Tverdostup, Maryna; Paas, Tiiu

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Faculty of Social Sciences
School of Economics and Business Administration

ECONOMIC PERFORMANCE ANALYSIS OF SELECTED BLUE ECONOMY SECTORS IN ESTONIA AND FINLAND

Maryna Tverdostup, Tiiu Paas

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Economic performance analysis of selected blue economy sectors in Estonia and Finland

Maryna Tverdostup[1], Tiiu Paas[2]

Abstract

The study aims to assess productivity and efficiency of selected blue economy sectors in two neighbouring countries: Estonia and Finland. The analysis relies on the Amadeus database for both countries, implementing Data Envelopment Analysis (DEA) and calculating partial productivity measures. The results of the study show that, on average, blue sectors report high performance indicators in coastal regions of the countries, the only exceptions being the tourism and bio and subsea activities sectors in Estonia and marine (cargo) transportation in Finland. The common pattern of imperfectly efficient blue sectors in both countries is a substantial excess of 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 of Estonia and Finland stipulates close cross-border cooperation as a major tool to improve 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 development of policy recommendations.

Key words: blue economy, economic performance analysis, cross-border statistics.

JEL codes: C44; C61; R11; Q32

[1] University of Tartu and University of Innsbruck; maryna.tverdostup@ut.ee
[2] University of Tartu; tiiu.paas@ut.ee

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1. INTRODUCTION

The important role of blue economy in regional development has long been recognized by the policymakers and scholars. 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. In Europe, the sea is a distinctive part of the national economies of 22 countries. The calculated input of the blue economy is 5.4 million jobs and gross value-added of around 500 billion euros per year (Ecorys 2012, p.5). These aspects make the blue economy a vital component of national economies in the countries with access to the seas and oceans.

Moreover, maritime-related sectors are in the spotlight of environmental debate, since the environmental pressures generated are a side effect of intensified exploitation of the sea basin and increased economic activities in the blue area. Environmental concerns draw greater policy and scientific attention, since the development of environmental regulations needs to balance economic advantages and environmental externalities of blue economy operations. Long-term sustainable development of blue economies, balancing the economic benefits with the wellbeing of the world's oceans and seas, has become the major objective of numerous policies and Maritime Special Plans (MSP) (UNEP 2015, CSIRO 2015).

The concept of the "blue economy" was developed by Gunter Pauli's influential book "The Blue Economy: 10 years, 100 innovations, 100 million jobs" (Pauli 2010). The term blue economy brings together various aims and objectives related to the resources and activities linked to the seas and oceans). Harmonized development of the blue economy, balancing coastal and marine economic activities with sustainable economic values, is viewed as a core of sustainable economic growth (Smith-Godfrey 2016, COM 2017, COM 2014). Smith-Godfrey (2016) emphasizes that the blue economy embodies "sustainable industrialisation of the oceans to the benefit of all", harmonizing improvements in equity and wellbeing of both people and the environment, and allowing measurement of the effectiveness of the values and activities in quantitative terms.

The objective of this paper is to provide the methodological framework for analysing economic performance, focusing on the economic performance analysis of selected blue sectors of Estonia and Finland. In this study, economic performance of a sector is defined as achieving the objective of the sector's activity measured by turnover (as the main indicator of business expansion and growth) in relation to resources used for the achieving that sector's objective (labour, fixed assets, current assets). Assessment of economic performance involves comparisons of outcome (turnover), inputs (resources) and their interactions in blue sectors and regions of Estonia and Finland.

The study highlights the efficiency of blue sector economic performance in the cross-border blue region. The paper relies on the Amadeus database from year 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 MSP (Maritime Spatial Planning) process of Estonia and Finland as well Europe as a whole (Gänzle 2017, BaltSea Plan 2011). The study outlines the blue region as a coastal area, including Harju, Ida-Viru and Lääne-Viru Counties in Estonia, and Kymenlaakso, Uusimaa and Finland Proper regions in Finland.

The major contributions of the paper are, firstly, empirical verification of proposing the implemented quantitative methodology to address the economic efficiency 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 paper addresses advantages and drawbacks of both approaches and presents the framework for unification of the findings from both empirical approaches. Secondly, the study analyses and discusses the findings in the specific context of the blue economy and cross-border cooperation. The paper highlights the special features of blue economy operation and elaborates on potential consequences of inefficient operation, specifically in the context of the blue economy. Thirdly, the study delivers several policy suggestions on improvement of economic efficiency of selected blue sectors. The research identifies cross-border cooperation, shared infrastructures and operations as key tools to improve economic performance of certain blue sectors.

Assessment of economic performance and competitiveness of maritime sectors became a particularly important topic in the research agenda of recent decades of several countries and regions during recent decades. Competitive advantages of the marine sector were addressed by, among others, Benito et al. (2003), who explored the Norwegian maritime sector and factors driving its high competitiveness, applying cluster analysis. Yan et al. (2015) analysed the competitiveness of China's marine industry as one of the most acute issues faced by the Chinese government. Saundry and Turnbull (1997) focussed specifically on the profitability of U.K. privatized maritime ports. Torres and Hanley (2017) estimated the monetary value of ecosystem services provided by coastal and marine resources with an aim to increase the social efficiency of decision-making processes. Pokki et al. (2018) performed economic and financial analysis of the Finnish fishing fleet. Similarly, economic performance of the Portuguese fisheries sector was addressed by Leitão and Baptista (2017).

The context of Estonia and Finland sharing the offshore area of the Gulf of Finland provides a valid setting for the cross-border economic performance analysis of the blue economy. Both countries are characterized by a considerable share of coastal regions (almost 65% in Estonia and around 60% in Finland[3]). The blue economy generated over 82% of gross value-added (GVA) in Estonia and over 67% of GVA in Finland in 2010. Pohjola et al. (2018) document a substantial role the selected blue sectors play in the national economies of Estonia and Finland, focusing on the number of companies, business turnover and employment. Their results indicate that maritime sectors create opportunities for sustainable growth, economic competitiveness and jobs. According to COM (2012), the majority of the population resides in coastal areas (almost 74% in Estonia and almost 64% in Finland). Hence, the blue region included in the analysis has the highest population density in both Estonia and Finland.

Alongside providing the relevant context for blue economy analysis, the blue region of Estonia and Finland offers a valid setting for running the cross-border assessment of economic efficiency. Trade activity has long been the major aspect of cross-border cooperation. According to Statistics Estonia (2017), Finland is the major trading partner of Estonia: 16% of Estonian export is going to Finland and 13% of Estonian imports is coming from Finland. Marine transportation (passenger and cargo) has been another dimension of tight cross-border cooperation. As an example, in 2016, 84% of passengers who arrived in Estonia by international transport used the shipping lines operating between Finland and Estonia.

However, over the last decade, new policy aspects of cross-border cooperation in the blue area have been pursued. Since sustainable growth is recognized as an underlying feature of blue

[3] Estimates are taken from Eurostat (2011), available at https://ec.europa.eu/eurostat/en/web/products-statistical-books/-/KS-HA-11-001-13

economy development, Estonia and Finland share a joint responsibility for harmonized economic development in the Baltic Sea space. Hence, several joint policy actions and regulations have been developed in order to ensure balanced economic growth and cross-border cooperation in the blue area (BSR Tourism Forum 2017, BaltSea Plan 2011). Therefore, Estonian–Finnish cross-border cooperation in the blue area is currently entering a new phase, incorporating not only mere economic transactions but also mutual development of MSPs and putting forward modernized legislation, aiming to ensure environmentally sustainable economic development.

The rest of the paper is organized as follows. Section 2 discusses the data and methodology applied in the study. Section 3 presents empirical findings. The final section discusses the major results of the study, derives conclusions and suggests potential policy implications.

2. DATA AND METHODOLOGY

2.1. Data

The study relies on the Amadeus database, developed by Bureau Van Dijk[4]. The Amadeus database comprises information on more than 21 million enterprises from 44 countries, collected from over 35 expert and local information providers. The database is regularly updated and allows tracking of company records over the previous 10 years.

Amadeus data covers all publicly and privately owned enterprises and provides a set of company-level indicators, which are crucial for the analysis. Among other entries, the database incorporates information on a set of financial items and descriptive profiles of enterprises, including sector and location. The ultimate advantage of the Amadeus database is 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 measuring, reporting and data release procedures are the same for all countries, which allows safe cross-country comparisons[5] to be made.

However, the database does have some limitations. A company's location specifies a registration address of an enterprise. 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 running business in the same on- and offshore area. However, the issue may result in the omission of some blue companies, which are registered elsewhere, but operate in the blue region. The latter may lead to an underestimation of a true number of blue enterprises and, hence, describing the lower margin of the actual scope of the blue economy.

This paper defines the blue economy as a separate entity within a national economy, which is directly involved in on- and offshore economic activities in the Gulf of Finland. Hence, extracting the blue economy at the national level implies identification of the blue sectors

[4] For more information see: https://www.bvdinfo.com/en-gb/our-products/data/international/amadeus

[5] Recent research by the European Commission (2016) stressed an importance of cross-border comparability of data in maritime economic studies. Among other issues, differences in definition of blue industries were highlighted. Furthermore, comparative economic analysis requires identical metrics and measurement techniques for variables of interest, which is not necessarily the case when national registry databases are used to make cross-country assessment.

(industries) and the blue region. 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", conducted by the European Commission in 2014. The blue industries are identified following the statistical classification of economic activities in the European Community (NACE Rev. 2)[6], developed by Eurostat, and presented in Appendix 1.

The blue region under investigation covers a coastal area of Gulf of Finland in Estonia and Finland, focusing on all counties (NUTS 3 level regional units), which have direct access to the sea from both Estonia and Finland. Thus, the blue region of Estonia includes Harju, Ida-Viru and Lääne-Viru Counties. The blue region of Finland comprises Kymenlaakso, Uusimaa and Finland Proper counties. Hence, the blue economy considered in this study is shaped by five aforementioned industry sectors, operating 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 asset, 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 owned by the firm and used in the operation process for more than one year. Current assets refer to assets that can be converted into cash, used or consumed within a year. Labour expenses are approximated through the number of employees working at the enterprise. Relying on the actual number of employees instead of total wage cost appears more relevant for the productivity assessment, as it gives a more exact measure of individual productivity.

The output indicator is yearly turnover generated through an enterprise's operation, as a revenue from all goods (services) sold, plus revenue received from support, maintenance and after-sale services. Importantly, turnover includes revenues received from secondary activities, which are not under the scope of a firm's primary operation. When applied to an entire industry, turnover captures all revenues from all 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 companies within the five blue sectors, which are registered in the blue region and satisfy the following criteria: (i) number of employees is more than one; (ii) turnover in the last year exceeded 1000 EUR; (iii) all input and output indicators of interest are available (no missing data). The majority of observations have the most recent entries dating back to 2015, while financial indicators from 2016 are disclosed for around 33% of firms in the blue economy. Therefore, the analysis relies on 2015 data only.

2.2. 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 limitations of the data, the analysis is restricted in the choice of productivity measure. Namely, to apply more complex productivity estimations, accounting for multiple inputs and outputs (e.g. multifactor or total factor productivity), all data should be measured in monetary terms and rely

[6] For more information see: http://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF

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 number of employees, rather than total labour expenses.

The paper presents productivity assessment in several areas. Namely:

- Average fixed assets productivity across sectors, as $\sum_{i=1}^{n} \frac{Turnover_i}{Fixed\ assets_i} \cdot \frac{1}{n}$,
- Average current assets productivity across sectors, as $\sum_{i=1}^{n} \frac{Turnover_i}{Current\ assets_i} \cdot \frac{1}{n}$
- Average labour productivity across sectors, as $\sum_{i=1}^{n} \frac{Turnover_i}{Number\ of\ Employees} \cdot \frac{1}{n}$, where index $i = 1, \dots, n$ refers to companies operating in that particular blue sector.

The second research dimension tackles relative efficiency of blue sectors. The main analytical tool used for efficiency analysis is Data Envelopment Analysis (DEA). 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 (Sherman and Zhu 2006). The DEA approach, developed by Charnes et al. (1978), is a linear programming technique which accounts for multiple inputs and outputs in relative efficiency assessment. DEA refers to relative efficiency since it measures efficiency of a unit of analysis (e.g. a sector in the cross-blue-sectors database) assuming that all other units lay on or below the efficiency frontier (i.e. achieving 100% efficiency) (Baltazar et al. 2014, Martin and Roman 2006). This paper leaves out mathematical details of the DEA approach[7], but elucidates the most relevant features of the efficiency tool.

Technically, DEA estimates efficiency scores (ranking from 0 to 100%) of each decision-making unit, 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 current efficiency and 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 are increasing if a proportional increase in all inputs results in a more than proportional increase in all outputs. Decreasing returns, conversely, imply that an increase in inputs leads to a less than proportional increase in outputs (Banker et al. 2004).

Along with an efficiency score, DEA estimates slacks for each input and output variable of each decision-making unit. Slack associated with input variables refers to an excess of resources which should be eliminated in order to reach full efficiency. Output variable slacks represent a shortage of outputs to be covered in order to achieve full efficiency. Within this paper, a DEA

[7] For more details on mathematical formulation of DEA see Charnes et al. (1978, 1994)

model with variable returns to scale, three inputs (fixed and current assets, labour) and one output (turnover) is specified[8]. The study estimates both input- and output-oriented models as they convey different types of evidence for subsequent application in scenario building.

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

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 considering inputs and outputs with different scales and units of measurement.	No	Yes
3. Identifies the "best practice" units, i.e. those which achieved full efficiency.	Yes	Yes
4. Estimates amounts of inputs resources which 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 analytical procedure to be achieved.	No	Yes
6. Provides an estimate of additional services/products which 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

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

3. EMPIRICAL RESULTS

3.1. Descriptive profile of the blue sectors

This section provides a general overview of 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 region.

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, specifically, because a share of the blue economy in regional turnover reaches 10.5% and 9.4%, respectively. In Estonia, Ida-Viru County appears as to be a blue economy which is operating well, accounting for 43.2 % of total regional turnover, though for only 37.2 % of employees and 26.4% of current assets. Nonetheless, the relative shares of blue economies in the total regional

[8] To verify stability of the results, several alternative approaches were implemented, specifically with two outcomes (turnover and profit after tax) and varying number of inputs (stepwise inclusion of resources). Major findings remain stable across the frameworks.

economies should be addressed with caution, given the issue of company registration vs. actual operation locations, discussed in Section 2.1.

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

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

Region	Inputs						Output	
	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	20600.0	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	23300.0	11.8	8589.2	5.0	30233	2.5	315000.0	9.5
Finland Proper	806.7	9.5	707.9	8.5	5423	6.1	19600.0	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 includes only companies which reported all input and output indicators in 2015. TRE stands for the total regional economy.

Table 3 presents the average (per enterprise) amounts of resources employed and 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.

Table 3. Estonian and Finnish maritime industries – inputs and outputs, average 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	45795	7696	127	41587	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	327536	111848	219	439130	69
Water transport	45686	9091	113	34529	36
Coastal tourism	1833	2312	53	8641	253
Marine construction	2494	21852	98	31851	37

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

Bio and subsea activities is 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 resources–output ratios across the blue sectors. These imbalances will be addressed in more detail in the remainder of the section.

3.2. Productivity profile of the blue sectors

The first step in our economic performance analysis concerns a productivity assessment of blue sectors applying partial productivity measures. All three productivity dimensions are assessed relative to turnover volume. Since the estimation procedure allows 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, namely, cross-sectorial and cross-regional.

First set of productivity results includes productivity measures of labour and fixed assets across both Estonian and Finnish blue sectors, measured relative to turnover. Table 4 presents our productivity ranking of blue sectors and suggests the industries with highest and lowest productivity.

Table 4. Partial productivity of labour 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 includes only companies which reported all input and output indicators in 2015.

The productivity ranking displayed in Table 4 immediately reveals strong inter-sector disparity in productivity ranks with respect to labour and fixed assets. The results suggest that the energy sector has the highest labour productivity both in Estonia and Finland. However, it shows average productivity of fixed assets in both countries. Similarly, coastal tourism, characterized by the lowest productivity of labour in both Estonia and Finland, reveals the highest productivity of fixed assets in Finland. The reason for such disparities can be twofold. Firstly, imbalance across two indicators can signal inefficiencies in utilizing certain resources, resulting in a substantial excess and low return rate per unit of labour 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 gap in labour resource is considerably smaller, taking the size of the two sectors into account. The aforementioned difference in the relative shares of resources is attributed to the nature of the sector and specific nature of business operation[9]. 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.

Hence, the productivity assessment clearly reveals its substantial limitations in the performance analysis. Partial productivity measures give only 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 single input and single output, they provide only a limited picture of actual performance. To more thoroughly assess effectiveness of resource use and extent of their use in outcome production, an analysis taking into account multiple inputs and outputs is needed.

3.3. 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 (a) within each respective country (within-country; Estonian and Finnish blue economics separately assessed and (b) across two 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 on average per industry. Our efficiency analysis relies on the application of DEA methods (see section 2.2). Along with efficiency and slack estimates, we report returns to scale for each sector.

a. Within-country assessment

As outlined in section 2.2, input- and output-oriented models are fundamentally different in their optimization objective. While the input-oriented model (IOM) sets an objective to minimize inputs but maintain current output (turnover) level, the output-oriented model (OOM) aims for maximization of output, given current resource use. Hence, the two estimation frameworks yield different optimization requirements, although relative efficiency estimates are comparable.

Table 5 presents DEA estimation results for Estonian blue sectors within the Estonian blue economy and table 6 for Finnish blue sectors within the Finnish economy (within country efficiencies).

Specifically, under both input- and output-oriented models, energy, marine transportation and marine construction sectors achieve full and strong efficiency in Estonia, since their efficiency score is 100% and all 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 both, IOM

[9] Naturally, the energy sector employs much more complex and expensive fixed assets (infrastructure, facilities, equipment) compared to the tourism sector, though much less labour, due to the high degree of automatization and computerization.

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 efficiency of the bio and subsea sector, overall inputs should be reduced by 32%[10], in both IOM and OOM frameworks of Estonia, through employing more effective technologies and more accurate resource management. Further reduction of specific resources is determined by the optimization objective. With IOM, input slacks suggest that fixed assets should be further reduced by 7% (on average 560,900 EUR per enterprise) and current assets by 37% (on average 1,468,000 EUR per enterprise) 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% (on average 1,441,000 EUR per enterprise). Unlike IOM, the objective is to maximize turnover, which can be achieved even with resources lower than currently given.

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 stand for excess of respective resource (input), number in parenthesis is a percentage of slack relative to average resource in given sector. Output slacks represent shortage of turnover (output).

To reach full efficiency in the Estonian tourism sector, the IOM DEA procedure suggests reducing overall inputs by 19% with further reduction in the fixed assets by 3% (on average 55,000 EUR per enterprise) and employment by a considerable 50% (on average 26 employees per enterprise). Turnover slack under IOM identifies that there is an output shortage of 2% (on average 55,100 EUR per enterprise); thus, to achieve full efficiency total industry turnover should be increased. To reach full efficiency through maximization of turnover, the sector should decrease overall expenses by 16% and further decrease employment by 52% (on average 27 employees per enterprise).

[10] Throughout this paper, DEA results are estimated on the average enterprise level. Therefore, relative efficiency and slacks refer to a single enterprise in the respective industry, rather than a whole industry.

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

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 stand for excess of respective resource (input), number in parenthesis is a percentage of slack relative to average resource in given sector. Output slacks represent shortage of turnover (output).

In order to increase efficiency of the maritime transportation sector, along with an overall 2% reduction in resources, fixed assets need to be reduced by 45% (on average, 20,518,100 EUR per enterprise) and employment expenditures by a huge 75% (on average 84 employees per enterprise) under an IOM framework; with an OOM approach, a further fixed assets reduction of 5% (on average 2,300,000 EUR per enterprise) and of labour expenses by 45% (on average 51 employees per enterprise) would be necessary.

b. Between-country assessment

The principal difference of the between-country framework is that the efficiency of each sector is now assessed relative to the efficiencies of all 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 those between-country reveals whether there are significant efficiency gaps across the two countries, which sectors require particular attention and could, possibly, rely on the positive experience of the neighbouring state.

Tables 7 and 8 presents Estonian and Finnish blue sectors efficiency estimates based on input- and output-oriented models. The indicators presented in these tables reveal that changing the benchmark does not alter the overall picture of sectorial efficiency, however, it changes the magnitudes of inefficiency levels. In Estonia, the bio and subsea activities and tourism sectors remained the least efficient. Importantly, when compared to both Estonian and Finnish blue sectors, efficiency of bio and subsea activities reduces further to 42%. This result suggests that operation of the bio and subsea activities sector is subject to substantial problems in Estonia, which are even more evident when the performance of the blue economy in neighbouring 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: Fixed assets (th. EUR)	Input slacks: Current assets (th. EUR)	Input slacks: Labour (employees)	Output slack: Turnover (th.EUR)	Returns to scale
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, year 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 stand for excess of respective resource (input), number in parenthesis is a percentage of slack relative to average resource in given sector. Output slacks represent shortage of turnover (output).

In Finland, the maritime transport sector is the only inefficient one, when compared to all 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 only Finnish blue sectors (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 substantial reduction of fixed assets.

The significant inefficiency of the Finnish maritime transportation case study motivated a more detailed analysis of this specific blue sector. Namely, the additional DEA estimation results, enclosed in Appendix 2, replicate the models from Tables 7 and 8, but with the Finnish marine sector disaggregated into (i) marine cargo transportation (NACE Rev.2 code 502); and (ii) marine passenger transportation (NACE Rev.2 code 501).

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, 7 and 8 is driven by cargo transportation, while passenger transportation reveals an efficiency of 100%. Moreover, in aggregate the transportation sector achieved efficiency of about 97%, thus, only 3% below the fully efficient operation. However, in the cargo transportation sub-sector, the performance level varies from 75% to 77%, depending on the background model type (see Tables A1 and A2 in Appendix 2).

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, year 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 stand for excess of respective resource (input), number in parenthesis is a percentage of slack relative to average resource in given sector.

The poor efficiency of the Finnish cargo transportation sector may be induced by various operational and management-related factors. The only clear inference provided by the DEA results is a strong indication of excessive fixed assets. Specifically, both models (IOM and OOM) suggest 7% and 9% fixed assets reduction, respectively, additional to the overall corresponding resource expenditure reduction of 25% and 23%. Hence, these additional results of our analysis support the outcome.

4. DISCUSSION AND CONCLUSIONS

The blue economy constitutes a vital part of maritime regional economies, both in Estonia and in Finland. The main objective of this paper was to provide the methodological framework for analysing economic performance of blue sectors exploring distinct features of sectoral operation in the coastal regions of Estonia and Finland.

The results suggest that three out of five blue sectors in Estonia (energy, marine construction and marine transportation) appear to be highly efficient. It implies that blue industries have an important role in the economy of a blue region, as they generate maximal efficiency through effective use of resources and achieving maximal economic output per unit of resources utilized. 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 objective, then a fixed assets 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). Thus, our overall results suggest that there is still room for improvement of economic performance and strengthening the economic role of blue industries in the coastal region without employing additional resources and increasing environmental pressures, particularly in bio and subsea activities and tourism.

In Finland, four out of five sectors are fully efficient (bio and subsea resources, energy, marine construction, tourism). Only the marine cargo transportation sector is inefficient in Finland. Fixed assets are the most excessive resource, yielding lower efficiency. 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. Reduction of excessive fixed assets through more careful resource management and more effective operational technologies will positively reflect on sectorial performance and efficiency and, crucially, 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 suggest that (i) better use of available resources (inputs) and (ii) facilitating cross-border cooperation are the potential ways for improving economic performance of blue sectors and maritime regions.

Well-developed cross-border cooperation can open up new opportunities for more efficient use of resources, particularly tangible assets, and thereby also create conditions for lessening an excess of fixed assets and environmental pressure. Cross-border cooperation is particularly relevant in the case of the imperfectly efficient sectors. Specifically, bio and subsea activities is an imperfectly efficient sector in Estonia, while being fully efficient in Finland.

Cross-border cooperation in a 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 one form of beneficial cross-border cooperation. Marine (cargo) transportation is a fully efficient and high-performing sector in Estonia, while being inefficient in Finland. Cross-border cooperation through sharing the infrastructure, as well as adopting the fixed assets and labour 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 Finnish tourism business, specifically in human resource management.

Importantly, a number of limitations of the DEA procedure and Amadeus database must be acknowledged when interpreting the results of the analysis. Along with several strong advantages (discussed in section 2.2 and summarized in Table 1) the DEA approach has some restrictions related to the technical features of the estimation procedure. Firstly, the results of DEA analysis provide evidence based only on resources and outputs included in the estimation procedure. Therefore, the estimates of slacks, i.e. suggested ways to improve economic efficiency, rely on the resources included in the analysis. Actually, this narrow approach may leave out other important factors driving economic performance and, potentially, unbalancing economic efficiency. These factors can relate to the operational features of the enterprise, financial procedures and the specific nature of sectorial research profile. Therefore, the identified resources slacks may not necessarily signal strong inefficiencies, but rather intermediate resource excess. Therefore, the results on excessive resources need to be addressed with particular caution and interpreted purely as indicative evidence.

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

Another major restriction of the research relates to the data itself. The results of the Amadeus-based analysis suggest that intensified cross-border cooperation could be one of the ways to improve performance of inefficient sectors. However, for more detailed analysis and further recommendations on effective cross-border cooperation, harmonized and detailed statistical data is needed. Non-availability of high-quality cross-border statistics restricts opportunities for cross-border cooperation, due to the difficulties in identification of threats and opportunities. Detailed and better-harmonized cross-border statistics would allow mapping of the areas for improvement and the possibilities of cross-border cooperation aiming to foster the economic development in the blue region and enhance the effort to strengthen the economic and sustainability profiles. High environmental vulnerability of the blue regions triggers the necessity to precisely identify the current state of industries and detect the interrelations to non-blue sectors and between the blue sectors across borders. Another key advantage of reliable cross-border data is that it would allow better identification of on-going cooperation and existing ties across blue sectors and thereby creating new possibilities for improving economic performance of blue sectors and regions.

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Appendix 1

Definition of the blue sectors

Industry	Sectors included (NACE Rev. 2)[11]
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

[11] For more information see: http://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF

Appendix 2

Table A1. Efficiency estimates of blue sectors in Estonia and Finland (between-country), input-oriented model

Input-oriented model (IOM)	**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	42%	0	0	0	0	Increasing
Energy	1	100%	0	0	0	0	Constant
Cargo marine transport	1	100%	0	0	0	0	Increasing
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	Increasing
Energy	1	100%	0	0	0	0	Constant
Passenger marine transportation	1	100%	0	0	0	0	Constant
Cargo marine transport	3	75%	3872.3 (7%)	0	0	0	Increasing
Tourism	1	100%	0	0	0	0	Increasing
Marine construction	1	100%	0	0	0	0	Constant

Table A2. 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	40%	0	101.6 (2%)	0	0	Increasing
Energy	1	100%	17819.1 (39%)	0	80 (63%)	0	Constant
Cargo marine transport	1	100%	1035.6 (64%)	29.9 (5%)	0	0	Increasing
Tourism	2	77%	1174.7 (57%)	0	22 (43%)	220.0 (6%)	Increasing
Marine construction	1	100%	0	0	0	0	Constant
Finland							
Bio and subsea activities	1	100%	0	335.8 (25%)	0	0	Increasing
Energy	1	100%	0	0	0	0	Constant
Passenger marine transportation	1	100%	0	0	0	0	Constant
Cargo marine transport	3	77%	6273.0 (9%)	0	14 (9%)	0	Increasing
Tourism	1	100%	0	0	0	0	Increasing
Marine construction	1	100%	0	0	0	0	Constant

Source: Amadeus data, year 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 stand for excess of respective resource (input), number in parenthesis is a percentage of slack relative to average resource in given sector.

KOKKUVÕTE

Merendussektorite majandustegevuse analüüs Eesti ja Soome näitel

Töö eesmärgiks on hinnata majandustegevuse efektiivsust ja tootlikkust merendusega seotud sektorites Eesti ja Soome mereäärsetes piirkondades selgitamaks võimalusi piiriülese koostöö arendamiseks. Analüüsi läbiviimisel on kasutatud Amadeus andmebaasis toodud mikroandmeid ettevõtete käibe, tööjõukulude ning põhi- ja käibevara kohta. Analüüsimeetodina on rakendatud lineaarse programmeerimise andmepiirangu (ka andmeraja) analüüsi ehk DEA meetodit (DEA- *Data Envelopment Analysis).* Uurimistöö tulemustest nähtub, et Eesti mereäärsete piirkondade energeetika, ehituse ja transpordisektorid toimivad efektiivselt. Biomajanduse ja turismiga seonduvate sektorite puhul on Eesti mereäärsetes regioonides veel reserve ressursitootlikkuse parendamiseks ning tehtud investeeringute efektiivsemaks kasutamiseks. Soomes on madalaim ressursitootlikkus merekaubavedudega tegelevas sektoris, kus olemasolev põhivara ei ole leidnud veel täielikku kasutamist. Piiriülese koostöö tugevdamine annab täiendavaid võimalusi, et olemasolevaid ressursse ja eelkõige just põhivarase tehtud investeeringute kasutamist tõhustada, aga ka mõlema riigi paremaid äri – ja juhtimiskogemusi jagades luua häid tingimusi majandustegevuse efektiivsuse tõstmiseks. Eestis on eriti oluline arendada piiriülest koostööd just turisminduse vallas, et tõsta turismisektori töötajate tootlikkust just mereäärsetes piirkondades. Uurimistöö tulemusena selgusid ka mitmed vajakajäämised statistikasüsteemides, mis ei võimalda alati kasutada piisavalt usaldusväärseid ja täpseid andmeid mereäärsete piirkondade majandustegevuse analüüsimiseks ja piiriülese koostöö arendamiseks.