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What Can Support Cross-Border Cooperation in the Blue Economy? Lessons from Blue Sector Performance Analysis in Estonia and Finland

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Abstract: Cross-border cooperation creates possibilities for improving the economic performance of the economies of different countries and allows for the efficient use of resources by considering sector-specific conditions for cooperation. The objective of this paper is to provide a methodological framework for analysing the economic performance of selected blue sectors, suggesting additional information for the development of cross-border cooperation in two neighbouring countries: Estonia and Finland. The analysis of the economic performance of the selected blue sectors relies on the Amadeus database for both countries, the implementation of Data Envelopment Analysis (DEA), and the calculation of partial productivity measures. The results of the study show that, on average, blue sectors report good performance indicators in coastal regions, but there are also some signs of imperfect efficiency. The common pattern of imperfectly efficient blue sectors in both countries is due to an excess of some fixed assets, which convey extra costs for business activities and, to some extent, generate excessive environmental pressures. The special nature of a shared blue economic area between Estonia and Finland stipulates close cross-border cooperation as an important tool to improve the performance of the imperfectly efficient sectors through shared "best practice" operations, technologies, and infrastructures. However, the lack of appropriate cross-border statistical data restricts analytical opportunities and the development of policy recommendations.

Keywords: blue economy; economic performance analysis; cross-border cooperation

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1. Introduction

The important role of the blue economy in regional development has long been recognized by the policymakers and scholars [1–3]. Coastal regions and areas are documented as having economic development potential and growth trends exceeding those of inland regions, suggesting that blue economy sectors possess strategic resources and exhibit good economic operation practices [4,5]. These aspects make the blue economy a vital component of national economies in countries with access to seas and oceans.

The term "blue economy" brings together various aims and objectives that are related to the resources and activities that are linked to the seas and oceans [6]. In this paper, "blue economy" is defined as "a concept that promotes economic growth, social inclusion, and preservation or improvement of livelihoods while at the same time ensuring environmental sustainability. It refers to the decoupling of socioeconomic development through oceans-related sectors and activities from environmental and ecosystems degradation" [7]. The harmonized development of the blue economy, which includes balancing coastal and marine economic activities with sustainable economic values, is viewed as the core of sustainable economic growth [8,9]. Therefore, the management of marine economic activities requires policies that would foster sustainable development and reduce costs for countries with blue economic sectors. This article suggests the development of cross-border cooperation (CBC) between blue economies as a possible policy direction.

Discussions on cross-border cooperation cover such topics as the levels, drivers, and determinants of CBC [10–13]; the consequences of CBC [14–16]; good practices of CBC [17–21], etc.

Cross-border cooperation has been organized for various matters, for example, for Arctic governance [22], tourism [23], and electricity provisions [24]. The EU's legal framework for maritime spatial planning (MSP) and opportunities for the establishment of long-term cross-border cooperation are explained in [25]. Cross-border MSP in European Macaronesia in combination with a participatory approach suggests a framework for implementing it to other transboundary marine areas [26]. The authors of [27] investigated the contributions of territorial cooperation programs in the Baltic Sea Region (BSR) to the sustainable development of tourism by applying qualitative methods. However, there is still a lack of literature devoted to the question how CBC can help to overcome the obstacles of sustainable development in blue economies and how the need for such cooperation in particular blue sectors can be identified by applying quantitative methods.

The objective of this paper is to provide a methodological framework for analyzing the economic performance of selected blue sectors, suggesting additional information for the development of cross-border cooperation in two neighboring countries from the Baltic Sea Region, Estonia, and Finland. In the study, the economic performance of a sector is defined as achieving the objective of the sector's activity as measured by turnover (the main indicator of business expansion and growth) in relation to the number of resources used for achieving the objectives of that sector (labor, fixed assets, current assets). In the present study, the assessment of economic performance involves comparisons of the outcomes (turnover), inputs (resources), and their interactions in the blue sectors and regions of Estonia and Finland.

The study highlights the efficiency of blue sector economic performance in the cross-border blue region. Throughout this paper, efficiency is referred to as the degree to which the greatest possible output per unit of input is achieved by a decision-making unit [28]. The paper relies on the Amadeus database from 2015 and focuses on five distinct blue economy sectors: bio and subsea activities; energy; water transportation; blue tourism; and marine construction. Our selection of the blue economy sectors is justified by their importance in the maritime spatial planning processes of Estonia and Finland as well of Europe as a whole [29,30]. The study outlines the blue region as a coastal area and includes the Harju, Ida-Viru, and Lääne-Viru Counties in Estonia and the Kymenlaakso, Uusimaa, and Finland Proper regions in Finland.

The major contributions of the paper are, firstly, the empirical verification of the proposed quantitative methodology to address the economic performance analysis of the blue sectors. That is, the paper estimates and compares simple partial productivity measures vs. the more sophisticated and complex Data Envelopment Analysis (DEA) technique. Relying on the selected blue sectors, the present paper addresses the advantages and drawbacks of both approaches and presents the framework for the unification of the findings from both empirical approaches. Secondly, the study analyses and discusses the findings in the specific contexts of the blue economy and cross-border cooperation. The paper highlights the special features of blue economy operation and elaborates on the potential consequences of inefficient operation, specifically in the context of the blue economy. Thirdly, the study delivers several policy suggestions on how to improve the economic performance of selected blue sectors. The research identifies cross-border cooperation, shared infrastructures, and operations as key tools to improve the economic performance of certain blue sectors.

Importantly several limitations of the DEA procedure and Amadeus database must be acknowledged when interpreting the results of the present analysis. Therefore, the results of the conducted empirical analysis need to be addressed with some caution and should be interpreted purely as indicative evidence.

Along with several strong advantages (discussed in Section 3.2 and summarized in Table 1), the DEA approach has some restrictions that are related to the technical features of the estimation procedure, which are also carefully discussed in the methodological part of the paper.

Table 1. Key characteristics of PPM and DEA methodologies.

Characteristic	PPM	DEA
1. Estimation procedure considers all available resources (inputs) and operation results achieved (outputs).	No	Yes
2. Unit-invariant, meaning that the optimization problem is independent of units of measurement, allowing inputs and outputs with different scales and units of measurement to be considered.	No	Yes
3. Identifies the "best practice" units, i.e., those which achieved full efficiency.	Yes	Yes
4. Estimates amounts of input resources that would have been saved if relatively inefficient units had reached maximum efficiency.	No	Yes
5. Identifies potential changes in the inefficient units allowing savings estimated within the analytical procedure to be achieved.	No	Yes
6. Provides an estimate of additional services/products that could have been provided given the amount of inputs used.	No	Yes
7. Ease of use for a single enterprise (decision-making unit).	Yes	No

Another major restriction of the research is related to the data. The results of the Amadeus-based analysis suggest that intensified cross-border cooperation could be one of the ways to improve the performance of inefficient sectors. However, for a more detailed analysis and further recommendations on effective cross-border cooperation, internationally harmonized and detailed statistical data are needed. The lack of appropriate cross-border statistical data restricts analytical opportunities and the development of policy recommendations.

The rest of the paper is organized as follows: Section 2 provides an overview of the literature devoted to cross-border cooperation in blue economies and maritime sectors and mainly focuses on the Baltic Sea Region lessons. Section 3 discusses the data and methodology applied in the study. Section 4 presents the empirical findings. The final section discusses the major results of the study, derives conclusions, and suggests potential policy implications.

2. Related Literature

Cross-border cooperation has been employed for a long time as a means to provide services and to jointly solve the environmental, social, and financial issues of neighboring countries [31]. In many cases, CBC demonstrates the positive effects of knowledge transferring from one party to another. Such as, for example, Helsinki–Tallinn Euregio, which enhanced cooperation between the two capitals and created an informational exchange in bordering areas that facilitated the integration of Estonia into the EU [32]. Even though it is considered to be both a barrier and opportunity for CBC, the Gulf of Finland is considered to be the basis for the cooperation between Estonia and Finland in tourism and environmental issues [33].

Several studies are concentrated on the CBC in the Baltic Sea Region [34–37]. The authors of [38] revealed the origin, typologies, and barriers of cross-border cooperation development in the BSR by analyzing financial tools and applying interviews. Within the European Union, cross-border cooperation is initiated and coordinated by regional development programs, such as INTERREG III [39].

The role of cross-border cooperation in the development of blue economies is underestimated. Only a few studies that are devoted to cross-border cooperation in maritime sectors can be named. The authors of [40] introduced a zoning proposal for marine protected areas in the Red Sea Marine Peace Park for joint management by Jordan and Israel by applying the spatial multi-criteria analysis method and survey techniques. The authors of [41] examined marine spatial planning procedures using the example of the Baltic Sea Region and concluded that cross-border interactions mainly take place in the fields of environment and health. The study also offered solutions to overcome these imbalances.

The assessment of the economic performance and competitiveness of maritime sectors has become a particularly important topic in the research agenda of several countries and regions during recent decades. The competitive advantages of the marine sector were addressed by, among others, [42], who explored the Norwegian maritime sector and the factors driving its high level of competitiveness by applying cluster analysis. The authors of [43] analyzed the competitiveness of China's marine industry as one of the most acute issues faced by the Chinese government. The study presented in [44] specifically focused on the profitability of privatized U.K. maritime ports. The authors of [45] estimated the monetary value of the ecosystem services provided by coastal and marine resources, with an aim to increase the social efficiency of decision-making processes. The study presented in [46] performed an economic and financial analysis of the Finnish fishing fleet. Similarly, the economic performance of the Portuguese fisheries sector was addressed by [47]. The Data Envelopment Analysis (DEA) approach has been applied to estimate the relative efficiency of industrial fishing in Estonia using the example of the Baltic Sea area trawl fleet. As a result, the Estonian fleet has shown relatively lower efficiency in terms of labor use than capacity [48].

Cross-border effects were measured in the article by [49]. The results show that some border regions in the European Union lack efficiency, stimulating cross-border cooperation in those regions where resources are inefficiently exploited. The authors of [12] emphasize the factors that determine cross-border cooperation. Among the decisive factors are the EU funds, interpersonal relationships, and historical and geographical proximity of the border regions. The performance indicators of blue sectors are associated with measuring the success of exploitation and beneficiation [50].

Methodological approaches to study cross-border cooperation are rather diverse. Among the most applied methods are social capital, social network analysis and interviews [51,52], the network analysis of secondary data [53], case studies [18,54], and the Living Lab's method [55]. The question of cross-border professional cooperation and labor mobility has been studied by applying mobile positioning data [56] and semi-structured interviews [41,57]. However, the DEA approach has not been applied for developing cross-border cooperation between neighboring countries in maritime sectors. The present article focuses on the blue sectors of two countries in the Baltic Sea region—Estonia and Finland. Cross-border cooperation between these countries is particularly understudied, especially in terms of the application of methods to identify blue sectors for potential cross-border cooperation.

3. Data and Methodology

3.1. Data

The study relies on the Amadeus database, which was developed by Bureau van Dijk. The Amadeus database comprises information on more than 21 million enterprises from 44 countries and that was collected from over 35 expert and local information providers. The database is regularly updated and allows company records from the previous 10 years to be tracked.

Amadeus data cover all publicly and privately-owned enterprises and provide a set of company-level indicators, which are crucial for analysis. Among other entries, the database incorporates information on a set of financial items and on the descriptive profiles of enterprises, including their sector and location. The ultimate advantage of the Amadeus database is its complete comparability of data entries across all countries, including Estonia and Finland. Unlike national data sources (registry data, national survey information), the Amadeus database ensures that the measuring, reporting, and data release procedures are the same for all countries, which allows safe cross-country comparisons to be made.

The database does have some limitations. A company's location specifies an enterprise's registration address. However, the company's registered address may differ from the place where that company is actually operating. We believe that in the scope of our study, this issue affects identified companies to a smaller extent, since it is more likely that blue enterprises registered in the blue region are also conducting business in the same on- and offshore areas. However, the issue may result in the omission of some blue companies that are registered elsewhere but that operate in the blue region. The latter may lead to an underestimation of the true number of blue enterprises and hence means that a lower margin of the actual scope of the blue economy will be described.

This paper defines the blue economy as a separate entity within a national economy that is directly involved in on- and offshore economic activities in the Gulf of Finland. Hence, extracting the blue economy at the national level implies the identification of blue sectors (industries) and the blue region. The present economic analysis specifically focuses on five broad blue sectors (industries): bio and subsea activities, energy, water transportation, blue tourism, and marine construction. Similar blue sectors were defined within the "Study on Blue Growth, Maritime Policy and the EU Strategy for the Baltic Sea Region", which was conducted by the European Commission in 2014. Blue industries were identified following the statistical classification of economic activities as outlined in the European Community (NACE Rev. 2), which was developed by Eurostat and is presented in Appendix A Table A1.

The blue region under investigation covers the coastal area of the Gulf of Finland in Estonia and Finland and focuses on all counties (NUTS 3 level regional units) that have direct access to the sea from both Estonia and Finland. Thus, the blue region of Estonia includes the Harju, Ida-Viru, and Lääne-Viru Counties. The blue region of Finland comprises the Kymenlaakso, Uusimaa, and Finland Proper counties. Hence, the blue economy that is considered in this study is shaped by five aforementioned industry sectors that operate in the defined blue regions of Estonia and Finland.

The paper focuses on three input variables (resources) and one output measure (turnover) available in the Amadeus database. The input variables are fixed assets, current assets, and employees. All three input resources are defined in the standard accounting manner. Specifically, fixed assets comprise long-term tangible and intangible assets that are owned by the firm and that have been used in the operation process for more than one year. Current assets refer to the assets that can be converted into cash, used, or consumed within a year. Labor expenses are approximated through the number of employees working at the enterprise. Relying on the actual number of employees instead of the total wage cost appears to be more relevant for the productivity assessment, as it provides a more exact measure of individual productivity.

The output indicator is yearly turnover, which is generated through an enterprise's operation as the revenue from all goods (services) sold plus the revenue received from support, maintenance, and after-sale services. Importantly, turnover includes the revenue received from secondary activities that are not under the scope of a firm's primary operation. When applied to an entire industry, turnover captures all of the revenue from all of the firms in the sector, regardless of whether the revenue originates from the main, secondary, or support activities. Hence, turnover indicates a company's (or sector's) growth, as a result of demand for goods (services) produced and their efficient realization. Increased turnover is a sign of business expansion and growth.

The final sample includes all of the companies within the five blue sectors, which are registered in the blue region and that satisfy the following criteria: (i) the number of employees is more than one; (ii) the turnover in the last year exceeded EUR1000; (iii) all of the input and output indicators of interest are available (no missing data). The majority of the observations have their most recent entries dating back to 2015, while the financial indicators from 2016 are disclosed for around 33% of firms in the blue economy.

3.2. Methodology

The first dimension of economic performance analysis is a classical productivity assessment of blue industries. Productivity is addressed through straightforward partial productivity measures (PPM). The latter is estimated as a simple ratio of one output to one input. Due to data limitations, the analysis is restricted in terms of the choice of productivity measures. Namely, to apply more complex productivity estimations that account for multiple inputs and outputs (e.g., multifactor or total factor productivity), all data should be measured in monetary terms and should rely on the same scale. Employment expenses are not given in the Amadeus database. Thus, one of the most important input factors is merely reported as the number of employees rather than total labor expenses.

The paper presents productivity assessment in several areas, namely:

- Average fixed assets productivity across sectors: $\sum_{i=1}^{n} \frac{\text{Turnover}_i}{\text{Fixed assets}_i} \frac{1}{n}$
- Average current asset productivity across sectors: $\sum_{i=1}^{n} \frac{\text{Turnover}_i}{\text{Current assets}_i} \frac{1}{n}$
- Average labor productivity across sectors: $\sum_{i=1}^{n} \frac{\text{Turnover}_i}{\text{Number of Employees}} \frac{1}{n}$, where index I = 1, . . . , n refers to companies operating in that particular blue sector.

The second research dimension tackles relative the efficiency of the selected blue sectors. The main analytical tool used for efficiency analysis is Data Envelopment Analysis (DEA). The DEA approach, developed by [58], is a linear programming technique that accounts for multiple inputs and outputs when conducting a relative efficiency assessment. DEA refers to relative efficiency since it measures the efficiency of a unit of analysis (e.g., a sector in the cross-blue-sectors database) by assuming that all other units lay on or below the efficiency frontier (i.e., achieving 100% efficiency) [59,60]. This paper leaves out the mathematical details of the DEA approach but elucidates the most relevant features of the efficiency tool.

Technically, DEA estimates the efficiency scores (ranking from 0 to 100%) of each decision-making unit by assuming that all other units are fully efficient (have 100% efficiency score). Methodologically, DEA allows the optimization problem to be formulated in several ways depending on the objective. The paper applies two types of DEA modelling to evaluate the current efficiency and to gain inference into potential areas for further improvement, namely:

1. Input-oriented DEA assessment (IOM—input-oriented model): Puts minimization of inputs as the objective function. In this set-up, outputs are taken as given, and DEA provides evidence suggesting how to decrease operational costs (i.e., amount of resources used) to reach a given output.
2. Output-oriented DEA assessment (OOM—output-oriented model): Puts maximization of outputs as the objective function. Thus, the optimization procedure seeks opportunities to increase output for the resources provided.

In addition to objective function, the DEA approach allows the choice between constant and variable returns to scale. Constant returns to scale imply that an increase in input results in a proportional increase in output. Variable returns to scale can be increasing, decreasing, or constant. Returns to scale increase if a proportional increase in all of the inputs results in a more than proportional increase in all of the outputs. Decreasing returns, conversely, imply that an increase in inputs leads to a less than proportional increase in outputs [61].

Along with an efficiency score, the DEA estimates provide slack for each input and output variable of each decision-making unit. The slack associated with input variables refers to an excess of resources that should be eliminated in order to reach full efficiency. Output variable slacks represent a shortage of outputs to be covered to achieve full efficiency. Within this paper, a DEA model with variable returns to scale, three inputs (fixed and current assets, labor), and one output (turnover) is specified. The study estimates both input- and output-oriented models, as they convey different types of evidence for subsequent application in scenario building and in providing necessary information for the development of cross-border cooperation.

Taking all aspects relevant for the study into account, Table 1 compares Partial Productivity Measures (PPM) to DEA methods across several areas.

The DEA approach unifies all sectors analyzed in a single estimation procedure, potentially ignoring substantial differences across sectors. This major omission can relate to the variation in the relative importance of specific resources in different sectors, which is directly reflected in the slack estimates. Nonetheless, applying a unified estimation framework for all sectors also has a big advantage, as it allows reliable cross-sectorial comparisons to be derived. Therefore, these advantages of the DEA approach still outweigh its limitations in the context of the given paper.

In order to thoroughly evaluate blue economy efficiency and to address the role of blue industries in regional economies, the study considers two analytical benchmarks: First, the input- and output-oriented efficiencies are estimated within each country separately. Thus, the efficiencies of the five blue sectors are compared separately for Estonia and Finland. Second, the efficiencies of the blue sectors relative to other blue industries in both Estonia and Finland are evaluated. This benchmark allows more reliable cross-country results to be derived.

4. Empirical Results

4.1. Descriptive Profile of the Blue Sectors

This section provides a general overview of the major indicators of interest from the Amadeus data for the year 2015 across the blue sectors. Table 2 provides a summary of input and output variables across the Estonian and Finnish blue regions.

Table 2. Total resources and outputs of the blue economy across the blue region.

	Inputs						Output	
Region	**Fixed Assets (Million EUR)**	**% of TRE**	**Current Assets (Million EUR)**	**% of TRE**	**Employees**	**% of TRE**	**Turnover (Million EUR)**	**% of TRE**
Estonia								
Harju	1359.8	16.6	393.5	4.8	8451	6.5	20,600.0	9.1
Ida-Viru	1296.8	65.2	165.4	26.4	5342	37.2	944.5	43.2
Lääne-Viru	15.4	2.4	1.2	0.3	206	2.1	1140.0	0.7
Finland								
Uusimaa	23,300.0	11.8	8589.2	5.0	30,233	2.5	315,000.0	9.5
Finland Proper	806.7	9.5	707.9	8.5	5423	6.1	19,600.0	7.8
Kymenlaakso	649.4	19. 4	153.1	12.1	747	5.9	3265.7	10.5

Source: Amadeus database, 2015. Note: The sample only includes companies that reported all input and output indicators in 2015. TRE stands for the total regional economy.

The results from Table 2 document Ida-Viru (in Estonia) and Kymenlaakso (in Finland) as the regions with the highest share of the blue economy. In Finland, Kymenlaakso and Uusimaa are good examples of regions with a developed and well-performing blue economy, which is specifically because a share of the blue economy in regional turnover reaches 10.51% and 9.42%, respectively. In Estonia, Ida-Viru County appears to be a blue economy that is operating well, accounting for 43.15% of the total regional turnover, though for only 37.18% of employees and 26.41% of current assets.

Interestingly, in all blue counties in Estonia and Finland, the reported shares of fixed assets are considerably higher than the respective shares of turnover. This evidence signals a potential excess of long-term material resource usage by the blue industries compared to non-blue sectors. However, the descriptive evidence provided above is not sufficient to draw any conclusions on fixed resource overuse, and this evidence will be analyzed in more detail within this paper.

Table 3 presents the average (per enterprise) amounts of resources employed and the output generated by each blue sector in the year 2015. The results indicate that the energy sector is the largest in terms of average inputs and output in both Estonia and Finland. Bio and subsea activities represent the second largest blue sector in Estonia in terms of turnover and fixed assets employed. In Finland, water transportation exhibits the second largest share of turnover and fixed assets associated with any of the sectors. The bio and subsea activities sector in Finland offers interesting insights, as it has relatively low average inputs but generates a high turnover. Other such examples are the coastal tourism and water transportation sectors in both Estonia and Finland. Hence, the descriptive evidence revealed potential disproportionalities in the resource–output ratios across the blue sectors. These imbalances will be addressed in more detail in the remainder of the section.

Table 3. Estonian and Finnish maritime industries—average inputs and outputs over blue region.

Sector	Current Assets (th. EUR)	Fixed Assets (th. EUR)	Labour (Employees)	Turnover (th. EUR)	N
Estonia					
Bio and subsea activities	8166	3922	36	6689	9
Energy	45,795	7696	127	41,587	51
Water transport	1617	662	16	3803	4
Coastal tourism	2062	816	52	3747	120
Marine construction	409	1434	44	6101	22
Finland					
Bio and subsea activities	1989	1342	12	4855	9
Energy	327,536	111,848	219	439,130	69
Water transport	45,686	9091	113	34,529	36
Coastal tourism	1833	2312	53	8641	253
Marine construction	2494	21,852	98	31,851	37

Source: Amadeus database, 2015. Note: The sample only includes companies that reported all input and output indicators in 2015.

4.2. Productivity Profile of the Blue Sectors

The first step in our economic performance analysis concerns a productivity assessment of the selected blue sectors by applying partial productivity measures. All three productivity dimensions are assessed relative to their turnover volume. Since the estimation procedure allows the inclusion of only one resource and one output, in order to maintain consistency, we produced a set of individual productivity indicators for each input relative to each output. Furthermore, the study uses productivity assessment along two comparative frameworks: the cross-sectorial and cross-regional frameworks.

The first set of productivity results includes the productivity measures of labor and fixed assets across the blue sectors of both Estonia and Finland, which are measured relative to turnover. Table 4 presents the productivity ranking of the blue sectors and suggests the industries with the highest and lowest levels of productivity.

The productivity ranking displayed in Table 4 immediately reveals strong inter-sector disparity in the productivity ranks with respect to labor and fixed assets. The results suggest that the energy sector has the highest labor productivity in both Estonia and Finland. However, it shows the average productivity of the fixed assets in both countries. Similarly, coastal tourism characterized by the lowest levels of labor productivity in both Estonia and Finland, revealing the highest productivity of fixed assets in Finland. The reason for such disparities can be twofold. Firstly, an imbalance across two indicators can signal inefficiencies in utilizing certain resources, resulting in a substantial excess and low return rate per unit of labor employed. Secondly, observed disproportionalities can originate from the nature of the sector. Specifically, the energy sector requires significantly larger amounts of fixed resources compared to the tourism sector (see Table 3), while the labor resource gap is considerably smaller, taking the size of the two sectors into account. The difference in the relative shares of resources can be attributed to the nature of the sector and the specific nature of business operation. Thirdly, the output scales differ drastically across the sectors. Lastly, the combinations of resources differ across sectors with, for instance, larger relative shares of fixed assets in the water transportation and energy sectors compared to tourism.

Table 4. Partial productivity of labor and fixed assets in blue regions of Estonia and Finland: industry ranking.

Turnover/Employees	Turnover/Fixed Assets
Estonia	
1. Energy	1. Marine construction
2. Marine construction	2. Energy
3. Bio and subsea activities	3. Water transport
4. Water transport	4. Coastal tourism
5. Coastal tourism	5. Bio and subsea activities
Finland	
1. Energy	1. Coastal tourism
2. Bio and subsea activities	2. Water transport
3. Water transport	3. Marine construction
4. Marine construction	4. Energy
5. Coastal tourism	5. Bio and subsea activities

Source: Amadeus database, year 2015. Note: The sample only includes only companies that reported all input and output indicators in 2015.

Hence, the productivity assessment clearly reveals its substantial limitations in the performance analysis. Partial productivity measures only provide a crude measure of how effective each sector is in utilizing inputs to produce outputs. Furthermore, given cross-country and cross-sectorial differences, productivity relates to sector competitiveness rather than pure economic performance. As they rely on a single input and single output, they can only provide a limited picture of actual performance. For assessing the effectiveness of resource use and the extent of their use in outcome production, an analysis that considers multiple inputs and outputs is needed (see Section 4.3). The conducted efficiency analysis relies on the application of DEA methods (see Section 3.2).

4.3. Efficiency Profile of the Blue Sectors

This section evaluates efficiency in the blue industries using two benchmarks. Specifically, we evaluate the efficiency of the Estonian and Finnish blue sectors compared to other blue industries (Section 4.3.1) within each respective country (within-country), the Estonian and Finnish blue economics as separately assessed, and (Section 4.3.2) across two the countries (between-country, Estonian and Finnish blue economies jointly evaluated). Industry input and output measures are taken as an average across all companies operating in certain blue or non-blue sectors. Thus, all inferences to efficiency scores and slacks are measured as the average per industry.

4.3.1. Within-Country Assessment

As outlined in Section 3.2, input- and output-oriented models are fundamentally different in terms of their optimization objectives. While the input-oriented model (IOM) sets an objective to minimize inputs but maintain the current output (turnover) levels, the output-oriented model (OOM) aims to maximize output given current resource use. Hence, the two estimation frameworks yield different optimization requirements, although the relative efficiency estimates are comparable.

Table 5 presents the DEA estimation results for the Estonian blue sectors within the Estonian blue economy alone, and Table 6 represents the same information for the Finnish blue sectors (within-country efficiency).

Table 5. Efficiency estimates of blue sectors in Estonia (within-country).

Estonia	Rank	Efficiency Score	Input Slacks: Fixed Assets (th. EUR)	Input Slacks: Current Assets (th. EUR)	Input Slacks: Labour (Employees)	Output Slack: Turnover (th. EUR)	Returns to Scale
Input-oriented model (IOM)							
Bio and subsea activities	3	68%	560.9 (7%)	1468.0 (37%)	0	0	Increasing
Energy	1	100%	0	0	0	0	Constant
Marine transportation	1	100%	0	0	0	0	Constant
Tourism	2	81%	55.0 (3%)	0	26 (50%)	55.1 (2%)	Increasing
Marine construction	1	100%	0	0	0	0	Constant
Output-oriented model (OOM)							
Bio and subsea activities	3	68%	0	1441.0 (37%)	0	0	Increasing
Energy	1	100%	0	0	0	0	Constant
Marine transportation	1	100%	0	0	0	0	Constant
Tourism	2	84%	0	0	27 (52%)	0	Increasing
Marine construction	1	100%	0	0	0	0	Constant

Source: Amadeus data, year 2015 for Estonia. Note: Industry inputs and outputs are taken as an average over all individual companies operating in the sector. Input slacks represent excess of respective resource (input); number in parenthesis is the slack percentage relative to average resource use in given sector. Output slacks represent a shortage of turnover (output).

Table 6. Efficiency estimates of blue sectors in Finland (within-country).

Finland	Rank	Efficiency Score	Input Slacks: Fixed Assets (th. EUR)	Input Slacks: Current Assets (th. EUR)	Input Slacks: Labour (Employees)	Output Slack: Turnover (th. EUR)	Returns to Scale
Input-oriented model (IOM)							
Bio and subsea activities	1	100%	0	0	0	0	Constant
Energy	1	100%	0	0	0	0	Constant
Marine transportation	2	98%	20518.1 (45%)	0	84 (75%)	0	Increasing
Tourism	1	100%	0	0	0	0	Constant
Marine construction	1	100%	0	0	0	0	Constant
Output-oriented model (OOM)							
Bio and subsea activities	1	100%	0	0	0	0	Constant
Energy	1	100%	0	0	0	0	Constant
Marine transportation	2	98%	2300.0 (5%)	0	51 (45%)	0	Increasing
Tourism	1	100%	0	0	0	0	Constant
Marine construction	1	100%	0	0	0	0	Constant

Source: Amadeus data, year 2015 for Finland. Note: Industry inputs and outputs are taken as an average over all individual companies operating in the sector. Input slacks represent excess of respective resources (input); number in parenthesis is the slack percentage relative to average resource in a given sector. Output slacks represent a shortage of turnover (output).

Specifically, under both input- and output-oriented models, the energy, marine transportation, and marine construction sectors achieve full and strong efficiency in Estonia since their efficiency score is 100% and because all of inputs and outputs have zero slacks (see Table 5). However, two sectors are not fully efficient: the bio and subsea activities sector (68% efficiency score in IOM and OOM) and tourism (81% efficiency in IOM and 84% in OOM). The DEA procedure suggests that these two sectors are over-using resources, resulting in high production costs. To achieve full efficiency, a number of resource optimization steps should be implemented.

To increase the efficiency of the bio and subsea sector, the overall inputs should be reduced by 32%, in both the IOM and OOM frameworks for Estonia through employing more effective technologies and more accurate resource management techniques. Further reductions in the use specific resources are determined by the optimization objective. With IOM, the input slacks suggest that fixed assets should be further reduced by 7% (EUR560,900 per enterprise on average) and that current assets should be further reduced by 37% (EUR1,468,000 per enterprise on average) in order to reach full efficiency. In order to reach full efficiency, the OOM approach shows that current assets should be further reduced by 37% (EUR1,441,000 per enterprise on average). Unlike IOM, the objective is to maximize turnover, which can even be achieved with resources lower than those currently provided.

To reach full efficiency in the Estonian tourism sector, the IOM DEA procedure suggests reducing overall inputs by 19% and to further reduce fixed assets by 3% (EUR55,000 per enterprise on average) and employment by a considerable 50% (26 employees per enterprise on average). Turnover slack under IOM identifies that there is an output shortage of 2% (EUR55,100 per enterprise average); thus, to achieve full efficiency, total industry turnover should be increased. To reach full efficiency through turnover maximization, the sector should decrease its overall expenses by 16% and should further decrease employment by 52% (27 employees per enterprise on average).

Table 6 presents the efficiency estimates of Finnish maritime industries as evaluated within the Finnish blue economy on its own. Both input- and output-oriented models reveal that when compared to each other, four out of the five blue sectors achieve full efficiency: bio and subsea resources, energy, marine construction, and tourism. Marine transportation is the only blue sector with an efficiency below 100%; however, the degree of inefficiency is relatively insignificant, i.e., approximately 2% in both the IOM and OOM models.

In order to increase the efficiency of the maritime sector, along with an overall 2% reduction in resources, fixed assets need to be reduced by 45% (EUR20,518,100 per enterprise on average), and employment expenditures should be further reduced by a huge 75% (84 employees per enterprise on average) under an IOM framework; with an OOM approach, a further fixed assets reduction of 5% (EUR2,300,000 per enterprise on average) and of labor expenses by 45% (51 employees per enterprise on average) would be necessary.

4.3.2. Between-Country Assessment

The principal difference defining the between-country framework is that the efficiency of each sector is assessed relative to the efficiencies of all of the other blue sectors in Estonia and in Finland. Therefore, the between-country framework provides a broader view of industry performance. Comparing the within-country estimates to between-country estimates reveals whether there are significant efficiency gaps across the two countries and which sectors require particular attention and could, possibly, rely on the positive experience of the neighboring state.

Tables 7 and 8 present the efficiency estimates of the Estonian and Finnish blue sectors based on input- and output-oriented models.

Tables 7 and 8 reveal that changing the benchmark does not alter the overall picture of sectorial efficiency; however, it changes the magnitudes of the inefficiency levels. In Estonia, the bio and subsea activities and tourism sectors remained the least efficient. Importantly, when compared to both the Estonian and Finnish blue sectors, the efficiency of bio and subsea activities further reduced to 42%. This result suggests that the operation of the bio and subsea activities sector is subject to substantial problems, which are even more evident when the performance of the blue economy in the neighboring country of Finland is taken as a benchmark. In the tourism sector, the overall performance picture remained comparable to the within-country benchmark.

Table 7. Efficiency estimates of blue sectors in Estonia and Finland (between-country): input-oriented model (IOM).

Input-Oriented Model (IOM)	Rank	Efficiency Score	Input Slacks:			Output Slack: Turnover (th.EUR)	Returns to Scale
			Fixed Assets (th. EUR)	Current Assets (th. EUR)	Labour (Employees)		
Estonia							
Bio and subsea activities	4	42%	0	0	0	0	Decreasing
Energy	1	100%	0	0	0	0	Constant
Marine transportation	1	100%	0	0	0	0	Constant
Tourism	2	81%	55.0 (3%)	0	26 (51%)	55.6 (15%)	Increasing
Marine construction	1	100%	0	0	0	0	Constant
Finland							
Bio and subsea activities	1	100%	0	0	0	0	Constant
Energy	1	100%	0	0	0	0	Constant
Marine transportation	3	76%	734.0 (16%)	0	0	0	Increasing
Tourism	1	100%	0	0	0	0	Decreasing
Marine construction	1	100%	0	0	0	0	Constant

Source: Amadeus data, 2015, for Estonia and Finland. Note: Industry inputs and outputs are taken as an average over all individual companies operating in the sector. Input slacks represent an excess of a respective resource (input); number in parenthesis is the slack percentage relative to the average resource level in a given sector. Output slacks represent a shortage of turnover (output).

Table 8. Efficiency estimates of blue sectors in Estonia and Finland (between-country): output-oriented model.

Output-Oriented Model (OOM)	Rank	Efficiency Score	Input Slacks:			Output Slack:	Returns to Scale
			Fixed Assets (th. EUR)	Current Assets (th. EUR)	Labour (Employees)	Turnover (th. EUR)	
Estonia							
Bio and subsea activities	4	44%	0	0	0	0	Decreasing
Energy	1	100%	0	0	0	0	Constant
Marine transportation	1	100%	0	0	0	0	Constant
Tourism	2	84%	0	0	25 (50%)	0	Increasing
Marine construction	1	100%	0	0	0	0	Constant
Finland							
Bio and subsea activities	1	100%	0	0	0	0	Constant
Energy	1	100%	0	0	0	0	Constant
Marine transportation	3	76%	0	0	0	0	Increasing
Tourism	1	100%	0	0	0	0	Decreasing
Marine construction	1	100%	0	0	0	0	Constant

Source: Amadeus data, 2015, for Estonia and Finland. Note: Industry inputs and outputs are taken as an average over all individual companies operating in the sector. Input slacks represent an excess of a respective resource (input); number in parenthesis is the slack percentage relative to average resource use in a given sector.

In Finland, the maritime transport sector is the only inefficient sector when compared to all of the blue sectors in Finland and Estonia. An important insight from the cross-country assessment is the even lower efficiency of maritime transport than in the within-country framework. When compared to the Finnish blue sectors on their own (Table 6), overall efficiency reaches 98%, while in the cross-country framework, it drops to 76%. This finding implies that maritime transportation exhibits the second worst efficiency level (after the Estonian bio and subsea sector) in the cross-border framework. Moreover, an input minimization strategy means a substantial reduction in the fixed assets.

The major result is that these two Finnish transportation sub-sectors reveal drastically different efficiency measures. Namely, the imperfect efficiency of marine transportation documented in Tables 6–8 is driven by cargo transportation, while passenger transportation reveals an efficiency of 100%. Moreover, the transportation sector achieved an aggregate efficiency of about 97%: only 3% below fully efficient operation. However, in the cargo transportation sub-sector, the performance level varies from 75% to 77% depending on the background model type. The poor efficiency of the Finnish cargo transportation sector may also be induced by various operational and management-related factors.

5. Discussion and Conclusions

The blue economy constitutes a vital part of maritime regional economies in both Estonia and Finland. The objective of this paper was to provide a methodological framework for analyzing the economic performance of blue sectors by exploring distinct features of sectoral operation in the coastal regions of Estonia and Finland. The economic performance and efficiency of blue sectors were analyzed using classical productivity assessment and DEA approaches.

In the case of Estonia, the results suggest that three out of the five selected blue sectors in Estonia (energy, marine construction, and marine transportation) appear to be highly efficient. These sectors generate maximal efficiency through the use of resources and by achieving maximal economic output per unit of resources. At the same time, bio and subsea activities and tourism are the two sectors with the lowest efficiency and thus with the lowest value-added to blue economy performance in Estonia. It appears that if firms within these two blue sectors set cost minimization as their main objective, then a fixed asset surplus, which should be emphasized to achieve full efficiency, is significant. If companies are targeting output maximization, they could achieve full efficiency with a relatively smaller, but still substantial, reduction in fixed assets (in bio and subsea activities only). In Finland, four out of five sectors are fully efficient (bio and subsea resources, energy, marine construction, and tourism). Only the marine cargo transportation sector is inefficient. Some signs of inefficiency in the European cross-border regions have also been identified by [49]. However, the authors of the study discovered that industrial activities and cultural events are the sectors with the greatest inefficiency.

The common pattern of imperfectly efficient industries is that in both countries, inefficient sectors have an excess of fixed assets, conveying extra costs for business, lowering efficiency and, importantly, generating environmental pressures to some extent. Reducing excessive fixed assets through more careful resource management and more effective operational technologies will positively reflect on sectorial performance and efficiency and, crucially, will lead to a potential reduction in environmental pressures.

Given a strong economic connection between Estonia and Finland as well as an immense body of shared maritime resources, the results of our study confirm that (i) the better use of available resources (inputs) and (ii) facilitating cross-border cooperation are potential ways for improving the economic performance of blue sectors and maritime regions. Well-developed cross-border cooperation can open new opportunities for the more efficient use of resources, particularly tangible assets, thereby also creating conditions for lessening an excess of fixed assets, with environmental pressure being especially relevant in the case of imperfectly efficient sectors.

Cross-border cooperation in the form of “good practice” sharing through learning efficient operation strategies, resource management, and monitoring by the Estonian bio and subsea sector from the Finnish one may be a form of beneficial cross-border cooperation. This is similar to the results found by [50], who calculated the performance indicators of the blue economy to measure the success of exploitation and beneficiation. Cross-border cooperation through sharing the marine (cargo) transportation infrastructure as well as adopting the fixed assets and labor management practices from the Estonian side could positively reflect on Finnish sectorial efficiency. Coastal tourism is another example of potential cross-border sectorial cooperation. The low efficiency of the Estonian tourism industry can largely benefit from sharing certain infrastructure, developing joint recreational activities, and learning from the Finnish tourism business, specifically in terms of human resource management.

The outcomes of the empirical analysis conducted in this paper emphasizes the necessity to develop a unified statistical system with reliable data that can be updated quickly and that can provide essential information for developing cross-border cooperation. The authors [62,63] pointed to cross-border data issues as well. Detailed and better-harmonized cross-border statistics would allow areas of improvement and the possibilities of cross-border cooperation aiming to foster the economic development in the blue region to be mapped and enhance efforts to strengthen economic and sustainability profiles. Another key advantage of reliable cross-border data is that they would allow on-going cooperation and existing ties across blue sectors to be more easily identified, thereby creating new possibilities for improving the economic performance of blue sectors and regions and creating better conditions for sustainability.

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Appendix A

Table A1. Definition of the blue sectors.

Industry	Sectors Included (NACE Rev. 2)
1. Bio and subsea activities	0311—Marine fishing, 0321—Marine aquaculture
2. Energy	06—Extraction of crude petroleum and natural gas, 091—Support activities for petroleum and natural gas extraction, 19—Manufacture of coke and refined petroleum products, 2011—Manufacture of industrial gases, 351—Electric power generation, transmission and distribution, 3513—Distribution of electricity, 352—Manufacture of gas; distribution of gaseous fuels through mains, 3522—Distribution of gaseous fuels through mains, 4671—Wholesale of solid, liquid, and gaseous fuels and related products
3. Water transportation:	
Cargo	502—Sea and coastal freight water transport
Passenger	501—Sea and coastal passenger water transport
4. Blue tourism	551—Hotels and similar accommodation, 552—Holiday and other short-stay accommodation, 553—Camping grounds, recreational vehicle parks and trailer parks, 559—Other accommodation, 561—Restaurants and mobile food service activities, 563—Beverage serving activities, 79—Travel agency, tour operator reservation service and related activities, 932—Amusement and recreation activities
5. Marine construction	301—Building of ships and boats, 3011—Building of ships and floating structures, 3012—Building of pleasure and sporting boats, 3315—Repair and maintenance of ships and boats, 4291—Construction of water projects

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