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An applied framework to estimate the direct economic impact of Marine Spatial Planning

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ABSTRACT

The complex nature of the Marine Spatial Planning (MSP) requires the integration and consideration of multiple elements, ranging from the ecological and environmental to the socio-economic as well as the political, institutional or cultural. To succeed, the public policies demand techniques and tools that allow to evaluate the effects or impacts on the society. By applying an empirical approach, this paper presents a framework to evaluate the direct economic impacts linked to the implementation of MSP policies in three case studies: Belgium, Germany and Norway. The methodological procedure is sequenced in 4 phases: identification of the sectors involved, data collection, construction of counterfactual scenarios and estimate of impacts after consulting the stakeholders. With the application of this framework to the case studies, an estimate was made of the variations in the value of production for each marine sector that can be directly attributed to the implementation of the MSP. In general, they were positive in the three cases analysed. In the medium scenario, cumulative final direct impacts of € 1875 million were estimated in the German case (2010–2016 period), € 929 million in the Belgian case (2014–2016) and € 2262 million in the Norwegian case (2013–2016). These results can serve as the basis for further estimations of indirect and induced impacts of the implementation of spatial management policies in a blue economy context.

1. Introduction

Around the world, Maritime Spatial Planning (MSP) encourages compatible uses, reduce use conflicts, and balance sustainable use and marine conservation. This balance among the ecological, biological, socioeconomic and institutional aspects in an ecoregion is one of the pillars of the ecosystem-based management (EBM) [1]. Therefore, MSP is a competent management tool to implement EBM [2–7]. Given the complexity of managing marine ecosystems, MSP is a tool to plan and manage human activities, promoting a more rational use of both space and marine resources. This approach is based on the balance between protecting marine ecosystems and carrying out human activities for economic and social purposes. In concrete, the MSP is a dynamic process in which the temporal and spatial distribution of human activities is analysed and assigned in a specific marine zone, aiming to achieve preselected environmental, economic and social objectives, defined and specified through a policy-driven process [8]. It also looks to deal with (or anticipate) situations of conflict between users whose activities are incompatible or who compete for the same resources and marine space [9,10], or between users and the environment itself as a result of the potential impact of human activities on the marine environment [11,12].

This planning option can provide clear ecological and environmental benefits linked to the conservation of biodiversity, the protection of biologically and ecologically important zones or the reduction of human impacts on ecosystems [13,14]. It can also create economic effects related, for example, to the sustainment and development of income-generating activities or the reduction of costs derived from a decrease in the number of conflicts that might have arisen between the different users of the marine environment [15,16]. Positive impacts can also be generated by promoting the economic use of space (multi-use), which enables the synergy of interests and reduction of conflicts between users of the marine realm and helps to reduce their transaction costs [17,18]. Furthermore, MSP can contribute towards generating

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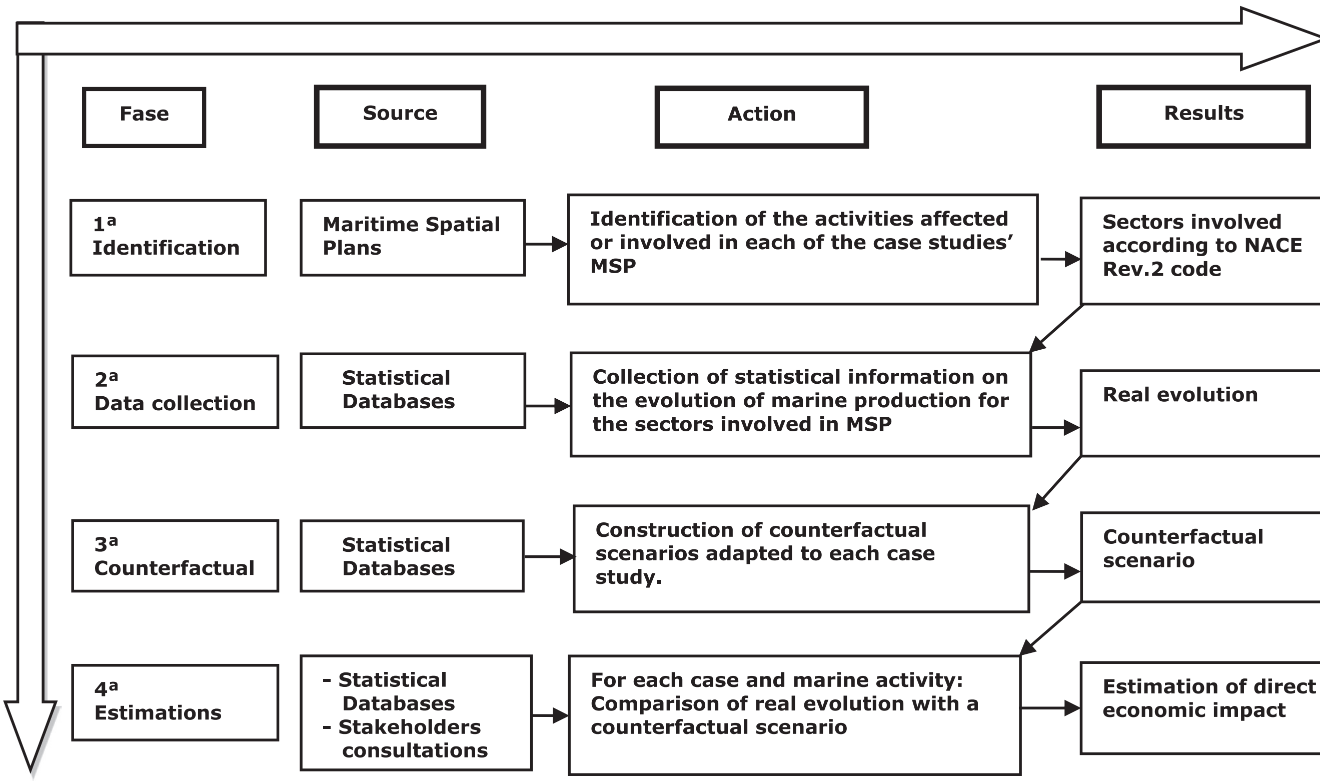

Fig. 1. Methodology by phases.

social benefits, such as increased job opportunities for coastal populations, the protection of their sea-related cultural heritage and improved quality of life in coastal areas [19].

The design and full application of MSP is relatively recent and limited. Among its most pioneering applications are the Great Barrier Reef Marine Park at the beginning of the 1980s [20], the marine functional zoning carried out by China at the end of the same decade [21], or the various different marine spatial plans drawn up at the state level with regard to the U.S.'s 3-nautical-mile limit to its territorial sea [22]. It is estimated that, since then, around 140 MSP plans in 70 countries have been developed, implemented or are in the process of being prepared at the national, regional or local level [23,24]. Due to the progressive application of MSP, scientific interest from a variety of disciplines has also increased. In a recent review of the existing literature [25], up to 91 documents (published between 2000 and 2018) were found whose focus was the evaluation of economic impacts. Both the aforementioned review of the literature on this topic and other recent ones [26,27] reached a similar conclusion: only a small number of these studies included any element related to the quantification of economic impacts associated with or derived from the application of the MSP. This scarcity of specific studies opens the door to move forward in this research area.

There is no singular methodology for evaluating the economic impacts of public policies [28]. To a large extent, the choice of a suitable methodology for the analysis depends on the very characteristics of the programmes, public policies to be evaluated or even the goal of the analysis. This means having prior knowledge of the operating rules of the public programme applied and the information available to be able to choose the most suitable or, quite simply, the only impact evaluation methodology possible. Despite the fact that the 2014 European Union Directive on Marine Spatial Planning [29] required all Member States to have developed their own marine planning by 2021, to date there are few plans fully implemented in the EU countries. In particular, MSP is mainly limited to Germany, the UK, the Netherlands, Belgium and, recently, Latvia and Lithuania [26,30]. In Norway (although it is not EU members), MSP is also fully implemented, and in other European countries (such as Portugal, Poland, Malta and Sweden), its development is at an advanced stage [31–33].

This paper focuses on proposing a methodology to estimate the direct economic impacts derived from or linked to the implementation of MSP based on the analysis of three front-runner cases in MSP implementation: Belgium, the German Baltic zone and the zone encompassing the North Sea and Norway's Skagerrak strait. It should be noted that in this work we exclusively consider direct economic impacts measured through the evolution of the activity level of the blue economy sectors concerned with the corresponding MSP. For this, the annual evolution of the value of the production of each activity sector will be used as a reference variable. That is, in this analysis, other economic impacts such as those mentioned above are not considered. In the next section, we will specify the methods followed and the materials available and used for each case and stage of the framework proposed. In section three, the results obtained are presented and discussed. We will finish by summarising the main conclusions in the last section.

2. Materials and methods

To estimate the potential economic impacts of MSP, a stepwise framework is introduced in Fig. 1. It is structured in four phases which are explained below, including the simplified assumptions adopted.

2.1. Identification of sectors of activity involved

In every case study, it is necessary to identify the marine activities concerned or that might be directly affected by MSP, explicitly described in the plan.

In the case of the German Baltic Sea, the MSP programme covers all of the waters of its Exclusive Economic Zone (EEZ) beyond 12 nautical

Table 1
Classification of Blue Economy activities involved in the MSP of each case study.

Group	Sectors	NACE Codes	Activity	GE	BE	NO
1. Living Resources	1.1. Fisheries and Aquaculture	A0311	Marine fishing	√	√	√
		A0321	Marine aquaculture	√	√	
		G4638	Wholesale of other food, including fish, crustaceans and molluscs			
		C1020	Processing and preserving of fish, crustaceans and molluscs			
2. Non-Living Resources	2.1. Extraction of oil and gas	B0610	Extraction of crude petroleum			√
		B0620	Extraction of natural gas			√
		B0910	Support activities for petroleum and natural gas extraction			√
	2.2 Extraction of aggregates	B0811	Quarrying of ornamental and building stone, limestone, gypsum, chalk and slate	√	√	
		B0812	Operation of gravel and sand pits; mining of clays and kaolin	√	√	
		B0899	Other mining and quarrying	√	√	
	2.3. Seabed mining	B0710	Mining of iron ores	√		√
		B0721	Mining of uranium and thorium ores	√		√
		B0729	Mining of other non-ferrous metal ores	√		√
		B0990	Support services to other mining and quarrying	√		√
3. Shipping	3.1. Maritime Transport	H5010	Sea and coastal passenger water transport	√	√	√
		H5020	Sea and coastal freight water transport	√	√	√
		H5229	Other transportation support activities	√	√	√
		N7734	Rental and leasing services of water transport equipment		√	
	3.2. Ports	H5210	Warehousing and storage services		√	
		H5222	Service activities incidental to water transportation		√	
4. Tourism and recreation	4.1. Coastal Tourism	H49	Land transport	√		√
		H50	Water transport	√		√
		H51	Air transport	√		√
		I55	Accommodation	√	√	√
		I56	Food and beverage service activities	√	√	√
		N77	Renting and leasing of motor vehicles, recreational and sports gods			√
		N79	Travel agency, tour operator reservation service and related activities	√	√	√
		R90-92	Culture and entertainment			√
5. Energy	5.1. Energy	D3511	Production of electricity	√	√	√
6. Public	7.1. Military	O84	Public activities (Military)	√	√	
7. Construction	8.1. Construction	F4291	Construction of water projects	√		

Source: Own elaboration based on [25].

miles (comprising approximately 4500 km^2), because planning in territorial waters falls within the competence of the federal states (Länder). This planning began in 2004 and culminated in 2008 with the publication of the Plan, which came fully into effect in December 2009 [25]. In 2017 its review began and the new plan is expected to be completed by 2021. The declared objectives of the current plan are aimed at coordinating the different uses (traditional and new) of the marine space by trying to avoid conflicts and also in a way which is compatible with the protection of the marine environment. In short, the German Baltic Sea MSP programme affects the following 9 activities: fishing and mariculture, exploitation of non-living resources, marine transport, energy production (wind energy in particular), leisure and tourism, marine scientific research, submarine cables and pipelines, military and marine environment. In addition, in the 12 nautical miles another MSP plan was developed (in alignment with the EEZ plan). This plan for the Territorial Sea of Mecklenburg–Vorpommern (MV) was adopted in 2005 (and updated in 2016) and it integrates the single uses in the territorial sea of this region [34]. On the one hand, the aquaculture is prioritised in the MV plan on contrary than in the EEZ plan, just the contrary with extraction of oil and gas. On the other hand, the lack of comprehensive information about ammunition dump sites and sediment deposition in the EEZ causes the inexistence of planning actions of these uses. One of the difference between the EEZ plan and the MV plan are the considerations regarding aggregate extraction. In particular, the EEZ MSP considers safeguarding and exploiting non-living resources (marine aggregates, mining, hydrocarbons) as an important basis for Germany's future economic development. The legal framework distinguishes between exploitation and production licences. The first grant the exclusive right to explore for mineral resources in a particular field whereas the second is limited to exploit minerals. However, the issuing of mining licences is a coastal state (Länder competence) and it is aligned in the MV plan.

Belgium maintains a small part of the North Sea (covering some 3454 km^2) under its jurisdiction, surrounded by maritime zones under the jurisdiction of the Netherlands, France and the UK [25]. It is one of the most intensely used maritime zones, whose uses (shipping, fishing, tourism, sand extraction etc.) may come into conflict with each other. Perhaps for this reason, the implementation of a Belgian MSP programme began back in 2003, and became fully binding from a legal perspective in 2014 (the process is well documented in [35,36]). The MSP programme must be renewed in 6-year cycles, meaning that the current plan is valid from March 2014 to March 2020, at which date the next plan will come into effect. The Belgian plan expressly mentions 13 sectors involved in MSP: fisheries, aquaculture, mineral extraction, shipping, ports, offshore renewable energy production, tourism, scientific research, submarine cables and pipelines, military, nature protection, underwater cultural heritage, and coastal protection.

For the EEZ under Norwegian jurisdiction (almost 2.4 million km^2), three different plans exist: The Barents Sea, the Norwegian Sea and the North Sea. These management plans date back to 2009, when the laws on marine resources and nature management were passed [25]. In this study, only the MSP relating to the North Sea and the Skagerrak strait is considered, being Norway's most intensely used maritime zone and where potentially conflicting activities take place. Following similar basic management approaches as in the previous plans (purposes, aims and principles), current marine planning in this zone came into effect in April 2013. It is an integrated management plan based on the ecosystem, whose general objective is to facilitate co-existence among the different marine activities and the sustainability of natural resources and the environment. The sectors of economic activities directly contained in the plan can be summarised under the following 8 sectors: fishing, fish processing industry, mineral extraction, petroleum activities, marine transport, leisure and tourism, offshore renewable energy, and marine bioprospecting.

Once the economic activities directly concerned were identified in each of the three case studies, it was necessary to relate them to their corresponding activity code for statistical purposes. Based on the criterion proposed in [37] and its adaptation to the economic activity classification system in the European Union [38], each activity can be identified by its NACE Rev.2 code. The results obtained for the three case studies are summarised in Table 1.

2.2. Real evolution of marine activity production

Once the marine activities involved in each case were identified, the statistical data necessary for the analysis had to be gathered. Given that we were trying to evaluate economic impacts, we had to select a relevant variable that would be representative. In the usual characteristic of an MSP plan, it is to enhance governments' coordination, reduce the transaction costs of the companies involved and promote the investment climate [39]. All of this will facilitate the growth of marine activities, an increase that can be gauged quantitatively through the "production value", an output variable of the economic activity. In the frame of the study financed by the European Commission [25], this production value was gathered for the 2008–2016 period. A detailed explanation of the assumptions made and the method of obtaining the data can be found in the aforementioned European Commission document. As a result, Tables A1, A2 and A3 of the Appendix show the information provided in said document on the evolution of the production values of the marine activities involved for the three case studies (values expressed in homogeneous monetary units, euros for the year 2010, €$_{2010}$, using the implicit GDP deflator). Fig. 2 shows the evolution of these figures by large groups of activity sectors.

For the 2008–2016 period, in the German case, the annual value of the production of the marine activities considered ranged around 20,000 million €$_{2010}$. The Fig. 2 shows that the volume of production reached its minimum in 2008, to subsequently grow to the maximum in 2013, the year after which the value of production suffered a slight decrease. The most relevant group of activities is shipping (especially related to maritime transport), which represented just over 58% of the total value during the analysis period. The second group of relevant marine activities in this case are those related to maritime and coastal tourism (mainly accommodation and food service activities), which represented almost 41% of the total in the same period. The rest of the marine activities involved only represented 0.5% of the total value.

In the Belgian case, during the 2008–2016 period, the annual value of the production of the marine sectors considered reached an average of just over 12,000 million €$_{2010}$. Fig. 2 shows that until 2012, this figure presents an increasing trend, to later oscillate between 12,300 and 14,400 million €$_{2010}$ annually. In this case, the most relevant group of activities are those associated with tourism and recreation, which represented just over 44% of the total value during the analysis period. The second most important group of marine activities is shipping (linked to both maritime transport and port activity), which represented almost a third of the total value. The rest of the activities represented 23% of the total value, standing out among them those related to maritime construction projects.

The evolution of the value of marine production in the Norwegian case is undoubtedly conditioned by the set of activities related to the extraction of oil and gas (included under "Rest of marine activities" in Fig. 2). During the 2008–2016 period, the average annual marine production amounted to 160,000 million €$_{2010}$, of which approximately 84% originated in the oil and gas extraction sector. As activity in this sector declined, the total annual value of Norwegian marine production

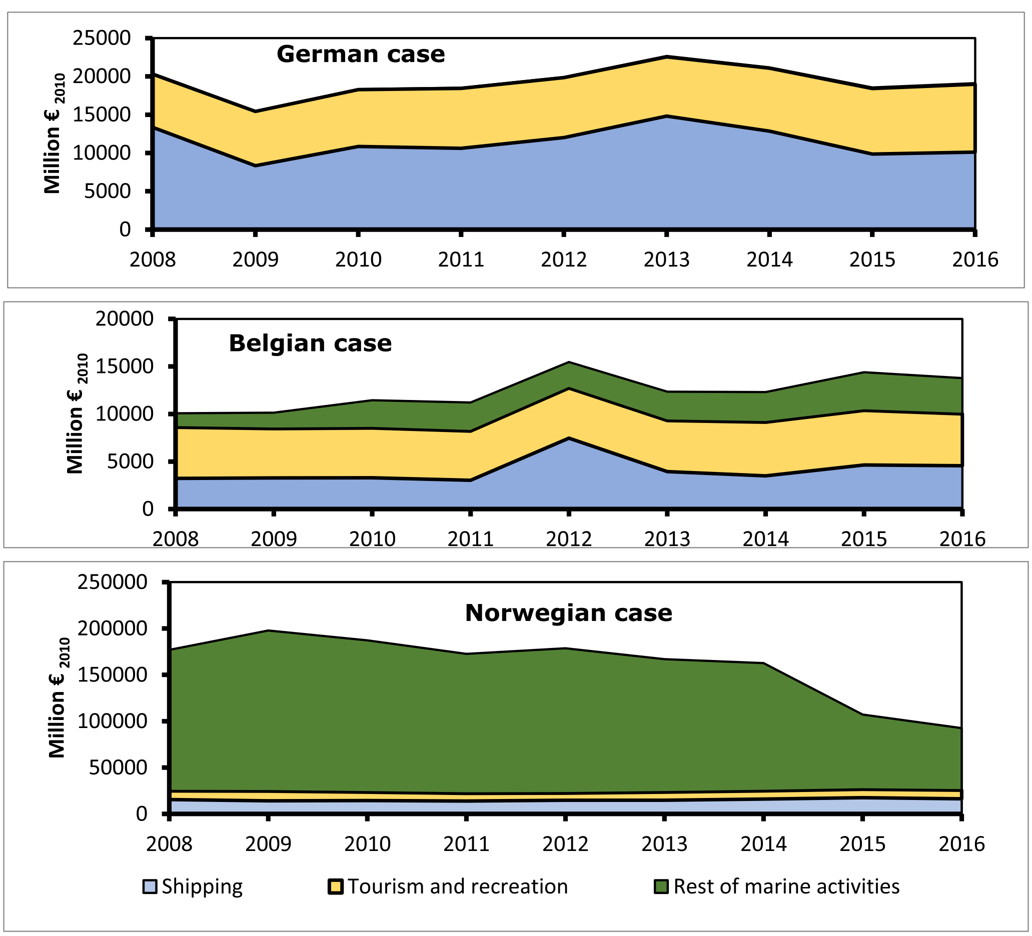

Fig. 2. Evolution of the value of the production of marine activities in the three case studies.

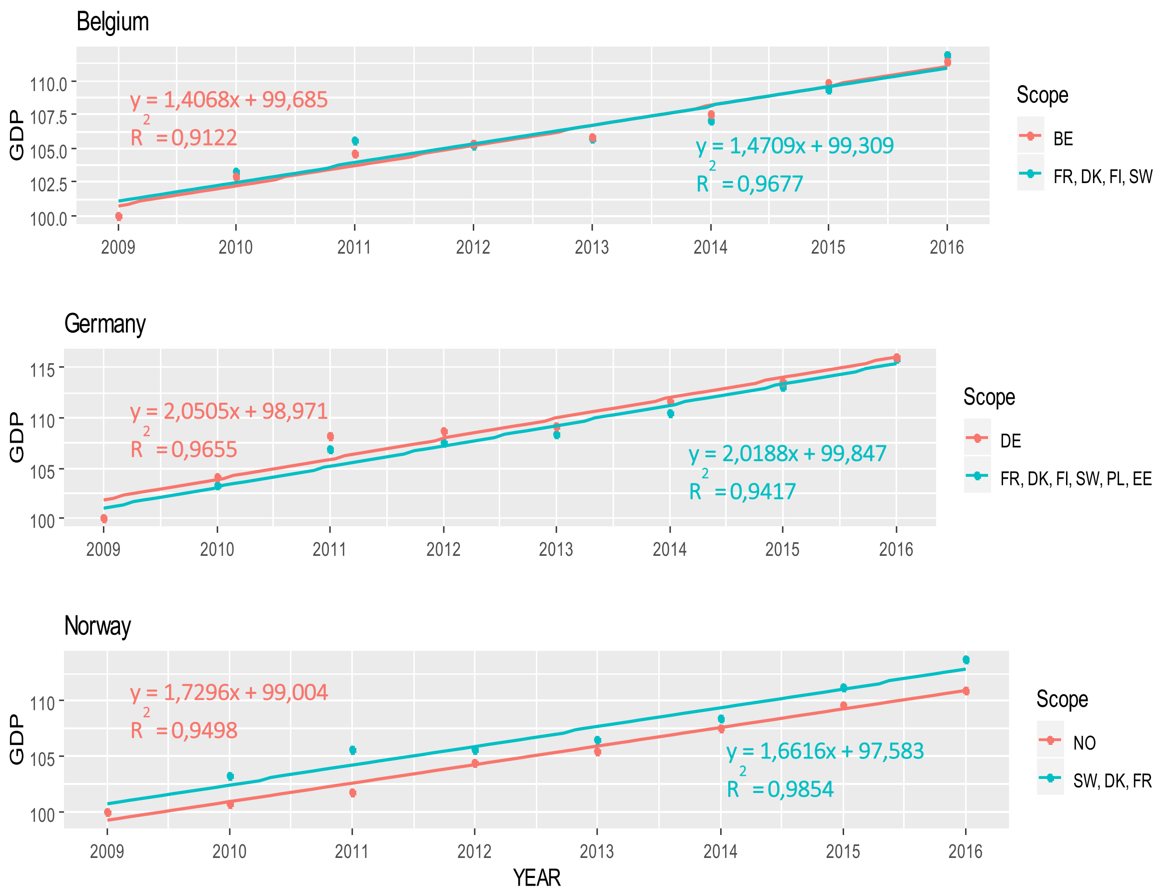

Fig. 3. Linear adjustment (ordinary least squares) of the evolution of the Chain Linked Volumes (index 2009 = 100) of the real GDP of each case study with relation to their respective control groups (period 2009–2016).

also declined, reaching its lowest in 2016, the last year of the series (92,547 million €$_{2010}$). The other two large groups of activities (shipping and tourism) represented on average around 10% and 6% of the total, respectively. In both cases, their annual production values remained quite stable throughout the analysis period.

2.3. Construction of the counterfactual scenarios

Once the evolution of the production (directly affected by MSP) is identified, an alternative hypothetical scenario is developed to simulate what would happen if the plan had not been implemented. In this sense, the annual impact of public planning could be estimated through the difference between both figures for each year: the real value less the value in the counterfactual scenario. The key to performing an accurate causal estimation lies in being able to build an appropriate counterfactual scenario.

In some cases, it is possible to resort to experimental designs in which, for example, only a group of randomly chosen individuals are involved in the public programme [28]. If this were so, we could choose the individuals that do not take part in said programme as a control group (counterfactual) with which to be compared. Obviously, this is not the situation in our three case studies, as all of the companies that carry out similar activities in a regulated maritime zone are bound by their corresponding MSP programme. The impossibility of applying experimental designs in our case studies makes it necessary to look for other kinds of methods, called quasi-experimental designs [40].

The simplest quasi-experimental procedure consists of designing a counterfactual scenario using the information available before the policy has been put into practice. By using interrupted time series, the aim is to estimate the normal behaviour of the agents in a period prior to the implementation of the MSP programme, projecting the trends observed in each case into the future [15,16]. The impact would be calculated by comparing the real data with the counterfactual data based on these projections. Here, the individuals from the control group coincide with those affected by the public programme. However, the disadvantage of this method is the need to assume that no factors (different from those contained in the public programme) have influenced the results obtained (once said programme has been implemented). In our case studies, it is difficult to assume this. The available information embraces the 2008–2016 period, in which the three countries experienced a major economic crisis initially, and then a subsequent recovery, circumstances which have undoubtedly affected our reference value (value of marine activity production).

Given the circumstances, the impact assessment could be more robust if a counterfactual scenario, based on a contemporary control group, could be developed. This control group should be made up of companies similar to those being studied, but not involved in the public programme and subject to similar contemporary factors (economic cycle). Matching techniques enable us to find the most similar pairing for each individual analysed. The impact evaluation would be obtained by comparing the results of each individual with those obtained for their corresponding pairing [28]. These techniques are aimed at minimising selection bias in the control group, but a wide sample of individuals is necessary, as is properly defining their observable characteristics to find

Table 2
Stakeholders' perceptions of MSP's effect on production differences in marine activities with respect to other neighbouring economies.

NACE codes	Activity	Belgium			Germany			Norway		
	scenarios	Low	Med.	High	Low	Med.	High	Low	Med.	High
A0311	Marine fishing	0%	12.5%	25%	0%	12.5%	25%	0%	12.5%	25%
A0321	Marine aquaculture	0%	12.5%	25%						
G4638	Wholesale of other food, including fish, …	0%	12.5%	25%						
C1020	Processing and preserving of fish,.	0%	12.5%	25%				0%	12.5%	25%
B0610	Extraction of crude petroleum							0%	0%	0%
B0620	Extraction of natural gas							0%	0%	0%
B0910	Support activities for petroleum.							0%	0%	0%
B0811	Quarrying and building stone, limestone, …	75%	87.5%	100%	50%	67.5%	75%			
B0812	Operation of gravel and sand pits;.	75%	87.5%	100%	50%	67.5%	75%			
B0899	Other mining and quarrying				50%	67.5%	75%			
H5010	Sea and coastal passenger water transport				0%	12.5%	25%	0%	12.5%	25%
H5020	Sea and coastal freight water transport	0%	12.5%	25%	0%	12.5%	25%	0%	12.5%	25%
H5229	Other transportation support activities	0%	12.5%	25%	0%	12.5%	25%	0%	12.5%	25%
N7734	Rental services of water transport.	0%	12.5%	25%						
H5210	Warehousing and storage services	0%	12.5%	25%						
H5222	Service activities to water transportation	0%	12.5%	25%						
H49	Tourism: Land transport				0%	12.5%	25%	0%	12.5%	25%
H51	Tourism: Air transport				0%	12.5%	25%	0%	12.5%	25%
I55	Tourism: Accommodation	0%	12.5%	25%	0%	12.5%	25%	0%	12.5%	25%
I56	Food and beverage service activities	0%	12.5%	25%	0%	12.5%	25%	0%	12.5%	25%
N77	Tourism: recreational and sports goods							0%	12.5%	25%
N79	Tourism: Travel agency, …	0%	12.5%	25%	0%	12.5%	25%	0%	12.5%	25%
R90–92	Tourism: Culture and entertainment							0%	12.5%	25%
D3511	Production of electricity	75%	87.5%	100%	25%	37.5%	50%			
F4291	Construction of water projects	0%	12.5%	25%						

Source: European Commission (2020) [25].

the suitable pairing with which to be compared. This is not possible in our analysis because, as occurs with experimental designs, in the Belgian case, MSP affects all of the national agents equally and, in the other two cases, the agents from other areas of the country would be subject to other regional marine regulation plans (plan for the German North Sea and plans for the Barents and Norwegian Seas).

Another option is to define the control group by analysing the contemporary development of the same marine activities in other neighbouring economies, with a similar environmental, economic and social context, and in which MSP regulation has not yet been applied. The hypothetical counterfactual scenario would be built on the assumption that, as MSP has not been implemented, the rhythm of development of marine activity production would be similar to that experienced with the same activities in neighbouring countries. This was the option adopted in [25], where the marine activities of 8 economies with a similar socio-economic climate in the North Sea and the Baltic Sea (Estonia, Latvia, Lithuania, Sweden, Finland, Poland, Denmark and France) were chosen as a single control group. As with the previous techniques, the key lies in finding, for each case study, the countries or groups of countries in the surrounding environment with contemporary circumstances as similar as possible to those of the marine sectors affected by MSP.

In the case studies it is assumed that the development of economic activity is the main observable characteristic that enables establishing similarity between two economies. In the 8 neighbouring economies mentioned, the country or combination of countries whose GDP growth trend is as similar as possible to that of the three case studies is calculated. Using multivariate analysis techniques, other socioeconomic variables could be used to establish comparison groups, but those other circumstances that might affect marine activities can be adequately collected through consultation with stakeholders. By analysing the GDP chain-linked volumes, index 2009 = 100, for the 2009–2016 period (see Table A4), we found that the annual growth rates of real GDP in the German economy in this period developed in a similar way to the average annual rates of a group of 6 countries: France, Denmark, Finland, Sweden, Poland and Estonia (see Fig. 3). In the Belgian case, likenesses were found with a group of 4 countries: France, Denmark, Finland and Sweden. For the Norwegian case, a group of 3 countries was found: France, Denmark and Sweden.

Once the control group for each case study was established, the conditions were in place to construct the hypothetical scenarios. Using Eurostat as the main data source and applying a similar criterion to the one used in [25], information was compiled on the evolution of the Production Value for the 2008–2016 period corresponding to the marine activities involved. All data were collected in millions of euros and were harmonised with the $€_{2010}$ using the GDP Price Index (implicit deflator) of each selected economy. Based on this information, the annual variation rate (AVR) of the production value of each activity was calculated for all the countries in our control group. Within each control group, the AVR values were averaged, obtaining the results shown in Tables A5, A6 and A7. These tables show the average trends the marine sectors in the control groups (countries in which MSP was not applied) experienced during the period in which said regulation was already being applied in our three case studies. The interpretation of these data is simple. For example, in the case of Germany, MSP had already been implemented for the entire 2010–2016 period. In the 6 countries that make up the control group, the value of fisheries production (code A0311) grew by an AVR of 5.03% in 2010. To build the counterfactual scenario, we will assume that, in the event MSP had not been implemented in Germany, fisheries activities would have shown a similar behaviour to the average for the control group; that is, the value of fisheries production in the German Baltic Sea ought to have also grown by a similar 5.03% in 2010 with respect to the year before. This criterion is applied to the remaining marine activities involved and for the periods corresponding to each case study.

2.4. Estimate of direct impacts

An initial approach to estimating the possible direct economic impacts consists of contrasting the real evolution of marine activities production observed (values in Tables A1, A2 and A3) with the estimated evolution in their corresponding counterfactuals (built based on the AVRs in Tables A5, A6 and A7).

Initial Direct Impact = Real value – Counterfactual value.

The previous estimate would be a valid approximation if it were certain that the MSP implementation and the general trend of the

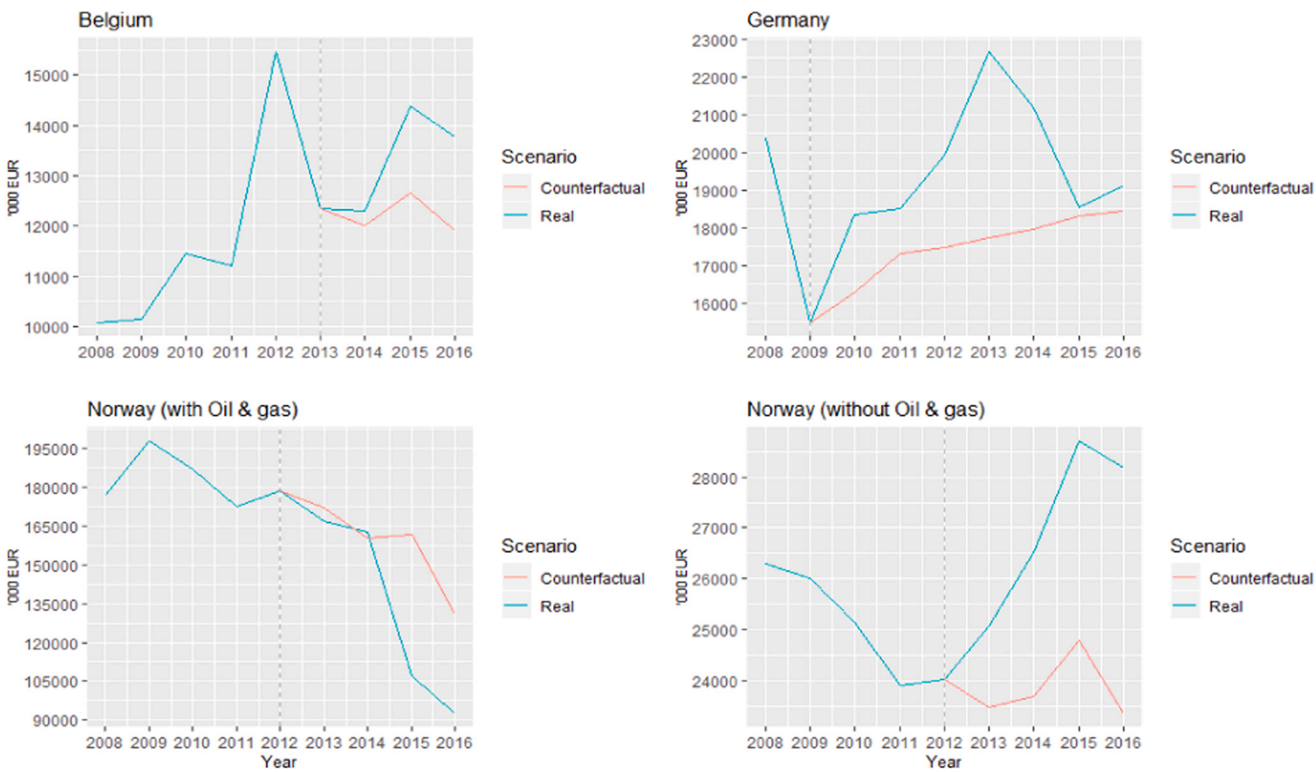

Fig. 4. Evolution of the real and counterfactual production value of marine sectors for the three case studies (million constant Euros, $€_{2010}$).

economic cycle were the only significant elements that conditioned the marine sector activity during the periods analysed in each case. It is evident that this argument is naive. The evolution of production with regard to sea-related industries is also conditioned by many other factors, both activity sector-specific and related to the political, social and institutional circumstances of each economy. For this reason, it is appropriate to consult the stakeholders (business leaders, companies and sectoral organisations, government agencies, etc.), as they have the best knowledge of their respective activities and the specific circumstances that condition the results of their industries' annual production.

In this work, the results of the stakeholder consultation collected in the European Commission report (2020) [25] are assumed. This report provides a detailed description of how this process was carried out for each case study. From this process, it can be highlighted that the consultations carried out with the stakeholders were structured in two parts. The first was qualitative, in which the perceptions, insights and subjective evaluations of those interviewed were gathered in an effort to capture the main elements of satisfaction (or dissatisfaction) with the MSP implemented. The second was more quantitative. Those interviewed were shown data on the temporal evolution of production (both in monetary terms as well as through the AVRs) pertaining to the corresponding marine activities, both in their zone of reference and in the surrounding countries. If evolutions were observed to be different to those in surrounding countries, the interviewees had to determine the extent (in percentage terms) to which this difference was attributable to the implementation of the corresponding MSP. Given the difficulty of setting a single impact percentage, to facilitate their answers, they could also decide between four options. If they considered that MSP had conditioned their industry's production activity very heavily, they had to choose the option "over 75%". If the impact was high, but less so, they could choose the option "between 50% and 75%". If they considered that the influence was moderate, they could choose the option "between 25% and 50%". Lastly, in the case of limited impacts, the option was "less than 25%". The results of this stakeholder consultation process are summarised in Table 2.

As can be seen, the stakeholders' responses on the effect of MSP on sectoral production levels are highly similar in the three case studies. Generally, it can be perceived that the marine industries most highly sensitive to MSP regulations are those linked to the extraction of aggregates (NACE codes B0811, B0812 and B0899) and offshore wind energy production (code D3511). For the remaining marine industries, the stakeholders estimate that the impact of MSP with regard to the differential behaviour of the volume and evolution of their production activities is minimal or null, as other factors with a more decisive influence exist (availability of fishing quotas, situation of the natural reserves and international oil markets, changes in international tourism services market, etc.). These stakeholders' responses were used to refine, adjust and weight the initial impact estimated by including other circumstances that conditioned the differences observed. Furthermore, three different direct impact scenarios can be built by applying the extreme percentages of each range to each of the marine activities: low, high and medium. The low-impact scenario is the lowest percentage of each range of the direct impacts initially estimated (see Table 2). The high-impact scenario is the highest percentage, and the medium-impact scenario is calculated by averaging the results obtained in the previous scenarios. The final direct impacts would be estimated by applying the corresponding percentages in Table 2 to the value of the initial direct impacts in each case study.

Table 3
Germany: Final direct impacts on the production value of marine activities in the medium-impact scenario. (Units, million constant Euros, €$_{2010}$).

NACE codes	Activity	2010	2011	2012	2013	2014	2015	2016
A0311	Marine fishing	0.5	1.6	2.4	6.6	6.0	6.0	5.7
B0811	Quarrying of building stone, limestone,…	4.0	0.8	-0.2	-0.5	-0.5	1.1	1.2
B0812	Operation of gravel and sand pits …	6.4	1.7	-0.1	-0.5	-0.5	1.6	1.3
B0899	Other mining and quarrying	0.6	0.2	0.0	0.0	-0.1	0.2	0.1
H5010	Sea and coastal passenger water transport	-28.5	18.8	40.1	33.4	119.8	123.6	158.5
H5020	Sea and coastal freight water transport	166.3	96.4	158.1	274.0	105.7	42.2	-32.0
H5229	Other transportation support activities	112.2	33.2	130.0	359.4	179.1	-169.8	-57.4
H49	Tourism, Land transport	0.2	-3.1	-17.1	-18.8	-12.6	4.6	-22.3
H51	Tourism, Air transport	9.9	0.4	-1.3	-0.2	15.4	1.6	15.5
I55	Tourism, Accommodation	0.3	3.7	8.6	-5.6	3.1	8.6	7.4
I56	Tourism, Food and beverage activities	2.0	3.0	-10.3	-34.2	-9.5	9.1	11.4
N79	Tourism, Travel agency, tour operator …	-6.4	-5.1	-5.7	1.4	-3.6	-1.5	-8.3
D3511	Production of electricity	0.0	0.0	0.0	1.4	1.0	11.5	12.3
TOTAL	**TOTAL**	**267.4**	**151.5**	**304.6**	**616.4**	**403.4**	**39.0**	**93.5**
	Standard deviation	258.6	149.4	304.8	616.3	403.5	29.0	83.3

Source: Own elaboration.

Table 4
Belgium: Final direct impacts on the production value of marine activities in the medium-impact scenario. (Units, million constant Euros, €$_{2010}$).

NACE codes	Activity	2014	2015	2016
A0311	Marine fishing	0.1	0.1	0.0
A0321	Marine aquaculture	0.0	-0.1	-0.1
G4638	Wholesale of other food, including fish, crustaceans and molluscs	0.4	0.2	-0.6
C1020	Processing and preserving of fish, crustaceans and molluscs	-0.2	0.1	0.2
B0811	Quarrying of ornamental and building stone, limestone, …	-0.8	-9.7	-1.8
B0812	Operation of gravel and sand pits; mining of clays and kaolin	24.9	10.2	39.5
H5020	Sea and coastal freight water transport	-17.2	48.7	57.7
H5229	Other transportation support activities	-2.5	3.1	-1.6
N7734	Rental and leasing services of water transport equipment	-22.2	-19.2	-1.3
H5210	Warehousing and storage services	0.1	3.7	9.7
H5222	Service activities incidental to water transportation	-6.8	47.5	38.6
I55	Tourism, Accommodation	4.4	-2.5	-28.5
I56	Tourism, Food and beverage service activities	-2.0	-4.3	-12.4
N79	Tourism, Travel agency, tour operator reservation service …	42.3	29.6	41.1
D3511	Production of electricity	130.8	147.6	174.3
F4291	Construction of water projects	18.5	89.1	100.7
	TOTAL	**169.8**	**344.1**	**415.4**
	Standard deviation	37.0	217.2	233.7

Source: Own elaboration.

Table 5
Norway: Final direct impacts on the production value of marine activities in the medium-impact scenario. (Units, million constant Euros, €$_{2010}$).

NACE Codes		2013	2014	2015	2016
A0311	Marine fishing	-8.8	-0.1	4.3	11.1
C1020	Processing and preserving of fish …	-2.5	1.3	54.5	91.8
B0610	Extraction of crude petroleum	0.0	0.0	0.0	0.0
B0620	Extraction of natural gas	0.0	0.0	0.0	0.0
B0910	Support activities for petroleum and gas …	0.0	0.0	0.0	0.0
H5020	Sea and coastal freight water transport	97.0	246.5	364.3	460.8
H5229	Other transportation support activities	1.8	8.7	-4.6	-26.9
H49	Tourism, Land transport	6.8	8.1	5.8	6.0
H50	Tourism, Water transport	1.9	3.7	4.1	9.3
H51	Tourism, Air transport	17.0	27.4	29.5	25.8
I55	Tourism, Accommodation	17.7	6.0	-3.1	-19.4
I56	Tourism, Food and beverage service activities	26.8	11.7	-4.4	-11.6
N77	Tourism, Renting of recreational goods	2.3	2.0	1.6	3.9
N79	Tourism, Travel agency, tour operator …	24.3	20.8	15.9	26.2
R90–92	Tourism, Culture and entertainment	16.2	17.3	20.6	25.1
	TOTAL	**200.5**	**353.3**	**488.6**	**602.1**
	Standard deviation	200.5	353.3	488.6	602.1

Source: Own elaboration.

3. Results and discussion

3.1. Results

With the third phase concluded, the results of the counterfactual scenarios are shown in Tables A8, A9 and A10. If these counterfactual estimated values are subtracted from the actual observed values (Tables A1, A2 and A3), the initial direct impact estimates are obtained (see Tables A11, A12 and A13). The evolution of these initial direct impacts for the three case studies is represented in Fig. 4.

In the cases of Germany and Belgium, the differences between the real value of the production of the marine sectors and their corresponding counterfactual scenario are positive in all the years of application of their corresponding MSP. In the German case, the estimated initial direct impacts represent an accumulated value in the entire period (2010–2016) of 14,759 million €$_{2010}$. In the Belgian case, the accumulated value of these estimated initial direct impacts amounts to 3903 million €$_{2010}$ in the 2014–2016 period.

The results obtained for the Norwegian case are highly conditioned by the decreasing evolution of the production of the activities related to the extraction of oil and gas. In this case, the differences between the real and the counterfactual value of the marine sectors analysed turned out to be negative, reaching an initial cumulative direct impact of −95,636 million €$_{2010}$ in the 2013–2016 period. On the other hand, in the consultation with the stakeholders, agents from the oil and gas sector stated that such a downward dynamic in the production value bore absolutely no relation to the MSP implemented and only some relation to the Norwegian economy's economic cycle. The basic determining factor in these results was related to the situation of the resource's natural reserves and to the evolution of international markets and said markets' average product prices [25]. If we accept this opinion and disregard the activities linked to oil and gas extraction, the comparison between the real evolution of the total production value with respect to the remaining marine activities and that which corresponds to the counterfactual scenario would provide a very similar result to that shown in the previous cases. Without oil and gas extraction activities, the estimated initial direct impacts would reach a positive figure of 13, 156 million €$_{2010}$ accumulated in the 2013–2016 period. However, as has been pointed out, these results must be adjusted in accordance with the stakeholders' perceptions. In all cases, it would appear logical to think that the final economic impact of MSP should be set at a lower figure than that estimated as the initial direct impact. The stakeholders' perceptions can help us discover other circumstances that might condition MSP's real impact level. Assuming the percentages shown in Table 2, we can obtain the scenarios to estimate the final direct impact. In Tables 3, 4 and 5, the results obtained for the medium-impact scenario are shown.

In the German case, the final direct impacts linked to MSP implementation in its Baltic maritime zone appear to be clearly positive (see Table 3). In the medium-impact scenario, the final direct impacts exceed 150 million €$_{2010}$ annually for the 2010–2014 period, dropping below 100 million €$_{2010}$ in 2015 and 2016. The standard deviations of the total estimated results for the three scenarios are high; therefore, the real direct impacts can vary within a significant range. If we accumulate the final direct impacts during the 7 years of the period analysed, it can be seen that, in this case, most of the marine activities involved have benefited from the implementation of MSP. The activities linked to maritime transport have seen a significantly higher evolution in their production value with respect to the values estimated in the counterfactual scenario. In fact, these three maritime transport activities (NACE codes H5010, H5020 and H5229) constitute more than 95% of the total net final direct effects for the German case overall. This is completely aligned with the overall aim of the plan. Although its production figures are still modest, the growing presence of offshore wind energy production should be noted, an activity facilitated by the existence of MSP. Some activities related to tourism have had negative accumulated effects, while the remaining ones have been positive (those linked to fisheries and mining), although in both cases, the extent of the final effects have been moderate.

In the Belgian case, the final direct impacts produced positive results in the first 3 years of MSP implementation. In net terms, in the average-impact scenario, the direct effects on the production value exceeded 160 million €$_{2010}$ in the first year of MSP implementation (2014), 340 million in 2015 and 410 million in 2016. It is necessary to point out that, especially for the last two years mentioned, the standard deviation of the results estimated for the three scenarios (high, medium and low-impact), is relatively high (see the last row in Table 4). Therefore, the results estimated for the final direct effects move within a wide range of possibilities. The implementation of MSP would seem to have an unequal effect on Belgian marine sectors. The sector with the greatest positive direct effect was the offshore wind energy production sector (D3511), followed at quite a distance by the gravel and sand extraction industry (B0812) and aquatic construction projects (F4291). Other sectors appear to suffer negative direct effects, such as the rental of equipment for marine transportation and the hotel and restaurant sectors linked to marine and coastal tourism. For their part, the production results of other activities, such as those related to fisheries and aquaculture (production, sale and processing), have scarcely changed since the implementation of MSP.

For the Norwegian case, once the activities linked to oil and gas were ruled out, we obtained distinctly positive and rising results for the final direct effects (see Table 5). In the first year of its MSP implementation, net effects equivalent to 200 million €$_{2010}$ were estimated, growing each year by more than 100 million €$_{2010}$ compared with the previous year. In line with the other two case studies, the standard deviation of the net results estimated for the three scenarios is high; in the Norwegian case, in the low-impact scenario, the net impact results with regard to the value of production derived from MSP implementation could be practically null. If the value of the direct effects on production in the 4 years analysed is accumulated, the activity that benefits the most from MSP is related to maritime transport of goods (H5020), constituting more than 70% of the accumulated final effects total. This is followed by fish processing (C1020) and some activities related to tourism (I56, N77, N79 and R90–92).

3.2. Discussion

The results on the direct economic impacts that we have just shown are highly conditioned by the methodological procedure used for their estimation. The applied framework proposed in this document has several advantages, among which four can be highlighted. First, it is the result of the empirical analysis of specific case studies, which is why it is adapted to their specific limitations and conditions. Second, it is a technically simple methodological proposal, making it replicable and applicable to other similar case studies. Third, through a quasi-experimental procedure, obtaining an adequate counterfactual scenario with which to establish comparisons is carried out by selecting control groups with contemporary economic characteristics similar to those of the case studies. Fourth, the incorporation of the stakeholders' perceptions in the estimation procedure allows for taking into account variables and circumstances other than the strictly economic ones, which can significantly qualify the results obtained.

In the proposed methodology developed in this work, it is highly relevant to follow a specific sequence of action in four phases: identification, data collection, counterfactual scenarios and estimations. The first phase is useful for discovering planners' economic priorities by sector. In the case of the German Baltic Sea, planning would seem to prioritise the compatibility of traditional economic uses (mainly maritime transport) with environmental objectives. In the Belgian case, zonal planning would seem to prioritise a reduction in conflicts between traditional uses (tourism, navigation, extraction of aggregates) and the development of new possibilities (offshore wind energy production). In the Norwegian case, planning priorities would appear to focus on ecosystem management, with the aim of reconciling traditional marine activities with sustainability objectives.

The restrictions appear in the second phase, as the statistical information of the activities concerned is not usually complete and accessible (for example, data on public sector activity). Sometimes the MSP areas of interest are not fully reflected in the official sectoral statistics (for example, in the case of tourism or activities that are not completely marine). Lack of sufficiently disaggregated information is also detected for the analysis of regional marine planning. These shortcomings constitute a weakness of the proposed procedure, but they are problems shared with other possible alternative methodological proposals.

The third phase is the most critical and difficult of the entire procedure, as it can significantly condition the results obtained. To build the counterfactual scenarios, we resorted to searching for control groups in surrounding countries that shared a marine environment and similar economic and social circumstances. However, if all the neighbouring countries are already applying their own MSP, there would be no way to establish a suitable control group, which would make it impossible to apply the proposed method. On the other hand, the choice of longer or shorter periods could cause variations in the set of countries that are part of the control group and, therefore, the results obtained in the estimates could be different. As before, this would be a weakness of the method shared with other alternatives that also need to use time series data.

In the fourth phase (estimations), the direct economic impact estimates were carried out by contrasting the real values with the counterfactual ones, obtaining initial direct economic impact results that had to be refined and adjusted based on the insights and perceptions of the stakeholders. The main advantage of this way of proceeding is the consideration of both relevant contemporary socio-economic factors and other circumstances that could influence the evolution of marine activities. These different circumstances are captured through a process of stakeholder interviews and questionnaires. Key stakeholders are assumed to know their industries and can introduce elements and additional information on the particular circumstances of each activity that was not observed or considered in the procedure followed. Another weak point of the proposed procedure may reside in this last point. The stakeholders selected for the sample must be recognised experts with knowledge of the marine sectors involved; in addition, they must be in a position to collaborate in this activity. To increase the chances of success of this procedure, it is also convenient to have previously established protocols for interviews and procedures for the systematic analysis of the information obtained with them.

4. Conclusions

Proper MSP requires the integration and consideration of multiple aspects: ecological and environmental, economic, social, political and cultural. This need to coordinate and reconcile different approaches and aims makes the processes of preparing, designing, implementing and monitoring MSP more complex. For this reason, it is necessary to rely on tools and techniques that enable us to evaluate the possible impacts related to these public policies. To date, there has been a notable scarcity of studies that deal with developing and applying tools related to the evaluation of MSP's economic impact. This scarcity could be explained by the complex nature of the task. The aim of this study was to progress in this field. To do so, we sought to find an empirical approach which, based on the analysis of three specific cases, enabled us to choose the suitable methodology to estimate the direct economic impacts derived from the implementation of the corresponding MSP programme.

Despite the fact that, in the three cases studied, the stakeholders consider the effect of MSP to be low or null (with the exception of offshore wind energy production and the extraction of aggregates), the results obtained show a significant positive impact of the MSP implementation. It was estimated that the German marine planning for the Baltic Sea area has led to an increase in the production value of the marine sectors involved of just over 1875 million $€_{2010}$ accumulated in the 2010–2016 period. In the Belgian case, this figure was 929 million $€_{2010}$ (accumulated in the 2014–2016 period) and in the Norwegian case 2262 million $€_{2010}$ (accumulated in the 2013–2016 period).

Analysis of the results achieved by sectors of activity, verified that some economic activities benefit more than others from the application of MSP. Generally, for the three cases, the estimated sectoral impact results are consistent with the priorities and orientations of their corresponding marine planning. In the German case, the activity sector that undoubtedly benefited the most was the one relating to activities linked to maritime transport. In the Belgian case, the sectors that benefited most were offshore wind energy, gravel and sand extraction, and aquatic project construction. In this case, some sectors seemed to have suffered negative effects, such as maritime and coastal tourism activities. Lastly, in the Norwegian case, having dismissed the oil and gas extraction sector, the activity sectors that benefited most from MSP were those linked to maritime transport and tourism activities.

In addition to the estimated direct impact results, the analysis carried out provides a known methodological framework, but adapted to the impact evaluation of MSP's public policies. This methodological framework has several advantages: it adapts to each specific reality, uses techniques that allow its replication and application to other similar cases, and considers both socioeconomic variables and stakeholders' opinions. Weak aspects of this procedure have also been pointed out, which leaves the methodological proposal open for future improvements.

One of these improvements is related to the statistical information used. In this work, the main source of information has been the Eurostat database, a statistical database that presents some shortcomings that should be eliminated. Among them, it could be point out that the information related to the marine activities of the public sector is not accessible, which implies an evident underestimation of the possible economic impacts of the MSP. For certain sectors (Tourism, Energy, for example), the data could be disaggregated into land activities and marine activities, with its corresponding NACE code, which would avoid having to use approximations to estimate the part of the value of production that is considered marine.

Another possible improvement is related to the method for the construction of the counterfactual scenarios, since the possibility of using hierarchical cluster analysis or other multivariate analysis techniques could be considered for the selection of the countries that make up the control group. Another area for improvement would be the possibility of developing protocols and procedures to improve the capture and processing of information provided by stakeholders.

Although each marine plan is subject to its own particular circumstances, the proposed methodological procedure could be useful to carry out an economic evaluation of the direct impacts derived from these public policies. Once the direct impacts have been estimated, we will be in a position to attempt to estimate the indirect and induced economic impacts with the help of other methodologies, such as input-output analysis. This subsequent analysis will provide a more complete view of the economic implications derived from the regulation of the use of marine space.

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CRediT authorship contribution statement

All the work in this document has been carried out jointly by the 4 authors.

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Appendix

See Appendix Tables A1–A13.

Table A1
Germany: Evolution of the production value of marine activities before and after MSP. (Units, million constant Euros, €$_{2010}$). In bold, years when MSP is in force.

NACE Codes	2008	2009	2010	2011	2012	2013	2014	2015	2016
A0311	64.6	47.1	**53.5**	**72.1**	**78.5**	**114.1**	**103.6**	**104.3**	**104.8**
B0811	12.2	1.4	**7.8**	**3.1**	**1.2**	**0.8**	**0.6**	**3.2**	**3.2**
B0812	21.7	1.7	**12.1**	**4.8**	**1.8**	**1.1**	**1.0**	**4.2**	**3.9**
B0899	1.4	0.2	**1.1**	**0.4**	**0.2**	**0.1**	**0.1**	**0.4**	**0.3**
H5010	85.0	381.3	**223.0**	**688.9**	**854.0**	**837.2**	**1522.0**	**1557.7**	**1858.3**
H5020	4382.6	2638.7	**3784.9**	**3313.4**	**3858.4**	**4589.2**	**3296.5**	**2867.0**	**2027.7**
H5229	8887.4	5318.2	**6842.4**	**6607.6**	**7296.0**	**9388.8**	**8032.0**	**5435.8**	**6226.6**
H49	3202.0	2857.3	**2959.7**	**3107.3**	**3089.5**	**3128.0**	**3184.3**	**3283.7**	**3284.9**
H51	856.8	842.9	**942.4**	**922.6**	**929.3**	**911.4**	**1020.6**	**918.3**	**1020.6**
I55	932.3	1002.3	**1036.8**	**1126.5**	**1174.7**	**1093.3**	**1192.1**	**1293.7**	**1364.7**
I56	1508.8	1956.4	**1996.2**	**2149.1**	**2119.3**	**2032.8**	**2297.4**	**2493.1**	**2678.2**
N79	441.7	429.5	**484.2**	**519.9**	**515.5**	**564.8**	**524.0**	**562.6**	**511.4**
D3511	0.0	0.0	**0.0**	**0.0**	**0.0**	**3.7**	**2.6**	**30.8**	**32.7**
TOTAL	20,396.5	15,477.1	**18,344.0**	**18,515.8**	**19,918.4**	**22,665.5**	**21,176.8**	**18,554.7**	**19,117.3**
Price Index	97.53	99.25	100.00	101.07	102.63	104.64	106.49	108.59	110.07

Source: European Commission (2020) [25].

Table A2
Belgium: Evolution of the production value of marine activities before and after MSP. (Units, million constant Euros, €$_{2010}$). In bold, years when MSP is in force.

NACE codes	2008	2009	2010	2011	2012	2013	2014	2015	2016
A0311	2.7	2.4	2.6	2.7	2.5	2.2	**2.6**	**2.6**	**2.4**
A0321	0.7	4.3	4.2	4.1	0.9	0.9	**0.9**	**0.3**	**0.4**
G4638	32.7	45.3	43.6	43.1	42.0	38.4	**41.8**	**42.7**	**40.0**
C1020	16.7	15.5	13.4	14.7	17.4	18.4	**18.7**	**20.0**	**21.7**
B0811	35.5	15.5	53.4	64.5	57.7	42.1	**36.3**	**24.4**	**29.8**
B0812	260.7	258.7	277.8	272.3	178.0	249.7	**262.2**	**240.3**	**273.5**
H5020	845.2	838.7	547.6	536.9	4695.3	2023.7	**1815.0**	**2395.5**	**2212.0**
H5229	1092.6	962.2	1241.7	946.8	900.1	449.7	**419.0**	**482.2**	**425.1**
N7734	137.0	135.9	133.4	188.8	222.1	253.9	**83.9**	**146.1**	**239.8**
H5210	194.7	184.6	235.4	384.5	421.4	171.2	**162.1**	**170.0**	**228.9**
H5222	958.9	1155.4	1134.0	973.3	1218.1	1042.4	**1013.4**	**1445.1**	**1451.2**
I55	1078.5	1070.2	1050.4	810.7	795.0	770.9	**824.9**	**803.4**	**639.9**
I56	1008.5	871.2	926.0	965.3	912.9	1031.4	**1037.2**	**1054.5**	**1028.7**
N79	3290.3	3240.7	3255.8	3394.6	3561.7	3562.9	**3783.1**	**3881.2**	**3782.0**
D3511	0,0	4,8	36,6	72,6	144,7	235.4	**368.3**	**396.1**	**422.1**
F4291	1119.0	1332.8	2490.6	2534.5	2296.7	2452.5	**2435.1**	**3286.7**	**2977.2**
TOTAL	10,073.7	10,138.2	11,446.5	11,209.5	15,466.5	12,345.6	**12,304.6**	**14,391.0**	**13,774.9**
Price Index	97.39	98.15	100.00	102.00	104.02	105.10	105.85	106.91	108.84

Source: European Commission (2020) [25].

Table A3
Norway: Evolution of the production value of marine activities before and after MSP. (Units, million constant Euros, €$_{2010}$). In bold, years when MSP is in force.

NACE codes	2008	2009	2010	2011	2012	2013	2014	2015	2016
A0311	433.7	452.7	522.3	566.2	469.3	**412.3**	**440.0**	**528.6**	**602.7**
C1020	1038.1	982.6	1182.5	1213.5	1166.4	**1173.0**	**1228.4**	**1627.7**	**2003.3**
B0610	142,750.7	159,819.8	150,833.0	137,571.1	136,690.2	**121,823.3**	**115,874.1**	**56,361.7**	**46,016.6**
B0620	0.0	0.0	0.0	0.0	5299.3	**5397.0**	**4946.6**	**6555.8**	**5521.2**
B0910	7880.8	11,990.1	11,198.7	11,144.7	12,609.4	**14,596.6**	**15,334.9**	**15,571.7**	**12,826.0**
H5020	13,089.9	11,725.9	11,992.0	11,489.7	12,299.9	**12,253.3**	**13,497.5**	**14,924.8**	**14,036.3**
H5229	2110.7	2080.0	2141.8	2146.6	2220.5	**2269.3**	**2263.9**	**2297.0**	**1981.8**
H49	482.8	540.6	467.9	426.8	396.1	**456.3**	**476.7**	**465.7**	**491.5**
H50	277.3	310.4	268.7	245.1	227.4	**262.0**	**282.8**	**323.5**	**373.2**
H51	852.7	954.7	826.4	753.7	699.4	**805.8**	**881.0**	**950.5**	**903.5**
I55	2041.4	2285.5	1978.3	1804.3	1674.4	**1882.1**	**1859.8**	**1871.4**	**1861.6**
I56	3425.3	3834.9	3319.4	3027.6	2809.6	**3158.0**	**3123.4**	**3139.0**	**3179.6**
N77	141.4	158.3	137.0	125.0	116.0	**133.6**	**139.8**	**145.7**	**170.7**
N79	997.2	1116.4	966.3	881.4	817.9	**942.3**	**934.4**	**942.8**	**985.5**
R90–92	1087.2	1217.2	1053.6	960.9	891.8	**1056.4**	**1103.8**	**1174.4**	**1275.1**
TOTAL	176,916.1	197,812.7	187,185.4	172,628.0	178,639.3	**166,905.3**	**162,675.6**	**107,187.0**	**92,547.1**
Price Index	96,91	86,56	100,00	109,64	118,15	116,01	108,76	98,66	93,96

Source: European Commission (2020) [25].

Table A4
Gross Domestic Product: Chain linked volumes, index 2009 = 100.

	2009	2010	2011	2012	2013	2014	2015	2016
Belgium (BE)	100,00	102,88	104,63	105,35	105,86	107,51	109,77	111,42
Germany (DE)	100,00	104,17	108,23	108,75	109,17	111,56	113,54	116,04
Norway (NO)	100,00	100,70	101,71	104,43	105,54	107,55	109,67	110,88
Denmark (DK)	100,00	101,83	103,16	103,46	104,38	106,11	108,55	112,12
Estonia (EE)	100,00	102,67	110,27	113,76	115,30	118,69	120,94	124,13
France (FR)	100,00	101,94	104,18	104,49	105,10	106,12	107,24	108,46
Latvia (LV)	100,00	95,51	101,53	105,73	108,21	110,22	113,85	115,85
Lithuania (LT)	100,00	101,52	107,61	111,78	115,74	119,80	122,23	125,38
Poland (PL)	100,00	103,63	108,81	110,57	112,12	115,85	120,31	123,94
Finland (FI)	100,00	103,20	105,78	104,33	103,41	102,99	103,61	106,30
Sweden (SE)	100,00	106,16	109,45	108,70	109,87	112,95	117,94	120,70
FR,DK,FI,SE,PO,EE	100,00	103,24	106,94	107,55	108,36	110,45	113,10	115,94
FR,DK,FI,SE,PO,EE	100,00	103,28	105,64	105,25	105,69	107,04	109,34	111,89
FR,DK,SE	100,00	103,31	105,59	105,55	106,45	108,39	111,24	113,76

Source: Own elaboration based on data from Eurostat.

Table A5
German case: annual variation rate of the production value of the control group's marine activities.

NACE codes	2010	2011	2012	2013	2014	2015	2016
A0311	5.03%	19.38%	0.08%	3.48%	-9.20%	0.71%	5.03%
B0811	-2.85%	25.03%	-10.77%	1.23%	-8.63%	-2.62%	-5.82%
B0812	2.51%	20.68%	-3.00%	-7.84%	-8.83%	0.07%	0.37%
B0899*	16.68%	2.80%	-22.11%	2.08%	-8.40%	5.69%	-2.28%
H5010	18.39%	19.39%	-1.06%	6.92%	-1.09%	0.85%	3.84%
H5020	-6.98%	3.58%	2.00%	-7.56%	2.25%	3.19%	-9.73%
H5229	11.79%	6.67%	-1.35%	4.12%	1.31%	2.95%	-1.59%
H49	3.54%	5.87%	3.01%	1.61%	0.22%	-1.18%	6.67%
H51	2.41%	6.53%	2.15%	-2.82%	-1.73%	0.92%	-0.93%
I55	3.21%	6.04%	0.84%	2.86%	2.58%	4.90%	6.60%
I56	1.20%	7.34%	3.59%	4.76%	2.89%	1.98%	6.87%
N79	12.99%	8.21%	6.14%	1.49%	0.76%	4.88%	5.11%
D3511	7.97%	1.75%	-9.59%	22.77%	-2.03%	-4.19%	1.41%

* With respect to this activity, there is no data for Denmark, Sweden and Estonia. We have disregarded atypical data for Poland for the year 2011.
Source: Own elaboration based on data from Eurostat.

Table A6
Belgian case: annual variation rate of the production value of the control group's marine activities.

NACE codes	2014	2015	2016
A0311	-9.89%	4.67%	4.81%
A0321	-0.66%	0.93%	15.16%
G4638*	1.05%	6.21%	8.42%
C1020	10.54%	-5.41%	4.62%
B0811	-11.54%	-4.78%	-9.98%
B0812	-6.39%	-2.15%	-0.13%
H5020	-3.53%	2.74%	-12.72%
H5229	-2.40%	4.16%	-4.26%
N7734**	2.86%	14.71%	-16.43%
H5210	-5.99%	-12.65%	7.41%
H5222	2.47%	-0.31%	7.31%
I55	2.46%	4.23%	5.44%
I56	2.09%	3.44%	3.56%
N79	-3.30%	5.78%	-5.24%
D3511	-7.06%	3.98%	-2.00%
F4291	-6.73%	12.53%	-15.62%

* A atypical data for France were disregarded for the year 2014.
** A atypical data for Finland were disregarded for the year 2014.
Source: Own elaboration based on data from Eurostat.

Table A7
Norwegian case: annual variation rate of the production value of the control group's marine activities.

NACE codes	2013	2014	2015	2016
A0311	2.85%	-8.59%	11.93%	4.11%
C1020	2.29%	2.08%	-2.17%	6.52%
B0610	-4.21%	-8.32%	0.04%	-22.97%
B0620	-4.21%	-8.32%	0.04%	-22.97%
B0910	-1.40%	-5.39%	3.24%	-3.47%
H5020	-6.29%	0.45%	4.26%	-13.39%
H5229	1.56%	-2.70%	6.35%	-5.88%
H49	1.51%	2.50%	1.68%	5.76%
H50	8.36%	2.59%	14.88%	2.84%
H51	-4.27%	-1.19%	8.03%	-2.46%
I55	3.93%	4.13%	4.65%	6.38%
I56	4.78%	2.92%	4.77%	3.08%
N77	-0.79%	7.87%	7.19%	4.79%
N79	-8.55%	2.71%	6.13%	-4.81%
R90–92*	3.93%	4.13%	4.65%	6.38%

* Eurostat does not have data for this activity, therefore we assume the annual average rates for activity I55.
Source: Own elaboration based on data from Eurostat.

Table A8
Germany: Counterfactual production value of marine activities. (Units, million constant Euros, €$_{2010}$).

NACE codes	Activity	2010	2011	2012	2013	2014	2015	2016
A0311	Marine fishing	49.5	59.1	59.2	61.2	55.6	56.0	58.8
B0811	Quarrying stone, limestone…	1.4	1.7	1.5	1.6	1.4	1.4	1.3
B0812	Gravel, sand pits …	1.8	2.1	2.1	1.9	1.7	1.7	1.7
B0899	Other mining and quarrying	0.2	0.2	0.2	0.2	0.1	0.2	0.1
H5010	Sea passenger transport	451.4	538.9	533.2	570.1	563.9	568.7	590.5
H5020	Sea freight water transport	2454.5	2542.4	2593.3	2397.3	2451.3	2529.5	2283.5
H5229	Other transportation support	5945.0	6341.7	6255.9	6513.9	6599.2	6793.8	6685.9
H49	Tourism, Land transport	2958.3	3131.9	3226.2	3278.1	3285.2	3246.6	3463.0
H51	Tourism, Air transport	863.2	919.6	939.4	912.9	897.1	905.3	896.9
I55	Tourism, Accommodation	1034.5	1097.0	1106.2	1137.9	1167.3	1224.5	1305.3
I56	Tourism, Food and beverage	1980.0	2125.4	2201.7	2306.6	2373.3	2420.4	2586.7
N79	Tourism, Travel agency, …	535.2	560.8	560.8	553.8	552.5	574.7	577.4
D3511	Production of electricity	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	**TOTAL**	**16,274.9**	**17,320.8**	**17,479.6**	**17,735.5**	**17,948.6**	**18,322.7**	**18,451.1**

Source: Own elaboration from Eurostat data.

Table A9
Belgium: Counterfactual production value of marine activities. (Units, million constant Euros, €$_{2010}$).

NACE codes	Activity	2014	2015	2016
A0311	Marine fishing	2.0	2.1	2.2
A0321	Marine aquaculture	0.9	0.9	1.1
G4638	Wholesale of other food, including fish, crustaceans and molluscs	38.8	41.2	44.7
C1020	Processing and preserving of fish, crustaceans and molluscs	20.3	19.2	20.1
B0811	Quarrying of ornamental and building stone, limestone, …	37.2	35.5	31.9
B0812	Operation of gravel and sand pits; mining of clays and kaolin	233.7	228.7	228.4
H5020	Sea and coastal freight water transport	1952.2	2005.8	1750.7
H5229	Other transportation support activities	438.9	457.2	437.7
N7734	Rental and leasing services of water transport equipment	261.2	299.6	250.4
H5210	Warehousing and storage services	161.0	140.6	151.0
H5222	Service activities incidental to water transportation	1068.1	1064.8	1142.7
I55	Tourism, Accommodation	789.8	823.2	868.0
I56	Tourism, Food and beverage service activities	1052.9	1089.1	1127.9
N79	Tourism, Travel agency, tour operator reservation service …	3445.1	3644.1	3453.1
D3511	Production of electricity	218.8	227.5	222.9
F4291	Construction of water projects	2287.5	2574.1	2172.0
	TOTAL	**12,008.5**	**12,653.7**	**11,904.9**

Source: Own elaboration from Eurostat data.

Table A10
Norway: Counterfactual production value of marine activities. (Units, million constant Euros, €$_{2010}$).

NACE codes	Activity	2013	2014	2015	2016
A0311	Marine fishing	482.6	441.2	493.8	514.1
C1020	Processing and preserving of fish …	1193.2	1218.0	1191.6	1269.3
B0610	Extraction of crude petroleum	130,937.2	120,045.8	120,095.4	92,506.3
B0620	Extraction of natural gas	5076.3	4654.0	4655.9	3586.3
B0910	Support activities for petroleum and gas extraction	12,432.6	11,762.0	12,143.7	11,721.9
H5020	Sea and coastal freight water transport	11,761.5	11,813.9	12,317.1	10,668.3
H5229	Other transportation support activities	2255.2	2194.3	2333.7	2196.6
H49	Tourism, Land transport	402.0	412.1	419.0	443.1
H50	Tourism, Water transport	246.5	252.8	290.5	298.7
H51	Tourism, Air transport	669.6	661.6	714.7	697.1
I55	Tourism, Accommodation	1740.2	1812.0	1896.2	2017.1
I56	Tourism, Food and beverage service activities	2944.0	3029.9	3174.5	3272.2
N77	Tourism, Renting and of recreational goods	115.1	124.1	133.0	139.4
N79	Tourism, Travel agency, tour operator …	748.0	768.3	815.3	776.1
R90–92	Tourism, Culture and entertainment	926.8	965.1	1009.9	1074.3
	TOTAL	171,930.6	160,155.0	161,684.3	131181.0

Source: Own elaboration from Eurostat data.

Table A11
Germany: Initial direct impacts on the production value of marine activities. (Units, million constant Euros, €$_{2010}$).

NACE codes	Activity	2010	2011	2012	2013	2014	2015	2016
A0311	Marine fishing	4.0	13.0	19.3	52.8	48.0	48.4	46.0
B0811	Quarrying of building stone, limestone,…	6.4	1.3	-0.3	-0.8	-0.8	1.8	1.9
B0812	Operation of gravel and sand pits …	10.3	2.6	-0.2	-0.8	-0.8	2.5	2.1
B0899	Other mining and quarrying	0.9	0.2	0.0	-0.1	-0.1	0.2	0.2
H5010	Sea and coastal passenger water transport	-228.4	150.0	320.8	267.1	958.1	989.0	1267.8
H5020	Sea and coastal freight water transport	1330.4	771.0	1265.1	2191.9	845.3	337.5	-255.8
H5229	Other transportation support activities	897.4	265.9	1040.1	2874.9	1432.8	-1358.0	-459.3
H49	Tourism, Land transport	1.4	-24.5	-136.7	-150.1	-100.9	37.1	-178.1
H51	Tourism, Air transport	79.1	3.0	-10.1	-1.5	123.5	12.9	123.6
I55	Tourism, Accommodation	2.3	29.5	68.5	-44.6	24.9	69.2	59.5
I56	Tourism, Food and beverage activities	16.3	23.7	-82.5	-273.8	-75.9	72.7	91.5
N79	Tourism, Travel agency, tour operator …	-51.0	-40.8	-45.2	11.0	-28.5	-12.1	-66.0
D3511	Production of electricity	0.0	0.0	0.0	3.7	2.6	30.8	32.7
TOTAL	**TOTAL**	**2069.1**	**1195.0**	**2438.7**	**4930.0**	**3228.2**	**232.0**	**666.1**

Source: Own elaboration.

Table A12
Belgium: Initial direct impacts on the production value of marine activities. (Units, million constant Euros, €$_{2010}$).

NACE codes	Activity	2014	2015	2016
A0311	Marine fishing	0.7	0.5	0.3
A0321	Marine aquaculture	0.0	-0.6	-0.6
G4638	Wholesale of other food, including fish, crustaceans and molluscs	3.0	1.5	-4.7
C1020	Processing and preserving of fish, crustaceans and molluscs	-1.7	0.7	1.6
B0811	Quarrying of ornamental and building stone, limestone, …	-0.9	-11.1	-2.1
B0812	Operation of gravel and sand pits; mining of clays and kaolin	28.5	11.6	45.1
H5020	Sea and coastal freight water transport	-137.2	389.6	461.3
H5229	Other transportation support activities	-19.9	25.0	-12.6
N7734	Rental and leasing services of water transport equipment	-177.3	-153.5	-10.6
H5210	Warehousing and storage services	1.1	29.4	77.9
H5222	Service activities incidental to water transportation	-54.7	380.3	308.4
I55	Tourism, Accommodation	35.1	-19.8	-228.1
I56	Tourism, Food and beverage service activities	-15.7	-34.7	-99.2
N79	Tourism, Travel agency, tour operator reservation service …	338.0	237.0	328.9
D3511	Production of electricity	149.5	168.7	199.2
F4291	Construction of water projects	147.6	712.6	805.2
	TOTAL	**296.2**	**1737.3**	**1870.0**

Source: Own elaboration.

Table A13
Norway: Initial direct impacts on the production value of marine activities. (Units, million constant Euros, €$_{2010}$).

NACE codes		2013	2014	2015	2016
A0311	Marine fishing	-70.3	-1.2	34.8	88.6
C1020	Processing and preserving of fish …	-20.1	10.4	436.1	734.0
B0610	Extraction of crude petroleum	-9113.9	-4171.7	-63733.6	-46489.7
B0620	Extraction of natural gas	320.8	292.6	1899.8	1934.9
B0910	Support activities for petroleum and gas …	2163.9	3572.9	3428.0	1104.1
H5020	Sea and coastal freight water transport	775.8	1972.2	2914.5	3686.5
H5229	Other transportation support activities	14.1	69.6	-36.7	-214.8
H49	Tourism, Land transport	54.3	64.6	46.7	48.3
H50	Tourism, Water transport	15.6	29.9	33.1	74.5
H51	Tourism, Air transport	136.2	219.4	235.7	206.4
I55	Tourism, Accommodation	141.9	47.7	-24.8	-155.5
I56	Tourism, Food and beverage service activities	214.0	93.5	-35.5	-92.6
N77	Tourism, Renting of recreational goods	18.6	15.7	12.7	31.3
N79	Tourism, Travel agency, tour operator …	194.3	166.2	127.4	209.4
R90–92	Tourism, Culture and entertainment	129.6	138.7	164.6	200.8
	TOTAL	**-5025.3**	**2520.5**	**-54,497.3**	**-38,634.0**

Source: Own elaboration.

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