as part of the use table: Table 41. Use, value added and its components, gross fixed capital formation and assets by activity. Table 4.1 contains columns according to ISIC Rev.4 categories and includes rows for 'output at basic prices', 'intermediate consumption at purchasers' prices', 'value added at basic prices' split into 'compensation of employees', 'other taxes less subsidies on production', 'operating surplus and mixed income, gross', 'gross fixed capital formation', and 'gross fixed assets'. Countries contributing to the OECD SUT Database are not able to provide statistics for all possible product and transaction categories in the SUTs for a variety of reasons. The database therefore contains different levels of detail in both transactions and products for each country. In general, the detail for activities in each country is mirrored by the availability for products. Availability of categories in the supply table is, in general, the same as the availability in the use table. The colours are intended to highlight the different sections of the tables but are not indicative of commonalities between the tables.

Source: Jolliffe, Jolly and Stevens (2021[12]) *Blueprint for improved measurement of the international ocean economy: An exploration of satellite accounting for ocean economic activity* doi.org/10.1787/aff5375b-en

Employment

All participating countries measure employment in ocean economic activities in some way. *Employment* is a measure of people resident in an economic territory that are part of the *labour force* and are *economically active*. The labour force is the totality of all the people who are available for participating in productive activities. Economically active persons are those engaged in the production of goods and services that fall within the traditional production boundary of the SNA. The size of the labour force is necessarily smaller than the size of the

population because not all people are available for work. *Unemployment* is a measure of the people in the labour force that are not employed.

In general, ocean economy employment statistics are presented by industry aggregates. The metric used by Canada, Italy and the United States is the number of persons employed. In the SNA, employed members of the labour force can be either e*mployees* or *self-employed*. Employees hold a formal or informal agreement to work for an employer resident in the economic territory. All persons in paid employment are counted as employees including those that might be considered to employ themselves such as the owner managers of incorporated small and medium enterprises. Self-employed persons in the SNA are defined as the owners or joint-owners of *unincorporated enterprises* (see section on 'Components of gross value added' above).

Employment can take many forms. There are full-time workers, part-time workers, those who have multiple jobs, volunteers etc. Counting the number of employed persons does not therefore provide a standardised measure of employment. A simple standardised measure of employment is to estimate the number of employed persons in *full time equivalents*. Belgium (Flanders), Ireland, Korea, Norway, and Portugal all estimate employment in ocean economic activities in full-time equivalents (FTE). This gives a rough idea of the number of people employed as if they were all working full time jobs. FTEs are measured in the SNA using estimates of the number of *hours worked* in productive activities. Although hours worked differs from hours paid, it is often hours paid that is collected from employers in labour force surveys. For productivity statistics, the number of hours actually worked is the preferred metric of employment.

Key data sources

Rather than collect data directly from economic units operating across the ocean economy, the participating countries use a range of tables from the national accounts as source data. In practise, these data act as a starting point from which analysts conduct more detailed estimates of ocean economic activity using complementary information. While the majority of the source data used in the participating countries originate in existing statistical sources, bespoke surveys of establishments from particular industries are carried out in some countries (Ireland and Korea in particular).

The national accounts attempt to measure the economic activity of all the institutional units resident in an economic territory from all institutional sectors. Constraints such as the prohibitively large resources required to collect data from every small enterprise and on every informal activity mean that this is not directly possible. An area where national statisticians tend to have access to lots of data is units controlled by government (i.e. those from the general government sector as well as corporations controlled by government). But national statistical offices tend not to have ready access to the records of units that are not controlled by government. For the majority of units from the other institutional sectors, a combination of *administrative sources* such as tax records and *statistical surveys* are generally used to estimate the appropriate entries. Statistical business registers therefore play an important role in the sampling methodology.

The participating countries rely in particular on the results of two types of official survey conducted by national statistical offices for source data in measurements of ocean economic activity – enterprise surveys focussed on *business activity* and household and labour force surveys for information on employment. In surveys of business activity, samples of establishments operating in manufacturing, construction and many service industries are

surveyed. The population statistics produced from a combination of large enterprise accounting statements and sample surveys are often published in collections of *structural business statistics*.

In Ireland, for example, a key source of data for the measurement of ocean economic activity is the national statistical office's Structural Business Statistics (SBS) database. Key variables published through structural business statistics tend to include turnover and output as well as those related to inputs to the production process. Demographic information may also be collected enabling statistics to be constructed based on factors such as number of employees and founding year.

Establishments in agriculture, forestry and fishing are not normally included in structural business statistics. Statistics on these industries are therefore collected separately using a combination of administrative sources such as records on crop yields and fish catch from national authorities and annual surveys. Data on marine fisheries and marine aquaculture in Ireland, for example, are provided by the state fisheries agency (Bord Iascaigh Mhara) that collect them.

In addition to structural business statistics, the various matrices of the SUTs provide foundational data sources for measures of ocean economic activity. This source is particularly prevalent in the four countries that have produced thematic accounts – Korea, Norway, Portugal and the United States. Typically, the most detailed SUTs constructed by national statistical offices are not made publicly available for multiple practical reasons including confidentiality concerns. The involvement of national statistical offices means that the most detailed level SUTs can be used as a starting point. These SUTs tend to have many product categories. The detailed SUTs constructed by the United States' Bureau of Economic Analysis have 5 000 product categories, for example. But even the most detailed SUTs do not necessarily separate ocean economic activity from the rest in all cases (see section on 'Establishments and their aggregation into industries' above).

In Norway, statistics lifted from the detailed SUTs are used to split existing categories where possible. The output value of marine aquaculture feed, for example, is estimated by calculating the share of the total use of feed products attributed to the marine aquaculture industry in the use table. This ratio is then applied to the domestic output of the feed industry in the supply table. In other cases, complementary sources from outside the SNA are used. In the United States, information taken from other statistical resources and industry reports are used to breakdown the necessary product categories. In Portugal, information from research, development and innovation surveys, higher education demographics databases, and ocean economy focussed newsletters complement the data taken from SUTs and other official sources.

In general, the source data for measurements of ocean economic activity outlined above are supplemented by complementary information from broader sources. Where values are missing from the SBS, for example, Ireland reverts to the alternative data sources given in Table 3. Korea uses the Bank of Korea's statistical tables and Canada relies upon Statistics Canada's input-output model for complementary data.

Some participating countries are also beginning to invest in bespoke and regular surveys to assist their measurements of the ocean economy. Since 2015, Korea Maritime Institute (KMI) has worked alongside Statistics Korea and the Korean Ministry of Oceans and Fisheries to conduct an annual statistical survey. While KMI designs and implements the National Ocean Economy Survey, the Ministry of Oceans and Fisheries – which is mandated to manage statistics on the Korean ocean economy to support effective policymaking – funds, acts as reviewer and ultimately approves the statistics based on the screening and technical approval

of Statistics Korea. The survey is targeted at a representative sample of the full population of enterprises operating in the Korean ocean economy and is conducted by trained surveyors through personal interviews. The survey population of interest is constructed using lists of enterprises from Statistics Korea, lists of organisations belonging to known ocean economy industry associations, and lists of establishments holding fisheries licenses held by the Ministry of Oceans and Fisheries. The results of the annual survey contribute to KMI's ocean economy analysis including its annual Korea's Ocean Economy publication series and future ocean economy thematic account.

In Ireland, the Ocean Economy Enterprise Survey is an online survey of companies operating in the Irish ocean economy conducted every two years by the Marine Institute. It is based on questionnaires developed by the national statistical office for their annual business surveys and is used to understand the turnover, operating expenses, value of exports, and number of employees operating in marine sectors. The survey informs estimates for activities that are difficult to measure using existing statistical sources. Where necessary to increase coverage, the survey results are combined with information from company accounts. In addition, a Survey of Marine and Coastal Overseas Tourism Activity in Ireland was conducted in 2018. The survey involved face-to-face interviews with 620 overseas tourists in four different locations. The survey provided information regarding the kinds of activities that marine and coastal tourists partake in, the importance of these activities in the overall activity carried out while in Ireland, and expenditure on marine and coastal activities.

Table 3. Ireland's Ocean Economy publications rely upon a range of different source data from various sources

Data sources used to measure Ireland's ocean economic activities

Ocean economic activity	Data source
Shipping and Maritime Transportation Logistics:	Annual Services Inquiry 2008 - 2016, Ireland Central Statistics Office (CSO) IShip Index 2008-2018, Irish Maritime Development Office (IMDO) Quarterly National Household Survey (Transport and storage) 2015; 2016, CSO
Tourism and leisure in marine and coastal areas	Domestic and overseas visitors 2017-2018, Fáilte Ireland Quarterly National Household Survey (Accommodation and food service activities) 2017; 2018, CSO
Sea Fisheries	The Business of Seafood 2018, Bord Iascaigh Mhara (BIM)
International Cruise	Irish Maritime Transport Economist 2012 to 2018, IMDO Maritime Statistics, CSO
Oil and Gas Activity	Census of Industrial Production 2008 - 2016, CSO SEMRU company survey
Renewable Energy	SEMRU Company Survey
Water Construction	Buildings and Construction Inquiry 2008 - 2016, CSO
Marine Engineering	SEMRU Company Survey Quarterly National Household Survey (Industry) 2015; 2016, CSO Industrial Turnover Index 2016, CSO
Boat Building	Census of Industrial Production 2008 – 2016, CSO Industrial Turnover Index 2016, CSO
High Tech Marine Services	SEMRU Company Survey
Marine Commerce	SEMRU Company Survey
Marine Retail Services	SEMRU Company Survey Annual Survey Inquiry 2008 - 2016, CSO Quarterly National Household Survey (Wholesale and retail trade) 2015; 2016, CSO Retail Sales Inquiry 2016, CSO
Marine Biotechnology & Bio-products	SEMRU Company Survey

Source: Norton et al. (2022[4])*Ireland's Ocean Economy 2022* https://oar.marine.ie/handle/10793/1807

Current values and volume terms for monetary variables

All participating countries publish their statistics in annual time series of varying lengths. Monetary variables in the SNA are expressed in value terms under a common currency unit. *Current value measures* for a good or service are calculated by multiplying the quantity of units of the product by a price per unit. While market prices are often recorded in the business accounts of enterprises and other financial statements, non-market goods and services have no recorded price per unit on which to calculate value. For non-market products, the price per unit in the value equation is estimated using a variety of techniques depending on the characteristics of the product in question. For example, a common technique for non-market services produced by the general government sector is to calculate the total value of the costs of producing the service. Differences in the value of different non-market products in this case are a function of the relative costs of producing them.

The statistics on ocean economic activity produced by Korea, Portugal, Ireland, and Italy are provided in current values only. But current value measures calculated through the equation described above increase or decrease with price even if the quantity of units remains the same. Differences in current values between time periods may therefore be driven by changes in the price level per unit rather than changes in the quantity (and quality) of units. Price indices such as the Producer Prices Index (PPI) and Consumer Price Index (CPI) gather information on changes in price levels for products relative to a given base year. They measure changes in prices for homogenous products but prices of a particular category of a good or a service may also change over time because of improvements or degradations in the *quality* of varieties of the same product (heterogeneity within individual product categories beyond price). This has implications for causal policy analysis which requires an understanding of changes in the quantity or quality of goods and services in isolation from price.

To overcome these issues, Norway and the United States publish statistics on ocean economic activities in time series valued in current prices and in *volume terms*. Unlike current value measures, volume measures reflect changes across accounting periods in product quantity and quality independent of changes in the price level. Recording changes in the volumes of goods and services from year to year is therefore one of the prime purposes of the national accounts. Often price indices that are adjusted for changes in quality are used to *deflate* current value measures into volume estimates. In general, current values should be deflated at the most detailed level of product category possible using the most appropriate price index available. For example, PPIs are commonly used to deflate domestic output and CPIs might be used to deflate household final consumption. For products that are not suitably covered by price indices, alternative indicators of pure price changes can be used including modelling approaches for products where qualities change rapidly and regularly. In certain cases, volume indicators based in part on proxies may also be used.

Several methods are available for removing the effect of changes in the pure price level on changes in current values. One option is to weight the current values in an annual time series at the most detailed level possible by prices and volumes in a fixed base year. In the base year, current values will equal volumes in constant prices. In all other years, volumes will be expressed in terms of the price structure in the base year. The resulting volume series are called "constant price" measures with the base year also stated. The implied growth rates between periods in constant price measures are sometimes referred to as "real growth".

Norway provides estimates for ocean economic activity in constant prices fixed to a base year of 2016. Fixing the base year means that volume aggregates (i.e. the sum of all components of a particular category or variable) for all years other than the base year are recorded as if they possessed the price structure in the base year. Often aggregates in constant price series are

rebased every five years in line with updates to the base year in price indices. Revisions to the time series are then performed to match prices and volumes in the new base year. But the further away from a fixed base year an aggregate value lies, the less relevant to economic reality the price structure becomes. Relative prices change frequently in most non-agricultural product categories and the effects of these changes on aggregate volumes in a given year are not suitably reflected in a fixed base year methodology. Changes in volumes between periods suggested by aggregates in constant prices may therefore produce inaccurate estimates of real growth rates (unless relative price changes reverse which can happen but does not occur often for most important product categories in technologically advanced countries).

The United States provides its estimates of ocean economic activity in current value terms and in *chained volume* series for both gross output and gross value added in the ocean economic activities it measures. One solution to the problems associated with aggregates calculated from constant price series with a fixed base year is to change the base year for the volume series more frequently. In annual time series, volumes for a given year can be calculated according to the prices of the year preceding it. Volume measures calculated in this manner are called *previous years' price* series. Aggregate volumes based on previous years' prices can then be referenced to a particular year through *chain-linking*. In effect, chain-linking changes the base year every year throughout a volume series while leaving volumes in the reference year equivalent to current values. The reference year selected is normally the latest year for which a coherent set of price and volume estimates are available. The stated reference year for the United States' estimates is 2014 for all annual volumes between 2014 and 2021. The published results also include the detailed quantity and price indices used to calculate the chained volumes as well as their annual changes in percentage terms.

In comparison to the fixed base method as pursued by Norway in its measures of ocean economic activity, chain-linking such as that conducted by the United States reduces the magnitude of the revisions to volumes that occur when the reference year changes. *Chained volume measures* lead to more accurate and consistent aggregate growth rates than those calculated from constant price series.

Chain-linking is therefore used to express volumes for the main national accounts aggregates such as GDP in all OECD member countries. However, chain-linking of aggregate volumes is performed at the expense of losing additivity over the components of aggregates for years more than one consecutive year beyond the reference year. *Non-additivity* occurs when chain volume series in monetary terms are calculated by extrapolating values backwards from the reference year using a chain volume index. Practically, this means the sub-categories of a particular level of a hierarchy will not sum to the headline category in years more than one year beyond the reference year. For this reason, national statistical offices attempt to change the reference year as frequently as possible in order to at least maintain additivity, or estimates close to additivity, in the latest datasets. Furthermore, chain-linking can be reversed by analysts in order to return additive properties to the volumes they are concerned with analysing. The benefits of chain-linking aggregate volumes are therefore considered to outweigh the downsides of non-additivity in a time series.

4 Thematic accounting for ocean economic activity in four participating countries

The countries participating in the OECD ocean economy measurement project generally estimate industry-level aggregates for production and employment for all establishments resident in an economic territory that partake in ocean economic activity. But most countries do not have access to detailed lists of establishments that fall into this category and do not have the resources available to measure their performance directly. Despite this, the system of national accounts (SNA) represents the best resource available upon which to base measurements of ocean economic activity and ensure the statistics produced are coherent nationally and internationally. In one way or another, the participating countries all use national accounts data in their studies.

Nevertheless, any analyst of the ocean economy attempting to use the SNA will eventually have to deal with the problem of isolating the ocean relevant parts of statistics organised according to existing statistical classification categories. Often supplementary information from outside the SNA is required to estimate partial values from existing categories. The SNA allows for this type of analysis through the creation of thematic accounts.

Thematic accounts highlight key areas of the economy that are not readily visible in published statistics. They allow for this through the use of more detailed categories from existing statistical classification systems or through the calculation of partial categories. Certain rearrangements to the structure of the core national accounts are also feasible. Among other possibilities, the value of goods and services produced by establishments for their own use may be separated from the industry of the establishment and counted under the industry category that principally produces those goods and services. A thematic account focussed on transport might count transport services produced by mining and quarrying industries as a secondary output under the different transportation industries, for example. Thematic accounts of this type do not in general alter the production boundary and, although new information can be introduced, do not change the other central concepts of the SNA.

This paper is on ocean economic activity as contained within the traditional production boundary of the SNA. However, in a related type of accounts, the production boundary can be extended to include the production of goods and services beyond the traditional production boundary and allow for the inclusion of asset classes that have no monetary value such as air and water in physical units. The United Nations Statistical Commission has agreed upon several sets of guidelines for these accounts, including the System for Environmental-Economic Accounting (UN SEEA). A key benefit of compiling thematic accounts for ocean economic activity that meets the standards of the SNA is the potential to link to UN SEEA type accounts for the ocean as and when they become available.

Examples of thematic accounts that solve issues with introducing complementary information to produce coherent statistics on specific areas of the economy are becoming plentiful. By 2019, national statistical offices had been involved with the compilation of thematic accounts on at least 13 separate topics (UN Economic and Social Council, 2009[13]). A major challenge in the compilation of thematic accounts is the alignment of complementary information to the definitions and standards of the SNA. Adjustments typically required include corrections made to ensure that the collected data are exhaustive of the total economy, consistent over time and are balanced in terms of the supply and use of products. Jolliffe, Jolly and Stevens (2021[1]) introduce some of the reasons for pursuing the development of ocean economy thematic accounts as a solution to commonly experienced measurement challenges such as these. A useful introduction to the compilation of thematic accounts more generally is available in van de Ven (2021[14]).

At present, four of the participating countries (Korea, Norway, Portugal and the United States) have produced ocean economy thematic accounts. Belgium (Flanders), Canada, Ireland and Italy pursue alternative approaches. All four thematic accounting countries differ in the methodology they have adopted thus far. The following section outlines the approaches of the four thematic account producing countries.

Korea's account

Korea published estimates from its first thematic account for ocean economic activity in 2023. The account builds on over a decade of previous work on measuring ocean economy activity. Multiple studies by KMI and affiliated researchers have used input-output tables to measure the gross output and value added generated by Korean ocean economic activities. Since 2018, KMI has conducted measurements of ocean economic activities published in the Korea's Ocean Economy series using input-output tables from the Bank of Korea that are made to correspond with the 2018 Korean National Classification for Marine and Fisheries industries.

The account is focussed on ocean economic activity and, similar to developments in thematic accounting for ocean economic activity in the three other thematic account producing countries, does not include environmental-economic linkages. In 2019, KMI initiated a basic structure for the account and conducted a pilot project using statistics focussed on fisheries production. The ocean economy thematic account mirrors the structure of the core national accounts of Korea and includes production accounts, income accounts, capital accounts, overseas transaction accounts, and an employment account.

The purpose of Korea's thematic account is to set up a foundational economic indicator measurement system for the ocean economy that corresponds to the national accounting system. Data from the thematic account are intended to contribute to the establishment and monitoring of development goals and aid in the preparation of industrial policies for the ocean economy. In 2023, the Ministry of Oceans and Fisheries (MOF) announced a plan to publish official statistics from the national ocean economy thematic account.

Ocean economic activities are not readily visible in the Korean national accounts. The Korea Maritime Institute (KMI) has therefore adopted a set of principles for calculating the ratio of ocean to land-based activity in the national statistics released by the Bank of Korea. The first principle is that if the ocean economic activity appears wholly in the official statistics then there is a "one-to-one" connection and no additional breakdown is required. For example, all extraction of offshore petroleum and natural gas occurs offshore in Korea and this entire category of economic activity is therefore considered part of the ocean economy. The principles are then ordered so that if the first principle is not applicable, the second will be used. If the first

and second are not applicable, then the third will be used and so on up to the sixth and final principle. The six principles used by KMI are as follows:

- **One-to-one connection**: No further action required. Marine fishing, marine aquaculture, extraction of crude petroleum and natural gas, fish processing and storage, and shipbuilding are all categories of activities that are 100% attributable to the ocean economy in Korea and already appear in the Bank of Korea's tables.

- **Utilise product level output statistics**: A ratio is calculated using detailed product subcategories in tables presenting output statistics. The table currently used by KMI is the Supply Amount Table that is supplementary to the Bank of Korea's analytical input-output tables. This contains detailed information for 3 000 product categories. For example, the proportion of seawater and coastal transport in the total for freight transportation in the Supply Amount Table provides the ratio for maritime freight transport.

- **Utilise sales survey statistics**: A ratio is calculated using the results of the National Ocean Economy Survey and relevant industrial sales statistics are used as the numerator and economic census microdata on sales are used as the denominator. For example, the share of maritime ports activity in the total is calculated by dividing revenues in the port industry revealed by the National Ocean Economy Survey by total revenues in port activities related to 'Warehousing and support activities for transportation' taken from the economic census.

- **Utilise statistics besides sales**: A ratio is calculated using alternative sources. For example, the ratio of the number of visitors to marine resource parks out of all domestic natural parks and the ratio of sea aggregate collection out of the total amount of domestic aggregate collection are respectively used for marine leisure and tourism and marine resources development.

- **Utilise intermediate demand rate**: Where ocean economic activities provide intermediate inputs to other ocean economic activities, demand for the product from the ocean and fisheries industry becomes the numerator and the total intermediate demand for the product is the denominator. For example, the ratio for the maritime manufacturing sector is calculated by dividing the intermediate demand for manufacturing equipment from ocean and fisheries industries by the total intermediate demand for manufacturing in the overall economy.

- **Additional sample surveys**: When no information is available from the above, then ad-hoc surveys of particular areas of ocean economic activity may be used. Currently, Korea's national ocean economy thematic accounts are calculated at the mid (two digit) or small (three digit) level categories. This approach is used only when it is necessary to look at partial sub-categories (four digit) such as sub-categories of the port industry. No examples of this approach have been pursued as of yet.

Norway's account

Norway produced its first estimates from a thematic account for ocean economic activity in 2022. The results of the project are published on Statistics Norway's website alongside a document describing the methodology employed (see Table 1). The methodology begins by estimating Norwegian domestic output of goods and services produced by "core", "supplier" and "external source" ocean economic activities.

All production by the *core activities* accounted for in the supply table is considered part of the ocean economy. *Supplier activities* are measured by taking the values of a list of products used by the core ocean industries as intermediate consumption and assigning them to activities in the supply table proportionally. If, for example, maritime shipbuilding accounted for 40% of total

intermediate consumption of the product steel then 40% of the domestic output of the steel industry is considered part of the ocean economy (assuming the steel industry is the only producer of steel). A total of 93 detailed product codes are included in this exercise. *External source activities* rely upon information from outside the national accounting system in order to calculate a share of a broader category for which statistics are available.

Initially, domestic output at basic prices of the goods and services produced by the three sets of activities is estimated. In order to value total supply at purchasers' prices, the value of imports, taxes less subsidies and trade and transport margins for each product are added to the total output of products at basic prices. These values are calculated by multiplying the results recorded in the supply table for each variable by the same coefficient used to estimate output at basic prices. This implies that products produced exclusively by *core industries* will have imports, taxes less subsidies and trade and transport margins at the full value appearing in the supply table. To continue the steel example and assuming that maritime shipbuilding is the only economically significant consumer of steel, 40% of the value of steel product imports, 40% of the value of steel product taxes and subsidies and 40% of the value of steel product trade and transport margins are added to the total domestic output of ocean economy steel at basic prices.

To estimate intermediate consumption by each ocean economic activity in purchasers' prices, the share of production associated with the ocean economy in the total output of each domestic ocean activity is applied to the intermediate consumption of the same activities in the use table. Values for final demand, investment and exports of the relevant products are also calculated in the same manner as imports, taxes less subsidies and trade and transport margins in order to estimate total use at purchasers' prices. The result is a set of balanced SUTs for ocean economic activity (total supply of ocean-related products at purchasers' prices equals total use of ocean-related products at purchasers' prices).

From the balanced SUTs, gross value added (gross product) is calculated for each ocean economic activity by subtracting the total value of intermediate consumption per activity from the total value of domestic output per activity. In addition, gross fixed capital formation, labour costs and employment in full-time equivalents are calculated using the same shares estimated for breaking down intermediate consumption. Information on employment is derived from the national accounts. In the latest release, the activity-level aggregates are calculated annually for the years 2016 to 2021 (with preliminary values for 2022) and are provided in current prices and at constant 2021 prices.

The calculations are performed by an internal customary software developed by Statistics Norway that generates the ocean economy estimates algorithmically. The software takes the *core activities* in their entirety and calculates the appropriate shares for the *supplier activities*. Ocean-related value coefficients are input manually into the system for the *external source activities*. The software outputs the disaggregated SUTs described above according to several different structures but does not allow for estimates to be produced for years prior to 2016 for technical reasons.

Box 3. Alternative method to thematic accounting: Canada's approach to isolating ocean economic activity

The *Marine Sectors in Canada Methodology* details the methods and data sources used to estimate the performance of various ocean economic activities published in the *Marine Sectors in Canada Summary Tables*. Much of the source information is derived from detailed statistical releases produced by Statistics Canada. In general, data on expenditure on ocean economy products by industry are

collected from the detailed tables that underpin the national accounting system. The ratio between ocean economy expenditure and overall expenditure by product is then fed into Statistics Canada's input-output model in order to estimate the direct contribution of ocean economy industries to gross domestic product and employment as well as the indirect and induced effects of this activity on the overall economy.

Industries in the statistical series are categorised according to the North American Industry Classification System (NAICS) or classifications related to it such as Statistics Canada's Input-Output Industry Classification (IOIC) system. For many of these industry categories, the ocean economy represents 100% of the value in existing statistical releases. Where this is not the case, estimates are made based on background research and ocean economy domain expertise provided by Department of Fisheries and Ocean Canada. Recreational boating, for example, is estimated using sales data from the 2020 National Marine Manufacturer Association (NMMA) Canadian Recreational Boating Statistical Abstract. Information on the spending of the federal government in the ocean economy is taken from the reports of various government departments.

Portugal's account

Portugal became the first country to produce an ocean economy thematic account in 2016. Initially, the production, intermediate consumption, gross value added, other taxes on production, other subsidies on production, and gross operating surplus associated with the reference population of ocean economy establishments are measured. For the most part, the data sources used are the same as those used for the core national accounts. The compilation is also completed for establishments originating in the full range of institutional sectors defined in the core national accounts: non-financial corporations; financial corporations; general government; households; non-profit institutions serving households; and, the rest of the world.

For non-financial corporations and households, for example, statistics from the output matrices developed for the core national accounts are used. Firstly, the output of ocean related products by each establishment in the reference population for each of the two institutional sectors are recorded. The intermediate consumption associated with ocean production is then calculated under the assumption that ocean-related intermediated consumption is equivalent to the ratio of total intermediate consumption on total output (i.e. the technical coefficients are the same). An estimate of the value added of each establishment generated from ocean related production can then be estimated by subtracting the estimated establishment-level intermediate consumption from the estimated output. The methods pursued in the remaining institutional sectors are representative of differences in the economic behaviour of the establishments belonging to each sector (non-market output is counted in the output of the general government sector, for example).

The method then places the data collected in the production account into a supply and use framework. The SUTs are used to reconcile statistics on the supply side such as output with those on the demand side such as intermediate consumption. The tables constructed are derived from the SUTs of the core national accounts. In order to achieve balance between supply and use, the calculation of variables beyond those collected in the production account is required. For the completion of the supply table, imports, trade and transport margins, taxes on products, and subsidies on products are estimated by ocean related product. On the use side, final consumption by households, final consumption by general government, and final consumption by non-profit institutions serving households, gross fixed capital formation, and

exports are estimated. The methods by which each of these additional variables is calculated is specific to the variable in question.

The results of the ocean economy thematic account are made publicly available on INE's website as well as the websites of the statistical offices of the Autonomous Region of Azores and the Autonomous Region of Madeira. In INE's statistical release, a total of 37 data tables are accessible that detail the various variables calculated for each of the geographical locations.

United States' account

The United States thematic account – called the US Marine Economy Satellite Account – is compiled from detailed product level statistics that underpin the core national accounting system by the Bureau of Economic Analysis (BEA). Firstly, product categories meeting the criteria outlined in the definition of the ocean economy are selected from the BEA's core SUTs which contain detail on 5 000 individual products. The output of each product meeting the criteria is then measured from the supply table.

For some product categories in BEA's SUTs, the share of ocean output is equal to 100% of output. Where this is not the case, estimated coefficients based on background research and ocean sectoral expertise provided by the National Oceanic and Atmospheric Administration (NOAA) and the BEA are used to split the existing product categories. The external data sources used to evidence the selection of a particular coefficient value are released with the statistics. Aquaculture products, for example, are split between marine and freshwater aquaculture activities using data from NOAA's *Fisheries of the United States* programme for statistics on landings, processed products and foreign trade.

The core SUTs are also used to understand the industries that are involved in the production of the ocean products and for developing the key statistical outputs of the thematic account. Identifying the industries producing ocean products enables the calculation of gross output (domestic output plus intermediate consumption), gross value added (domestic output minus intermediate consumption), compensation of employees, and employment. These metrics are estimated at industry-level in the supply and use framework. The share of ocean products in intermediate and final consumption from the use table are assumed to be equivalent to the share of ocean output in the total output of each product from the supply table. While most of the results of the thematic account are presented at industry-level, the results are also aggregated into bespoke activity groupings relevant to user groups.

The current version of the US MESA focusses on ocean economic activity contained within the traditional production boundary of the SNA, but plans are in place to include measures of environmental-economic linkages. The United States National Strategy to Develop Statistics for Environmental-Economic Decisions released in 2023 includes several recommendations for extending the US MESA to account for marine natural capital (White House, 2023[15]). NOAA and the BEA are the lead agencies involved with realising the strategy for the ocean economy with the first pilot versions of the accounts planned for release in 2024/2025.

Box 4. Alternative method to thematic accounting: Ireland's approach to isolating ocean economic activity

The measurements conducted by Ireland's Marine Institute and Socioeconomic Marine Research Unit (SEMRU) through the Ireland's Ocean Economy publication series are based upon different source statistics produced by different official statistical institutes in Ireland (Table 3). The source data for the marine fishing and marine aquaculture industries, for example, are taken from Ireland's Seafood Development Agency which is responsible for the production of many statistics on fisheries, aquaculture, and seafood processing. Data on international cruise passengers are taken from the Irish Maritime Development Office. And other tourism statistics are taken from the National Tourism Development Authority (Fáilte Ireland).

Many of the established ocean economic activities beyond the fishing, aquaculture, and international cruise industries are measured using statistics produced by the Ireland's national statistics office – the Central Statistical Office (CSO) – and categorised by a list of codes from Statistical Classification of Economic Activities in the European Community (NACE). The variables measured by CSO include turnover, gross value added, employment, and for some categories, intermediate consumption. In certain limited cases the ocean economic activity appears wholly in the CSO's official statistics – there is a "one-to-one" connection between the released statistic and the ocean economy and no additional breakdown is required. However, many of the statistics made available by the CSO are only partially attributable to ocean economic activity. This mainly depends on whether or not the NACE classification categories separate ocean activity from the rest.

The Marine Institute and SEMRU have therefore adopted a set of methods for calculating the ratio of ocean to land-based activity in statistics that are only partially ocean-related. For example, marine and coastal tourism are associated with seven unique NACE codes, all of which include non-ocean-related activity. The Fáilte Ireland Accommodation Occupancy Survey provides information on the number of nights spent in coastal local administrative units, although densely populated coastal areas such as Dublin city centre are removed from the estimations due to the potential inclusion of visitors with no interest in marine and coastal tourism.

In addition, the Household Travel Survey carried out by the CSO measures the travel patterns of Irish residents involving overnight stays. It collects data on destinations and provides some information on travel to coastal counties appearing in Eurostat's Nomenclature of Territorial Units (NUTS) 3 classification of administrative areas (the smallest areas outlined by the system). For tourism leisure activities, the proportion of marine related enterprises (taken from a database held by the Marine Institute) in the total for Ireland (recorded in the CSO's business registry) for each relevant NACE code is used as a coefficient for ocean economic activity. (A Tourism Satellite Account (TSA) for Ireland is being produced but is not finalised and is not yet used for estimations of marine and coastal tourism in Ireland.)

Statistics from the CSO are not available for all of the activities in the established ocean economic activities measure in the Ireland's Ocean Economy series and are not available for any of the emerging activities. When no information is available from any official statistical resource, surveys of particular areas of ocean economic activity are used. SEMRU has pursued this approach through surveys of marine related enterprises and marine and coastal tourists.

5 Recommendations for national measurement strategies and areas for future work

This paper has presented national arrangements for the measurement of ocean economic activity in the countries participating in the OECD ocean economy measurement project. Ten principles from the system of national accounts (SNA) that are particularly relevant to producing coherent measures of ocean economic activity have been summarised. The principles are then used as the foundation for comparing the participating countries' approaches to ocean economy measurement. The analysis shows that each participating country pursues the most accurate measures possible given the resources at their disposal. It also reaffirms previous OECD findings that there is no unique approach to measuring the ocean economy across countries and that thematic accounting represents the appropriate framework for producing statistics on ocean economic activity. This section collects key takeaways from the previous sections to provide recommendations for the future of ocean economy measurement in OECD member countries and beyond. Several areas for potential future study are also suggested.

Eight recommendations for national measurement strategies

Many practical tips can be drawn out from the efforts of the participating countries to guide countries interested in producing measurements of ocean economic activity. The following eight recommendations are for countries considering aligning their measurement strategies with the national accounts. Reconciling national ocean economy measures with the SNA in all countries would result in statistics that are comparable with overall economies and facilitate the production of coherent international statistics. The OECD will continue leading and expanding research on ocean economy measurement and stands ready to support OECD member countries and partner economies as they develop their measurement strategies.

1) Consult user communities early-on to co-decide what can be measured given standard definitions of the ocean economy

A good definition of the ocean economy is crucial from the beginning of the analysis. Overarching definitions help to focus compilation efforts on the areas of the overall economy that are most important for measurement. The OECD definition of ocean economic activities for international statistics outlined in on page 14 can be used as a starting point by countries considering measurement strategies for international comparability. A useful national-level addition to the OECD definition would clarify whether major lakes and transitional waters are to be included or excluded.

Definitions can be costly to change given the effort that will be sunk into collecting information based on them, so it is worth undertaking in advance a broad consultation of potential user groups in order to ensure that each element is understood. Once the definition has been fixed, the activities to be measured from both a production process and institutional sector perspective can be considered by compilers given the seven additional recommendations outlined below. Although measures should aim to be as expansive as possible in terms of the ocean economic activities covered, initial priority should be given to those that are perceived to be the most important in terms of production and employment. The consultation process offers a good opportunity to gather expertise from different communities to ascertain what cannot be missed and for complementary ocean information to be collected from different sources. It also presents an opportunity to ensure that domain-specific terminology and jargon are explained in accessible terminology.

2) Curate a list of economic units in-scope of the ocean economy and keep it up-to-date

A good ocean economy definition will assist compilers in delineating establishments resident in an economic territory that are conducting ocean economic activity from those that are not. The establishment view of the ocean economy is important because it provides the foundation from which supply and use tables (SUTs) for the ocean economy can be constructed and industry-level statistics generated. Countries with the resources available could consider the development of satellite business registers of the establishments that fit within their definition of the ocean economy. However, this is not a simple undertaking. If the resources are not available for a full satellite register, regularly updated lists of the most important ocean economy establishments (in terms of value added and/or employment) would assist compilers by clarifying the industries in which ocean economy establishments operate and, if needed, enabling targeted statistical surveys of the establishments involved to be conducted. As establishments will start-up and close-down, enter and exit markets, the population of ocean economy establishments will be in constant flux. A plan to maintain and update lists of ocean economy establishments, at least on an annual basis, should be agreed from the beginning.

3) Use existing classification systems to categorise ocean economy statistics even if they only partially match

Most national statistics are structured according to existing statistical classification systems such as the UN's ISIC for industries and CPC for products. Existing statistical classification systems rarely provide satisfactory coverage of the ocean economy in isolation from other areas of the economy. There are perhaps two options for dealing with this. The first is to develop an alternative classification system that creates entirely new categories with their own unique definitions. The second is to create partial categories of existing statistical classifications. The second option is preferable given it enables comparisons with national statistics and helps to ensure statistics are coherent. Practically, this requires the construction of detailed concordance tables between existing classification systems and categories that are specific to the ocean economy. Partial categories should follow the underlying principles of the established statistical classification system, be mutually exclusive and have well defined labels.

4) Formalise and maintain collaborations between ocean economy domain experts and national accountants

One common theme running through the methods of the participating countries is the use of existing statistical information systems for the overall economy. In general, the national

accounts provide the overarching structure and main data source for measurements of ocean economic activity. There are many rules and guidelines set out in the SNA. The guidance often includes jargon that is unfamiliar or easy to misinterpret for those that are not working directly on or with the national accounts. And there are many nuances, caveats and potential contradictions to consider at all stages of the compilation process. This complexity is not without reason. Countries that follow the guidance of the SNA closely can have faith in the quality of their national statistics and are able to compare themselves across countries with confidence. The benefits of this are invaluable to policymakers, policy analysts and the communities they serve.

While ocean domain experts have specific information on the type of activity that should be counted in measurements of the ocean economy, national accountants are best placed to understand the conventions and requirements of the national accounts. A combination of the two knowledge bases is necessary if accurate measures of ocean economic activity are to be achieved. For this reason, countries that have produced detailed and coherent estimates of ocean economic activity have often built partnerships between ocean economy experts and national accountants first. Partnerships between ocean domain experts and national statistical offices is a measurement strategy that has proven to be effective.

5) Prioritise the application of thematic accounting frameworks for combining official statistics with complementary ocean economy information

The partnerships suggested in the previous recommendation are perhaps especially crucial during the production of thematic accounts for the ocean economy. Thematic accounting enables the blending of national statistics with complementary information in order to highlight areas of the economy that are not immediately visible in the structure of the core national accounts. The statistics produced through ocean economy thematic accounts should accurately capture ocean economic activity in isolation from the rest, be comprehensive in the range of ocean economic activities captured, and result in statistics that are comparable with the core national accounts.

6) Record methodically all adjustments made to both official statistics and any complementary information used and clearly explain the method adopted

One of the key tasks during the construction of thematic accounts is the calculation of specific ocean economy partials of existing statistical categories. While there are many data points collected through national accounting systems that are suitable for this task, in reality calculating partials for the entirety of ocean economic activity requires substantial amounts of complementary information sourced from data that is not intended for direct use in the national accounts. Where complementary ocean information is used, it will almost always need to be adjusted to meet the standards of the national accounts. Sometimes these adjustments can be significant and difficult to achieve. For example, the SNA requires that output be measured at the point in time that a product is produced. Often data on ocean economic activities are collected when a product is sold. In this case, adjustments are required to ensure that the correct data are applied to the correct accounting period. A good understanding of the properties of complementary ocean economy information (ocean domain expertise) and the definitions and guidelines of the SNA (national accountant expertise) are required. Clarifying the assumptions relied upon to adjust complementary ocean economy information is therefore of primary importance throughout the compilation process.

7) Ensure any statistics produced are consistent over time and, in addition to current value time series, provide monetary variables in volume terms

A further area where the expertise of national accountants is likely required is in ensuring the time constituency of the statistics. To be useful for policy analysis, measurements of the ocean economy should be conducted at least annually and the statistics provided in time series form. The effects of all changes to both the ocean complementary information and the national accounts such as revisions due to new benchmark years should be taken into account throughout the time series. Furthermore, the statistics produced should be made available in both current value and volume terms. Compiling time series in value and volume terms at the same time helps to improve the accuracy of the measures but is technically challenging. Much of the data and technical expertise required for producing suitable volume measures is available through national statistical offices.

8) Develop a strategy for building-upon regular measurements of ocean economic activity so that they may be used effectively in environmental-economic decision making

Finally, it is worth reiterating that measurements of ocean economic activity are only worthwhile if they are to be used and built upon. Efforts to disseminate published statistics widely will help encourage use. Regular contact with user groups at all stages of the compilation process can help statisticians understand their requirements and wishes. Targeted surveys of the users of published statistics can inform efforts to improve public understanding of the data and help to ensure no barriers to access are created by the mode of dissemination.

Perhaps most importantly, however, thematic accounts for ocean economic activity may be used as the foundation from which more holistic accounts for marine environmental-economic linkages can be built. The achievement of a fully integrated statistical information system for the ocean economy would represent a major step towards securing countries ability to effectively govern the sustainable development of the ocean economy into the future. Accounting for the provisioning services flowing from the marine environment would allow for analysis of the trade-offs inherent in the development of the ocean economic activities that exploit them, for example.

Fully embedding environmental information in current official statistics is a substantial task replete with many technical challenges. A pragmatic strategy is therefore required and countries are most likely to succeed if they start with the information currently available and follow international guidance in the form of the United Nations System for Environmental-Economic Accounting (UN SEEA). The United States' Office of Science and Technology Policy strategy for accounting for the environment highlighted on page 41 above is a good example. It recommends using fish assessment reports and offshore fossil fuel reserve estimates as the basis for summarising the flow of natural resources to the relevant industries measured through the current US MESA. From this starting point, the strategy recommends more detailed measures be added according to their utility to decision makers.

Areas for future OECD work

The OECD will continue supporting OECD member countries and partner economies as they develop their ocean economy measurement strategies. A next phase in the OECD ocean economy measurement project will involve developing further the OECD's international experimental statistics on ocean economic activity. Currently, unbalanced SUTs in current values for six participating countries have been produced based on the information made

available by them. Further work is required to balance the supply of products with their use, estimate volumes terms for countries where it has been possible to produce tables for multiple years and, if requested by participating countries, create publication ready tables for public release.

While this experimental work is ongoing, there continues to be strong demand from policymakers for ready-to-use data that enables comparisons of ocean economies across countries and over time. The OECD has therefore used the lessons learned from working alongside the participating countries to derive indicators of ocean industrial activity for 31 of 38 OECD member countries (of the seven countries not included, six are landlocked and one does not contribute sufficient statistics to the OECD's databases for accurate estimates to be produced). The datasets are currently being expanded to non-OECD member countries with important ocean economies in order to provide global coverage. The indicators of global ocean economic activity will then provide the statistical basis for the ongoing OECD ocean economy foresight project and feed into OECD inputs to the next United Nations' Ocean Conference in 2025.

Regional accounts for ocean economic activity represent another area where further research is required. Regional accounts use the same accounting concepts of the SNA but treat each region as a separate and distinct economic territory. Transactions are recorded between units resident in different regions like they are between resident units and the rest of the world in the core national accounts. Some institutional units such as national general government units should not be assigned to any particular region and it can often be difficult to assign complex corporations with broad geographical footprints to a unique region within a country. Challenges such as these mean that often regional accounts focus on measuring regional production at industry-level rather than replicating the full sequence of the SNA. Regional accounting therefore poses an additional challenge to those associated with ocean economy measurement and steps towards overcoming these challenges will likely be an increasingly important topic of future research.

Finally, an area of promising research relates to the linking of accounts for ocean economic activity with environmental accounts. Recent OECD research has resulted in the production of air emissions accounts for maritime transport that are compliant with internationally agreed environmental-economic accounting frameworks. Additional methods by which air emissions could be allocated to other energy intensive activities present one way in which their environmental effects could be better accounted for. In parallel, additional research could be conducted into the data required to produce other international environmental-economic accounts for the ocean economy such as those measuring emissions from economic activity to seawater.

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