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Final Report

“Assessment of the role of marine industries in the region”

(Deliverable T.1.8.1)

2019

PLAN4BLUE

SYKE.FI/PROJECTS/PLAN4BLUE

ABSTRACT

Title: Deliverable T.1.8.1. "Assessment of the role of marine industries in the region"

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Abstract: The general aim of this study is to provide additional background information for the elaboration of blue regions' development scenarios relying on the analysis of economic performance of blue sectors in selected coastal regions of Estonia and Finland. Analysis bases on the on the OECD Input-Output data and enterprises' database Amadeus. The study focuses on the analysis of economic performance of blue sectors in coastal regions looking also for the answer of how blue economy related industries are connected to the national economies. The results of the study show that on average blue sectors report high performance indicators in coastal regions under investigation. The common pattern of non-perfectly efficient blue sectors in both countries is the excess of fixed assets, which convey extra costs for business activities and to some extent generate excessive environmental pressures. Potential ways to improve economic performance of blue sectors is to facilitate efficient cross-border cooperation. Particularly, cross-border cooperation benefits inefficient sectors, when sharing "good practice" and developing joint infrastructure can strengthen performance of the sectors in both countries. To support these activities the improvement of the system of cross-border statistics is necessary.

Key words: marine industries, blue economy, economic performance analysis, Input-Output tables (IOT) analysis, cross-border cooperation.

Acknowledgements

The authors is/authors are thankful for INTERREG Central Baltic programme for co-funding the Plan4Blue project. They are also extremely thankful to the project team members for their valuable comments and support during all project activities including also several effective project meetings and seminars.

The document should be sited as follows:

Paas, T., Tverdostup, M. Ashyrov, G. (2019). *Assessment of the role of marine industries in the region*. Plan4Blue, Final Report (Deliverable T.1.8.1)

EXECUTIVE SUMMARY

"*Assessment of the role of marine industries in the region*"

The general aim of the study is to provide additional background information for the elaboration of the blue regions' development scenarios relying on the analysis of economic performance of blue sectors in maritime regions of Estonia and Finland. The elaboration of background information relies on the conceptual framework of the Blue Growth Scenarios development procedures (see Pöntynen & Erkkilä-Välimäki, 2018) that brings out three main ways for the elaborating Blue Growth Scenarios: probable, possible and preferred.

The empirical analysis bases on the OECD Input-Output data (IOT – Input-Output Tables) and the enterprises' database Amadeus. The results of IOT based analysis show that blue economy related industries play a remarkable role in maritime regions and to a large extent drive economic success of regional and national economies in generating new growth and employment in Estonia and Finland[1].

The results of Finnish and Estonian blue sectors' economic performance analysis (productivity, efficiency and sensitivity analysis) based on the Amadeus database show that major indicators of economic success of blue sectors are: (i) on average higher labour and current assets productivity of blue sectors, relative to non-blue; (ii) generally high efficiency of blue sectors, suggesting that resources are on average effectively utilized and produce maximal economic returns.

Main results of the Finnish and Estonian blue sectors' economic performance analysis (productivity, efficiency and sensitivity analysis) based on Amadeus database including also proposals for the improvement of sectors' development patterns in Finnish and Estonian maritime regions are summarised in the Appendices 4 and 5 of this Report[2]. The results are in line with the main conclusions presented in the Deliverable D.T.1.6.1. (see de Andres Gonzalez et al., 2018) which base on the ORBIS database' analysis showing that employment and turnover growth trends are rather un-stable and non-linear. This outcome once again confirm that it is impossible to make long-run predictions and elaborate scenarios relying only on statistical information. The combination of quantitative and qualitative approaches is unavoidable by the elaboration of Blue Growth Scenarios.

The best performing blue sectors are energy, water (cargo) transportation and marine construction in Estonia, while in Finland, the "best practice" industries are bio & subsea activities, energy, tourism, marine (passenger) transportation and marine construction. These sectors

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[1] The results of the OECD Input-Output Tables based analysis are published as the Working Paper of the School of Economics and Business Administration (SEBA) University of Tartu; see https://majandus.ut.ee/sites/default/files/mtk/dokumendid/febawb109.pdf

This Publication can be cited as follows: Ashyrov, G., Paas, T., Tverdostup M. The Input-Output Analysis of Blue Industries: Comparative study of Estonia[1] and Finland. *Working Papers of the School of Economics and Business Administration*, N0 109, University of Tartu, 2018, 25 p.

[2] The results of the Amadeus data based analysis are published as the Working Paper of the School of Economics and Business Administration (SEBA) University of Tartu; https://majandus.ut.ee/sites/default/files/mtk/dokumendid/febawb115.pdf

This Publication can be cited as follows: Tverdostup M., Paas, T. Economic Performance Analysis of Selected Blue Economy Sectors in Estonia and Finland, *Working Papers of the School of Economics and Business Administration*, N0 115, University of Tartu, 2019, 24 p.

are characterised by complete efficiency and relatively high labour productivity and they are playing a crucial role in socio-economic development of maritime regions.

Some blue sectors require certain improvements to increase their role in development of maritime regions in Estonia and Finland. The results of analysis of blue sectors' economic activities allow us to bring out the common pattern in economic performance of not-perfectly efficient blue sectors in both countries: there is an excess of fixed assets, which conveys extra costs for business activities, lower efficiency and, to some extent generate excessive environmental pressures. Consequently, there is still space for the improvement of economic performance and strengthening the role of blue sectors in maritime region's development without employing additional resources and increasing environmental pressures, particularly in bio & subsea activities and tourism in Estonia and marine (cargo) transportation in Finland. Possibilities for the implementation of both production expansion and cost reduction strategies are quantitatively analysed in this study (see part 4).

Of course, one should consider, that economic performance analysis rely on the available statistical data (Amadeus database, IOT) which has certain limitations (see part 2.2). There are problems with the classification and aggregation of industries, sectors and economic activities as well as with the bringing out whether these activities take place in maritime regions or in the places where firms are officially registered. But in general, despite of these limitations, it is possible to conclude that there is good potential for the improving blue sectors' economic performance relying on the new challenges offered by the cross-border cooperation. Thus, the main "data driven" results can be summarised as follows

(i) The common pattern of non-perfectly efficient blue sectors in both countries is the excess of fixed assets, which convey extra costs for business activities and to some extent generate excessive environmental pressures.

(ii) Potential ways for the improving economic performance of blue sectors and regions are facilitating cross-border cooperation that can open new possibilities for more efficient use of resources, particularly tangible assets, and thereby create conditions for declining excess of fixed assets and environmental pressure. Cross-border cooperation also benefits inefficient sectors, when sharing "good practice" and developing joint infrastructure. That can strengthen economic performance of the sectors in both countries.

(iii) The system of cross-border statistics should be remarkable improved considering also the needs of spatial planners and local authorities of border countries. Cross-border activities cannot be correctly traced relying only on available statistical information; the generalisation level of present statistical information is often too high.

Some main challenges and proposals for the development of cross-border statistics are as follows: (i) Harmonization of registry data. The national-level data sources including administrative registry data are substantially different across EU countries, due to different reporting procedures, metric systems, content of specific indicators; there is no harmonized registry data available; (ii) Development of cross-country unified data collection and processing procedures; (iii) Improvement of disaggregation of data in terms of NUTS regions and their enterprise-level financial indicators; (iv) Recording cross-border operations and financial flows.

The identified limitations of statistical information and elaborated proposals for its development can be considered as the necessary side product of our economic analysis.

CONTENTS

1. INTRODUCTION

1.1. Aim and main tasks of the report

The general aim of this study is to evaluate a role of blue industries in the economy of some selected maritime regions of Estonia and Finland to provide additional information for the elaboration of the coastal regions' (blue regions) development scenarios (Blue Growth Scenarios). The deliverable provides general overview of how blue economy industries are connected to the national economies (on Input-Output tables (IOT) based analysis). Another key product of this deliverable are productivity, efficiency and sensitivity profiles of each blue sector in Estonia's and Finland's coastal areas, which describe and analyse economic performance of blue regions and sectors. The role of blue sectors in coastal areas is assessed through their relative weight in regional economy and contribution into overall performance of a regional economy. The latter is evaluated from a perspective of employed resources and produced outputs. More specifically, we conduct empirical exercises to assess the role of blue sectors in the regions, putting emphasis on effectiveness and efficiency of their operation. Furthermore, we analyse how they reflect on the overall performance of regional economy. The most relevant determinants of blue sectors' development are derived based on the analysis of current economic performance and on exploring potential ways to improve economic performance of blue regions.

The report focuses on several tasks, framing the overall aim of the deliverable, namely:

- Evaluating the relative share of blue economy in Estonian and Finnish blue region economies.
- Assessing the productivity and efficiency profile of blue sectors and blue sub-regions.
- Evaluating input-output sensitivity of blue economy and identifying key factors of blue sectors' growth and financial success.

Throughout the report, we will refer to a number of terms, referring to the sectors and region of our analysis, namely:

1) Blue/ maritime/ coastal sectors or industries identify economic sectors related to the sea activities, which will be precisely defined in section 2.2.1.
2) Blue/ maritime/ coastal economy is a union of all sectors related to the sea activities, e.g. defined in the previous point.
3) Blue/ maritime/ coastal region or area stands for the region of our analysis, which will be explained in more detail in section 2.2.2.
4) Overall blue/ maritime/ coastal regional economy includes all the sectors, related or not to the sea activities, which operate in the blue/ maritime/ coastal region.
5) Overall national economy refers to all sectors, related and not related to the sea activities, in all the country of analysis (either Estonia or Finland).

1.2. Research structure

Analysis of economic role of marine industries comprises analysis based on OECD Input-Output (I-O) tables describing inter-industrial linkages within a national economy, as well as on the Amadeus database that provides information on enterprises' economic performance.

On I-O tables (IOT) based Input-Output analysis evaluates linkages of blue economy with other sectors of national economy, irrespective of blue region. This part of study employs OECD input–output (I–O) analysis to investigate possible impact of the blue industries in the national economy of Estonia and Finland for the period 1995–2011. The OECD database comprise information on 34 sectors of a national economy. We specifically focus to eight sectors which are highly related to blue industries amongst these 34 sectors considering sectors and classifications of the Amadeus database:

- C01T05: Agriculture, hunting, forestry and fishing
- C10T14: Mining and quarrying
- C23: Coke, refined petroleum products and nuclear fuel
- C34: Motor vehicles, trailers and semi-trailers
- C35: Other transport equipment
- C45: Construction
- C55: Hotels and restaurants
- C60T63: Transport and storage

The essence and limitations of I-O data are presented in the part 2 (sub-chapter 2.1) and introduction to the I-O tables based methodology is the part 3 (sub-chapter 3.1).

Relying on the Amadeus database consisting of information on enterprises economic performance (see sub-chapter 2.2) we explain a research sequence for assessment of economic role of blue economy sectors. The research methodology includes the methods for productivity, efficiency and sensitivity analysis of blue economy is introduced in the sub-chapters 3.2, 3.3 and 3.4.

First, we evaluate individual productivity of major resources across all blue sectors in Estonia and Finland. Definitions of blue sectors are presented in the Table 2.1. Productivity is defined as a ratio of unit, or in our case company or sector, output (outcome) and input (resources). Thus, productivity is defined as a share of total output associated with one unit of resources used. These measures are estimated for each company (sector) independently, irrespective other companies' (sectors') indicators.

Second, we will in detail assess efficiency of blue sectors' operation applying Data Envelopment Analysis (DEA) methodology. Following DEA approach, efficiency is measured relative to benchmark, as a company's (sector's) productivity relative to productivity of other companies (sectors). Therefore, hereinafter efficiency will be referred to as overall productivity of a unit of interest (sector), taking into account a set of inputs and outputs, relative to benchmark (other sectors') overall productivity.

Both productivity and efficiency analyses tackle effectiveness of performance taking into account resources used in operation cycle and outcomes achieved. However, the fundamental difference in two approaches is in their scope. While partial productivity estimates incorporate single input and output, efficiency evaluation procedure manage multiple resources and outcomes. Furthermore, productivity measures do not account for other sectors' performance (no benchmark), whereas efficiency measure makes a reference to a benchmark. Despite interpretational differences, productivity and efficiency measures complement each other by exploit the same set of inputs and outputs of interest. Both analytical approaches explore current performance of blue sectors, identify problematic and successful in terms of efficiency industries and look separately into actual productivity of each resource.

Additionally, the third section of our analysis tackles input-output sensitivity analysis. While two previous sections looked at resource productivity and sectorial efficiency per se, sensitivity analysis answers what is an effect of one unit change in resources on output. Thus, sensitivity analysis quantifies actual effect of resources on outputs. Applying regression analysis allows to further test for statistical significance of individual input effect on output and thus to evaluate factors most relevant and important for further blue industry development.

Figure 1.1 presents structure of the Amadeus database based economic performance analysis and expected research outcome. It introduces in a detail the research sequence, as well as specific research questions, methods and applicability of findings presented in the next parts of the study.

Thus, we will first present productivity and resource intensity analysis of Estonian and Finnish blue sectors, followed by in depth efficiency estimation and sensitivity analysis across blue sectors. The latter will be compared to identical measures across non-blue sectors and non-blue regions for comparison.

Preliminary empirical results of our study are presented in the part 4, which consists of two subparts.

In the subpart 4.1, we present the results of analysis that relies on the OECD Input-Output Tables (IOT) and explores backward and forward linkages of industries that are in some way related to blue economies (e.g agriculture, hunting, forestry and fishing; mining and quarrying; coke, refined petroleum products and nuclear fuel; motor vehicles, trailers and semi-trailers; other transport equipment; construction; hotels and restaurants; transport and storage; see also 1.2). Backward linkages indicate the importance of certain industry to whole national economy in terms of inducing production effects. For instance, if blue sectors have higher backward linkages comparing to non-blue, it is possible to conclude that expansion of blue industry production is beneficial to the whole economy in terms of stimulating productive activities. And opposite, if a blue industry has higher forward linkages than non-blue, it would imply that its production is more sensitive to fluctuations of national economy and its industries. Identifying these linkages enables policy makers to better analyse how sensitive is development of whole economy to changes in certain industries. The results of analysis provide background information for Blue Growth Scenario building.

The subpart 4.2 relies on enterprise data provided by the Amadeus database. It focuses on the analysis of economic performance of blue regions and sectors comparing productivity and efficiency of blue sectors with non-blue and discovering possibilities for better use of available results (labour, assets). Sensitivity analysis brings out how development plans (e.g. growth of production and/or profit growth) can affect inputs' (labour, assets) demand. And opposite, if there are necessities for limitation of resources (e.g., shortage of labour; decrease of fixed assets to diminish environmental pressure), possible changes in proposed outputs (growth) will be quantified. Thus, this part of study provides additional information for joint analysis of environmental, social and economic aspects of coastal regions' development as well as for scenario building and spatial planning.

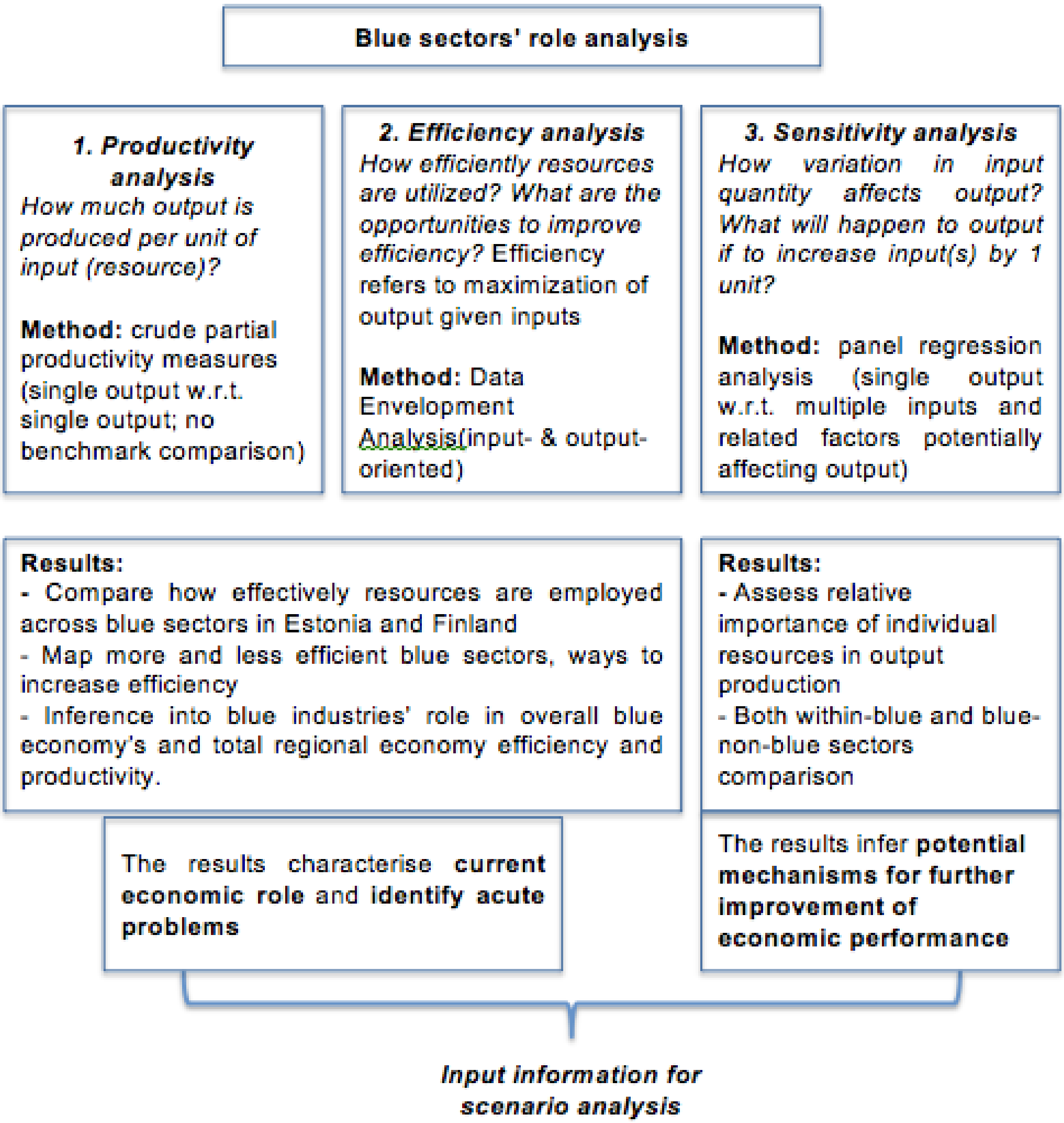

Figure 1.1. Structure of the deliverable and research outcomes.

In the part 5 we present the results of sector-specific economic profiles of the main blue sectors in Estonia (sub-part 5.1) and Finland (sub-part 5.2). Relying on the results of economic performance analysis of sectors and regions (part 4) as well on some experts' opinions, the following economic activities are chosen for the sector-specific analysis: bio & subsea, energy, marine cargo transportation, blue tourism and marine construction. In the case of Finland separately also marine passenger transportation profiles are elaborated.

Part 6 presents discussions and conclusions focusing on the outlooks of blue sectors developments and challenges for improvement of statistical information that can generate additional support for cross-border cooperation.

2. DATA

2.1. Overview of Input-Output (I-O) tables (OECD) and their limitations

We exploit Input-output tables from OECD input–output (I–O) database for purpose of investigating the impact of the blue industries in the national economy of Estonia and Finland for the period 1995–2011. The OECD database comprise information on 34 sectors of a national economy. OECD database gather statistics related I-O tables (IOT) from each member countries.

IO tables can be defined either as product to product (product outputs) or industry to industry tables (industry outputs). Our main data source, OECD Input-Output Tables (IOT) database, uses industry to industry approach. This approach has own advantages, since it enables for higher integration with pools of statistics collected according to industrial activity such as R&D expenditure, employment, foreign direct investment and energy consumption. Furthermore, this database is a very beneficial in order to make empirical analysis for economic researches, structural analysis, and to examine economic impacts of sectors at the international level since it emphasises inter-industrial relationships consisting all sectors of the economy[3].

There could be another possibility to exploit Input-Output tables of Estonia and Finland by obtaining from respective statistics offices. However, the IO table approach differs across countries, since Finnish IO table takes industry to industry approach, while Estonian IO table takes product to product approach. In order to avoid these data obstacles, we rely on the OECD IOT database which provides homogenous industry to industry approach for both countries. Thus, the OECD IOT database that are used for analysis are identical in terms of data structure and data collection process. Therefore, analysis and results are more comparable between two neighbouring countries. Also, for extended analysis, it is also possible to include other countries for investigating the role of blue sectors between different countries.

While using the OECD IOT database, there are also some shortcomings. Although it provides homogenous statistical data for both countries, it lacks detailed statistics and details about sectors. Number of sectors are relatively limited, compared to IO tables which have been provided by national statistics offices of Estonia and Finland. Moreover, IOT database has been gathered until 2011. Compared to IO tables which have been provided by national statistics offices of Estonia and Finland and are rather outdated.

2.2. Overview of Amadeus database and its shortcomings

The major source of data for analysis economic performance of blue sectors' enterprises is Amadeus database, developed by Bureau Van Dijk[4]. Amadeus database comprises information on more than 21 million of enterprises from 44 countries, which is collected from more than 35 expert and local information providers. The database is regularly updated and allows to track company's record up to 10 years back.

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[3] For more information see: http://www.oecd.org/trade/input-outputtables.htm

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

Amadeus data covers all publicly and privately-owned enterprises and provides a set of company-level indicators, which are crucial for our analysis. Namely, the database incorporates the following information:

- standard financial items, which include balance sheet entries, profit and loss account entries and a number of standard ratios;
- general descriptive information, such as enterprises title, address, contact information, CEO name, legal form, year of incorporation, trade description and NACE Rev. 2 activity codes, number of employees, etc.;
- overview section, which encloses textual overview of main activities, counties of operation, description of main products and services;
- ownership information;
- other items related to enterprise's operation and performance.

The ultimate advantage of Amadeus database is complete comparability of data entries across all countries, including Estonia and Finland. Unlike national data sources (registry data, national survey information), Amadeus database ensures that measuring, reporting and data release procedures are the same for all countries, which allows to safely conduct cross-country comparison. Recent research by 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.

Database has also some limitations and shortcomings. Companies' location implies a registration address of an enterprise. However, an address of company's location may differ from a place where company is actually operating. In our case, this issue affect identified companies to lower extend, since it is rather likely that blue enterprises registered in blue region are also running business in the same blue area. However, the issue may result in omission of blue companies, which are registered elsewhere, but operate in blue region. It may lead to underestimation of true number of blue firms presented in project area.

2.2.1. Definition of blue economy

We define blue economy as a separate part within national economy, which is directly involved in on- and offshore economic activities in the Gulf of Finland. Economic analysis specifically focuses on five blue sectors (industries): bio & subsea activities, energy, water transportation, blue tourism, marine construction. Similar blue sectors were defined within "Study on Blue Growth, Maritime Policy and the EU Strategy for the Baltic Sea Region", conducted by Europen Comission in 2013. We identify blue industries following the statistical classification of economic activities in the European Community (NACE Rev. 2)[5], developed by Eurostat (Table 2.1).

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

Table 2.1. Definition of blue industries

Industry	Sectors included (NACE Rev. 2)
Bio & subsea activities	0311 - Marine fishing, 0321 - Marine aquaculture
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
Water transportation	501 - Sea and coastal passenger water transport, 502 - Sea and coastal freight water transport
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
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

While the major focus of the deliverable is on blue industries, we consider a number of other sectors operating in the blue region as benchmark. To assess a role of blue economy in a region, indicators of blue sectors will be compared to respective measures of non-blue industries, defined following NACE Rev. 2 broad structure:

1. Agriculture, forestry and fishing (NACE Rev. 2 codes 100-399)
2. Mining and quarrying (NACE Rev. 2 codes 500-999)
3. Manufacturing (NACE Rev. 2 codes 1000-3399)
4. Electricity, gas, steam and air conditioning supply (NACE Rev. 2 codes 3500-3599)
5. Water supply; sewerage, waste management and remediation activities (NACE Rev. 2 codes 3600-3999)
6. Construction (NACE Rev. 2 codes 4100-4399)
7. Wholesale and retail trade; repair of motor vehicles and motorcycles (NACE Rev. 2 codes 4500-4799)
8. Transportation and storage (NACE Rev. 2 codes 4900-5399)
9. Accommodation and food service activities (NACE Rev. 2 codes 5500-5699)
10. Information and communication (NACE Rev. 2 codes 5800-6399)
11. Financial and insurance activities (NACE Rev. 2 codes 6400-6699)
12. Other business services (NACE Rev. 2 Codes 6800-8299)
13. Public services (NACE Rev. 2 codes 8400-8599)
14. Healthcare (NACE Rev. 2 codes 8600-8899)
15. Arts and art related activities (NACE Rev. 2 codes 9000-9399)
16. Other activities (NACE Rev. 2 codes 9400-9999).

2.2.2. Definition of blue region

Study area covers a coastal area of Finnish bay in Estonia and Finland. Unlike environmental analysis conducted within Work Package 2 of the project, economic analysis will define a coastal area in broad terms. Namely, we focus on entire counties (NUTS 3 level regional units), which have a direct access to Finnish bay from both Estonia and Finland.

Thus, blue region includes:

- Estonia: Harju county, Ida-Viru and Lääne-Viru counties.
- Finland: Kymenlaakso, Uusimaa and Finland Proper counties.

For identification of counties were companies are located, we used a *region* variable available in Amadeus dataset.

2.2.3. Research sample and key indicators of interest (inputs and outputs)

Identification of a research sample requires imposing criteria on individual observations (companies) and decision on time frame for analysis. Our research sample includes all companies within five blue sectors, registered in blue region and satisfying the following criteria:

1) number of employees is more than one;
2) turnover in the last year exceeded 1000 EUR;
3) all input and output indicators of interest are available (no missing data).

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 blue economy. Therefore, a major part of our analysis will rely on 2015 data merely, while sensitivity assessment will use a panel data from 2010-2015 for validity reason. Table 2.2 summarises data used for economic performance analysis of blue economy industries.

Table 2.2. Data used for economic performance analysis

Research task	Data source
Productivity analysis	Amadeus general and financial data for all maritime firms operating in blue region from 2015.
Efficiency analysis	Amadeus general and financial data for all maritime firms operating in blue region from 2015.
Sensitivity analysis	Panel data for years 2010-2015, created based on Amadeus general and financial yearly data for all maritime firms operating in blue region.

Throughout the report, we will focus on two input variables and three output measures available in Amadeus database. In order to keep all parts of analysis interrelated and conjunct, they all will address the same measures of inputs and outputs' variables.

The analysis will focus on two major economic outcomes: yearly turnover and profit after tax. Both measures are important and interrelated indicators of performance, however, they possess several fundamental differences.

- Turnover is generated through enterprise's operation as a revenue from all goods (services) sold, plus revenue received from support, maintenance, after-sale services. Importantly, turnover includes revenues received from secondary activities, which are not under a scope of firm's major operation. When applied to entire industry, turnover captures all revenues from all firms in the sector, regardless if the revenue originates from the main, secondary or support activities.
- Profit after tax is a derivative of turnover and is measured as all revenues minus all expenses incurred by the enterprise: costs related to major activity (raw materials,

machinery and equipment, employee costs etc.), rent and utility costs, taxes and other costs.

For profound estimation both turnover and profit should be analysed, as they convey different type of information. Turnover indicates company's (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; however, it does not necessarily yield financial success. Profit, on its turn, informs about enterprise's (sector's) actual financial performance and business success. Growing profit is an evidence of successful, cost-efficient business operation.

Following the overall framework of the deliverable, we focus on three major input factors: fixed asset, current assets and employees, defined as follows:

- Fixed assets – long-term tangible and intangible assets owned by the firm and used in the operation process for more than one year. Following the Amadeus data structure, total fixed assets incorporate three major components:
  1) tangible assets – any real estate, land, machinery, vehicles, equipment, material tools owned by a company and used in the operation process;
  2) intangible assets – trademarks, copyrights, patterns, goodwill owned by a firm and used in operation.
  3) other fixed assets – unusual items, that cannot be classified in one of the previous asset categories. For instance,
  4) deferred charges (long-term prepaid expenses), non-current receivables.
- Current assets – assets, which can be converted into cash, used or consumed within a year. Current assets incorporate the following components: cash and cash equivalence, short-term investments, accounts and notes receivable, inventories, which are in disposal for usage or sale, etc.
- Number of employees – approximate labour expenses of the company.

Given a special emphasis of the project on sustainable blue growth, sensitivity analysis will primary focus on fixed assets, and more specifically on tangible fixed assets, as they directly approximate: (i) actual extent of blue area penetration (through such fixed assets as land, real estate and production facilities); (ii) means of operation and usage of on- and offshore area (through machinery, vehicles, tools and equipment, etc.).

3. METHODOLOGY

3.1. Input-Output Tables (IOT) analysis

Evaluation of inter-sectoral linkages has been conducted by using a classical representation of I-O models of the national economy. For purpose of calculating the power of relationship among industries, the linkage effect analysis has been performed. It relies in the assumption-that the economy in linked industries can be enhanced through linking input and output activities (Hirschman, 1958). Typically, the linkage effect can be divided into the two effects which are backward linkage effect and the forward linkage effect. Similar methodology has been also applied in some marine industry related studies. One earlier research is done by Van der Linden (2001) about the economic effect of maritime policy issues and investigated a basic macroeconomic framework for the 1997 shipping industry as an international industry. Later, Kwak et al. (2005) analyse the role of the maritime industry in the Korean economy, Morrissey and O'Donoghue, (2013) investigate the role of the marine sector in the Irish national economy by using IO tables and backward-forward linkage measures.

Backward and forward linkages are useful instruments for proposing policy implications. By calculating backward linkages, we can indicate importance of the specific industry to the economy in terms of inducing production effects. For example, if blue industry has higher backward linkages than non-blue industries, it would mean that expansion of blue industry production is more beneficial to the whole economy in terms of stimulating productive activities. In terms of policy implications of forward linkages, if blue industry has higher forward linkages than non-blue industries, it would imply that its production is comparatively more sensitive to variations in other industries' production activities. Furthermore, calculating these two linkage effects enable policy makers to a quantitative analysis of the blue economy's structural relationship with other non-blue economies. Consequently, investment decision can be made based on the importance of the sectors within economy (Morrissey and O'Donoghue, 2013).

The general equation of the I-O models can be depicted as follows.

Demand-driven model:

$$X_i = \sum_{j=1}^{n} X_{ij} + D_i = \sum_{j=1}^{n} a_{ij} X_j + D_i \qquad (1)$$

Suppy-driven model:

$$X_j = \sum_{j=1}^{n} X_{ij} + V_j = \sum_{j=1}^{n} k_{ij} X_i + V_j \qquad (2)$$

where X_i represents the sum of gross outputs in sector i =1,…,n; a_{ij} are defined as direct input coefficients which divide X_{ij} the transaction flows between producing sector i and supply sector j by X_j the sum of gross outputs in sector j ; k_{ij} denotes direct output coefficients which divide X_{ij} the transaction flows between producing sector i and supply sector j by X_i the sum of gross inputs in sector i; and D_i symbolises the part of gross output in sector i sold to the final demand, and V_j represents the final value added by sector j . Hence, Eq. (1) depicts the demand-driven model as viewing I–O tables vertically, while Eq. (2) articulates the supply-driven model as horizontally (Kawk et al., 2005).

We can also indicate demand driven model in a matrix form:

$$X = (I - A)^{-1} D \quad (3)$$

here I represent the $n \times n$ unit matrix and $(I - A)^{-1}$ is known as the Leontief inverse matrix and denotes the total direct and indirect outputs in sector i per unit of final demand in sector j (Pérez-Labajos, 2001). A is a matrix of input coefficients defined as;

$$A = \left[a_{ij} = \frac{z_{ij}}{x_j}\right] = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix} \quad (4)$$

Nevertheless, the standard demand-driven model cannot accurately measure the impacts of new production activity in each blue industry on all other industries of the economy because changes in the final demand come about as an effect of forces outside the model such as changes in consumer tastes and government purchases. For this purpose, the individual blue industry has to be handled as exogenous and put into the final demand group (Morrissey and O'Donoghue, 2013; Cai, and Leung, 2004). Therefore, we could refer to this approach as the blue (maritime) sector-based I–O analysis.

Based on this I-O model, the backward linkage from one unit of output change in the blue industry i can be calculated by;

$$\Delta x_j = (I - A_{jj})^{-1} A_{ji} \quad (5)$$

The marine sectors, i Leontief supply driven(LSD_i) multiplier is given by;

$$LSD_i = 1 + e'(I - A_{jj})^{-1} A_{ji} \ldots . (6)$$

where 1 denotes the initial unit output change in the blue industry i and e is the summation vector employed to aggregate the elements in Δx_j, which is the impacts of this initial output change on the rest of the economy through blue industries i's backward linkages (Morrissey and O'Donoghue, 2013). To make linkage comparison among the industries easier, we calculated a backward linkage index by using the following formulae (Pérez-Labajos, 2001):

$$BL_j^* = \frac{LSD_i}{(1/n) * \sum_{j=1}^{n} LSD_j} \quad (7)$$

Where n is the number of industries within the I-O table.

In order to calculate forward linkages, the use of Leontief row sums are controversial since Leontief forward linkage calculations are based on the strength of backward linkages (Cai, Leung, Pan and Pooley, 2005). Thereof, the forward oriented Goshian model, in spite of own caveats (Cai, Leung, and Mak 2006), it is widely used alternative (Cai, Leung, Pan and Pooley, 2005; Cai, Leung, and Mak 2006; Kawk et al., 2005).

Using the similar derivation as we did for calculation of backward linkages, we can calculate the impact of one unit output change in the blue industry on the output of other industries as:

$$\Delta x_j = (I - B_{jj})^{-1} B_{ji} \quad (8)$$

Consequently, we can present Goshian supply driven (GSD) multiplier (Morrissey and O'Donoghue, 2013):

$$\mathrm{GSD_i} = 1 + \mathrm{B_{ji}}(\mathrm{I} - \mathrm{B_{jj}})^{-1}\mathrm{e} \ \ldots (9)$$

Forward linkage index:

$$\mathrm{FL_j^*} = \frac{\mathrm{GSD_j}}{(1/\mathrm{n}) * \sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{GSD_i}} \qquad (10)$$

Forward linkages and backward linkages are also called power of dispersion and sensitivity of dispersion, respectively. If these two effects' values are greater than one, these industries have crucial function in economic development in maintaining other industries (forward linkage effect) as well as increasing other industries (backward linkage effect) (Lin, and Chang, 1997).

On one hand, from the blue industry perspective, the backward linkage effect demonstrates that production activities of the individual blue industry may induce greater use of other sectors as an input for blue industry production. On the other hand, the forward linkage effect indicates that blue industry production may be used as an input to other industries for their own production (Pietroforte, and Bon, 1995; Yoo, and Yang, 1999). The high amount of intermediate inputs means the nature of marine sector involving the assembly of many different products purchased from a large number of industries. Forward and backward linkage effects are suitable in evaluating the effect of the blue industries on the national economy as a whole (Kawk et al., 2005).

Further to proceeding an examination of inter-sectoral linkages within an economy, IO analysis also allows to measure entire the repercussions created by an increase in demand in a sector or group of sectors, which might not, supposedly, appear related with it (Pérez-Labajos, 2001). Therefore, we have calculated multipliers such as output, employment multipliers. We estimated output and employment multipliers, based on I– O tables, that these multipliers reflect the effects of changes in a activity's output or employment upon all other activities throughout the economy.

The effects of a variation in final demand, for example variations in Consumption, Investment, Government Expenditure or Export, are estimated through theses multipliers (Aroca, 2001). These multipliers will provide policymakers, in addition to backward and forward linkage results, more clear results for considering production stimulating policies and employment creation processes regarding blue economies.

While we were calculating output multipliers, it is possible to analyses whether there is an external increase in final demand or not. We distinct into two system multipliers: The open system multipliers do not consider the probability that when there is an exogenous increase in final demand, the employees will receive more money that they spend in the country. Another system multiplier is that closed system multipliers take into account a possibility that whole additional wage is being spend in the country (Aroca, 2001).

According to Isard et al. (1998), many researches doubt output multipliers are not very informative and beneficial since they add up output over all sectors in the economy; it implies output multipliers provide the same value to all sectors. Furthermore, employment impacts linked with output in the different sectors as well as income multipliers are remarkable measure of economic importance of sectors. Employment creating impacts of sectoral expansions are often main concerns for policymakers. Thus, for purpose of proposing policy implications, we will take into account results of these multipliers. Indeed, the marine sector is especially assumed to be high employment advantages to local and coastal areas. (Ó Donnchadha, Callaghan, Niland, 2000; Collier, 2001). The Type I and II Employment Multipliers are calculated since they deliver a clear insight of the effect of the blue sector on employment than measuring the effect of a euro spent in final demand on employment. These multipliers estimate the effect using the number of working employees for the sector. It implies that the employment multiplier expresses us how many number of jobs there will be created in the entire market, assuming for every job created in a specific sector. (Aroca, 2001).

As Miller and Blair (2009) noted that it is generally accepted that Type I multipliers possibly underestimate economic effects (because household activity is non-existent) and Type II multipliers possibly provide an overestimate (due to the rigid assumptions about wages and attendant consumer expenditure). For instance, Oosterhaven, Piek and Stelder (1986) suggest: "These two multipliers [Type II and Type I] may be considered as upper and lower bounds on the true indirect effect of an increase in final demand; a realistic estimate generally lies roughly halfway between the Type I and Type II multipliers."

By evaluating all these multipliers produced in the Input-output analysis section, it allows us to obtain a well-defined representation of the strength of the inter-industry relations among industries. It also enables us to analyse how important of these relations impacted the Estonian and Finnish economy between 1995-2011 in context of output produced, employment enhanced. Furthermore, for increasing competitiveness of these blue industries with other non-blue industries, it is possible to take into account these multipliers as an instrument. Therefore, policymakers will able to create industry-specific policies for further developments in the blue industry.

3.2. Productivity analysis

The first dimension of economic role analysis is productivity assessment of blue industries. We analyse productivity relying on a simple partial productivity measures. The latter is estimated a simple ratio of one output to one input. Due to specifications of our data, we are restricted in productivity measure choice. Namely, to apply more complex productivity estimations, accounting for multiple inputs and outputs (e.g. multifactor or total factor productivity), all later should be measured in monetary terms, applying same scale. In our case, employment expenses are not given. Thus, one of the most important input factors is reported as number of employees. It does not allow us to combine it with other input factors due to index number problem.

The report presents productivity assessment in several arrears. Namely, we analyse:

- Average fixed assets productivity across sectors, as $\sum_{i=1}^{n} \frac{Output_i}{Fixed\ assets_i} \cdot \frac{1}{n}$ (11),
- Average current assets productivity across sectors, as $\sum_{i=1}^{n} \frac{Output_i}{Current\ assets_i} \cdot \frac{1}{n} \dots . (12)$
- Average labour productivity across sectors, as $\sum_{i=1}^{n} \frac{Output_i}{Number\ of\ Employees} \cdot \frac{1}{n}$ (13), where index $i = 1, \dots, n$ refers to companies operating in certain blue sector.

3.3. Efficiency estimations (Data Envelopment Analysis)

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 report efficiency will be referred to as a degree to which the greatest possible output per unit of input is achieved by a decision-making unit (Sherman and Zhu 2006).

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 cross-blue-sectors database) under the assumption that all other units lay on or under the efficiency frontier (achieve 100% efficiency) (Martin et al. 2006). We will leave out mathematical details of DEA approach[6] as it is outside the scope of a report, however will point out most relevant features of 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 formulating the optimization problem in several ways, depending on the objective. We apply two types of DEA modelling to evaluate current efficiency and gain inference into possibilities for further improvement. Thus, we perform:

a. Input-oriented DEA assessment – implies that objective function is minimization of inputs. In this set up, outputs are taken as given and DEA provides suggestive evidence on how to decrease operational costs (i.e. amount of resources used) to reach a given output.
b. Output-oriented DEA assessment – put maximization of outputs as objective function. Thus, optimization procedure seeks for possibilities to increase output provided the resources used.

Additionally, to objective function DEA approach allows to choose between constant and variable returns to scale. Constant returns to scale imply that increase in input results is proportional increase in output. Variable returns to scale can be either increasing or decreasing. Returns to scale are increasing if a proportional increase in all inputs results in more than proportional increase in all outputs. Decreasing returns, vice versa, imply that increase in inputs leads to less than proportional increase in outputs (Banker et al. 2004).

Along with efficiency score DEA estimates slacks for each input and output variables of each decision-making unit. Slack associated with input variables refers to excess of resources, which should be eliminated in order to reach full efficiency. Output variables' slacks stand for shortage of outputs to be covered in order to achieve full efficiency. DEA assessment will be performed using Stata software and build in package for DEA analysis.

Within our research we specify DEA model with variable returns to scale, three inputs (fixed and current assets, labour) and one output (turnover). We estimate both input- and output-oriented models as they convey different type of evidence for later application in scenario building.

In the framework of our research, DEA has a number of strong advantages, namely:

a. DEA compares units of analysis considering all available resources (inputs) used and operation results achieved (outputs).
b. DEA methodology is unit-invariant, meaning that optimization problem is independent of units of measurement, allowing to consider inputs and outputs with different scales and units of measurement.
c. It identifies the "best practice" units, i.e. those which achieved full efficiency.

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[6] For more details on mathematical formulation of DEA see Charnes et al. (1978, 1979)

d. DEA estimates amounts of resources which would have been saved if relatively inefficient units had reached maximal efficiency.
e. DEA identifies potential changes in the inefficient units allowing to achieve savings estimated within analytical procedure (point c).
f. DEA provides an estimate of additional services/products, which could have been provided given the amount of resources used (Sherman and Zhu 2006).

Therefore, applying DEA yields several important implications for the project. In particular, input- and output-oriented DEA assessment will give suggestive evidence regarding potential steps to optimize blue sector's performance. Figure 3.1 presents expected outcomes of efficiency assessment, their interrelation and application to other project parts.

In order to profoundly evaluate blue economy efficiency and address a role of blue industries in regional economy, we consider two analytical benchmarks. First, we estimate input- and output-oriented efficiencies within blue economy merely. Thus, we compare efficiencies of five blue sectors separately in Estonian and Finland. The results will approximate the role of individual blue sectors in regional blue economy. Second, we evaluate relative efficiencies of blue sectors relative to non-blue industries in blue region. Blue-non-blue comparative framework evaluates relative role of blue industries in overall regional economy efficiency and suggests whether blue sectors operate efficiently when non-blue industries performance is taken into account.

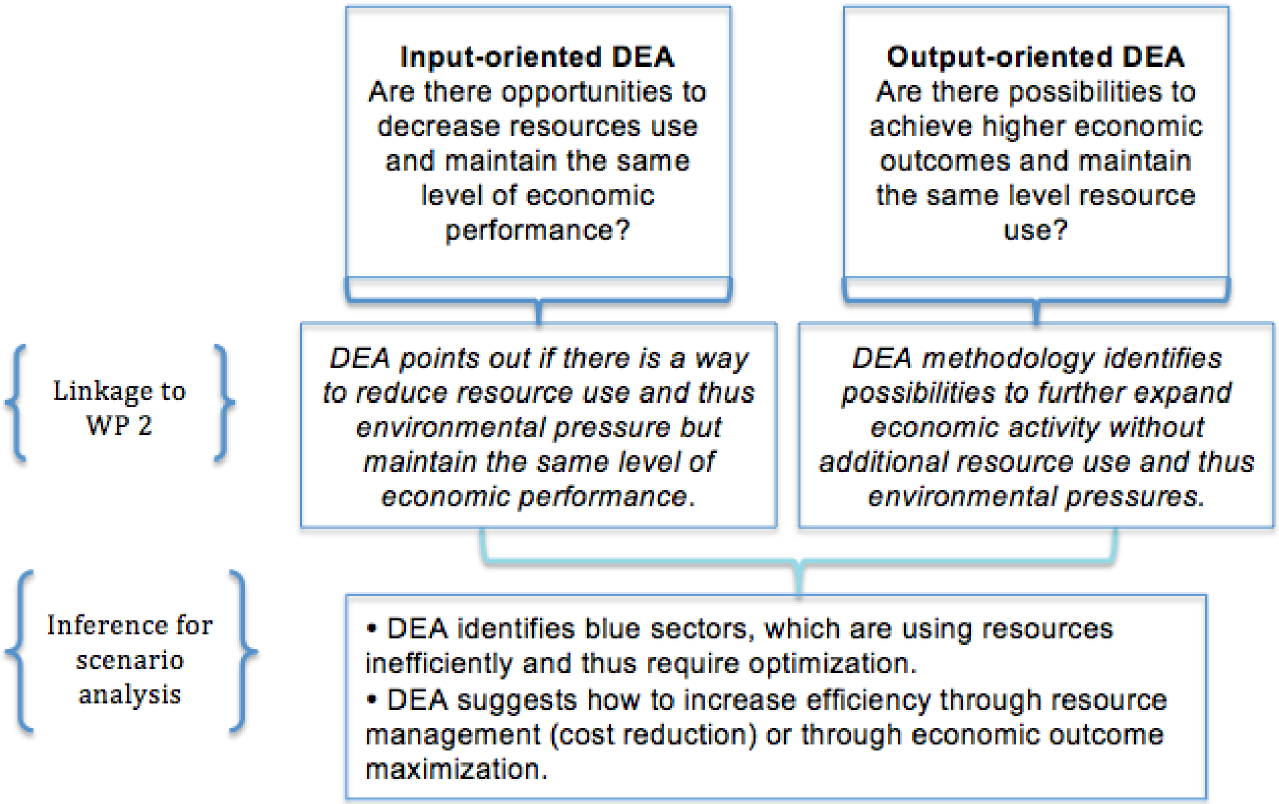

Figure 3.1. Efficiency (DEA) analysis outcomes and relation to other project parts.

3.4. Sensitivity analysis

Final part of the deliverable presents sensitivity analysis of blue sector in project area.

Economists define sensitivity as a degree to which the model outputs are affected by changes in selected input parameters (Beck et al. 1994). Consequently, sensitivity analysis implies estimation procedure that allows evaluating relative importance of model inputs (resources) on model outputs. Morgan and Henrion (1990) defined sensitivity analysis as a process of determining how changes in the model input values or assumptions affect the model outputs. According to Saltelli (2002), sensitivity analysis defines how uncertainty in outputs of the model can be assigned to uncertainties in differenced sources of inputs of the model.

Among different analytical techniques, sensitivity analysis is commonly viewed as one of the major tools of input-output interrelation analysis. In "Guidance on the Development, Evaluation, and Application of Environmental Models", developed by Environmental Protection Agency (2009), sensitivity analysis is viewed as one of the best practices to evaluate models, including environmental.

According to European Commission (EC) "Better Regulation Guidelines" (2015), sensitivity analysis should be applied in assessment of important impacts, especially if impacts of interest should be assessed quantitatively. Furthermore, EC Guidelines suggest that sensitivity analysis should be conducted jointly with scenario analysis to ensure that conclusions and implications of analysis rely on all evidence available (factual, opinion based evidence, etc.). In the context of this deliverable, sensitivity analysis will ensure that research conclusions rely on factual (empirical) data, collected within financial statements of analysed companies.

Appendix to the "Better Regulation Guidelines" (2015, p. 391) outlines major steps within sensitivity assessment. Namely, suggested steps are:

1) identification of major variable of interest (outcome variable);
2) identification of variables which are affected by uncertainty (input variables) and affect outcome variable;
3) characterize uncertainty and distribution of each input variable;
4) draw a sample from characterized distributions;
5) estimate the model;
6) evaluate relative importance of the factors.

Sensitivity assessment will rely on Amadeus database, which provides a complete set of financial indicators for all companies operating in the region off analysis. There is a clear advantage of using a ready empirical database, as it allows us to (i) obtain results which rely on actual, non-simulated data on financial performance; (ii) simplify analytical process, as steps 3 and 4 from aforementioned analysis sequence are not relevant for an empirical data source. Therefore, a set of analytical steps in our case reduces to four. In the following we explain each step in the context of the Project research.

- **Step 1.** Identification of major variable of interest (outcome variable)

Similarly to productivity and efficiency analysis, sensitivity assessment will focus on two major economic outcomes: yearly turnover and profit after tax.

- **Step 2.** Identification of major factor variables (inputs)

Following the overall framework of the study, we define three major input factors: fixed asset, current assets and employees.
Given a special emphasis of the project on sustainable blue growth, sensitivity analysis will primary focus on fixed assets, and more specifically on tangible fixed assets, as they directly approximate: (i) actual extent of blue area penetration (through such fixed assets as land, real estate and production facilities); (ii) means of operation and usage of on- and offshore area (through machinery, vehicles, tools and equipment, etc.).

Therefore, among all indicators available in companies' financial statements, tangible fixed assets are the most related to environmental pressures. Estonian Statistical Office defines environmental pressure as an impact of human activities on environment, captured by air emissions, waste and wastewater, use of land, forests, mineral resources, etc[7]. Econometric analysis within given deliverable take environmental pressures as given, as is a major research focus of Work Package 2. However, we will make an explicit reference to environmental pressures through assessment of interrelation between outputs (turnover and profit) and fixed assets input, which to a great extent capture a mechanism of environmental pressure.

Therefore, the model for sensitivity assessment can be mapped as presented by Figure 3.2.

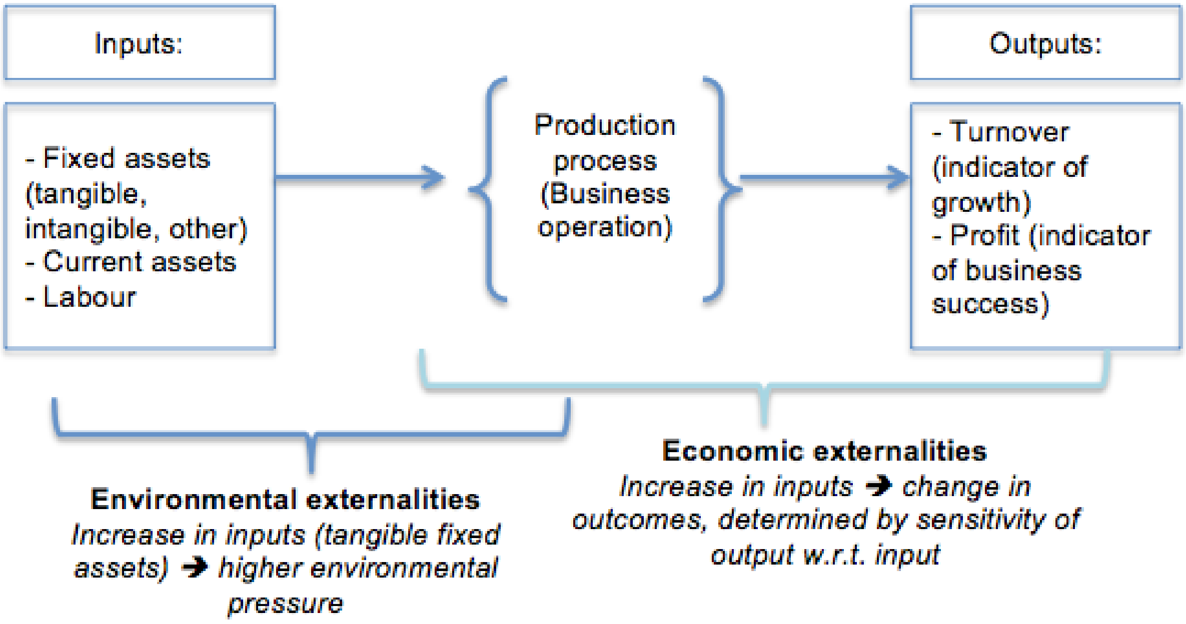

Figure 3.2. Sensitivity analysis sequence and relation to other project parts.

- **Step 3.** Statistical models one of the tools for sensitivity assessment. Regression analysis is the most commonly applied tool when dealing with empirical data and multiple inputs. Regression analysis relies on several assumptions feasible in our research context (linearity of input-output relationship, normality of distribution).

To evaluate sensitivity, we will build a panel data model for Estonia and Finland, that bases on Amadeus data from years 2010-2015. Panel data analysis was chosen instead of a usual ordinary least square approach (OLS) due to several reasons:

- Panel data allows capturing unobserved effects, thus it turns particularly useful when outcome variable is expected to depend on some unobserved (omitted) characteristics. Since our data in hand allows to control for a set of financial indicators and employment, we potentially omit numerous environmental, institutional, economic factors which affect company's turnover and profit. Panel data analysis ensures that these unobserved effects are captured to a large extent and heterogeneity of observed companies is accounted for. As a result, estimated effects (sensitivity coefficients) are more consistent.
- Using a panel dataset ensures a reasonable sample size. Our analysis relies on 6-year panel, which translates to approximately 6 times larger dataset, compared to single

[7] For more detailed information see: http://www.stat.ee/50890

year dataset. The major benefit of a bigger sample is higher validity and reliability of estimates.

Thus, sensitivity assessment relies on panel data of 6 years (hereinafter in the models year index is $t = 1, \dots, 6$), for all companies within blue economy (hereinafter in the models company index is $i = 1, \dots, N$). Depending on the scope, we estimate cross-blue-sectors and cross-blue-region sensitivities. Cross-blue sectors assessment follows the model:

$$logOutput_{it} = \alpha_i + \gamma' \cdot "logInputOfInterest"_{it} \times BlueSector_i + \beta' \cdot OtherInputs_{it} + \beta_2 Region_i + \varepsilon_{it} \quad (14)$$

Here $logOutput_{it}$ denotes output (either turnover or profit) of company i in year t. Similarly $"logInputOfInterest"_{it}$ refers to one of the input factors (total fixed assets, tangible fixed assets, current assets, or employees), we specifically focus in given regression, measured for company i in year t. We transform all monetary variables into logarithmic form in order to simplify interpretation of sensitivity coefficients. Noteworthy, time-invariant variables (e.g. blue sector, region) have only company index i.

From this model, we can interpret a vector of coefficients γ' as sensitivity vector, with each γ corresponding to relative sensitivity of $Output$ to $"InputOfInterest"$ in certain blue sector.

Similarly, to aforementioned model, cross-blue-region sensitivities will be estimated based on the model:

$$logOutput_{it} = \alpha_i + \gamma' \cdot "logInputOfInterest"_{it} \times BlueRegion_i \times BlueEconomy_i + \beta' \cdot OtherInputs_{it} + \varepsilon_{it} \quad (15)$$

Here the interaction term between three variables captures $Output$ sensitivity of $BlueEconomy$ (as a joint of five blue sectors) in each of preject $BlueRegion$ w.r.t $"InputOfInterest"$. Therefore, vector of coefficients γ' conveys the most important information on regional sensitivity of blue economy.

- **Step 4.** Evaluating the results

Final stage of sensitivity assessment will summarize results and suggest conclusions across two lines:

1) turnover sensitivity w.r.t. fixed assets will quantify interrelation between an increase in fixed assets and blue sectors' growth;
2) profit sensitivity w.r.t. fixed assets will quantitatively assess how an increase in fixed assets reflect on blue sectors' financial performance and business success.

Both research questions will be studies across five blue sectors in Estonia and Finland (hereinafter, sectorial sensitivity), as well across regions (counties) of the Project area (hereinafter, regional sensitivity). Due to our data limitations we are not able to fully study sensitivity within regions and sectors, however, we will present some findings which are consistent.

4. EMPIRICAL RESULTS

4.1. The role of maritime industries in national economies of Finland and Estonia: on OECD Input-Output Tables (IOT) based analysis.

4.1.1. Inter-industry linkages within national economies: forward and backward linkages

In this part of our deliverable, we present the results of analysis that relies on the OECD Input-Output Tables (IOT) allowing to analyse inter-industry linkages of a national economy. Backward linkages can identify the importance of certain industry to whole national economy in terms of inducing production effects. For instance, if blue sectors have higher backward linkages comparing to non-blue, it will be possible to conclude that expansion of blue industry production is more beneficial to the whole economy in terms of stimulating productive activities. And opposite, if a blue industry has higher forward linkages than non-blue, it would imply that its production is more sensitive to fluctuations of national economy and its industries. Identifying these linkages enable policy makers and spatial planners to better analyse how sensitive is development of whole economy to changes in certain industries.

The OECD database comprise information on 34 sectors of a national economy over the period 1995-2011. We specifically focus to eight sectors which are highly related to blue industries amongst these 34 sectors considering sectors and classifications of the Amadeus database: agriculture, hunting, forestry and fishing; mining and quarrying; coke, refined petroleum products and nuclear fuel; motor vehicles, trailers and semi-trailers; other transport equipment; construction; hotels and restaurants; transport and storage (see also 1.2).

Tables 4.1 and 4.2 present the backward and forward linkage effects of blue industries of Finland and Estonia during the period 1995 -2011. By estimating 16 years of forward and backward linkages of blue industries, we can observe some developments trends of these linkages. In general, there are no significant fluctuations of these linkages over the period under investigation neither in Estonia nor in Finland.

Table 4.1. Forward and backward linkages of blue industries in Finland. (1995-2011)

	i		**ii**		**iii**		**iv**		**v**		**vi**		**vii**		**Viii**	
Years	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL
1995	1,35	1,00	1,56	1,06	1,07	1,07	0,71	0,92	0,78	1,10	0,79	1,09	0,80	1,14	1,15	0,99
1996	1,40	1,02	1,57	1,07	1,09	1,00	0,73	0,95	0,72	1,04	0,77	1,09	0,79	1,16	1,15	0,99
1997	1,43	1,01	1,55	1,06	1,05	0,97	0,69	0,92	0,74	1,07	0,78	1,09	0,82	1,16	1,16	0,99
1998	1,47	1,03	1,50	1,06	1,06	0,97	0,69	0,93	0,74	1,09	0,76	1,07	0,82	1,13	1,15	0,98
1999	1,42	1,00	1,52	1,08	1,04	1,03	0,68	0,92	0,77	1,10	0,76	1,02	0,78	1,13	1,16	0,99
2000	1,35	0,99	1,81	0,90	0,99	0,75	0,65	1,06	0,76	1,14	0,74	1,11	0,86	1,13	1,22	1,01
2001	1,36	1,00	1,48	0,91	1,02	0,79	0,65	1,08	0,75	1,16	0,77	1,13	0,87	1,10	1,22	0,99
2002	1,35	0,99	1,57	0,90	1,00	0,76	0,65	1,05	0,78	1,18	0,77	1,13	0,89	1,10	1,22	0,98
2003	1,36	1,01	1,51	0,93	1,05	0,79	0,62	1,03	0,74	1,06	0,78	1,12	0,88	1,09	1,23	1,02
2004	1,36	1,01	1,50	0,95	1,04	0,79	0,63	1,01	0,76	1,07	0,77	1,12	0,88	1,10	1,23	0,99
2005	1,34	1,02	1,58	0,94	1,07	0,81	0,63	0,94	0,75	1,09	0,80	1,12	0,87	1,10	1,24	1,03

2006	1,35	1,03	1,53	0,92	1,09	0,78	0,63	0,98	0,71	1,12	0,79	1,12	0,87	1,10	1,25	1,07
2007	1,36	0,98	1,51	0,98	1,09	0,88	0,65	0,99	0,72	1,09	0,79	1,13	0,88	1,04	1,26	1,09
2008	1,31	0,97	1,59	0,99	1,10	0,84	0,68	1,01	0,74	1,10	0,80	1,13	0,87	1,09	1,35	1,07
2009	1,24	0,96	1,52	0,98	1,06	0,87	0,78	0,98	0,71	1,09	0,82	1,11	0,88	1,09	1,34	1,08
2010	1,29	0,96	1,48	1,02	1,09	0,94	0,73	0,97	0,77	1,03	0,84	1,10	0,88	1,07	1,37	1,07
2011	1,25	0,96	1,41	0,99	1,03	0,84	0,72	0,99	0,81	1,02	0,82	1,11	0,85	1,07	1,36	1,07

Note: Sectors: (i) Agriculture, hunting, forestry and fishing; (ii) Mining and quarrying; (iii) Coke, refined petroleum products and nuclear fuel; (iv)Motor vehicles, trailers and semi-trailers; (v) Other transport equipment; (vi) Construction; (vii) Hotels and restaurants; (viii) Transport and storage. FL: Forward Linkage value BL: Backward Linkage value.
Source: authors calculations based on OECD IOT data 1995-2011.

In the case of Finland, forward linkage values have been lower than 1 for four blue industries, that are, (iv)Motor vehicles, trailers and semi-trailers; (v) Other transport equipment; (vi) Construction; (vii)Hotels and restaurants for period of 1995-2011. It implies that when economic activities are booming the blue industries are less stimulated by overall industrial growth than other industries. In other words, these blue industries are not influenced much by business fluctuations. However, other four blue industries, (i) Agriculture, hunting, forestry and fishing, (ii) Mining and quarrying, (iii) Coke, refined petroleum products and nuclear fuel, (viii) Transport and storage, have higher forward linkage values than 1. These industries have a vital function in economic development in maintaining other industries by their outputs. In terms of backward linkages, we can observe that backward linkage values of industries higher than 1, which are (v) Other transport equipment, (vi) Construction, (vii) Hotels and restaurants, (viii) Transport and storage. Backward linkage value of the blue industry, Transport and Storage industry, has been fluctuating between 0.99 and 1.02 until 2005. Since 2005 we can see higher backward linkage value of this sector which is bigger than 1. One of the main development during 2004 was accession of many Eastern European countries into the European Union. This can be interpreted that the blue industry has bigger impacts in terms of investment expenditures on the national economy than other sectors. These blue industries, which have bigger backward linkage value than 1, have crucial function in economic development in increasing other industries' production levels. (backward linkage effect).

Table 4.2. Forward and backward linkages of blue industries in Estonia. (1995-2011)

	i		**Ii**		**iii**		**iv**		**v**		**vi**		**vii**		**viii**	
Years	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL	FL	BL
1995	1,29	1,18	1,46	0,97	1,36	1,05	0,79	0,93	1,03	0,90	0,89	1,04	0,71	1,12	0,95	1,11
1996	1,29	1,19	1,47	1,00	1,37	1,06	0,81	0,94	1,01	0,93	0,92	1,07	0,75	1,12	0,93	1,11
1997	1,23	1,07	1,47	1,00	1,35	1,08	0,81	0,93	0,96	0,93	0,88	1,05	0,77	1,11	0,92	1,11
1998	1,19	1,07	1,39	0,95	1,30	1,02	0,82	0,95	1,02	0,93	0,90	1,05	0,76	1,09	0,98	1,10
1999	1,16	1,10	1,67	0,95	0,87	1,21	0,71	0,95	1,11	1,05	0,91	1,01	0,84	1,10	0,97	1,10
2000	1,17	1,06	1,55	0,91	0,88	0,93	0,86	0,97	1,04	1,06	0,89	1,06	0,81	1,11	1,05	1,15
2001	1,21	1,06	1,42	0,90	0,80	0,88	0,86	0,95	0,93	1,05	0,81	1,05	0,81	1,10	1,06	1,16
2002	1,20	1,02	1,51	0,89	1,37	1,13	0,66	1,01	0,89	1,06	0,77	1,05	0,78	1,08	1,06	1,06
2003	1,26	1,09	1,42	0,93	0,99	0,99	0,88	0,94	0,84	0,99	0,78	1,10	0,81	1,14	1,15	1,14
2004	1,27	1,08	1,55	0,92	0,94	1,11	0,89	0,91	0,87	0,97	0,79	1,09	0,79	1,14	1,14	1,17
2005	1,29	1,10	1,39	0,90	0,89	0,83	0,74	0,97	0,92	1,06	0,78	1,05	0,82	1,13	1,18	1,20

2006	1,26	1,07	1,47	0,92	0,86	0,93	0,92	0,97	0,94	1,07	0,75	1,06	0,81	1,13	1,16	1,15
2007	1,24	1,08	1,48	0,93	0,91	0,98	0,94	0,97	0,95	1,07	0,73	1,08	0,81	1,07	1,17	1,20
2008	1,27	1,13	1,52	0,93	0,90	0,90	0,75	0,93	0,89	1,16	0,77	1,07	0,82	1,09	1,23	1,20
2009	1,27	1,13	1,59	0,91	0,83	0,96	0,78	0,96	0,94	1,18	0,77	1,08	0,83	1,12	1,23	1,22
2010	1,25	1,11	1,50	0,89	0,89	0,86	0,77	0,97	0,85	1,15	0,82	1,06	0,84	1,12	1,26	1,21
2011	1,27	1,10	1,46	0,90	0,79	0,90	0,76	0,95	0,74	1,13	0,79	1,08	0,92	1,11	1,26	1,20

Note: Sectors: (i) Agriculture, hunting, forestry and fishing; (ii) Mining and quarrying; (iii) Coke, refined petroleum products and nuclear fuel; (iv)Motor vehicles, trailers and semi-trailers; (v) Other transport equipment; (vi) Construction; (vii)Hotels and restaurants; (viii) Transport and storage. FL: Forward Linkage value BL: Backward Linkage value.
Source: authors calculations based on OECD IOT data 1995-2011.

The case of Estonia demonstrates that forward linkage values have been lower than 1 for five blue industries, that are, (iii) Coke, refined petroleum products and nuclear fuel, (iv)Motor vehicles, trailers and semi-trailers, (v) Other transport equipment, (vi) Construction, (vii)Hotels and restaurants for period of 1995-2011. It implies that when economic activities are booming the blue industries are less stimulated by overall industrial growth than other industries. In other words, blue industry is not influenced much by business fluctuations and is a vital input to national existence. However, other three blue industries, (i) Agriculture, hunting, forestry and fishing, (ii) Mining and quarrying, (viii) Transport and storage, have higher forward linkage values than 1. Although backward linkage values have been fluctuating over the years for some industries, we can observe that backward linkage values of industries higher than 1, that are (i) Agriculture, hunting, forestry and fishing, (v) Other transport equipment; (vi) Construction; (vii)Hotels and restaurants, (viii) Transport and storage. This blue industry, Other transport equipment, have improved its backward linkages values since 2004. In 2004, many Eastern European countries have joined to the European Union, as well as Estonia. This can be interpreted that the blue industry has bigger impacts in terms of investment expenditures on the national economy than other sectors.

Tables 4.3 and 4.4 summarise information on backward and forward linkages of industries related to blue sectors identifying industries that are more strongly (level of an index >1) or weakly (level of an index < 1) related to national economies in both countries during the last year of the analysed period.

Table 4.3. Distribution of sectors according to forward and backward linkages in Finland in 2011.

FINLAND	**HIGH FL(>1)** - remarkable influence from other industries	**LOW FL (<1) –** less remarkable influence from other industries
HIGH BL (>1) – remarkable influence to other industries	Transport and storage	Other transport equipment
		Construction
		Hotels and restaurants
LOW BL (<1) less remarkable influence to other industries**.**	Agriculture, hunting, forestry and fishing	Motor vehicles, trailers and semitrailers
	Mining and quarrying	
	Coke, refined petroleum products and nuclear fuel	

Source: authors calculations based on OECD IOT data 2011

Table 4.4. Distribution of sectors according to forward and backward linkages in Finland in 2011

ESTONIA	**HIGH FL (>1)** - remarkable influence from other industries	**LOW FL (<1)) –** less remarkable influence from other industries
HIGH BL (>1) – remarkable influence to other industries	Agriculture, hunting, forestry and fishing	Other transport equipment
	Transport and storage	Construction
		Hotels and restaurants
LOW BL (<1) - less remarkable influence to other industries**.**	Mining and quarrying	Motor vehicles, trailers and semitrailers

Source: authors calculations based on OECD IOT data 2011

According to previous literature focused on the analysis of backward and forward linkages of industries (Kwak et al., 2005), the industries can be categorised into intermediate manufacture, intermediate primary production, final manufacture, and final primary production, respectively) depending on values of linkage's indexes. If the of backward and forward linkage effects of an industry are matched as:

- high and high then is mainly characterised by intermediate manufacture production;
- high and low then by intermediate primary production;
- low and high then by final manufacture production;
- low and low then final primary production.

Thus, according to Table 4.4, Transport and storage and Agriculture, hunting, forestry and fishing industries in Estonia can be categorised as industries providing mainly intermediate manufacture production since they have high backward and forward linkage effect values. Transport and storage is the only sector that has both high forward linkage and backward linkage effects in both economies (see also table 4.3). Final manufacture production is mainly provided by Agriculture, hunting, forestry and fishing as well as Mining and quarrying, refined petroleum and nuclear fuel related industries in Finland and only by Mining and quarrying in Estonia.

We should keep in mind that if these two linkage effects' values are greater than one, these industries have crucial function in maintaining and development of other industries, and their development is also remarkable influenced by the success of other industries. In Estonian case, these industries are Agriculture, hunting, forestry and fishing and Transport and storage and in Finnish case also Transport and storage. Thus, creating favourable conditions for development of theses these two sectors should be particularly considered by the elaboration of Blue Growth scenarios.

4.1.2. Output, Income and Employment Multipliers

Based on the Input-Output Tables, it is also reasonable to calculate (see formula 9 in 3.1) and analyse output and employment multipliers that reflect the effects of changes in output or employment upon all other activities throughout the economy. Multipliers can provide additional quantitative information considering production stimulating policies and employment creation processes regarding blue economies. For instance, based on output multipliers, it is possible to analyse whether there is an external increase in final demand. The calculated multipliers allow us to obtain additional information on the strength of the inter-industry relations among industries and to analyse how important role have these inter-industries relations plaid in Estonia and Finnish during the years 1995-2011. Information on the calculated output and employment multipliers for Estonia and Finland are presented in Figures 4.1 and 4.2.

While we were calculating output multipliers, it is possible to analyses whether there is an external increase in final demand or not. Two types of system multipliers can be distinguished: open and closed system multipliers. The open system multipliers do not consider the probability where there is an exogenous increase in final demand; the employees will receive more money that they spend in different countries. Closed system multiplier takes into account a possibility that whole additional wage is being spend in the country.

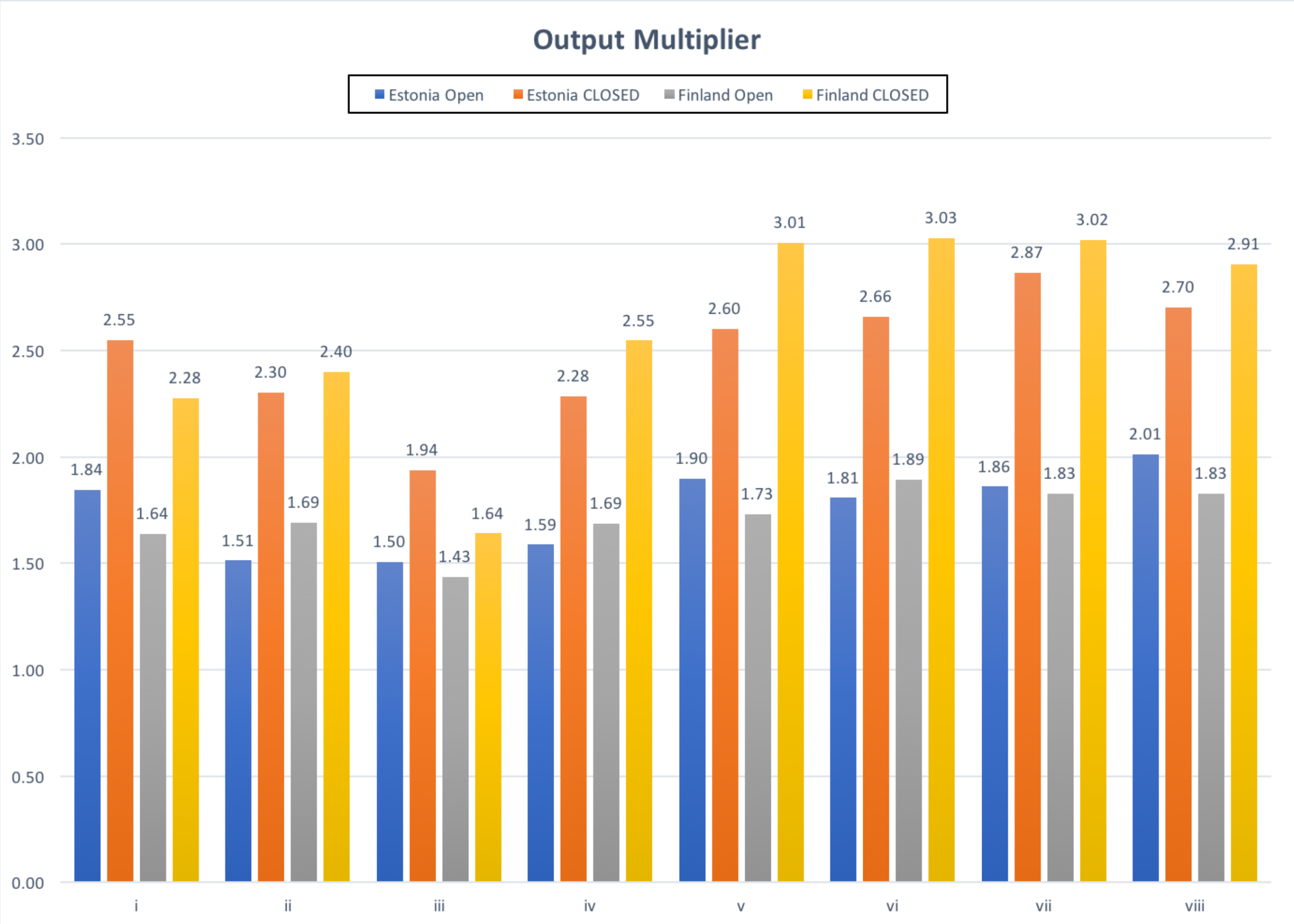

Figure 4.1. Output Multipliers for economies of Estonia and Finland, 2011

Note: Sectors: (i) Agriculture, hunting, forestry and fishing; (ii) Mining and quarrying; (iii) Coke, refined petroleum products and nuclear fuel; (iv)Motor vehicles, trailers and semi-trailers; (v) Other transport equipment; (vi) Construction; (vii)Hotels and restaurants; (viii) Transport and storage.

Source: authors calculations based on OECD IOT data 2011

There are some differences in the values of calculated open and closed system multipliers (see Appendix 1 and 2). In absolute numbers these values vary approximately between 1.50 - 3 euros, that means one unit (euro) increase of final demand (or added value; income) can increase output respectively on 1.50 - 3 euros in the analysed industries. In Finland, difference between open and closed system output multiplier is as a rule higher than Estonia. If we compare, for instance, hotels and restaurants sectors in Finland and Estonia, the real effect should vary between 1,86 and 2,87 for Estonia and between 1.83 and 3.02 for Finland. One can explain this result that wage differences between countries have significant impact on output multipliers of sectors. Taking into account that both Estonia and Finland are open economies, it reasonable to focus on analysing and discussing first of all open system multipliers' values. Figure 4.1 depicts output multipliers for blue sectors of Estonia and Finland, respectively.

According to the Figure 4.1, the open system multipliers of blue sectors vary between 1.50-2 Eur., and closed system multipliers respectively approximately between 2-3 euros in both countries Estonia and Finland. For instance, for one additional euro that is spent on final demand, the total output of Finland increases by EUR 1.73 and of Estonia by ca 2 eur if it is spent in the Transport and storage industry (open system multiplier). The calculated output multipliers of Hotels and restaurants sector show that increase in final demand could have remarkable effect in terms of euro of output produced within the economy, respectively 1.86 eur in Estonia (in case of open system) and 1,83 eur in Finland. Also income multipliers of Hotels and restaurant sector are rather high: 1.55 eur (open system) till 2.20 eur (closed system) in Estonia and respectively 1.59 and 2.42 eur in Finland. These results once again confirm that blue sector's activities in the field of hotels and restaurants are very impactful in development of blue regions. This sector has a strong effect on production activities of other sectors in overall economy. The effects of changes in final demand and income on total output are ordinarily larger when the additional euro flows to sectors associated with labour intensive sectors such as hotels and restaurants. Additionally to hotels and restaurants, also transport and storage, and construction sectors have high impact on total output in both countries (see Appendix 1 and 2.

If we compare to economy related industries with non-blue industries, we show that in general blue industries' output and income multipliers are slightly smaller than in non-blue industries. If we rank all sectors according to the output multiplier, Hotels and restaurants sector takes 4th place among all sectors in Estonia. In Finland, the best ranking position of blue sectors' output multipliers among all sectors belong to Construction (6th place). Analysing output, value added and income multipliers together, it is possible to summarise that three blue economy related industries – Hotels and restaurants; Transport and storage, and Construction - belong to top ten within the analysed 34 industries. Those, changes in final demand (also in income, and value added) will induce Hotels and restaurants, Construction, and Transport and storage industries to produce more output; a unit increase of final demand (or income) brings remarkable growth of output in these fields. Therefore, if investment policies in blue industries are aimed to foresee higher output results, these three sectors have good potential for future developments.

Preliminary results of employment multipliers (Figure 4.2) will enable us to analyse employment creating impacts of sectoral expansions and assist policymakers to tackle one of their main concerns about employment potentials in blue industries of Estonia and Finland. Furthermore, employment impacts linked with output in the different sectors are remarkable measure of economic importance of sectors.

Figure 4.2 illustrates open (type 1) and closed system (type 2) employment multipliers for Estonia's and Finnish blue sectors. Employment multipliers' show how many people can additionally be employed after investment of 100 thousand of euros in the respective sector.

In case of Finland, Coke, refined petroleum products and nuclear fuel has a highest employment multiplier amongst blue sectors which is 8 (open system) and 13 (closed system). According to these results, one can conclude that investments for Coke, refined petroleum products and nuclear fuel will create the highest employment opportunities compared to other blue economy related industries in Finland. Second highest employment multiplier is in Mining and quarrying sector (2.3 and 3.6) and third highest in Transport and storage sector (1.9 and 3).

Figure 4.1.3. Employment Multipliers for economies of Estonia and Finland, 2011

Note: Sectors: (i) Agriculture, hunting, forestry and fishing; (ii) Mining and quarrying; (iii) Coke, refined petroleum products and nuclear fuel; (iv)Motor vehicles, trailers and semi-trailers; (v) Other transport equipment; (vi) Construction; (vii)Hotels and restaurants; (viii) Transport and storage.

Source: authors calculations based on OECD IOT data 2011.

In Estonia, the value of employment sectors is remarkable smaller being on average between 1.5 and 3. Thus, investments in Estonia create less additional employment. Transport and storage sector has the highest employment multiplier among Estonian blue sectors.

4.2. Analysis of economic performance of blue regions and sectors

This part of the study relies on enterprise data provided by the Amadeus database. It focuses on the analysis of economic performance of blue regions and sectors in Finland and Estonia comparing productivity and efficiency of blue sectors with non-blue and discovering possibilities for better use of available resources (labour, fixed and current assets). Sensitivity analysis brings out how development plans (e.g. growth of production and/or profit) growth) can affect inputs' (labour, assets) demand. And opposite, if there are necessities for limitation of resources (e.g., shortage of labour; decrease of fixed assets to diminish environmental pressure), possible changes in proposed outputs (growth) will be quantified. This part of study provides additional information for joint analysis of economic, social and environmental aspects of coastal regions' development as well as for scenario building and spatial planning.

Following the results of DT.1.6.1, blue regions of Estonia and Finland are characterised by higher per capita GDP rates, lower unemployment, high growth potential[8]. This section will provide a number of additional analytical frameworks for economic performance analysis, allowing to draw generalized and cross-country-comparable conclusions on economic performance of blue industries.

Overview of Amadeus database, definitions of blue economy sectors and regions as well as explanations of blue sectors' input and output indicators used for economic performance analysis are presented in the part 2.2.

4.2.1. Descriptive analysis

A) Total input and output indicators of blue economy

This section aims to provide a general overview of major indicators of interest from Amadeus data for year 2015 across blue sectors. Namely, we descriptively analyse major input variables (fixed and current assets, number of employees) and output indicators (turnover and profit after tax). In order to better visualize a share of blue sectors in overall regional economy we present input and output profiles across both blue economy and non-blue-economy.

We start with estimating an overall share of blue sector in economies of three coastal counties in Estonia and three in Finland (see Table 2.1 in part 2.2 for definition of blue regions). Figure 4.2.1.1 presents a total number of enterprises operating in blue sectors across the regions of research. This table presents all companies registered in year 2015, regardless actual availability of variables of interest.

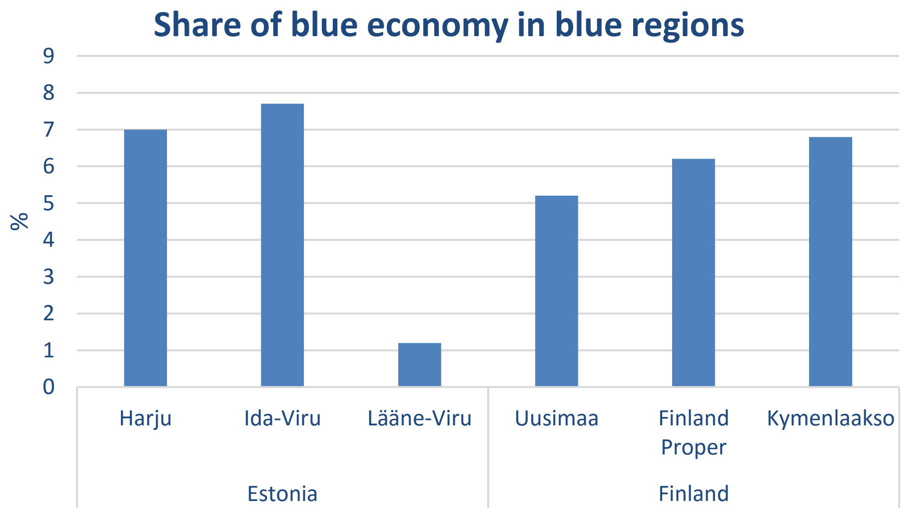

Figure 4.2.1.1. Total number of companies and share of blue sector operating in the coastal area – year 2015

Source: Amadeus database year 2015, all companies registered.

[8] For deeper investigation see Pohjola et al. (2018). *Report on blue economic potential, sectors strategies, and development trends* (DT.1.6.1.)

Based on Amadeus data, the largest number of blue companies is registered in capital regions – Harju county in Estonia and Uusimaa in Finland. In terms of blue sectors' share in overall regional economy, in Ida-Viru country almost 8% of all enterprises operating in a region are blue industries, while in Finland the highest share of blue sector in regional economy is in Kymenlaakso county (almost 8%).

Table 4.5. presents average input and output indicators across non-blue and blue sectors in research regions. As expected, in these regions blue economy holds the highest share of regional inputs in fixed assets, compared to remaining two inputs – current assets and employees. Since we expect fixed assets to a large extent reflect degree of environmental pressure, this result indicates that blue industries have relative higher environmental pressure, which will be addressed later in the report in more detail.

Results from Table 4.5 document Ida-Viru (in Estonia) and Kymenlaakso (in Finland) as the regions with the highest share of blue economy. In Finland, Kymenlaakso and Uusimaa are good examples of regions with developed and well-performing blue economy. Namely, because a share of blue economy in regions profits reach 19.4% and 15.2% respectively, while respective shares of employees are only 5.9% and 2.5% and shares of current assets are 12.1% and 5.0%. In Estonia, Harju county reports well-performing blue economy, which accounts for 9.3% of profits, while for only 6.5% or employees and 4.8% of current assets. Interestingly, Ida-Viru county in Estonia has massive blue economy, possessing 65.2% of county's fixed assets, 37.2% of employees and 43.2% of turnover, however, it reports negative profits in the amount of 138.21 th. EUR while overall economy of Ida-Viru is profitable. This pattern could result from certain regional peculiarities and may require further detailed investigation.

Appendix 3 presents distribution graph for each of resources and outputs across blue and non-blue economies. The data encounters several outliers (companies with excessively high inputs and/or outputs). Thus, in order to better visualize the distribution, we remove 5% of companies having the highest indicators in our detailed performance analysis. In the following analysis, we still consider a full sample.

Table 4.5. Total inputs (resources) and outputs of blue and non-blue sectors across blue region and share of blue economy – year 2015

Region	Overall non-blue sectors' input			Overall blue sectors' input			Blue sector % in total regional inputs		
	Fixed assets, mln. EUR	Current assets, mln. EUR	Employees	Fixed assets, mln. EUR	Current assets, mln. EUR	Employees	Fixed assets, mln. EUR	Current assets, mln. EUR	Employees
Estonia									
Harju	6849,74	7883,07	120905	1359,80	393,45	8451,00	16,56	4,75	6,53
Ida-Viru	693,31	460,72	9025,00	1296,75	165,36	5342,00	65,16	26,41	37,18
Lääne-Viru	631,06	414,40	9408,00	15,42	1,15	206,00	2,38	0,28	2,14
Finland									
Uusimaa	17400,00	164000,00	1183927,0	23300,00	8589,24	30233,00	11,77	4,96	2,49
Finland Proper	7716,95	7655,96	83638,00	806,69	707,90	5423,00	9,46	8,46	6,09
Kymenlaakso	2705,22	1116,80	11945,00	649,43	153,08	747,00	19,36	12,05	5,89

Region	Overall non-blue sectors' output		Overall blue sectors' output		Blue sector % in total regional outputs	
	Turnover, mln. EUR	Profit after tax, mln. EUR	Turnover, mln. EUR	Profit after tax, mln. EUR	Turnover, mln. EUR	Profit after tax, mln. EUR
Estonia						
Harju	20600,00	1005,04	2055,08	102,54	9,05	9,26
Ida-Viru	944,45	58,23	716,83	-138,21	43,15	-
Lääne-Viru	1139,98	34,33	8,25	0,38	0,72	1,10
Finland						
Uusimaa	315000,0	8302,09	32900,00	1491,13	9,45	15,23
Finland Proper	19600,00	1280,05	1650,25	62,45	7,78	4,65
Kymenlaakso	3265,73	123,99	383,47	29,79	10,51	19,37

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

B) Input and output indicators of the individual blue sectors

Figures 4.2.1.2 and 4.2.1.3 present cross-country summary statistics across five analyzed sectors (bio & subsea activities, energy, water transport, coastal tourism and marine construction). For all companies, financial indicators from last year available in Amadeus data (the most recent entry) are used. In our sample, the most recent entry year for all Estonian companies is 2015. Finnish firms are last observed in year from 2012 to 2016, with the biggest share in 2015 (68%). We specifically focus on financial measures used in further input-output analysis.

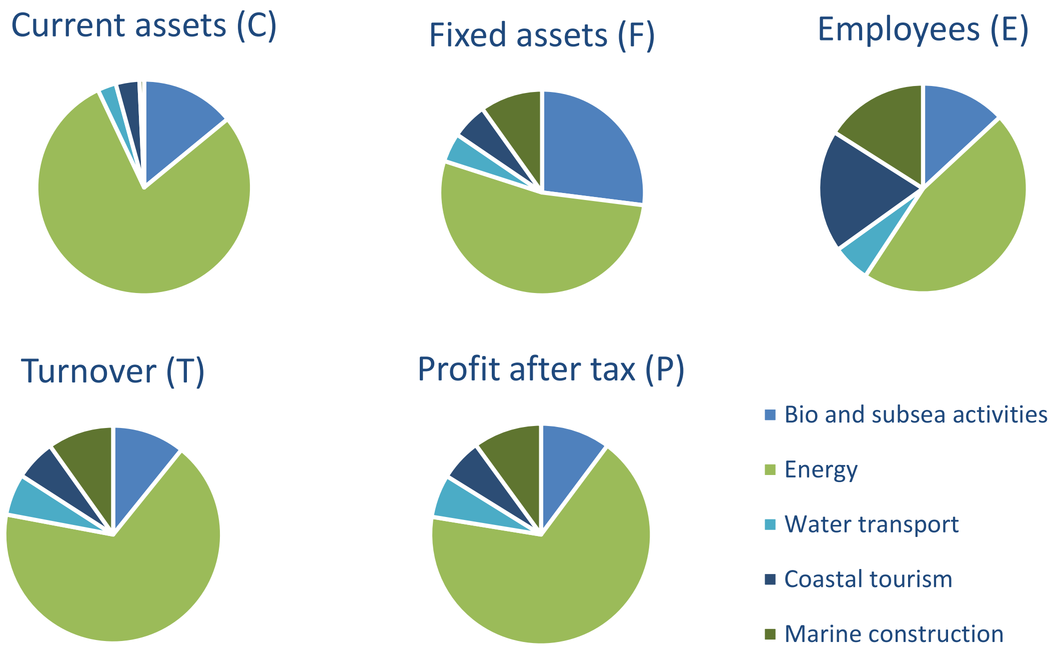

Figure 4.2.1.2. Estonian maritime industries – inputs and outputs average over blue region, year 2015

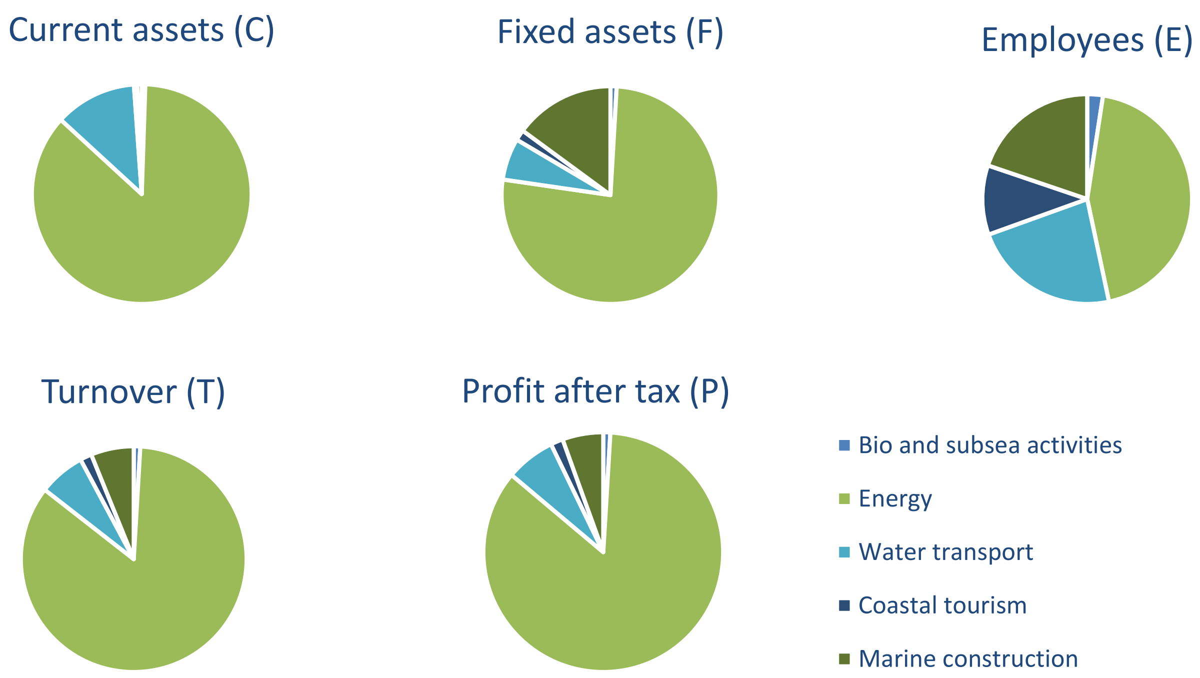

Figure 4.2.1.3. Finnish maritime industries – inputs and outputs average over blue region, year 2015.

Source: Amadeus database.

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

The figures indicate that energy sector is the largest in terms of average inputs and outputs. Marine construction is another big sector, reporting high average profits in both Estonia and Finland. Bio & subsea sector in Finland offers interesting insights, as it disposes relatively low average inputs, however, generates high profits. Another such example is water transportation sector in both Estonia and Finland.

4.2.2. Productivity ranking of blue industries

The first step of economic performance analysis concerns productivity assessment of blue sectors. Initial research focus of the deliverable is assessment of labour, fixed assets and current assets productivity. As explained in section 3.2, we evaluate sectorial labour productivity applying partial productivity measures. All three productivity dimensions are assessed relative to turnover volume and profit after tax. Motivation for this is twofold. Firstly, broader set of outcomes will give a more comprehensive picture of true productivity. Secondly, as we consider operationally different sectors, focusing on one single outcome may leave out important information and produce a biased picture of actual productivity in generating sectorial growth and financial success.

Since estimation procedure allows to include only one resource and one output, to maintain consistency, we produced a set of individual productivity indicators for each input relative to each output. Furthermore, this part of our study presents productivity assessment along two comparative frameworks: cross-sectorial and cross-regional. First will provide an inference to productivity of individual blue industries in Estonian and Finnish blue region. Thus, the results will identify the most/least productive industries of blue economy. Second, we will address cross-regional productivity variation, measured as productivity levels in three separate counties in Estonia (Harju county, Ida-Viru and Lääne-Viru) and three counties in Finland (Kymenlaakso, Uusimaa and Finland Proper).

First set of our productivity results include labour and fixed assets productivity measures across Estonian and Finnish blue sectors, measured relative to turnover and profit. Table 4.6 presents productivity ranking of blue sectors and infers industries with highest and lowest productivity.

Table 4.6. Partial productivity of labour and fixed assets in blue regions of Estonia and Finland, industry ranking – year 2015

Labour productivity	
Turnover / Employees	**Profit / Employees**
Estonia	
1. Energy	1. Bio and subsea activities
2. Marine construction	2. Energy
3. Bio and subsea activities	3. Water transport
4. Water transport	4. Marine construction
5. Tourism	5. Tourism
Finland	
1. Energy	1. Energy

2. Bio and subsea activities	2. Water transport
3. Water transport	3. Bio and subsea activities
4. Marine construction	4. Marine construction
5. Tourism	5. Tourism
Fixed assets productivity	
Turnover / Fixed assets	**Profit / Fixed assets**
Estonia	
1. Marine construction	1. Marine construction
2. Energy	2. Water transport
3. Water transport	3. Energy
4. Tourism	4. Tourism
5. Bio and subsea activities	5. Bio and subsea activities
Finland	
1. Tourism	1. Marine construction
2. Water transport	2. Energy
3. Marine construction	3. Water transport
4. Energy	4. Tourism
5. Bio and subsea activities	5. Bio and subsea activities

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

The results suggest that energy sector is clearly the most productive sector in terms of labour. Thus, the highest amount of turnover per one employee is generated in energy sector in both Estonia and Finland. In terms of profit volumes, energy is second in Estonian ranking, outperformed by bio & subsea activities. However, in Finland again energy is the leader in terms of units of profit generated per one employee.

Surprisingly, tourism sector has the lowest labour productivity in both Estonia and Finland. The sector is characterised by the lowest turnover and profit volumes generated per one employee. This result suggests that labour resource is not sufficiently well used in tourism sector. The reason could be twofold. Firstly, labour resource is not managed efficiently, resulting in both excess of labour force in the sector and relatively low input of labour into sectorial performance. Secondly, the reason of low labour productivity in tourism can ground in general operational problems of tourism industry.

In Estonia, the fixed assets are the most productive in marine construction sector. The largest amount of both, turnover and profit after tax, per unit of fixed assets (1 th. EUR) are generated in marine construction sector. In Finland, marine construction sector is leading only in terms of profit per unit of fixed assets. In terms of turnover productivity, marine construction is ranked third. Energy sector reveals much lower fixed assets productivity rank, compared to labour productivity. However, average fixed assets productivity may result from generally higher fixed assets consumption, due to higher infrastructure demands of energy sector, as compared to tourism or other blue industries.

Bio & subsea activities sector reveals the lowest productivity of fixed assets in both countries. Similarly to energy sector, bio & subsea activities is characterised by substantial stock of fixed assets in Estonia (see Figure 4.2.1.2.). However, it employs a relatively smaller share of other assets, thus, efficiency of fixed resources stock will be addressed in detail in subsection 4.2.4.

Next, figure 4.3. presents productivity assessment in cross-regional aspect. Namely, we focus on all inputs' productivity relative to turnover. To highlight the role of blue economy, we estimate productivity across blue and non-blue economy and analyse systematic differences. This figure gives a general inference into blue economy productivity relative to non-blue and approximates blue economy's role in regional economy productivity. The results suggest that on average blue economy appears more productive, than non-blue. The clear exception is productivity of fixed assets. Out of 6 countries under investigation in only two of them (Finland Proper and Uusimaa) blue economy has higher turnover volume per 1 EUR of fixed assets possessed by the all blue sectors, compared to non-blue. In Kymenlaakso and all three Estonian countries blue economy has lower turnover returns on fixed assets, relative to non-blue. This finding suggest that blue sectors may own excessive fixed assets and/or underuse them

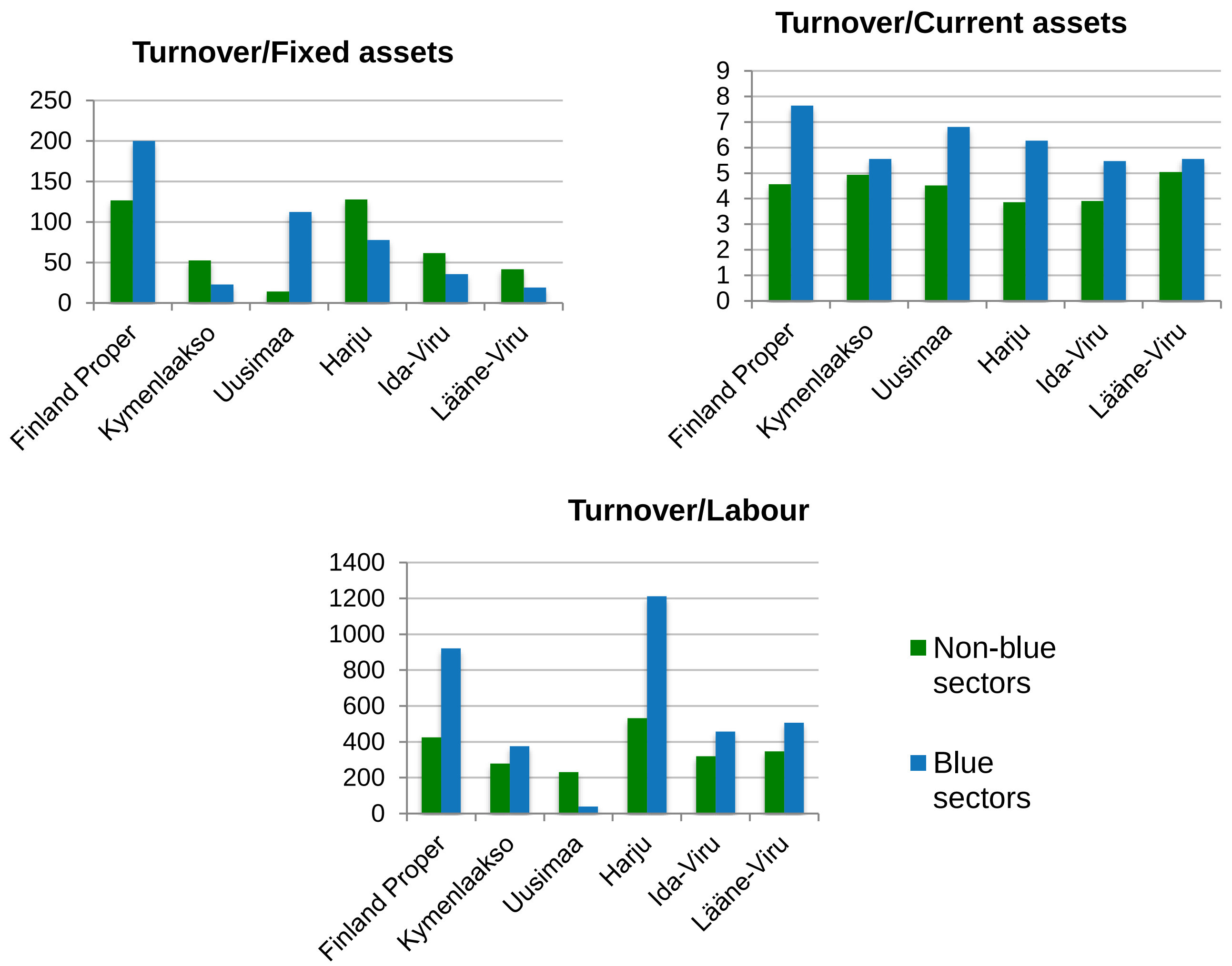

Figure 4.3. Blue economy cross-regional productivity relative to non-blue

Source: Amadeus database.

Note: The sample includes only companies which reported all input and output indicators in 2015

However, blue economy has remarkably higher amounts of turnover generated per unit of current assets and per one employee, compared to non-blue in all region of research. Hence, blue economy plays in important role in overall regional productivity and on average employ

labour resources and current assets more effectively than non-blue, yielding higher turnover returns.
However, partial productivity measures give only crude measure of how effective sector is utilizing inputs to produce outputs. As they rely on only single input and single output, they provide only limited picture of actual performance. To more profoundly assess effectiveness of resource use and extent of their use in outcome production, an analysis accounting for multiple inputs and outputs is needed. This is an objective of the next section of the report.

4.2.3. Productivity of blue sectors: marine transportation in Finland case study

Marine transportation sector appears to be one of the biggest sectors in Finland, having the high resource inputs and a good potential, despite facing several issues of current performance (will be addressed in detail in the following sections). Therefore, we specifically focus on marine transportation sector and we will disaggregate it into two sub sectors in case of Finland (table 4.7): marine cargo transportation and marine passenger transportation. Due to the data limitations, we were able to identify only marine cargo transportation in Estonia, while Finnish Amadeus data contains the record of both passenger and cargo transportation companies[9].

Table 4.7. Partial productivity of labour and fixed assets in blue sectors of Finland, industry ranking – year 2015

Labour productivity	
Turnover / Employees	**Profit / Employees**
1. Cargo transportation	1. Energy
2. Tourism	2. Cargo transportation
3. Marine construction	3. Bio & subsea activities
4. Energy	4. Marine construction
5. Passenger transportation	5. Tourism
6. Bio & subsea activities	6. Passenger transportation
Fixed assets productivity	
Turnover / Fixed assets	**Profit / Fixed assets**
1. Marine construction	1. Energy
2. Cargo transportation	2. Cargo transportation
3. Energy	3. Bio & subsea activities
4. Tourism	4. Passenger transportation
5. Passenger transportation	5. Marine construction
6. Bio & subsea activities	6. Tourism

[9] The major reason is non-availability of commplete financial records for maritime passanger transportation companies in Estonia. To ensure consistency, we included only firms, which reported all input and output inddicators, while the firms with imperfect data (at least one variable is missing) were excluded from analysis.

4.2.4. Efficiency of blue industries

In this section, blue industries' efficiency is assessed across two benchmarks. Namely, we evaluate efficiency of Estonian and Finnish blue sectors compared to other blue industries within respective country (within-country, Estonian and Finnish blue economics separately assessed) and across two countries (between-country, Estonian and Finnish blue economies are jointly evaluated). Industry input and output measures are taken as average across all companies operating in certain blue or non-blue sector. Thus, all inferences to efficiency scores and slacks are measured on average per industry. Efficiency analysis relies on application of DEA (Data Envelopment Analysis) methods (see Methodology part (3.3)).

Here we present the first set of results, analysing blue sectors efficiency relative to other blue industries and, thus, approximating the role of each blue sector blue economy performance.

A. Within-country assessment

A.1. Efficiency of Estonian blue sectors

Table 4.8 presents DEA estimation results for Estonian blue sectors within Estonian blue economy merely and yields the following results. Efficiency analysis is conducted implementing both, Input-oriented and Output-oriented models.

Table 4.8. Efficiency estimates of blue sectors in Estonia (within-country) – Amadeus 2015

Estonia	Rank	Efficiency score	Input slacks:			Output slack: Turnover	Returns to scale
			Fixed assets	Current assets	Labour		
Input oriented model							
Bio and subsea activities	3	68,0%	560,9 (7%)	1468,0 (37%)	0	0	Increasing
Energy	1	100,0%	0	0	0	0	Constant
Marine transportation	1	100,0%	0	0	0	0	Constant
Tourism	2	81,1%	55,0 (3%)	0	26 (50%)	55,1 (2%)	Increasing
Marine construction	1	100,0%	0	0	0	0	Constant
Output oriented model							
Bio and subsea activities	3	68,4%	0	1441,0 (37%)	0	0	Increasing
Energy	1	100,0%	0	0	0	0	Constant
Marine transportation	1	100,0%	0	0	0	0	Constant
Tourism	2	83,8%	0	0	27 (52%)	0	Increasing
Marine construction	1	100,0%	0	0	0	0	Constant

Source: Amadeus data from 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).

1) **Input oriented model** sets an objective to minimize inputs, but maintain current output (turnover) level. The results suggest that energy, marine transportation and marine construction sectors reach full and strong efficiency, since their efficiency score is 100% and all inputs and outputs have zero slacks. However, two sectors are not fully efficient under input-oriented model: bio & subsea activities sector (68% efficiency score) and tourism (81,1% efficiency). It implies that these two sectors area over-using resources, resulting in high production costs. Thus, if sectorial aim is to achieve full efficiency through reduction of inputs and thus decrease

in environmental pressures, while keeping turnover on the same level, the following recommendations follow from DEA analysis:

- Bio & subsea activities: overall inputs should be reduced by 32% (maximal efficiency minus actual) through employing more effective technologies and more accurate resource management. Input slacks suggest that even after overall cost reduction fixed and current assets use should be further reduced by on average 7% (560,9 th. EUR) and 37% (1468 th. EUR) in order to reach full efficiency.
- Tourism: overall inputs should be cut by 19% with further reduction in fixed assets by on average 3% (55 th. EUR) and employment by considerable 50%. Turnover slack identifies that there is an output shortage of average 2% (55,1 th. EUR), thus, to achieve full efficiency total industry turnover should be increased.

2) **Output oriented model** sets outcome maximization as objective function, provided a fixed level of input variables. As expected, efficiency scores under output-oriented approach are similar to input oriented, with full efficiency reached by energy, water transportation and marine construction sectors. Bio & subsea activities and tourism appear not fully efficient, as they reach only 68% and 83.8% efficiency scores. Based on output-oriented DEA model the following recommendations could be made:

- Bio & subsea activities: along with overall reduction of inputs by 32%, current assets should be further reduced by on average 37% (1441 th. EUR). Unlike input-orientation, objective is to maximize turnover, which can be achieved even with current resources lower than given.
- Tourism: to reach full efficiency through maximization of turnover, the sector should decease overall expenses by approximately 16% and further decrease employment by on average 52%.

A.2. Efficiency of Finnish blue sectors

Table 4.9 presents efficiency estimates of Finnish maritime industries, evaluated within blue economy merely. Both input- and output-oriented models revealed that when compared to other blue sectors, four out of five blue sectors achieve full efficiency: bio & subsea resources, energy, marine construction, tourism. Marine transportation is the only blue sector with efficiency falling under 100%, however, inefficiency is relatively insignificant, i.e. approximately 2 % in both models.

Table 4.9. Efficiency estimates of blue sectors in Finland (within-country) – Amadeus 2015

Finland	Rank	Efficiency score	Input slacks:			Output slack: Turnover	Returns to scale
			Fixed assets	Current assets	Labour		
Input oriented model							
Bio and subsea activities	1	100,0%	0	0	0	0	Constant
Energy	1	100,0%	0	0	0	0	Constant
Marine transportation	2	97,9%	20518,1 (45%)	0	84 (75%)	0	Increasing
Tourism	1	100,0%	0	0	0	0	Constant
Marine construction	1	100,0%	0	0	0	0	Constant
Output oriented model							
Bio and subsea activities	1	100,0%	0	0	0	0	Constant

Energy	1	100,0%	0	0	0	0	Constant
Marine transportation	2	97,9%	2300,0 (5%)	0	51 (45%)	0	Increasing
Tourism	1	100,0%	0	0	0	0	Constant
Marine construction	1	100,0%	0	0	0	0	Constant

Source: Amadeus data from 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).

1) **Input-oriented model** from suggests potential optimizations needed for tourism sector if the aim is to minimize costs, keeping the same level of economic output:

- Marine transportation: overall costs should be reduced by 2 % with the following decrease in fixed assets by 45% (20518,1 th. EUR) and employment expenditures by stunning 75%.

2) **Output-oriented model,** similarly to input-oriented suggest that efficiency of tourism sector can be further improved as follows:

- Marine transportation: overall input expenses to be reduced by 2% with additional reduction in fixed assets (5% or 2300 th. EUR on average) and labour expenses (45%).

B. Between-country assessment

Next, we evaluate efficiency of blue sectors in cross-country framework. The principal difference with the within-country framework is that 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 the industries' performance. Comparing within-country estimates to between-country allows reveal whether there are significant efficiency gaps across two countries and which sectors require particular attention and, possibly, could rely on the positive experience of the neighbouring state. Here we estimate the input- and output-oriented models, similarly to the previous section.

Table 4.10. Efficiency estimates of blue sectors in Estonia and Finland (between-country), input-oriented model – Amadeus 2015

Input oriented model	Rank	Efficiency score	Input slacks:			Output slack:	Returns to scale
			Fixed assets	Current assets	Labour	Turnover	
Estonia							
Bio and subsea activities	4	42,4%	0	0	0	0	Decreasing
Energy	1	100%	0	0	0	0	Constant
Marine transportation	1	100%	0	0	0	0	Constant
Tourism	2	81,0%	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	76,2%	734,0 (16%)	0	0	0	Increasing

Tourism	1	100%	0	0	0	0	Decreasing
Marine construction	1	100%	0	0	0	0	Constant

Table 4.11. Efficiency estimates of blue sectors in Estonia and Finland (between-country), output-oriented model – Amadeus 2015

Output oriented model	**Rank**	**Efficiency score**	**Input slacks:**			**Output slack:**	**Returns to scale**
			Fixed assets	**Current assets**	**Labour**	**Turnover**	
Estonia							
Bio and subsea activities	4	43,9%	0	0	0	0	Decreasing
Energy	1	100%	0	0	0	0	Constant
Marine transportation	1	100%	0	0	0	0	Constant
Tourism	2	83,7%	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	76,3%	0	0	0	0	Increasing
Tourism	1	100%	0	0	0	0	Decreasing
Marine construction	1	100%	0	0	0	0	Constant

Table 4.10 reports **the input-oriented model (i.e. cost reduction strategy)** results. Changing the benchmark did not alter the overall picture of sectorial efficiency, however, it changed the magnitudes of inefficiency level.

1) In **Estonia**, bio & subsea activities and tourism sectors remained the least efficient. Importantly, when compared to both Estonian and Finnish blue sectors, efficiency of bio & subsea activities reduced further to 42,2%. This result suggests that operation of bio & subsea activities sector is a subject to substantial problems, which appear to be even more evident, when the performance of the blue economy in the neighbouring Finland is taken as a benchmark. To reach the comparable level of efficiency, the overall costs (inputs) need to be reduced by 57,6%. In the tourism sector, the overall performance picture remained the same, with the only difference, that to achieve full efficiency, additionally to the production costs reduction of 19%, employment costs have to be cut by 50%.

2) In **Finland,** the maritime transport sector is the only inefficient, when compared to all blue sectors in Finland and Estonia. Important insight from the cross-country assessment is even lower efficiency of maritime transport, than in the within-country framework. When compared to only Finnish blue sectors overall efficiency reaches 97,9%, while in the cross-country framework it drops to 76,2%. This finding implies that maritime transportation reveals second worst efficiency level (after Estonian bio & subsea sector) in the cross-border framework. Moreover, input minimization strategy stipulates further reduction of fixed assets (by 16%), even after the overall reduction of input costs by 24,8% is performed.

Table 4.11 reports efficiency indicators under **the output-oriented model (i.e. production expansion strategy)**. Under the output-maximization model setting, the results are in line with the previously reported. Namely, in **Estonia**, bio & subsea activities and tourism sectors are worst performers, while in Finland maritime transportation appears to be strongly inefficient.

Conclusions and integration with previous findings: The results suggest that three out of five blue sectors in **Estonia** (energy, marine construction, marine transportation) appear to be strongly efficient. It implies that blue industries have important role in economy of a blue region, as they generate maximal efficiency through effective use of resources and achieving maximal economic outputs per unit of resources utilized. At the same time, bio & subsea activities and tourism are the two sectors with the lowest efficiency, and thus with the lowest value added to blue economy performance. Bio & subsea activities sector sets high objectives for the following years, specifically in the domain of aquaculture and farming of highly demanded species[10]. Moreover, documented development trends of the bio & subsea activities sector is rather positive. However, when compared to both Estonian and Finnish blue industries, bio & subsea activities sector appear to have even lower efficiency, suggesting that in cross-border scale, the sectors is even more disadvantaged. Inefficiencies of both sectors are largely generated by fixed assets excess. Apparently, if firms within these two blue sectors set as objective cost minimization, fixed assets surplus, which should be illuminated to achieve full efficiency, is drastic. If companies target output maximization, they could achieve full efficiency with relatively smaller, but still substantial, fixed assets reduction (bio & subsea activities only). Thus, overall results suggest that there still space for improvement of economic performance and strengthening economic role of blue industries in region's economies without employing additional resources and increasing environmental pressures, particularly in bio & subsea activities and tourism.

In **Finland** four out of five sectors are fully efficient (bio & subsea resources, energy, marine construction, tourism). Only marine transportation sector is being inefficient in Finland. Fixed assets are the most excessive resource, yielding lower efficiency of marine transportation sector. Moreover, the results, suggest that marine transportation sector reveals rather non-increasing trends in the performance indicators for the following years (de Andres Conzales et al. (2018). These findings, coupled with the evidence from the given deliverable suggests that marine transportation sector in Finland needs special attention of maritime spatial planners, as it accounts for a large share of overall blue economy assets and outputs, with rather unstable performance indicators.

Among not-perfectly efficient industries there is one common and important pattern in both countries, Estonia's and Finland's regions – most of them have an **excess of fixed assets**, which conveys extra costs for business, lower efficiency and, importantly, to some extent **generate environmental pressures**. This goes in line with earlier result from productivity assessment, which reported lower productivity of fixed assets in blue economy, compared to non-blue. Reduction of excessive fixed assets through more careful resource management, more effective operation technologies would positively reflect on sectorial performance and efficiency and, importantly, potentially reduce environmental pressures.

4.2.5. Efficiency of blue sectors: marine transportation in Finland case study

The findings of the previous section motivated a more detailed investigation of the inefficient sectors. In the previous section, we document strong inefficiency of marine transportation in Finland (see Tables 4.10 and 4.11). Given that marine transportation constitutes a significant

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[10] For more information see de Andres Conzales et al. (2018). *Report on blue economic potential, sectors strategies, and development trends* (DT.1.6.1.)

share in overall inputs and outputs of Finnish blue economy (see Figure 4.2.1.3), disproportionalities in the performance of the sector may have strong negative externalities on the performance of the whole Finnish blue economy.
Hence, in this section we will provide a more detailed look at efficiency levels of the marine transportation sector in Finland.

Table 4.12. Efficiency estimates of blue sectors in Finland (within-country) – Amadeus 2015

Finland	**Rank**	**Efficiency score**	**Input slacks:**			**Output slack:**	**Returns to scale**
			Fixed assets	**Current assets**	**Labour**	**Turnover**	
Input oriented model							
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	2	87,2%	29374,2 (43%)	0	74 (50%)	0	Decreasing
Tourism	1	100%	0	0	0	0	Increasing
Marine construction	1	100%	0	0	0	0	Constant
Output oriented model							
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	2	88,1%	29227.3 (43%)	0	79 (53%)	0	Decreasing
Tourism	1	100%	0	0	0	0	Increasing
Marine construction	1	100%	0	0	0	0	Constant

Table 4.12. presents the estimates, similar to the Table 4.11 and 4.10, however with marine transportation sector disaggregated into 2 subsectors (cargo and passenger transportation). The major finding is that two transportation sub-sectors reveal drastically different efficiency measures. Namely, imperfect efficiency of cargo transportation in Finland is driven by cargo transportation, while passenger transportation reveals complete efficiency. Moreover, in aggregate transportation sector achieved efficiency was about 97%, thus, only 3% below the fully efficient operation. However, in disaggregated cargo transportation, performance level varies from 87.2% to 88.1%, depending on the background model type.

1) **Input oriented model** sets an objective to minimize inputs, but maintain current output (turnover) level. Under this approach, cargo transportation spears the only inefficient sector in Finland. To achieve full efficiency, the overall resource costs have to be reduced by 12.*%, with further reduction of fixed asset by 43% and labour by 50%.

2) **Output oriented model** sets outcome maximization as objective function, provided a fixed level of input variables. Under this specification, marine cargo transportation still remains the only inefficient sector in Finland. To achieve 100% efficiency level, overall expenses should be reduced by 11.9%, additionally fixed assets and labour should be cut down by 43% and

53% respectively.

Hence, regardless the operation objective, the major driver of low efficiency of blue sectors is substantial excess of fixed assets and labour. This excess may be related to poor resource management, inefficient operation and technologies, and [potentially other factors, driving high resource consumption and disproportional return to utilized (held) resources.

Next, we look at two Finnish transportation sub-sectors in cross-country framework. This will provide an insight of transportation sector operation in broader perspective.

Table 4.13. Efficiency estimates of blue sectors in Estonia and Finland (between-country), input-oriented model – Amadeus 2015

Input oriented model	**Rank**	**Efficiency score**	**Input slacks:**			**Output slack:**	**Returns to scale**
			Fixed assets	**Current assets**	**Labour**	**Turnover**	
Estonia							
Bio and subsea activities	4	42,0%	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	74,8%	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 4.14. Efficiency estimates of blue sectors in Estonia and Finland (between-country), output-oriented model – Amadeus 2015

Output oriented model	**Rank**	**Efficiency score**	**Input slacks:**			**Output slack:**	**Returns to scale**
			Fixed assets	**Current assets**	**Labour**	**Turnover**	
Estonia							
Bio and subsea activities	4	39,5%	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	77,3%	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	76,9%	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

Tables 4.13 and 4.14 compare all Finnish blue sector to each other, and also to respective Estonian blue sectors. The results reveal that, than Finnish cargo transportation is analysed in cross-country framework, it reports even worse efficiency level, compared to within-country setting.

1) **Input oriented model:** to achieve 100% efficiency, overall resource expenditures should be reduced by 25.2%, with further reduction of fixed assets by 7%.

2) **Output oriented model**: to achieve full efficiency, overall resources need to be reduced by 23.1% and, additionally, fixed resources and labour should be cut down by 9% each.

Lower efficiency of marine cargo transportation in the cross-country framework, compared to within-country, signals relatively higher overall efficiency of Estonian sectors. Hence, when compared to both Estonian and Finnish sectors, cargo transportation appears even less efficient, than compared to Finnish marine industries only.

4.2.6. Input-output sensitivity of blue industries

This section of the deliverable presents sensitivity estimates addressing interrelation between several inputs and outputs (introduction to sensitivity analysis is presented in the Methodology part (3.4)). Namely, we focus on sensitivity of sectorial turnover and profits to the changes in fixed assets (both total and tangible only), current assets and labour. Similarly, to productivity assessment we will explore sensitivity of blue economy in two frameworks: cross-sectorial and cross-regional. We present estimates for sensitivity of blue sectors' turnover and profit relative to total fixed assets and tangible fixed assets on Figures 4.3, 4.4., 4.5 and 4.6. Full regression estimates, long with detailed functional specifications are enclosed in Appendix 4.

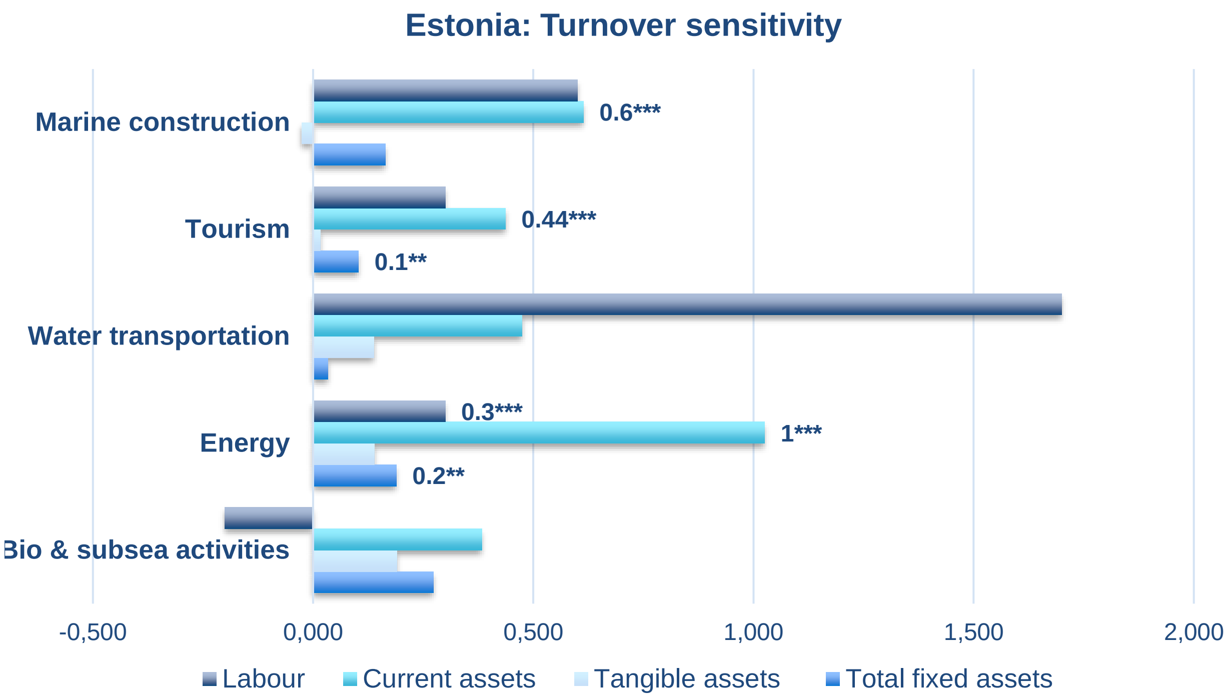


Figure 4.3. Regression estimates of output sensitivity. Estimated using panel regression model and Amadeus data from years 2010-2015 for Estonia. ** and *** correspond to 5% and 1% statistical significance respectively. Only elasticity coefficients significant at 5% or less are plotted.

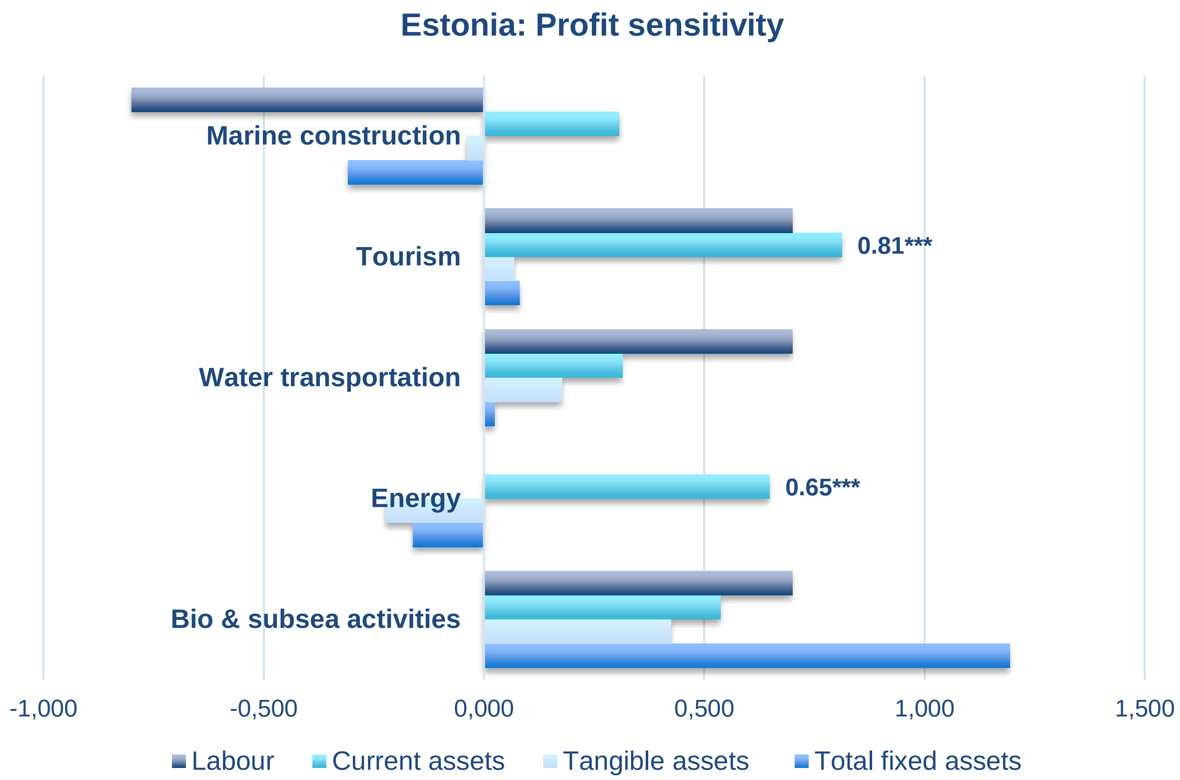
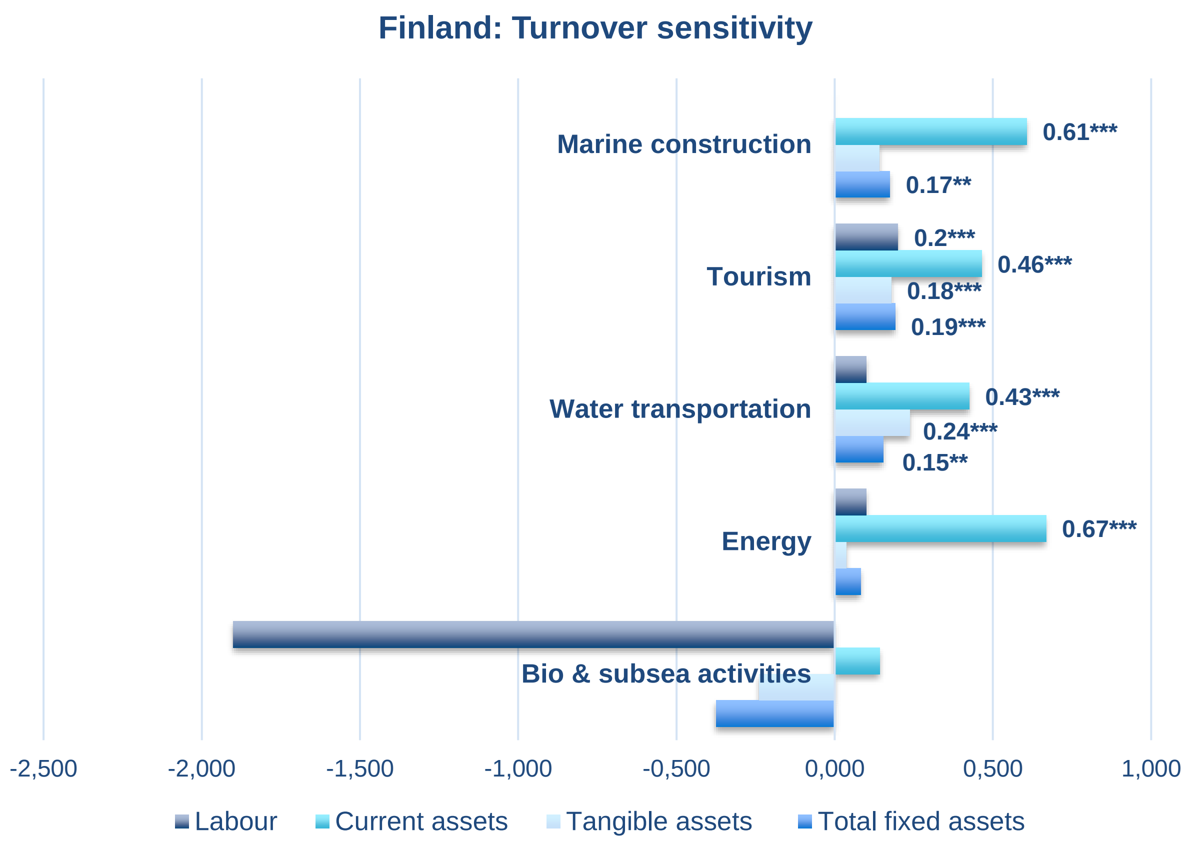


Figure 4.4. Regression estimates of output sensitivity. Estimated using panel regression model and Amadeus data from years 2010-2015 for Estonia. ** and *** correspond to 5% and 1% statistical significance respectively. Only elasticity coefficients significant at 5% or less are plotted.

The figures above present sensitivity coefficients of Estonian blue sectors. Association between assets and sectorial growth is captured by sensitivity coefficients of turnover. In Estonia, the strongest statistically significant associations between total fixed assets and turnover are observed in energy sector (1% increase in total fixed assets is associated with 0.19% increase in turnover) and tourism (1% increase in total fixed assets is associated with 0.1% increase in turnover). Weak association ($p = 10\%$) between total fixed assets and turnover is observed in marine construction sector (1% increase in total fixed assets is associated with 0.16% increase in turnover). Noteworthy, we have not documented strong and statistically significant association between tangible fixed assets and turnover. Current assets are significantly correlated with turnover in several blue industries, including marine construction (0.61%), tourism (0.44%) and energy (1%). Labour resource implies significant association with turnover in blue tourism sector (0.1%) and energy (0.2%). Hence, statistically strongest association with turnover is documented for current assets, however, it can be largely related to the nature of turnover, as it is directly related to cash flows, which are captured by the current assets.

Sensitivity of profit w.r.t. analysed resources in Estonia is statistically weaker, compared to profit sensitivity. The only significant association is documented for current assets in tourism and energy sectors. However, sensitivity indicators need to be addressed with caution, since insignificant coefficients may appear due to several factors. Firstly, there may be not enough observations for certain sectors[11]. Secondly, insignificant association may arise as a result of sector's inefficient operation and excess of certain resource. In this case, excessive resource mass lowers significance of input-output association, as excessive resources do not yield proportional output.



[11] This refers to Type II error (false negative).

Figure 4.5. Regression estimates of output sensitivity. Estimated using panel regression model and Amadeus data from years 2010-2015 for Finland. ** and *** correspond to 5% and 1% statistical significance respectively. Only elasticity coefficients significant at 5% or less are plotted.

Figure 4.6. Regression estimates of output sensitivity. Estimated using panel regression model and Amadeus data from years 2010-2015 for Finland. ** and *** correspond to 5% and 1% statistical significance respectively. Only elasticity coefficients significant at 5% or less are plotted.

Finnish blue sectors reveal, on average stronger sensitivity of outputs vs. inputs, compared to Estonian blue industries. Similarly to Estonian case, turnover is, generally, more sensitive relative to resources variation, while profit associates significantly only with current assets.

In Finland, the strongest association between total fixed assets and turnover was documented in tourism sector (1% increase in total fixed assets is associated with 0.19% increase in turnover), as well as in water transportation and marine construction (1% increase in total fixed assets is associated with respectively 0.15% and 0.17% turnover increases). Importantly, sensitivity of turnover relative to tangible assets is the highest in tourism and water transportation (1% increase in tangible fixed assets is associated with respectively 0.18% and 0.24% turnover increases). Labour significantly associates with turnover only in tourism sector (0.2%), while current assets yield statistically significant association with turnover in tourism sector (0.46%), in marine construction (0.6%), in water transportation (0.43%) and energy (0.67%).

These findings address us to a conclusion that there is clear association between fixed assets and sectorial growth, approximated with turnover, in tourisms sector both in Estonia and Finland, while energy sector is significantly sensitive in Estonia only, and marine construction along with water transportation – only in Finland. Moreover, we document, on average, low association between sectorial growth and profitability with labour resource, with the only exception of energy sector in Estonia and tourism sector in Finland. Surprisingly, we do not document significant association between assets expansion and sectorial profitability increase.

Thus, turnover growth has been mainly generated by fixed assets and that often has not been accompanied by profit' growth and efficient use of resources. Particularly evident is that in tourism sector if Finland. This conclusion is in line with our earlier results (see parts 4.2.2 and 4.2.3) that there is often excess of fixed assets that may generate additional environmental pressures and low efficiency of economic activities.

Blue regions' economies of both countries (like also non-blue economies) need implementation of innovations, new technologies and more careful resource management to improve efficiency performance and diminish environmental pressures. The results should be considered by the elaborating Blue Growth Scenarios and promoting cross-border cooperation of coastal areas. Well-developed cross-border cooperation will open new possibilities for more efficient use of resources and particularly tangible assets and thereby also decline excess of fixed assets and environmental pressure.

4.2.7. Sensitivity of blue sectors: marine transportation in Finland case study

This subsection addresses Finnish marine transportation sector in detail, focusing on passenger and cargo transportation. Figure 4.7 presents elasticity estimates for two subsectors, across four resources and two outcomes. Complete regression results are provided in Appendix 5.

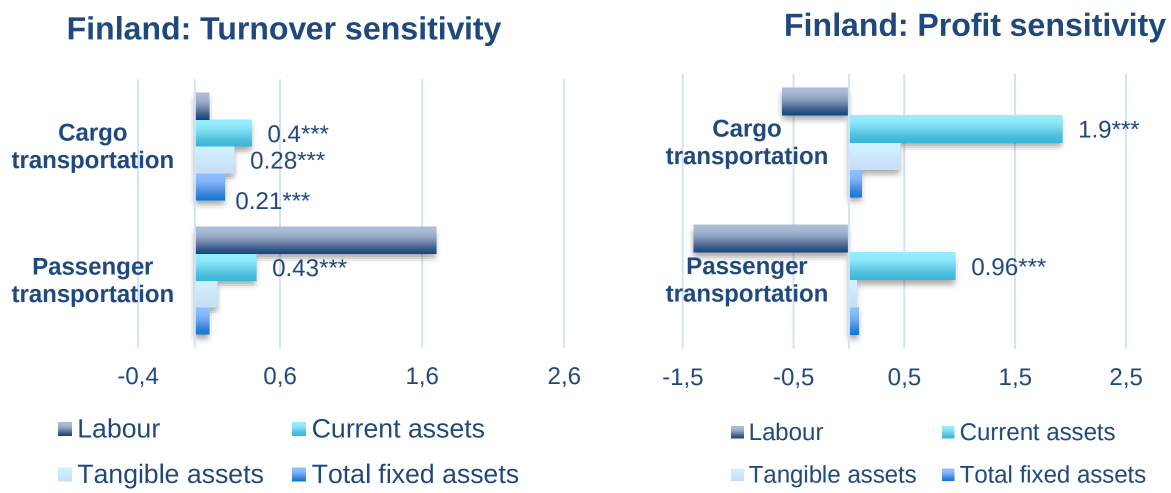


Figure 4.7. Regression estimates of output sensitivity of maritime cargo and passenger transportation. Estimated using panel regression model and Amadeus data from years 2010-2015 for Finland. ** and *** correspond to 5% and 1% statistical significance respectively. Only elasticity coefficients significant at 5% or less are plotted.

The results reveal that marine cargo transportation has, on average, statistically stronger sensitivity, compared to passenger transportation. Specifically, we found significant association between current assets, total fixed assets, and tangible fixed assets and turnover for cargo transportation, while in passenger transportation sector, significant coefficient is reported only for current assets. Noteworthy, despite lower statistical significance, passenger transportation reveal higher economic significance of some coefficients, namely labour resource (0.1% in cargo and 1.7% in passenger), and current assets (0.4% in cargo and 0.43% in passenger). Profit after tax reports significant associations with current asset only (1.9% in cargo and 1% in passenger).

Hence, marine transportation subsectors reveal moderate sensitivity, with cargo transport statistically outperforming passenger transportation. This finding needs to be addressed jointly with the results from section 4.2.4, since low sensitivity is tightly related to overall economic performance and, specifically, efficiency. These findings will be integrated and discussed in the following

5. SECTOR-SPECIFIC ECONOMIC PROFILES

In this part of the study sector-specific economic profiles of the main blue sectors of Estonia (5.1) and Finland (5.2) are presented. These profiles represent the synthesis of blue sectors economic performance analysis based on the methodological framework presented in the Fig. 1.1. Relying on the performance analysis results and some experts' opinions, the following activities are chosen for the sector specific analysis: bio & subsea, energy, marine cargo transportation, blue tourism and marine construction. In the case of Finland, marine passenger transportation profiles are also elaborated. The synthesis comprises the results of descriptive analysis and productivity, efficiency and sensitivity analyses reflecting also main strengths and weaknesses of the sectors-specific economic profiles.

5.1. Estonian blue sectors

1. Bio & subsea activities

<table>
<tr><th>Dimension</th><th>Economic profile</th><th>Strengths & weaknesses</th></tr>
<tr><td>Descriptive</td><td>The bio & subsea activities sector reveals the second largest average per-business-unit amount of fixed and current assets (27% and 14% respectively), and the fourth largest number of employees (13%). However, the sector's average per-business-unit turnover and profit is much lower in absolute amount and in percent of blue economy's total average outputs (11% and 10% respectively). Hence, these raw measures signal potential inefficiencies in resource use.</td><td rowspan="2">The major driver of sectorial low efficiency is an excess of resources and low rate of return to the total amount of resources. Excess of fixed assets suggested by DEA analysis, coupled with low productivity of fixed assets, points towards certain issues in fixed resources management, utilization and, possibly, overall underperformance of the sector.

To achieve full efficiency, the total resources employed in the sector need to be reduces by, at least, 32% (low margin is stipulated by within-EE framework).

Based on DEA results, to increase efficiency to 100%, two possible strategies can be pursued:

1. Cost minimization: reduce total resources by 32%, additionally reduce fixed assets by 7% and current assets by 37%.

2. Production expansion: reduce total resources by 32%, additionally reduce current assets by 37% (no additional fixed assets reduction).

Reduction of fixed assets will, potentially, yield positive environmental externalities, as it will decrease environmental pressures,</td></tr>
<tr><td>Productivity</td><td>Productivity analysis highlights efficiency of single resource vs. single output. However, this tells nothing about effectiveness of other resources. The sector reveals the highest productivity of labour in terms of profit after tax, and average in terms of turnover. Thus, highly productive labour suggests that effectively managed and generates the highest per person return, as compared all other blue sectors.</td></tr>
</table>

	However, productivity of fixed assets is the lowest among all blue sectors.	largely embodies in the sectorial material resources. However, improvement of resource management and measures aiming to increase productivity should accompany reduction and, potentially, offset the need to cut inputs. DEA procedure does not account for these, however, improved technology can increase productivity of fixed assets, resulting in smaller reduction needed to achieve full precision.
Efficiency	The least efficient blue sector in Estonia, and in the joint blue area of Estonia and Finland. The sector reveals ca. 68% efficiency as compared to other Estonian sectors and ca 43% when analysed relative to both Estonian and Finnish blue sectors. Imperfect efficiency represents an excess of resources and, especially, fixed assets.	
Sensitivity	Two major outputs of interest – turnover and profit – are not sensitive w.r.t. neither of the analysed resources (fixed and current assets, labour).	Insignificant association between resources and outputs, on the one hand, suggest that further investments in these resources should be made cautiously, as they may not pay off at expected rate. On the other hand, low sensitivity makes it less risky to decrease an excessive fixed and current assets, as most likely their excess is one of the factors, driving the observed insignificant association. Elimination of resources' excess and improvement of resource management may improve sector's investment attractiveness in future.

2. Energy sector

Dimension	Economic profile	Strengths & weaknesses
Descriptive	Energy sector is clearly the biggest blue sector in Estonia, in terms of resources and outputs. The sector holds the largest shares of fixed and current assets (53% and 79% respectively), employs the largest amount of people (46% of labour force) and generates the biggest share of blue economy's turnover and profit (67%). The indicators suggest resourceful operation and high performance.	The sector is one of the strongest and most efficient in Estonian blue economy. The current performance indicate that majority of blue economy resources are concentrated in the energy sectors and, most importantly, they are utilized efficiently and generate high returns. Overall result suggests that Estonian energy sector can be used as a "good practice" example for other blue industries.
Productivity	Estonian energy sector reveals the highest labour productivity in terms of sectorial turnover and second highest in terms of profit. Relative productivity of fixed assets is marginally lower, as compared to labour productivity of the sector.	

Efficiency	Strongly efficient sector. No excess of fixed assets is documented.	
Sensitivity	The association between variation in resources and outputs is the most significant in Estonian energy sector. In terms of turnover, 1% increase in labour associates with 0.3% increase in turnover, while total fixed and current assets increases of 1% translate into 0.19% and 1% raises in turnover. Associations between resources and profit are weaker, with pronounced significant association only for current assets (0.65% increase in profit, per 1% increase in current assets).	High sensitivity of outputs, coupled with full efficiency and no excessive resources, signals that the sector may have a sound investment potential. Current resources are effectively utilized and significantly associate with turnover (industry growth). Hence, further investments are likely to yield high return rates in terms of turnover. However, investment reflections on profits are not straightforward. Firstly, fixed assets reveal statistically insignificant but negative association with profit. Hence, further investments in material resources need to be cautious and account for potentially low returns.

3. Marine cargo transportation

Dimension	Economic profile	Strengths & weaknesses
Descriptive	In terms of average share in Estonian blue economy, marine cargo transportation is third sector in terms of fixed and current assets (5% and 3% respectively), as well as number of employees (6%). Importantly, sectorial share in terms of turnover and profits corresponds to or exceeds the shares of resources (6% of turnover and pofits). Hence, the average output to input ratio is positive.	Marine cargo transportation is an average sector in terms of volume and operation output. The sector is relatively stable in terms of resource productivity and fully efficient. These findings, generally, suggest that cargo transportation may have a good potential for further growth and expansion. Possibly, individual resources (labour, fixed assets) need more precise management, as they reveal relatively average productivity, while having no excesses. Further improvement of resources productivity has a potential to increase output further and achieve even higher performance levels.
Productivity	Marine cargo transportation reveals average productivity of labour and fixed assets.	
Efficiency	Fully efficient sector, both in within-Estonia and Estonia-Finland blue region scale, with no excesses of resources.	
Sensitivity	The sensitivity analysis revealed no significant associations between the resources and outputs.	Insignificant elasticity of outputs has to be address, keeping in mind full efficiency of the blue sector. Insignificant sensitivity can signal that performance of the sector may not improve further at the rate, equivalent to the investment rate. Current high performance indicators reflect successfully operation of the sector with given resources, however, further investments need to be done with a note of concern, since returns to these investment

		may be relatively lower. Moreover, investments in material resources and labour, if not accurately planned and measured, may generate excessive resources in future, which will drive performance indicators down.

4. Blue tourism

Dimension	Economic profile	Strengths & weaknesses
Descriptive	Blue tourism holds relatively small share of overall blue economy's stock of current assets and fixed assets (4% and 6%), while relatively big share of employees (19%). Output indicators are proportional to inputs of fixed and current assets (6% of both turnover and profit after tax), however, in terms of absolute number, labour resource may be relatively excessive, since the ratio of overall share of employees to turnover and profit is relatively high.	When analyzing individual resources and outputs, the most evident is low productivity of labour. Potentially excessive labour resource is observed already from the raw data (descriptive analysis). Further productivity assessment supports the point that labour resource generate relatively low per employee return. The final evidence from DEA analysys verifies that tourism sector is second in terms of efficiency (at best 84% efficiency), which is largely driven by the excess of labour and fixed resources. DEA analysis stipulates two alternative strategies to increase efficiency to 100%: **1. Cost minimization:** reduce total resources by 19% at least, additionally reduce fixed assets by 3% and labour by 50% at least. **2. Production expansion:** reduce total resources by at least 16%, additionally reduce labour by at least 50% (no additional current assets reduction). Hence, performance improvement required, firstly, improvement of labour resource management. While DEA interpretations suggest mere reduction, alternative strategy can be increase in labour productivity. DEA procedure assumes no technological, managerial or any other modification and innovations. Hence, resource reduction can be moderated by improvement of management (in case of labour) and financial procedures (in case of current assets).
Productivity	Tourism sector has the lowest productivity of labour (both in units of turnover and profit). Productivity of fixed assets is second worse among Estonian blue sectors.	
Efficiency	The second least efficient sector in Estonia. DEA results suggest that tourism sector achieves the maximum of 84% efficiency, as compared to other blue sectors in Estonia, as well as Estonia and Finland jointly. Imperfect efficiency in attributed to excessive fixed assets and labour. Along with imperfect efficiency, fixed assets excess implies environmental pressure, which is not sufficiently justified by economic returns.	
Sensitivity	Blue tourism reveals relatively weak, but significant sensitivity of fixed assets w.r.t. turnover, namely 0.1% increase in turnover, associated with 1% increase in fixed assets. However, both turnover and profit are sensitive w.r.t. current assets, yielding respectively 0.44% and	Significant elasticity of turnover to fixed and current assets suggest that any adjustments of these two resources need to be carefully evaluated. Excess of fixed assets, documented by DEA, suggest resource reduction, however, it may result in further decline in turnover, stipulated to significant elasticity. At the same time, further investments in neither

	0.81% increases, associated with 1% growth of current assets.	fixed, nor current resources may be not appropriate (despite significant elasticity), since the sector experience imperfect performance and overall efficiency needs to be first improved.

5. Marine construction

Dimension	Economic profile	Strengths & weaknesses
Descriptive	The share of marine construction in overall blue economy resources is varying. Namely, the sector holds a very small share of overall economy current assets (1%), while the share of labour resource and fixed assets is rather substantial (16% and 10% respectively). The sector's proportion of overall turnover and profit after tax outputs is 10%. Hence, the only resource, which exceeds in percentage share the output level is labour.	Despite the blue construction sector is fully efficient (DEA results), analysis of individual resources and outputs reveals potential threats for sectorial future performance. Namely, labour resorce has relatively low productivity and, given that the construction sector employs 16% of overall blue economy's labour, this can, potentially, generate excess of labour force in future. Due to efficient utilization of other resources and relatively high performance, potential problems with labour force management may be not evident. However, the results signal that more cautious personnel management is needed.
Productivity	The sector reveals the highest fixed assets productivity among all blue sectors in Estonia. Productivity of labour is average (second best in terms of units of turnover and second worst in terms of profit after tax).	
Efficiency	Marine construction is fully efficient sector, with no excesses of fixed, current assets and labour.	
Sensitivity	The sector reveals relatively low and insignificant sensitivity of turnover and profit w.r.t. fixed assets. Current assets are significantly associated with turnover (0.61% increase with 1% raise in current assets), however, not with profit after tax. Sensitivity of profit w.r.t. labour reveals an interesting pattern, since the elasticity coefficient, despite being insignificant is drastically negative (-0.8% decrease in profit with 1% increase in labour).	Sensitivity results yield a number of important implications. Firstly, negative elasticity of profit w.r.t. labour can relate to low productivity and relatively high share of labour force is sector's resource profile. It signals that personnel management need to target efficiency of employees and important aspect is improvement of labour productivity via modification and updating of technologies and production processes. Reduction of labour may be not the most feasible strategy, since, when analysed together, resource profile is efficient. Similarly, further investments in the fixed assets are not reasonable, due to low and weak sensitivity and relatively substantial current stock of material resources. Potentially, current assets can be increased further, as their current share is low and they are found to positively associate with turnover and (weakly) with profit.

5.2. Finnish blue sectors

1. Bio & subsea activities

<table>
<tr><th>Dimension</th><th>Economic profile</th><th>Strengths & weaknesses</th></tr>
<tr><td>Descriptive</td><td>The sector holds the lowest stock of resource among all blue sectors in Finland. The current and fixed assets account for only 1% of respective overall blue economy's resource stocks. The sector employs 2% of overall blue economy's labour resource. The output share correspond to the resources held, namely, bio & subsea activities account for 1% of blue economy's turnover and profit.</td><td rowspan="3">The sector is the smallest, in both resources and outputs, among all Finnish blue industries. However, the results, generally, suggest that Finnish bio & subsea activities sector have much better economic performance, compared to identical Estonian sector. The main advantage of Finnish bio & subsea activities is perfect efficiency and no excess of resources. Nonetheless, bio & subsea fixed assets, despite revealing no excess, has the lowest productivity among all blue sectors. This finding suggests to put special emphasis on fixed assets, as their generate the lowest return and may turn into excessive inputs, if not monitored and managed cautiously. Furthermore, unproductive fixed assets will rise an issue of unjustified environmental pressures, in case of even minor excess.</td></tr>
<tr><td>Productivity</td><td>The sector has an average labour productivity in terms of both turnover and profit after tax. Similar to Estonian bio & subsea activities sector, Finnish industry has the lowest fixed assets productivity. This suggests potential resource management issues, as material resources possessed by the bio & subsea activities sector are not generating returns comparable to other sectors.</td></tr>
<tr><td>Efficiency</td><td>The sector is fully efficient, both when compared to Finish blue sectors only, as well Estonian and Finnish sectors together.</td></tr>
<tr><td>Sensitivity</td><td>Sectorial turnover reveals low sensitivity to variation in fixed, current assets and labour. The only significant association is documented for current assets and profit after tax (1.7% increase in profit after tax with 1% increase in current assets). Importantly, several elasticity measures turned out negative, albeit insignificant. Tangible fixed assets are weakly negatively associated with both turnover and profit. Labour resource is weakly negatively associated with profit only.</td><td>Sensitivity results suggest that, based on the data in hand, further investments and expansions of resources, especially fixed assets and labour, need to be done with caution. Fixed tangible assets are negatively (statistically insignificantly) related to turnover and profit. Hence, further investment in expansion of tangible assets may be inappropriate. Further investments in expansion of other resources may either give low returns, or reflect negatively on overall performance of the sector. However, given sound efficiency, but low sensitivity, investments may tackle modernization of resources, especially fixed assets (lowest productivity in the blue economy). Improvement of resource quality, technological complexity and, hence, productivity, couple with improved resource management, may bring positive returns in future.</td></tr>
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2. Energy sector

Dimension	Economic profile	Strengths & weaknesses
Descriptive	Similar to Estonia, energy sector is the biggest among all Finnish blue industries. The sector employs 86% of blue economy's current resources, 76% of fixed resources and 44% of labour resource. The sector also contributes the most to the blue economy's output in Finland (85% of turnover and profit after tax). Hence, the resources are relatively balanced with the output.	Finnish blue energy sector is the biggest blue industry, similarly to the Estonian blue energy sector. The sector reveals high potential and good performance indicators. Perfect efficiency suggests that all resources, as a total input into production, are effectively used and managed. However, the evidence on relatively low profitability of fixed assets specifically cast doubts on fixed assets management. Hence, despite the results of analysis do not report fixed assets excess, their low productivity may signal potential future problems, in case if even marginal excess of fixed assets emerges.
Productivity	Energy sector reports the highest productivity of labour among all blue sectors in Finland. However, productivity of fixed assets is relatively lower. Energy sector ranks fourth in terms turnover per unit of fixed assets, and second in terms of profit.	
Efficiency	Energy sector reveals full efficiency in both within and cross-country frameworks.	
Sensitivity	Resources in energy sector is relatively less elastic w.r.t. outputs, as compared to other blue sectors in Finland. The only significant association is documented for current assets: 1% increase in current asserts associate with 0.67% and 0.89% increases in turnover and profit respectively.	Relatively low sensitivity in the context of energy sector signal relatively low returns to future investments. Given fully efficient use and no excess of resources, low sensitivity is not related to excessive inputs. Hence, insignificant elasticity is rather an indicator of imperfect resource management, and, potentially, reaching the "maximum" of resources given current output level. Hence, further investments into sectorial resources need additional thorough analysis of expected return rate.

3. Marine cargo transportation

Dimension	Economic profile	Strengths & weaknesses
Descriptive	Finnish marine cargo transportation accounts for a large share of resources, namely 17% of fixed assets, 9% of current assets and 26% of employees, making it second biggest sector in terms of utilized resources. The output level is 9% of turnover and 14% of profit. Hence, employment resource share drastically exceeds both outputs shares.	Marine cargo transportation is one the biggest blue sectors in Finland, holding a large share of blue economy's resources. However, the sector is one of most inefficient Finnish blue sectors. Despite high productivity of individual resources, overall input-output profile of the sector is inefficient, implying that resources are not generating returns, proportional to comparable resources employed in other sectors.

Productivity	Finnish marine cargo transportation reveal high labour productivity (first best w.r.t. turnover and second best w.r.t. profit). Productivity of fixed assets is second best among Finnish blue sectors, both relative to turnover and profit.	DEA analysis stipulates two alternative strategies to increase efficiency to 100%: **1. Cost minimization:** reduce total resources by 13%, additionally reduce fixed assets by 43% and labour by 50%. This will yield 100% efficiency in within-Finland scale. To reach full efficiency in Estonia-Finland scale, total resources need to be cut by 25%, and additionally fixed assets by 7%. **2. Production expansion:** reduce total resources by at least 26%, additionally reduce fixed asserts by 43% and labour by 53%. To achieve full efficiency Estonia-Finland scale, total resources should be reduced by 23% and additionally fixed assets and labour by 9% each. Hence, inefficiency of marine cargo transportation sector is potentially linked to resource management issues, drawbacks of overall operation and imperfections of managing material resources.
Efficiency	Cargo transportation reveals second worse efficiency level (88% in within-Finland scale, and 75% to 77% in Estonian-Finnish scale). The major driver of imperfect efficiency are excessive fixed assets and labour.	
Sensitivity	The sector reveals statistically significant, but economically average, sensitivity of turnover. Namely 1% increase in current assets or fixed assets implies 0.4% or 0.2% increases of turnover respectively. Profit is less sensitive to resources variations. The only significant association is documented for current assets (1.9%).	Sensitivity measures, coupled with low efficiency suggest that resources, despite their excess are still likely to generate positive returns. Hence, reduction of resources, suggested by DEA, needs to be cautiously evaluated, since sharp reduction of fixed assets can negatively reflect on sectorial growth (turnover). Hence, the dominant strategy should tackle improvement of resource management and better organization of resource portfolio, rather than mere reduction of fixed assets. Labour resource, revealing no significant sensitivity, may be less strongly interrelated with immediate changes in outputs. However, reduction of labour force needs to be further evaluated, since low sensitivity may be driven by excessive labour resource. In this case, reducing a number of employees with both increase efficiency measure and elasticity w.r.t. labour.

4. Marine passenger transportation

Dimension	Economic profile	Strengths & weaknesses
Descriptive	Marine passenger transportation accounts for relatively low share of resources: less than 1% of fixed resources, about 1% of current resources and 7% of labour resource.	Despite being fully efficient, the sector's fixed assets and labour resources are less productive, compared to other blue sectors in Finland. Low productivity of labour attributed to the share of employees being

	The sectorial share in outputs constitute 2% of turnover and 1% of profit after tax. Hence. Similarly to cargo transportation, share of employed labour substantially exceed share of produced outputs.	disproportionally larger than produced outputs. One potential explanation is good management of overall resource portfolio, which is eventually more important for performance, than productivity of individual resources. However, these findings still indicate necessity of potential improvements of resources management, especially in case of labour. Fixed assets also needs to be paid additional attention, since their low productivity can, ultimately, results in excessive stock of the resource.
Productivity	Passenger transportation has, on average, lower productivity of both fixed assets and labour, compared to marine cargo transportation. Specifically, the sector rankes the worst in labour productivity w.r.t. profit and second worst w.r.t. turnover. Productivity of fixed assets w.r.t. turnover and profit is average.	
Efficiency	The sector is fully efficient, with no excesses of assets documented.	
Sensitivity	Sensitivity of outputs w.r.t. inputs is relatively less statistically significant, compared to cargo transpiration. Significant association with turnover and profit is reported only for current assets (0.43% and 1% respectively).	Low significance of sensitivity measures suggest that resources investments may not generate substantial returns. However, given low productivity of individual resources, further expansion of those is not feasible. However, it indicates that investments in technology and improvement of operational procedures are needed, in order to improve resource productivity.

5. Blue tourism

Dimension	Economic profile	Strengths & weaknesses
Descriptive	Finnish blue tourism sector employs the smallest share of resources, compared to all other blue sectors. The sector holds less than 1% of current assets, 2% of fixed assets and 11% of labour resource. The tourism sector generates 6% of blue economy's turnover and profit.	The blue tourism sector is the smallest sector in Finnish blue economy in terms of resources and second smallest in terms of outputs. However, the sector is fully efficient and reveals no resources excesses, even when compared to both Estonian and Finnish blue industries. The only aspect, revealing imperfect operation, is labour resource, as it revels the lowest productivity level, which can signal about certain issues in personnel management. Hence, labour resource needs additional attention, due to potential threat of labour excess in the future, which could happen if productivity of labour will remain the lowest among all blue sectors.
Productivity	Finnish tourism sector, similar to Estonian blue tourism industry, reveals the lowest labour productivity, compared to all other blue sectors. These finding is closely related to the descriptive evidence on disproportionally large share of labour resource, as compared to the output level. Productivity of fixed assets w.r.t. turnover is the highest among all blue sectors, while w.r.t. profit only fourth, out of five sectors.	
Efficiency	Tourism sector is fully efficient both in the Finnish, and Finnish-Estonian scale.	

Sensitivity	The sector reveals the most statistically significant sensitivity of turnover relative to all resources. Namely, 1% increases in labour, current and total fixed assets associate with, respectively, 0.2%, 0.5% and 0.2% increases in turnover. Profit sensitivity is less significant, with only current assets yielding 0.8% raise in profit with 1% increase in the resource input.	Significant, albeit not very high in magnitude, elasticity of turnover indicates rather strong investment potential of the blue sector. With fully efficient performance and no excess of neither of the resources, the sector may provide a sound and stable return to further expansion and modernization of fixed and current assets. However, investments into labour should concern mostly improvements of personnel management and work organization, in order to improve productivity of labour. Mere hiring may lead to negative consequences and potential excess of labour in future.

6. Marine construction

<table>
<tr><th>Dimension</th><th>Economic profile</th><th>Strengths & weaknesses</th></tr>
<tr><td>Descriptive</td><td>Finish marine construction sector employ disproportional shares of resources, namely, only 1% of blue economy’s current assets, 15% of fixed assets and 20% of employees. The sector generates 6% of blue economy outputs. Hence, the overall share of the construction sector in Finnish blue economy is rather average, with low ratio of output to the stock of fixed assets and labour.</td><td rowspan="3">The sector reveals rather stable performance indicators. Being fully efficient and having no excess of neither of the assets, construction sector only cast doubts on labour resource management. Due to disproportionally high share of labour resource and its low productivity, certain attention to personnel management may be needed. However, large share of labour, same as fixed resources, may simply reflect specificity of construction sector, which requires a lot of human resources, equipment and premises. These argument also goes in line with full efficiency, suggesting that sectorial performance is rather stable, despite low labour productivity.</td></tr>
<tr><td>Productivity</td><td>The sector reveals rather low labour productivity in the blue economy (second worse), while fixed assets are relatively more productive (first best in terms of profit). Low labour productivity is largely related to the descriptive evidence on generally large share of labour employed by the construction sector.</td></tr>
<tr><td>Efficiency</td><td>The sector is perfectly efficient, no excess of the resources is documented.</td></tr>
<tr><td>Sensitivity</td><td>Elasticity coefficients of marine construction are predominantly insignificant. Only significant associations were documented for current assets (1 % increase relates to 0.6% raise in turnover and 1% increase in profit). Total fixed assets were found to significantly associate only with turnover (0.2% increase with 1% raise of fixed assets). Other resources have insignificant, albeit</td><td>Documented marginal sensitivity of turnover and profit suggest that further investments in the sector may not yield returns of expected scale. Albeit the sector is fully efficient and economically strong, it expansion of resources may generate disproportionally smaller returns in terms of sectorial growth (turnover) and financial performance (profit). Especially investments in human resources should tackle not mere hiring, but improvement of operation procedures, technologies</td></tr>
</table>

	positive and economically average, association with both turnover and profit.	(fixed resources investments) and workforce management, aiming to improve labour productivity.

6. DISCUSSION AND CONCLUSIONS

Blue economy and its industries constitute a vital part of maritime region economy, both in Estonia and Finland. The general aim of this study was to evaluate the role of blue industries in the economy of selected maritime regions of Estonia and Finland focusing on the analysis of blue economy industries' economic performance. The study provide general overview of how blue economy industries are connected to the national economies (on Input-Output tables (IOT) based analysis). Another key products of this deliverable are productivity, efficiency and sensitivity profiles of each blue sector in Estonia's and Finland's blue regions. The results of this research provide additional information for the elaboration of blue regions' development scenarios (Blue Growth Scenarios, see Pöntynen et al. (2018)) and for promotion of cross-border cooperation between coastal regions of Finland and Estonia.

6.1. Overview of blue economy's connection to the national economies of Finland and Estonia

We estimated inter-industry linkages such as forward and backward linkages, output, employment multipliers for purpose of addressing the impact of blue sectors on national economies of Finland and Estonia. To do that, we exploit Input-output tables from OECD input–output (I–O) database investigating the impact of the blue industries in the national economy of Estonia and Finland for the period 1995–2011. The OECD database comprise information on 34 sectors of a national economy using industry to industry approach. This approach offers possibilities to integrate several pools of statistics collected according to industrial activity such as R&D expenditure, employment, foreign direct investment and energy consumption. Of course, OECD IOT database has also some shortcomings that should be considered by conducting analysis and interpreting results. Although it provides homogenous statistical data for both countries, Estonian and Finnish data lacks more detailed statistics on industries: only 34 industries are involved; eight of them comprise activities related to blue economies ((i) Agriculture, hunting, forestry and fishing; (ii) Mining and quarrying; (iii) Coke, refined petroleum products and nuclear fuel; (iv)Motor vehicles, trailers and semi-trailers; (v) Other transport equipment; (vi) Construction; (vii)Hotels and restaurants; (viii) Transport and storage)

Results of I-O tables based analysis show that blue industries generally are not very tightly related to the national economies of Finland and Estonia (see Appendices 1 and 2). Weak forward linkages yield less spillover effects from the national economy, i.e. both general economic growth and decline will to lower extent reflect on blue industries. Backward linkages are similarly weak, implying that investments and positive dynamics within blue industries weakly reflect on other economic sectors and whole national economy. Thus, negative dynamics within blue economy yield only weak negative externalities to overall economy. These findings suggest that blue industries are relatively independent within national economy. At the same time such industries as agriculture, hunting, forestry and fishing in the case of Estonia and transport and storage in the case of both, Finland and Estonia have crucial function in maintaining and development of other industries. Their development and sustainability is also remarkable influenced by the success of other industries of countries' economies.

Output and employment multipliers analysis provide additional quantitative information for stimulating policies and employment creation processes in industries related to blue economy. A unit (one euro) increase of final demand (or income) brings particularly remarkable growth of output in Hotels and restaurants, Construction, and Transport and storage industries in both countries (around 2-3 euros), Estonia and Finland. Thus, these three sectors have good potential for future developments and creating favourable conditions for development of their activities should also be considered by the elaboration of Blue Growth scenarios. Analysis of employment multipliers show that investments in Coke, refined petroleum products and nuclear fuel industries create remarkable additional employment, e.g. investments of 100 thousand euro can create 8 – 13 new labour places in Finland. In Estonia's as well in other Finnish industries, employment multipliers are smaller but still remarkable: investments of 100 thousand euro create on average 2-3 new labour places. Transport and storage sector has the highest employment multiplier among Estonian blue economy related industries.

Thus, relying on the OIT analysis, it is possible to summarise that blue industries play a remarkable role in blue regions' development and to a large extent drive economic success of regional and national economies in generating new growth and employment in Estonia and Finland.

6.2. Economic performance of blue regions and future development

Analysis of economic performance of blue regions rely on enterprises data of the Amadeus database. It focuses on the exploring of economic performance of blue regions and sectors in Finland and Estonia comparing productivity and efficiency of blue sectors with non-blue and discovering possibilities for better use of available resources (labour, assets). In this concluding section, we discuss major findings in light of future development of blue economy and potential improvements. To recognize future opportunities both current performance and influential factors must be acknowledged.

Productivity and efficiency assessments address current performance and relative weight of blue sectors in regional economy, identifying acute problems and areas for potential improvement. Sensitivity assessment sheds a light on factors relevant for future economic success of sectors, as it explores associations between what industry "consumes" as resources and what financial outcomes it achieves. Both, current performance and future development dimensions, are interrelated with environmental aspect of industry's operation through identification of feasible extents of environmental pressure reduction with no (or insignificant) effect on economic performance.

Appendices 6 and 7 summarize major findings of productivity, efficiency and sensitivity analysis as well as identifies feasible improvements and future potential of the blue region sectors in Estonia and Finland. Generally, results of economic analysis mapped the most successful and promising blue sectors, as well as recognized industries with certain complications in financial performance and in using resources.

Despite weak linkages to overall economy, blue sectors report high performance indicators in the regions under investigation. Those suggest that blue industries play an important role in overall economy of the blue region and to a large extent drive economic success of regional and national economies. Major indicators of economic success of blue industries are (i) on average higher labour and current assets productivity of blue sectors, relative to non-blue and (ii) generally high efficiency of blue sectors, suggesting that resources are on average effectively utilized and produce maximal economic returns.

Results of the analysis suggest that energy, water (cargo) transportation and marine construction are the best performing blue sectors in Estonia. In Finland, the “best practice” industries are bio & subsea activities, energy, tourism, marine (passenger) transportation and marine construction. These sectors are characterised by complete efficiency and relatively high labour productivity, suggesting their high potential and important role in overall regional productivity and efficiency.

However, several blue sectors in Estonia and Finland require certain improvements to increase their potential and role in the region. In Estonia, bio & subsea activities and tourism are two sectors, which require more efficient resource use and higher economic returns generated per unit of inputs used. Both sectors have excessive fixed assets, thus independently on financial objective set by the sector (either profit maximization or cost reduction), excess of fixed asset can be reduced, yielding reduction of costs and, importantly, reduction of environmental pressure through more effective use of property, machinery, vehicles and other operational tools. Tourism sector in Estonia generally achieves imperfect efficiency and has the lowest labour productivity among all blue sectors in Estonia. It suggests that, on the one hand, human resources must be better managed in order to generate maximal returns per each employee, and on the other hand, it reflects potential inefficiencies of overall operation, not directly related to labour involved. Therefore, further investigation of tourism sector performance may be needed.

In Finland, marine (cargo) transportation sector is the least efficient. Efficiency analysis suggested that both fixed assets and labour resources are excessive and can be reduced to improve sector’s performance. Excessive human resources suggest that marine transportation sector in Finland does not use labour resource effectively and employment costs to economic returns are relatively high. One potential way to improve economic performance of marine transportation in Finland is to facilitate cross-border cooperation in the field and foster public-private partnership, as well as relevant networks’ activities.

Sensitivity analysis provides an insight into most relevant factors to consider in further development of blue sectors. Among those, insignificant association between resources used in operation and industry profit is identified. This result indicates lacking association between inputs and outputs, which imply that further investments into the sector may not necessarily result in profit increase, i.e. financial success, albeit for some industries (energy and tourism in Estonia; water transportation, tourism, marine construction in Finland) they may lead to business expansion.

To ensure that further investments will result in enhancing financial success, actual profitability of blue enterprises should be further studied in more detail. However, within this report we identified potential problems, related to resource use and productivity, which to large extent reflect on sectorial profitability. Blue regions’ economies of both countries (like also non-blue economies) need implementation of innovations, new technologies and more careful resource management to improve efficiency performance and reduce environmental pressures.

Reduction of excessive fixed assets through more careful resource management and implementation of innovative and effective operation technologies would positively reflect on economic performance and efficiency improvement. The results of the analysis show, that there is still space for improvement of economic performance and strengthening the role of blue industries in region’s development without employing additional resources and increasing environmental pressures, particularly in bio & subsea activities and tourism in Estonia and marine (cargo) transportation sector in Finland.

Potential ways for improving economic performance of blue sectors and regions are facilitating cross-border cooperation and fostering public-private partnership. Cross-border cooperation is particularly relevant in the case of imperfectly efficient sectors. Specifically:

- **Bio & subsea activities** is imperfectly efficient sector in Estonia, while fully efficient in Finland. Cross-border cooperation in a form of "good practice" sharing through learning the efficient operation strategies, resource management and monitoring, by Estonian bio & subsea sector from Finnish one may be one form of beneficial cross-border co-operation.
- **Marine (cargo) transportation** is fully efficient and high-performing sector in Estonia, while inefficient in Finland. Cross-border cooperation through sharing the infrastructure objects, as well as adopting the fixed assets and labour management practices from Estonian side, could positive reflect on Finnish sectorial efficiency.
- **Coastal tourism** is another example of cross-border sectorial cooperation. Low efficiency of Estonian tourism industry can largely benefit from sharing certain infrastructure objects, developing joint recreational activities and learning from Finnish tourism business, specifically, in the area of human resource management.

Therefore, possibilities for these activities should be profoundly considered by the development of Blue Growth Scenarios focusing also on improvement of networks' activities and creating supportive conditions for expanding private-public partnership (PPP) to facilitate cross-border cooperation. Well-developed cross-border cooperation can open new possibilities for more efficient use of resources, particularly tangible assets, and thereby also create conditions for declining excess of fixed assets and environmental pressure.

6.3. Cross-border statistical data in the blue region

Another important conclusion of given deliverable concerns the statistical data in the blue border regions. The results of economic analysis clearly indicated that blue regions have strong economic potential, however, this potential is not always efficiently used, resulting in high vulnerability of the blue regions' economy. The way to strengthen the blue regions and ensure that economic potential is not wasted is to facilitate the cross-border cooperation and partnership. The economic analysis results support this point, as we found significant cross-country differences in industries' efficiency. Hence, strong cross-border cooperation is one way to bridge those gaps and exploit the opportunities.

However, for the effective cross-border cooperation the harmonized and detailed statistical data are needed. Up till now, developing a high-quality cross-border statistics was challenging and mostly unsuccessful due to a number of factors.

- The national-level data sources (administrative registry data) are substantially different across EU countries, due to different reporting procedures, metric systems, content of specific indicators. Thus, harmonization of registry data across borders is particularly challenging and often impossible. Apparently, this is a big issue, since national data is detailed, reliable, contains information on the very low regional detail and on a wide range of characteristics.
- European or international level data, on the contrary, are harmonized across countries in terms of the data collection, reporting procedures and metric systems. Thus, it allows cross-border comparisons of indicators in non-biased way. However, the actual cross-border activities cannot be traced relying on these data. Furthermore, the level of data generalization is quite high, making it impossible to elicit the detailed regional or industry characteristics.

The data used in the Deliverable D.T.1.6.1, namely Orbis database, and in the given deliverable (Amadeus database in OECD input-output tables) refer to the second category. These data sources are harmonized across European countries and, in particular, Estonia and Finland. It allows an unbiased estimation of the cross-country differences on the general industry or regional level.

However, the major problem in the context of the blue region analysis, is high level of data abstraction. While the national registry data allows to precisely define the regions and, most importantly, contains detailed industry identifiers, Amadeus database provides only general industry categories. Thus, identification of sub-sectors is impossible, for instance, differentiating between different types of blue energy, or different types of construction activities in the blue area.

This substantial drawback reflects on the level of the economic analysis detailing within the given deliverable. But, most importantly, non-availability of a high-quality cross-border statistics restrict possibilities to cross-border cooperation, due to the difficulties in identification of threats and opportunities. Detailed and harmonized cross-border statistics would allow to map the areas for improvement and pin down the possibilities of cross-border cooperation aiming to foster the economic development in the blue region, and join the effort to strengthen the economic and sustainability profiles. High vulnerability of the blue regions triggers the necessity to precisely and in detail identify the current state of industries and detect the interrelations to other sectors and between the blue sectors across borders.

Another ultimate advantage of the cross-order data is that it would allow to identify currently on-going cooperation and existing ties across blue sectors in the blue region. These are required to define the present cooperation in the blue area and detect the areas for further partnership and cooperation in the blue region. This aspect is particularly relevant in the framework of the maritime spatial planning (MSP), since the planning activities in the Project area have to base on the tight cooperation, which, eventually, imply reliable and high-quality data.

All these arguments support the necessity to build up a harmonized and detailed cross border statistics. There was a number of actions aiming to develop a framework for cross-border data harmonization in several aspects, including the labour marker mobility[12] and cross border cooperation[13]. Apparently, developing the cross-border statistics is a challenging task, therefore, it requires a close collaboration of statistical institutions throughout the process of creating the cross-border database, maintaining and improving it. The high-quality cross-border statistical data requires a unified system of data collection and reporting, ensuring that all statistical information is provided on the same level of generalization and relies on the same measurement system. Furthermore, the complete cross-border statistical database may be used for identification of current collaboration and identification of areas (sectors) were cross-border cooperation still can be strengthened in order to improve the regions' performance.

[12] See https://ec.europa.eu/eurostat/cros/content/statistics-netherlands-cross-border-lmas_en

[13] See http://www.ksh.hu/cess2016/pdf/cess2016_b3_0500.pdf

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APPENDICES

Appendix 1. Output and employment multipliers for all industries in Estonia.

Estonia	**Output Multipliers**		**Value Added**		**Income Multiplier**		**Employment Multiplier**	
CTOTAL: TOTAL	Open	Closed	Type I	Type II	Type I	Type II	Type I	Type II
C01T05: Agriculture, hunting, forestry and fishing	**1,84**	**2,55**	**1,90**	**2,75**	**2,00**	**2,84**	**1,64**	**2,12**
C10T14: Mining and quarrying	**1,51**	**2,30**	**1,39**	**2,06**	**1,37**	**1,95**	**1,47**	**2,23**
C15T16: Food products, beverages and tobacco	2,07	2,83	2,81	4,28	2,49	3,54	3,02	4,30
C17T19: Textiles, textile products, leather and footwear	1,63	2,49	1,86	3,11	1,53	2,18	1,39	1,83
C20: Wood and products of wood and cork	2,20	2,99	2,84	4,34	2,51	3,57	2,71	3,80
C21T22: Pulp, paper, paper products, printing and publishing	1,85	2,69	2,07	3,23	1,81	2,58	1,94	2,92
C23: Coke, refined petroleum products and nuclear fuel	**1,50**	**1,94**	**1,63**	**2,16**	**2,31**	**3,29**	**1,99**	**2,83**
C24: Chemicals and chemical products	1,65	2,13	2,07	2,98	2,36	3,36	2,59	3,84
C25: Rubber and plastics products	1,68	2,43	2,04	3,33	1,66	2,36	1,63	2,34
C26: Other non-metallic mineral products	1,77	2,52	1,96	3,02	1,80	2,56	1,81	2,63
C27: Basic metals	1,87	2,71	2,78	4,52	2,26	3,21	2,67	3,90
C28: Fabricated metal products	1,77	2,52	2,14	3,46	1,81	2,57	1,82	2,65
C29: Machinery and equipment, nec	1,74	2,59	1,98	3,29	1,65	2,34	1,61	2,33
C30T33X: Computer, Electronic and optical equipment	1,56	2,13	1,89	2,99	1,74	2,47	2,08	3,33
C31: Electrical machinery and apparatus, nec	1,63	2,27	1,92	3,02	1,80	2,56	1,58	2,18
C34: Motor vehicles, trailers and semi-trailers	**1,59**	**2,28**	**1,78**	**2,80**	**1,61**	**2,29**	**1,82**	**2,79**
C35: Other transport equipment	**1,90**	**2,60**	**2,33**	**3,61**	**2,22**	**3,16**	**2,03**	**2,82**
C36T37: Manufacturing nec; recycling	1,92	2,78	2,21	3,55	1,85	2,62	1,61	2,17
C40T41: Electricity, gas and water supply	1,47	1,94	1,45	1,89	1,87	2,66	1,86	2,76
C45: Construction	**1,81**	**2,66**	**1,96**	**3,12**	**1,78**	**2,53**	**1,61**	**2,24**
C50T52: Wholesale and retail trade; repairs	1,70	2,64	1,66	2,52	1,46	2,07	1,38	1,96
C55: Hotels and restaurants	**1,86**	**2,87**	**2,12**	**3,43**	**1,55**	**2,20**	**1,41**	**1,92**
C60T63: Transport and storage	**2,01**	**2,70**	**2,35**	**3,42**	**2,35**	**3,34**	**2,11**	**2,94**
C64: Post and telecommunications	1,76	2,34	1,80	2,40	2,15	3,06	1,99	2,90
C65T67: Financial intermediation	1,62	2,45	1,58	2,27	1,62	2,30	1,84	3,17
C70: Real estate activities	1,44	1,76	1,30	1,51	2,76	3,92	2,33	3,36
C71: Renting of machinery and equipment	1,68	2,17	1,60	2,07	2,58	3,67	4,91	7,77

C72: Computer and related activities	1,52	2,71	1,43	2,33	1,30	1,85	1,55	2,90
C73T74: R&D and other business activities	1,58	2,68	1,52	2,45	1,40	1,99	1,51	2,47
C75: Public admin. and defence; compulsory social security	1,45	2,91	1,31	2,33	1,19	1,69	1,26	2,01
C80: Education	1,35	3,01	1,22	2,25	1,11	1,58	1,09	1,48
C85: Health and social work	1,36	2,81	1,25	2,29	1,15	1,63	1,15	1,64
C90T93: Other community, social and personal services	1,73	2,82	1,75	2,85	1,53	2,17	1,45	2,01
C95: Private households with employed persons	1,00	1,00	0,00	0,00	0,00	0,00	0,00	0,00

Note: Industries related to blue economy and their multipliers are presented in bold.

Source: authors calculations based on OECD IOT data 2011.

Appendix 2. Output and employment multipliers for all industries in Finland.

Finland	Output Multipliers		Value Added		Income Multiplier		Employment Multiplier	
CTOTAL: TOTAL	Open	Closed	Type I	Type II	Type I	Type II	Type I	Type II
C01T05: Agriculture, hunting, forestry and fishing	**1,64**	**2,28**	**1,54**	**2,13**	**2,03**	**3,09**	**1,37**	**1,67**
C10T14: Mining and quarrying	**1,69**	**2,40**	**1,84**	**2,82**	**2,30**	**3,51**	**2,28**	**3,59**
C15T16: Food products, beverages and tobacco	2,18	3,16	3,23	5,28	2,80	4,25	3,44	5,10
C17T19: Textiles, textile products, leather and footwear	1,61	2,64	1,71	2,99	1,61	2,46	1,35	1,86
C20: Wood and products of wood and cork	2,21	3,25	3,53	5,91	2,49	3,78	2,92	4,16
C21T22: Pulp, paper, paper products, printing and publishing	2,09	3,06	2,63	4,33	2,51	3,82	3,10	4,99
C23: Coke, refined petroleum products and nuclear fuel	**1,43**	**1,64**	**3,49**	**5,26**	**5,49**	**8,35**	**7,99**	**12,99**
C24: Chemicals and chemical products	1,73	2,40	1,92	2,95	2,33	3,54	2,92	4,89
C25: Rubber and plastics products	1,82	2,77	2,08	3,54	1,94	2,96	2,06	3,29
C26: Other non-metallic mineral products	1,76	2,79	1,85	3,20	1,74	2,65	1,82	2,95
C27: Basic metals	1,81	2,45	3,63	6,17	3,22	4,90	4,08	6,45
C28: Fabricated metal products	1,80	2,82	1,85	3,25	1,74	2,65	1,70	2,65
C29: Machinery and equipment, nec	1,78	2,72	1,96	3,38	1,96	2,98	2,12	3,48
C30T33X: Computer, Electronic and optical equipment	2,04	3,17	3,67	6,99	2,73	4,16	3,52	5,96
C31: Electrical machinery and apparatus, nec	1,78	2,70	1,91	3,28	1,97	2,99	2,09	3,42
C34: Motor vehicles, trailers and semi-trailers	**1,69**	**2,55**	**1,99**	**3,54**	**1,82**	**2,78**	**1,81**	**2,86**
C35: Other transport equipment	**1,73**	**3,01**	**1,75**	**3,38**	**1,51**	**2,29**	**1,54**	**2,47**
C36T37: Manufacturing nec; recycling	1,81	2,90	1,98	3,55	1,80	2,74	1,68	2,56
C40T41: Electricity, gas and water supply	1,45	1,95	1,37	1,86	1,97	2,99	2,51	4,25
C45: Construction	**1,89**	**3,03**	**1,96**	**3,46**	**1,84**	**2,81**	**1,90**	**2,98**
C50T52: Wholesale and retail trade; repairs	1,67	2,88	1,56	2,62	1,48	2,25	1,41	2,14
C55: Hotels and restaurants	**1,83**	**3,02**	**1,90**	**3,25**	**1,59**	**2,42**	**1,44**	**2,03**
C60T63: Transport and storage	**1,83**	**2,91**	**1,87**	**3,17**	**1,77**	**2,70**	**1,86**	**2,99**
C64: Post and telecommunications	1,80	2,91	1,74	2,84	1,79	2,72	1,81	2,93
C65T67: Financial intermediation	1,56	2,71	1,46	2,48	1,43	2,18	1,62	2,89
C70: Real estate activities	1,45	1,78	1,29	1,52	4,82	7,34	2,89	4,32
C71: Renting of machinery and equipment	1,59	2,22	1,47	2,06	2,07	3,15	1,89	2,85
C72: Computer and related activities	1,61	3,03	1,50	2,74	1,41	2,14	1,54	2,68

C73T74: R&D and other business activities	1,57	3,04	1,44	2,65	1,34	2,04	1,35	2,16
C75: Public admin. and defence; compulsory social security	1,61	2,94	1,53	2,75	1,37	2,09	1,35	2,11
C80: Education	1,40	3,24	1,27	2,50	1,15	1,74	1,18	1,95
C85: Health and social work	1,44	3,18	1,32	2,57	1,22	1,85	1,22	1,91
C90T93: Other community, social and personal services	1,63	2,85	1,53	2,60	1,46	2,22	1,35	1,97
C95: Private households with employed persons	1,00	1,00	0,00	0,00	0,00	0,00	0,00	0,00

Note: Industries related to blue economy and their multipliers are presented in bold.

Source: authors calculations based on OECD IOT data 2011.

Appendix 3. Distribution of major input and output variables across blue and non-blue sectors

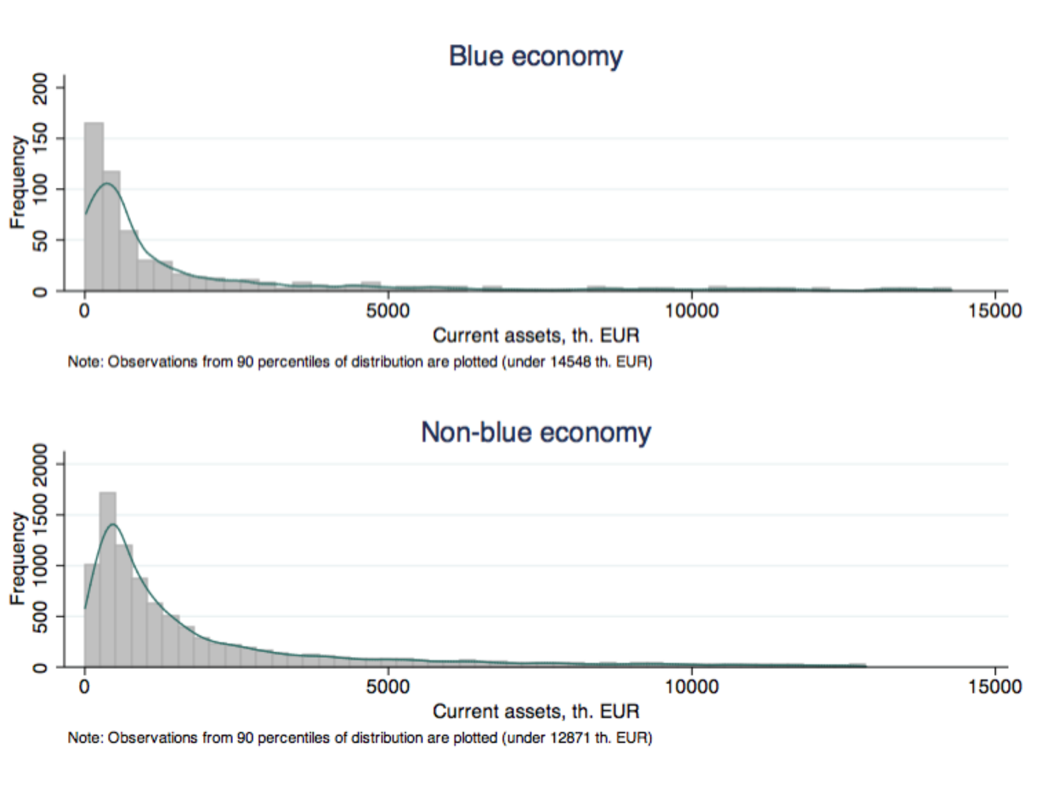

Figure A 3.1. Total fixed assets distribution, based on Amadeus data from 2015

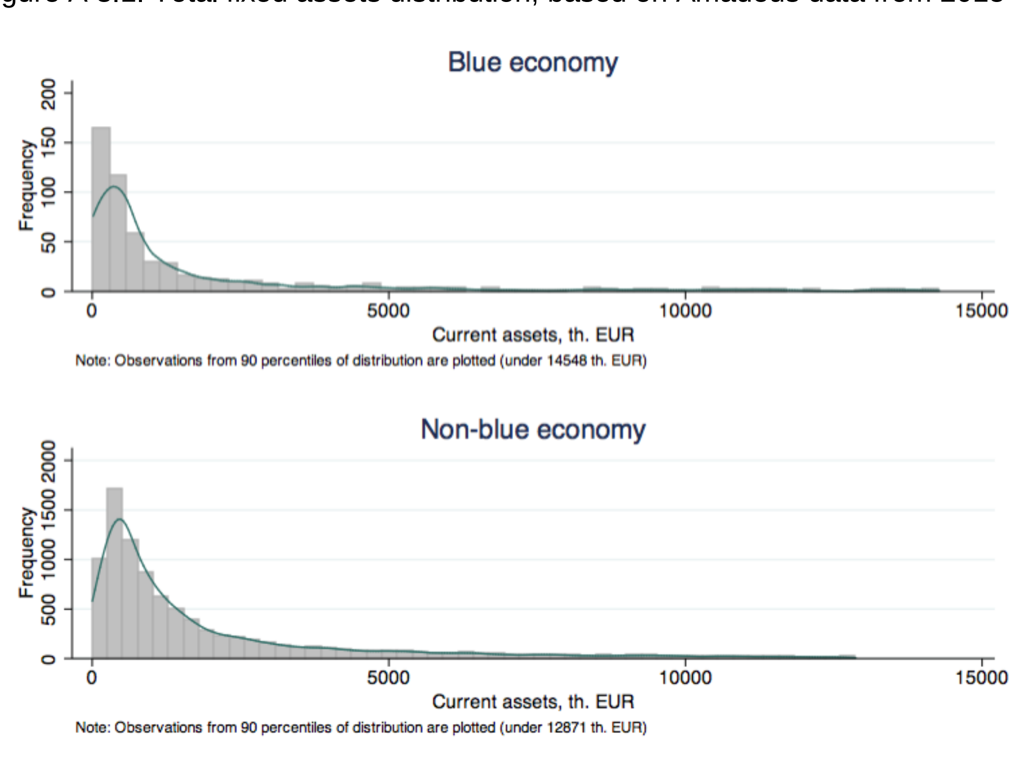

Figure A3.2. Total current assets distribution, based on Amadeus data from 2015

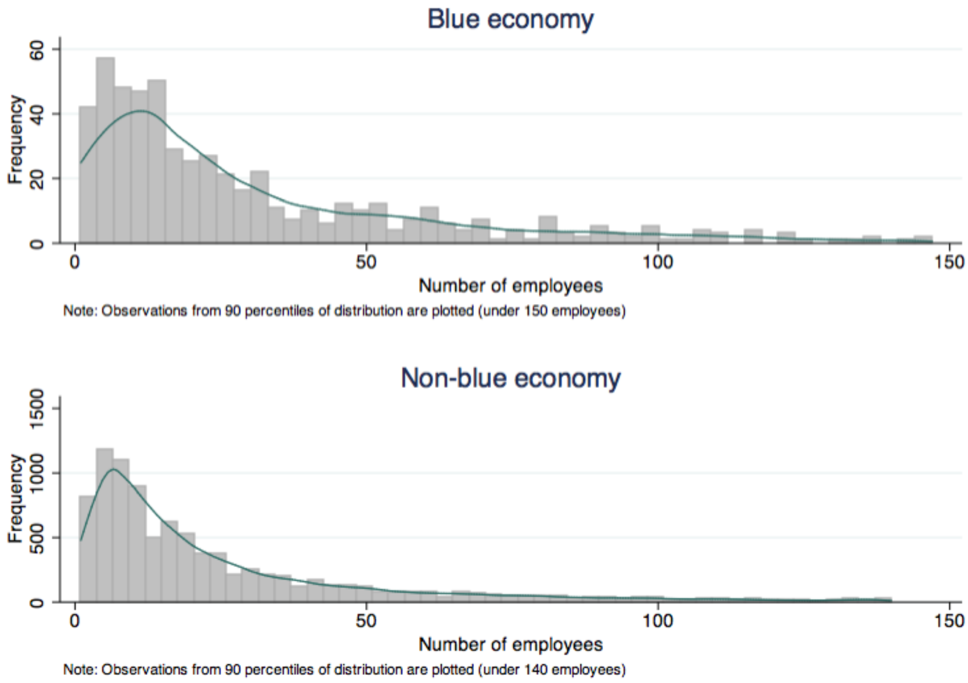

Figure A3.3. Distribution of number of employees, based on Amadeus data from 2015

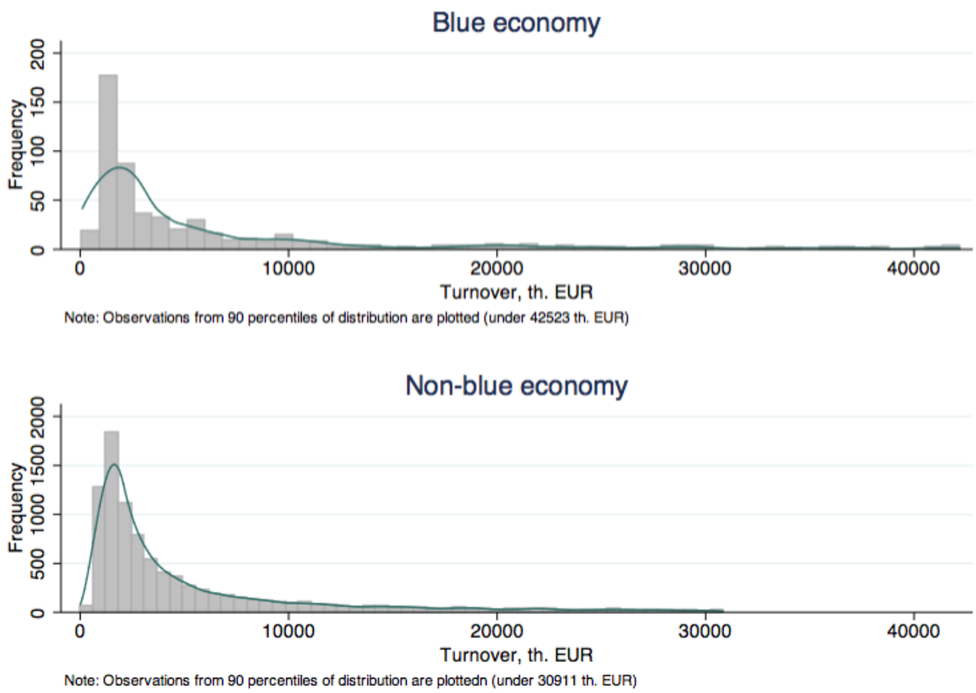

Figure A3.4. Distribution of turnover, based on Amadeus data from 2015

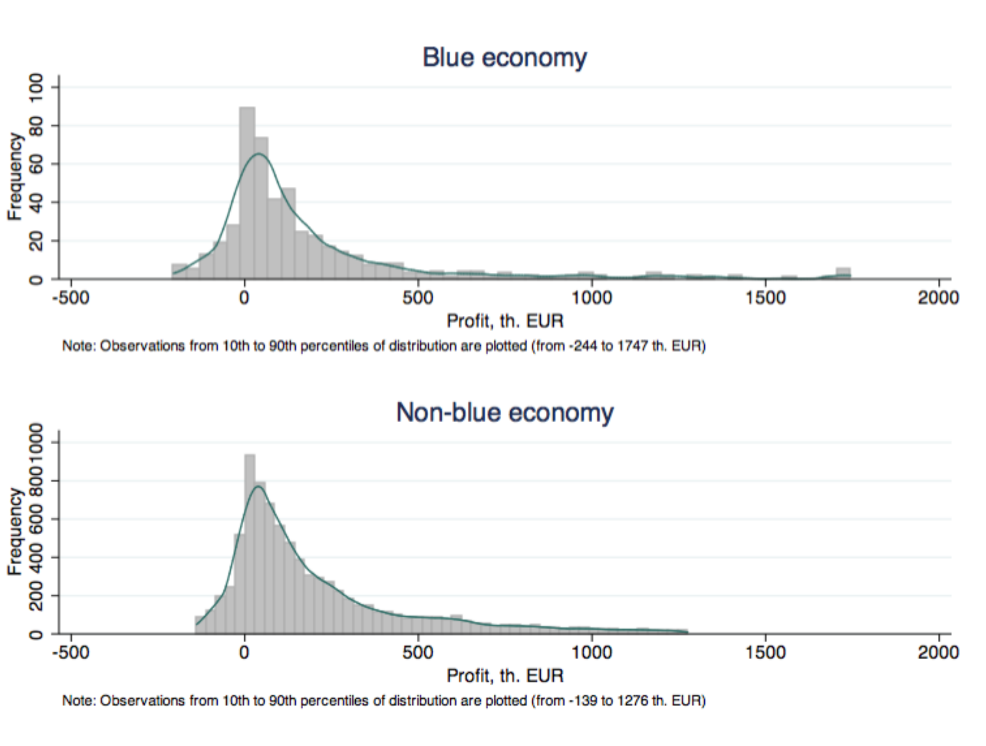

Figure A3.5. Distribution of profit after tax, based on Amadeus data from 2015

Appedix 4. Sensitivity estimates: output sensitivity relative to inputs (complete regression results)

ESTONIA

Blue sector:	Sensitivity of turnover relative to:			
	Total fixed assets	*Tangible assets*	*Current assets*	*Labour*
Bio & subsea activities	0.273	0.190	0.383	-0.200
	[-0,184; 0,730]	[-0,192; 0,572]	[-0,053; 0,819]	[-0,021; 0,018]
Energy	0.189	0.139	1.025	0.300
	[0,056; 0,323]**	[0,006; 0,272]*	[0,869; 1,182]***	[0,002; 0,004]***
Water transportation	0.034	0.138	0.474	1.700
	[-0,355; 0,423]	[-0,218; 0,494]	[-0,148; 1,097]	[-0,011; 0,046]
Tourism	0.103	0.016	0.437	0.300
	[0,038; 0,168]**	[-0,065; 0,096]	[0,338; 0,536]***	[-0,001; 0,007]
Marine construction	0.164	-0.026	0.614	0.600
	[0,007; 0,321]*	[-0,157; 0,106]	[0,406; 0,822]***	[-0,004; 0,016]
N	987	896	987	987

Blue sector:	Sensitivity of profit relative to:			
	Total fixed assets	*Tangible assets*	*Current assets*	*Labour*
Bio & subsea activities	1.194	0.424	0.537	0.700
	[0,247; 2,141]*	[-0,333; 1,182]	[-0,251; 1,326]	[-0,028; 0,041]
Energy	-0.161	-0.222	0.648	0.000
	[-0,480; 0,157]	[-0,478; 0,034]	[0,264; 1,032]***	[-0,002; 0,002]
Water transportation	0.024	0.177	0.314	0.700
	[-0,803; 0,852]	[-0,516; 0,871]	[-2,256; 2,884]	[-0,837; 0,851]
Tourism	0.081	0.068	0.812	0.700
	[-0,058; 0,219]	[-0,089; 0,226]	[0,585; 1,039]***	[-0,001; 0,016]
Marine construction	-0.308	-0.038	0.307	-0.800
	[-0,600; -0,015]*	[-0,320; 0,244]	[-0,158; 0,772]	[-0,034; 0,018]
N	812	689	757	757

Source: Amadeus data from years 2010-2015 (panel dataset) for Estonia.
Note: 95% confidence intervals are reported in square brackets.
Note on functional form of the models presented in the table:
[a] $logTurnover_{it} = \alpha_i + \gamma' BlueSector_i \times logFixedAssets_{it} + \beta_1 logCurrentAssets_{it} + \beta_2 Employees_{it} + \beta_3 Region_i + \varepsilon_{it}$
[b] $logTurnover_{it} = \alpha_i + \gamma' BlueSector_i \times logFixedTangibleAssets_{it} + \beta_1 logCurrentAssets_{it} + \beta_2 Employees_{it} + \beta_3 Region_i + \varepsilon_{it}$
[c] $logProfit_{it} = \alpha_i + \gamma' BlueSector_i \times logFixedAssets_{it} + \beta_1 logCurrentAssets_{it} + \beta_2 Employees_{it} + \beta_3 Region_i + \varepsilon_{it}$
[d] $logProfit_{it} = \alpha_i + \gamma' BlueSector_i \times logFixedTangibleAssets_{it} + \beta_1 logCurrentAssets_{it} + \beta_2 Employees_{it} + \beta_3 Region_i + \varepsilon_{it}$

Appendix 4 (continued). Sensitivity estimates: output sensitivity relative to inputs (complete regression results)

FINLAND

Blue sector:	Sensitivity of turnover relative to:			
	Total fixed assets	*Tangible assets*	*Current assets*	*Labour*
Bio & subsea activities	-0.375	-0.238	0.142	-1.900
	[-0,948; 0,198]	[-0,826; 0,349]	[-0,274; 0,558]	[-0,054; 0,015]
Energy	0.082	0.036	0.668	0.100
	[0,012; 0,153]*	[-0,026; 0,098]	[0,560; 0,775]***	[-0,000; 0,002]
Water transportation	0.154	0.237	0.425	0.100
	[0,048; 0,261]**	[0,116; 0,358]***	[0,322; 0,529]***	[-0,001; 0,002]
Tourism	0.191	0.178	0.464	0.200
	[0,155; 0,227]***	[0,136; 0,220]***	[0,409; 0,520]***	[0,001; 0,003]***
Marine construction	0.174	0.141	0.607	0.000
	[0,043; 0,305]**	[0,022; 0,260]*	[0,507; 0,707]***	[-0,000; 0,000]
N	1808	1686	1808	1808

Blue sector:	Sensitivity of profit relative to:			
	Total fixed assets	*Tangible assets*	*Current assets*	*Labour*
Bio & subsea activities	0.087	-0.581	1.738	2.300
	[-1,585; 1,758]	[-2,292; 1,130]	[0,570; 2,907]**	[-0,074; 0,121]
Energy	0.103	0.126	0.891	0.300
	[-0,243; 0,448]	[-0,113; 0,365]	[0,555; 1,227]***	[-0,001; 0,007]
Water transportation	0.103	0.316	1.121	-0.600
	[-0,241; 0,446]	[-0,132; 0,763]	[0,741; 1,502]***	[-0,010; -0,001]*
Tourism	-0.019	0.053	0.769	-0.200
	[-0,147; 0,108]	[-0,094; 0,201]	[0,566; 0,972]***	[-0,006; 0,002]
Marine construction	0.439	0.212	0.963	1.000
	[0,037; 0,842]*	[-0,162; 0,585]	[0,624; 1,303]***	[-0,009; 0,030]

N	1345	1272	1345	1345

Source: Amadeus data from years 2010-2015 (panel dataset) for Finland.
Note: 95% confidence intervals are reported in square brackets.
Note on functional form of the models presented in the table:
[a] $logTurnover_{it} = \alpha_i + \gamma' BlueSector_i \times logFixedAssets_{it} + \beta_1 logCurrentAssets_{it} + \beta_2 Employees_{it} + \beta_3 Region_i + \varepsilon_{it}$
[b] $logTurnover_{it} = \alpha_i + \gamma' BlueSector_i \times logFixedTangibleAssets_{it} + \beta_1 logCurrentAssets_{it} + \beta_2 Employees_{it} + \beta_3 Region_i + \varepsilon_{it}$
[c] $logProfit_{it} = \alpha_i + \gamma' BlueSector_i \times logFixedAssets_{it} + \beta_1 logCurrentAssets_{it} + \beta_2 Employees_{it} + \beta_3 Region_i + \varepsilon_{it}$
[d] $logProfit_{it} = \alpha_i + \gamma' BlueSector_i \times logFixedTangibleAssets_{it} + \beta_1 logCurrentAssets_{it} + \beta_2 Employees_{it} + \beta_3 Region_i + \varepsilon_{it}$

Appendix 5. Output sensitivity relative to inputs (complete regression results) in Finland, with maritime transport disaggregated into cargo and passaner transportation

Blue sectors:	Sensitivity of turnover relative to:			
	Total fixed assets	Tangible assets	Current assets	Labour
Bio & subsea activities	-0.375	-0.238	0.142	-1.9
	[-0.948,0.198]	[-0.826,0.349]	[-0.274,0.558]	[-0.054,0.015]
Energy	0.082	0.036	0.668	1
	[0.012,0.153]*	[-0.026,0.097]	[0.560,0.775]***	[-0.000,0.002]
Cargo transportation	0.101	0.159	0.433	1.7
	[-0.046,0.248]	[-0.045,0.364]	[0.315,0.552]***	[0.004,0.030]*
Passenger transportation	0.212	0.279	0.4	1
	[0.059,0.366]**	[0.129,0.430]***	[0.190,0.611]***	[-0.001,0.002]
Tourism	0.191	0.178	0.464	0.2
	[0.155,0.227]***	[0.136,0.220]***	[0.409,0.520]***	[0.001,0.003]***
Marine construction	0.174	0.141	0.607	0
	[0.044,0.305]**	[0.022,0.260]*	[0.507,0.707]***	[-0.000,0.000]
N	1808	1686	1808	1808

Blue sectors:	Sensitivity of profit relative to:			
	Total fixed assets	Tangible assets	Current assets	Labour
Bio & subsea activities	0.087	-0.58	1.738	2.4
	[-1.585,1.759]	[-2.292,1.131]	[0.571,2.905]**	[-0.074,0.121]
Energy	0.103	0.126	0.892	0.3
	[-0.243,0.448]	[-0.113,0.365]	[0.556,1.227]***	[-0.001,0.007]
Cargo transportation	0.09	0.071	0.96	-1.4
	[-0.407,0.587]	[-0.661,0.804]	[0.544,1.376]***	[-0.058,0.031]
Passenger transportation	0.114	0.462	1.924	-0.6
	[-0.361,0.590]	[-0.104,1.027]	[0.995,2.853]***	[-0.010,-0.001]*
Tourism	-0.019	0.054	0.769	-0.2
	[-0.147,0.109]	[-0.094,0.201]	[0.566,0.972]***	[-0.006,0.002]
Marine construction	0.439	0.213	0.964	1
	[0.037,0.842]*	[-0.161,0.586]	[0.625,1.304]***	[-0.009,0.030]
N	1345	1272	1345	1345

Source: Amadeus data from years 2010-2015 (panel dataset) for Finland.
Note: 95% confidence intervals are reported in square brackets.
Note on functional form of the models presented in the table:
[a] $logTurnover_{it} = \alpha_i + \gamma' BlueSector_i \times logFixedAssets_{it} + \beta_1 logCurrentAssets_{it} + \beta_2 Employees_{it} + \beta_3 Region_i + \varepsilon_{it}$
[b] $logTurnover_{it} = \alpha_i + \gamma' BlueSector_i \times logFixedTangibleAssets_{it} + \beta_1 logCurrentAssets_{it} + \beta_2 Employees_{it} + \beta_3 Region_i + \varepsilon_{it}$

[c] $logProfit_{it} = \alpha_i + \gamma' BlueSector_i \times logFixedAssets_{it} + \beta_1 logCurrentAssets_{it} + \beta_2 Employees_{it} + \beta_3 Region_i + \varepsilon_{it}$
[d] $logProfit_{it} = \alpha_i + \gamma' BlueSector_i \times logFixedTangibleAssets_{it} + \beta_1 logCurrentAssets_{it} + \beta_2 Employees_{it} + \beta_3 Region_i + \varepsilon_{it}$

Appendix 6. Summary of **Estonian** blue sectors' economic performance and the role in regional economy

Blue sector	Labour productivity profile	Efficiency profile	Sensitivity profile	Potential improvements (for scenarios)	Potential of the sector (for scenarios)
Bio & subsea activities	High labour productivity relative to profit after tax. Average productivity of labour in terms of units of turnover generated per one employee. Productivity of fixed assets is the lowest in Estonia.	Sector has the lowest efficiency among all Estonian blue sectors. There is a substantial excess of fixed and current assets.	Turnover and profit in the sector are insignificantly sensitive to any of the resources. Thus, an increase in these input does directly and strongly associate with sectorial growth and profitability increase. Profit has a weak association with fixed assets increase.	Excess of fixed assets documented within efficiency analysis can be reduced with relatively no harm for sectorial turnover and profit, due to low sensitivity of the latter w.r.t. fixed assets.	Reduction of excessive fixed asses will yield higher efficiency and lower costs faced by the sector, with output relatively unaffected. Reduction of fixed assets will also lower environmental pressures.
Energy	High labour productivity both in terms of profit and turnover. Average fixed assets productivity.	Highly and strongly efficient sector, with no excess of resources,	High sensitivity of turnover relative to fixed assets, labour and current resources. Profit is not significantly sensitivity relative to inputs.	One potential area for improvement identified form analysis concerns improvement of interrelation between resources and profit, implying overall operational improvements, ensuring that utilized resource generate profits.	Sector with high potential, however, due to low sensitivity of profit relative to assets, investments into fixed assets should be made cautiously in order to ensure high profitability.
Water (cargo) transportation	Average productivity of labour and fixed assets relative to both turnover and profit.	Highly and strongly efficient sector, with no excess of resources,	Insignificant association of turnover with assets increase.	Overall labour productivity can be further improved. Low sensitivity suggests that inputs are not sufficiently well employed and their utilization can be further improved.	Sector with high potential. However, similarly to energy sector, low sensitivity suggests that utilization of resources can be further improved in order to maximize returns to investments.
Tourism	The least labour productive sector in Estonia, both turnover and profit returns per employee are the lowest.	The second is second worst in terms of efficiency, with excess of labour and fixed assets.	Turnover is sensitive (albeit small in magnitude) relative to fixed assets, but not profit is not. Both turnover and profit are sensitive w.r.t. current assets.	The sector reveals imperfect efficiency, thus requires substantial reconsideration of resource use and resource management. Excessive fixed assets, additionally, generate economically unjustified environmental pressures. Labour productivity requires improvement. Low sensitivity suggests that inputs are	Reduction and more careful management of fixed assets and labour will increase efficiency of the sector. Significant association between turnover and fixed assets suggest that employed resource generates positive returns to sectorial growth. However,

Blue sector	Labour productivity profile	Efficiency profile	Sensitivity profile	Potential improvements (for scenarios)	Potential of the sector (for scenarios)
				not sufficiently well employed and their utilization can be further improved.	due to excess of resources and current inefficiency of the sector, further investments into the sector's resources may be not reasonable, but should rather tackle resource management and utilization.
Marine construction	Average productivity of labour relative to both turnover and profit. Highest fixed assets productivity among all Estonian blue sectors.	Sector has perfect efficiency.	Weak sensitivity of turnover relative to all resources, except current assets. Profit has insignificant association with all resources.	One potential aspect for improvement is improvement of labour productivity, which is also related to increasing output sensitivity w.r.t. labour.	Maritime construction has a good potential for further improvement and growth. Given full efficiency, the sector is stable and has a potential for further growth. However, low sensitivity of outputs needs to be considered. More effective resource management will allow to increase efficiency and lower operational expenses.

Appendix 7. Summary of **Finnish** blue sectors' economic performance and the role in regional economy

Blue sector	Labour productivity profile	Efficiency profile	Sensitivity profile	Potential improvements (for scenarios)	Potential of the sector (for scenarios)
Bio & subsea activities	Average productivity of labour relative to both turnover and profit. The lowest fixed assets productivity among Finnish blue sectors.	Highly and strongly efficient sector, with no excess of resources.	Turnover in the sector are insignificantly sensitive to all resources. Profit is sensitive only w.r.t. current assets.	Labour productivity within sector can be further improved. Low sensitivity of turnover and profit w.r.t. resources signals that employed resources may not generate maximal returns.	Sector with high potential. However, low sensitivity suggests that utilization of resources can be further improved in order to maximize returns to investments.
Energy	High labour productivity both in terms of profit and turnover. Productivity of fixed assets is relatively low.	Highly and strongly efficient sector, with no excess of resources.	Weak sensitivity of outputs w.r.t. resources. The only significant association is reported to current assets and both outputs.	One potential area for improvement concerns improving turnover and profit sensitivity in order to ensure that invested resources will generate maximal turnover and profit resources. Another aspect is fixed assets productivity increase.	Sector has very high potential, however due to low sensitivity of turnover and profit relative to assets, as well as low productivity of fixed assets, investments into fixed assets should be made cautiously in order to ensure high profitability. Especially, potential excess of fixed assets needs to be avoided, since low labour productivity can result in accumulation of non-productive resources.
Water (cargo) transportation	The sector reveals the highest productivity of labour and second highest productivity of fixed assets.	The second worst efficiency level. Excessive fixed assets and labour.	Quite strong sensitivity of turnover w.r.t. inputs. Profit is elastic only w.r.t. current assets.	Efficiency profile of the blue sector needs to be substantially improved, excess of resources needs to be reduced.	The sector, due to its large share, appears an important component of Finnish blue economy. Hence, improvement of efficiency profile is required. Potential steps include screening and reduction of resources, more profound resource management. Reduction of excessive fixed assets will also lower economically

Blue sector	Labour productivity profile	Efficiency profile	Sensitivity profile	Potential improvements (for scenarios)	Potential of the sector (for scenarios)
					unjustified environmental pressures.
Water (passenger) transportation	Average productivity of labour and fixed assets relative to both turnover and profit.	Highly and strongly efficient sector, with no excess of resources.	Weak association of outputs with assets increase. Only positive significant association is documented for current assets.	Overall labour and fixed assets productivity can be further improved. Low sensitivity suggests that inputs do not generate maximal profit returns and sectorial growth.	Sector with high potential and sound current performance. However, investments in the sector needs to account for low sensitivity and average productivity of resources.
Tourism	The least labour and fixed assets productive sector in Finland, both turnover and profit returns per employee are the lowest.	Fully efficient sector.	Turnover is sensitive relative to all resources. Profit is less sensitive, with significant association only with current assets increase.	Improvements are needed in the aspect of resources productivity. Low returns per unit of labour can, in a long run, result in efficiency decrease and accumulation of excessive resources.	The sector has a strong potential and sound current positions. However, future investments, especially in resources, need to account for low sensitivity of resources.
Marine construction	Average productivity of labour and fixed assets relative to both turnover and profit.	Highly and strongly efficient sector, with no excess of resources.	Strong sensitivity of turnover relative to fixed assets and current assets. Profit is sensitive only w.r.t. current assets.	Labour and fixed assets productivity within sector can be further improved.	Sector with a good potential. High sensitivity of turnover and weak but significant sensitivity of profit suggest that sector has a good basis for further investments and growth.

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