University of Tartu
Faculty of Social Sciences
School of Economics and Business Administration

THE INPUT-OUTPUT ANALYSIS OF BLUE INDUSTRIES: COMPARATIVE STUDY OF ESTONIA AND FINLAND

Gaygysyz Ashyrov, Tiiu Paas, Maryna Tverdostup

Tartu 2018

ISSN-L 1406-5967
ISSN 1736-8995
ISBN 978-9985-4-1104-9 (pdf)
The University of Tartu FEBA
www.mtk.ut.ee/en/research/workingpapers

The Input-Output Analysis of Blue Industries: Comparative study of Estonia and Finland

Gaygysyz Ashyrov[1], Tiiu Paas[2], Maryna Tverdostup[3],

Abstract

The paper focuses on examining the role of blue industries in the national economies of Estonia and Finland as two neighbouring countries that have a sea border. We exploit the Input-Output (I-O) methodology to analyse inter-industry linkages relying on the OECD I-O tables. The OECD database comprises information on 34 sectors of the national economy over the period 1995–2011. The results of the analysis show that despite rather weak overall backward and forward linkages of aggregated blue industries within the national economies, they play a remarkable role in the economic activities of maritime regions, and to a large extent drive the economic success of Estonian and Finnish regional and national economies in generating new growth and employment. The weak backward and forward linkages indicate that negative dynamics within the blue economy yield rather weak negative externalities for the overall economy, and by contrast, if the national economy as a whole is suffering under a crisis, the potential impact on industries is not particularly remarkable. These findings suggest that blue industries are relatively independent within national economies having a remarkable role in socio-economic development of maritime regions, and thereby, create good preconditions for the stable development of cross-border cooperation between the maritime regions of both countries.

JEL Classifications: C67, Q22, Q25, Q28, Q51, R15, O52

Keywords: marine industries, blue economy, Finland, Estonia, Input-Output tables analysis, cross-border cooperation.

1 School of Economics and Business Administration, University of Tartu, J. Liivi 4, Tartu, 50409, Estonia;
E-mail: gaygysyz.ashyrov@ut.ee
[2] School of Economics and Business Administration, University of Tartu, J. Liivi 4, Tartu, 50409, Estonia;
E-mail: tiiu.paas@ut.ee
[3]School of Economics and Business Administration, University of Tartu, J. Liivi 4, Tartu, 50409, Estonia;
Department of Public Finance, University of Innsbruck, Universitätsstraße 15, Innsbruck, 6020, Austria.
E-mail: maryna.tverdostup@ut.ee
The authors are thankful to the INTERREG Central Baltic programme for co-funding the Plan4Blue project and the project team members for their valuable comments and support during all project activities including several effective project meetings and seminars. Additionally, we are grateful to the Doctoral School in Economics and Innovation for providing financial support to the PhD student Gaygysyz Ashyrov to participate in the 25th INFORUM World Conference (Riga Technical University,28.08-1.09.2017), where we received valuable feedback and suggestions for the development of our research. The authors are also thankful to Jaan Masso and Patricio Aroca for their valuable suggestions.

1. INTRODUCTION

In 1936, Leontief presented the Input-output (I-O) approach, which is a useful technique in economic analysis and policy making. According to the I-O approach, forward and backward linkages represent the impact of a particular sector on other sectors in the economy. Leontief's model and its first implementations have been highly recognized and developed internationally (Rose, & Miernyk, 1989; Miller, & Blair, 2009), as well as being acknowledged through a Nobel prize in Economic Science for the development of the I-O method and for its implementation in applied economics[4]. The essential difference of Leontief's work from that of his predecessors is that it makes it possible to estimate I-O coefficients from data, to execute crucial algebraic manipulations, and to exploit the results to put forward solutions for a wide range of practical economic questions (Dorfman, 1973).

The Leontief model has been widely implemented to evaluate backward and forward linkages between industries (economic sectors) and to estimate the relevant multipliers. This procedure aims to identify ''key'' or ''leading'' sectors of the economy (Miller and Blair, 2009). Early works, including studies by Rasmussen (1956), Hirschman (1958), Chenery and Watanabe (1958), Yotopoulos and Nugent (1973), Jones (1976), and Schultz and Schumacher (1976), have offered several different definitions and modifications of the backward and forward linkages. Moreover, McGilvray (1977) and Hewings (1982), among others, investigated the precise role of linkage measures and the identification of leading sectors in development planning.[5] The analysis of these linkages for similar sectors in different countries has enabled the development of a method for performing international comparisons of the structure of production (San Cristobal and Biezma, 2006).

The aim of this research paper is to gain a better understanding of the role of blue industries in national economies by focusing on the analysis of the performance of blue industries in the national economies of two neighbouring countries, Estonia and Finland. Based on the national accounts, we calculate the backward and forward linkage effects of all economic industries in Finnish and Estonian economies in order to examine, (i) how much the blue industries are influenced by other industries, and (ii) how much impact the blue industries have on other industries. Relying on the output and employment multipliers, we analyse the effects of blue industries on other sectors of the countries' national economies. Considering the complexity of these inter-industry analyses, this paper contributes to the I-O literature by providing a comprehensive analysis of the blue industries. Moreover, our paper presents a clear picture of the evolution of the blue industries in Estonia and Finland. Hence, the results of this research will provide evidence suggesting policy recommendations targeting the future cross-border cooperation between the two countries.

Previous studies have used the backward and forward linkages and multiplier effects to investigate impacts of various economic industries in different countries; for example, the economic impacts of alternative levels of felling timber in Finland (Rimler et al., 2000), the mining sector of region II in Chile (Aroca, 2001), the role of the electric power industries in the

[4] "Wassily Leontief - Facts". *Nobelprize.org.* Nobel Media AB 2014. Web. 28 Feb 2018. Retrieved from URL: http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/1973/leontief-facts.html>

[5] Moreover, if a consistent data is available for more than a single period, the evolution of these linkages can be researched. In our case, since we have data for the period 1995-2011 we present evolutions of the economic interconnections

Korean national economy (Han et al. 2004), water use in the Spanish economy (Duarte et al. 2002), the interdependencies of industries in the Australian economy in terms of environmental pressure and resource depletion (Lenzen, 2003), the structural interdependence of the agricultural sector and energy sectors in Turkey (Karkacier and Goktolga, 2005), the mining industry in the European Union (San Cristobal and Biezma, 2006), and the role of transportation sectors in the Korean national economy (Lee and Yoo, 2016).

A similar methodology has been applied in some marine industry related studies. While 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 using IO tables and inter-industry linkages and multipliers. However, these studies are single-country case studies. In our study, we perform an analysis of the role of blue industries in Estonian and Finnish economies using IO datasets and methodology to foresee prospective cross-border cooperation opportunities.

The empirical part of our study relies on the OECD database, which comprises information on 34 sectors of the national economy over the period 1995–2011. We define the blue economy as a separate part within the national economy, which is directly involved in on- and offshore economic activities in the Gulf of Finland. We specifically focus on eight sectors, which among the full array of 34 sectors, are highly related to the blue industries: 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. Similar blue sectors were defined within the "Study on Blue Growth, Maritime Policy and the EU Strategy for the Baltic Sea Region", conducted by the European Commission in 2013. We identify blue industries following the statistical classification of economic activities in the European Community (NACE Rev. 2)[6] and developed by Eurostat. While using the OECD I-O database, we noticed a number of shortcomings that should be taken into account when conducting the analysis and interpreting the results. The main limitation of the OECD database is the high aggregation level (34 main industries). But despite this limitation, the OECD I-O is a valuable data source, due to the cross-country comparability of the I-O estimates and high reliance of the estimates. These two features make the data an appropriate source for the study of inter-industrial linkages within national economies in a cross-country framework.

The paper can be outlined as follows. The next section discusses the I-O methodology and the derivation of linkages, output and employment multipliers for the blue industry. Section 3 presents an overview of the data used in this study and its limitations. Empirical results of the IO analysis, such as backward and forward linkages, output multipliers and employment multipliers are provided in Section 4. The potential for implications from the results and some policy recommendations for strengthening cross-border cooperation are discussed in Section 5.

2. Methodology

This paper evaluates inter-sectoral linkages using classical I-O models of the national economy. To evaluate the depth of intra-industry relations, we performed an extensive analysis of the linkage effects. The foundations of this analysis rely on the assumption that the economy

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

operates through linking input and output activities (Hirschman, 1958). Typically, the linkage effect can be divided into two effects which are the backward and the forward linkage effects. The backward and forward linkages approach has been successfully implemented by several studies focusing on the analysis of marine industries (van der Linden 2001, Kwak all 2005, Morrissey and O'Donoghue 2013). One of the earliest studies in the marine field was conducted by Van der Linden (2001). The research focuses on the analysis of inter-industry linkages in the shipping industry as an international industry relying on data from 1997. Later, Kwak et al. (2005) analysed the role of the maritime industries in the Korean economy. Morrissey and O'Donoghue (2013) investigated the role of the marine sector in the Irish national economy using I-O tables and backward-forward linkage measures.

A backward and forward linkages analysis could provide valuable policy suggestions. By calculating backward linkages, we can indicate the importance of the specific industry in the overall economy in terms of production effects. For example, if a blue industry has a higher backward linkage than non-blue industries, it would mean that the expansion of the production of that blue industry is more beneficial to the whole economy in terms of stimulating productive activities. If a blue industry has more intensive forward linkages than non-blue industries, it would imply that its production is more sensitive to variations in the production activities of other industries. Furthermore, calculating these two linkage effects would enable policy makers to quantitatively analyse the blue industry's structural relationship with other non-blue industries. Consequently, this evidence could offer input for investment decisions at national and industry levels (Morrissey and O'Donoghue, 2013).

The general equation of I-O models can be depicted as either *demand-driven*:

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

Or *supply-driven*:

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

where X_i represents the sum of gross outputs in sector $i = 1, \ldots, n$; a_{ij} are defined as direct input coefficients which divide X_{ij}, the transaction flows between producing sector *i* and supplying 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*; D_i stands for the part of a gross output in sector *i* sold to the final demand; and V_j represents the final value added by sector *j*. Hence, equation (1) depicts the demand-driven model, implying the vertical analysis of the I-O tables, while equation (2) articulates the supply-driven model, inferring the horizontal analysis of the I-O tables (Kwak et al., 2005).

We can also indicate the demand-driven model (1) in a matrix form:

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

where I represents an $n \times n$ 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:

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

Nevertheless, the standard demand-driven model cannot accurately measure the impacts of a 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 taste and government purchases. For this purpose, the individual maritime industry has to be handled as exogenous and put into the final demand group (Morrissey and O'Donoghue, 2013; Cai, and Leung, 2004). We refer to this approach as the blue industry based I-O analysis.

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

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

For a particular marine economy sector *(i), the* Leontief supply-driven multiplier *(LSD$_i$)* is given by:

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

where 1 denotes the initial unit output change in blue industry i, and e' is the summation vector aggregating the elements in Δx_j, which represent the impacts of the initial output change on the rest of the economy through the backward linkages of blue industry *i* (Morrissey and O'Donoghue, 2013).

To make the comparison of linkages among the industries easier, we calculate a backward linkage index using the following formula (Pérez-Labajos, 2001):

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

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

In order to calculate forward linkages, the use of Leontief row sums is controversial since Leontief forward linkage calculations are based on the strength of backward linkages (Cai, Leung, Pan and Pooley, 2005). Compared to the Leontief model, which associates multiple inputs to each single output, the Ghoshian model associates multiple outputs to each single input (Morrissey and O'Donoghue, 2013). Thereof, the forward oriented Ghoshian model, in spite of its own caveats (Cai, Leung, and Mak 2006), is widely used as an alternative model in many studies (Cai, Leung, Pan and Pooley, 2005; Cai, Leung, and Mak 2006; Kwak et al., 2005).

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

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

where, B is the direct output coefficient matrix. Accordingly, we can present the Ghoshian supply-driven (GSD) multiplier (Morrissey and O'Donoghue, 2013):

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

And the forward linkage index:

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

Forward and backward linkages are also called the power of dispersion and the sensitivity of dispersion, respectively. If the values of these two effects are greater than one, the corresponding industry has a crucial role in economic development and supporting other industries (forward linkage effect) as well as increasing the performance of other industries (backward linkage effect) (Lin, and Chang, 1997).

On the one hand, from the blue industry perspective, the backward linkage effect demonstrates that the production activities of an 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 for other industries in their production (Pietroforte, and Bon, 1995; Yoo, and Yang, 1999). The high amount of intermediate inputs reflects the nature of the blue industry 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 blue industries on the national economy as a whole (Kwak et al., 2005).

The I-O analysis also allows us to measure the overall effect created by an increase in demand in a sector or group of sectors, which might not, supposedly, appear related (Pérez-Labajos, 2001). One of the crucial benefits of the information in the I-O model is that it enables us to measure the effect of changes in components which are exogenous to the model itself. Several most commonly used types of multipliers are those that estimate the effects of exogenous changes on (1) the outputs of the industries in the economy, (2) household incomes in each industry due to the new outputs, (3) job creation that is expected in each industry due to the new outputs. Furthermore, these multipliers have paramount importance since they enable us to perform impact analysis forecasting the future projections of variations in elements which are exogenous to the model of that economy (Miller and Blair, 2009).

The effects of a variation in the final demand, for example variations in Consumption, Investment, Government Expenditure or Exports, are estimated through the multipliers (Aroca, 2001). These multipliers will also provide policymakers with more clear results related to production stimulating policies and employment creation processes, in addition to the information on the backward and forward linkages. Calculating output multipliers allows us to analyse whether there is an external increase in final demand or not. It is possible to distinguish two types of system multipliers. The first type, open system multipliers, do not consider the probability that when there is an exogenous increase in final demand, the employees will receive more financial earnings that they then spend in the country. The second type, closed system multipliers, take into account the possibility that, for instance, the whole additional wage is being spent in the country (Aroca, 2001).

Following the multiplier calculation approach proposed by Acora (2001), employment multipliers can be divided into 2 types. Type I and II employment multipliers are calculated since they deliver a clear insight into 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 captures how many jobs will be created in the entire market according to every job created in a specific sector (Aroca, 2001). As Miller and Blair (2009) noted, it is generally accepted that Type I multipliers may underestimate economic effects (because household activity is not accounted for) and Type II multipliers may provide an overestimate (due to the rigid assumptions about wages and attendant consumer expenditure). Therefore, it is advisable to calculate Type I and Type II in order to obtain a true indirect effect of an increase in final demand (Oosterhaven, Piek and Stelder 1986).

There have also been some doubts on the expediency of the practical application of several multipliers. Isard et al. (1998) argue that multipliers are not always sufficiently informative and beneficial since they add up output over all sectors in the economy; this implies output multipliers may provide the same value to all sectors. But despite these doubts, employment impacts linked to output in different sectors, as well as income multipliers have been widely implemented as relevant measures of the economic importance of sectors. Employment creating impacts of sectoral expansions are often a main concern for policymakers, including the case of the blue economy. Indeed, the marine sectors are especially assumed to have high employment advantages for coastal areas (Ó Donnchadha, Callaghan, Niland 2000; Collier 2001).

Relying on the theoretical considerations and the results of previous applications, we implement an analysis based on I-O tables, including calculations of backward and forward linkages, and output and employment multipliers to analyse the role of blue industries in the national economies of Finland and Estonia. Therefore, the estimated output and employment multipliers reflect the effects of changes in an activity's output or employment upon all other activities throughout the economy. The implementation of the above presented methodological approaches enables us to analyse how important inter-industry relations are for the Finnish and Estonian economies and to better understand the role of blue industries in the national economies of these two neighbouring countries. We suppose that this additional information will be beneficial for policymakers to develop industry-specific policies for further developments in the blue industry.

3. DATA

The paper focuses on the case of two Northern European countries, Estonia and Finland. Estonia and Finland are geographically connected, with shared access to the Baltic Sea. This geographical proximity has increased the cross-border cooperation over the years. According to Statistics Estonia (2017a), Finland was one of the main trade partners of Estonia in 2016. This evidence applies especially to the blue economies of the two countries. In terms of cross-border trade, Finland has the biggest share of Estonian imports, which is 16%, and has the second biggest share of exports from Estonia, which is 13%. In 2016, the shipping lines between Estonia and Finland have carried 8.8 million passengers, which is almost 84% of the 10.5 million passengers that visited Estonian ports by international transport. Estonia's fishery industry is highly dependent on the Baltic Sea. In 2016, Estonian fisheries caught 60,440 tons of fish from the Baltic Sea, which constituted 80% of the total fish catch (Statistics Estonia, 2017b). Despite these statistics, there is the potential for the further development of cross-border cooperation between Estonia and Finland by focusing especially on blue industries. Therefore, additional empirical analysis of inter-industrial relations emphasizing the role of blue industries in the economic activities of the countries is necessary.

We exploit I-O tables from the OECD I-O database for the purpose of investigating the impact of blue industries in the national economy of Estonia and Finland for the period 1995–2011. The OECD database comprises information on 34 industries in the national economy. The OECD database gathers statistics related to I-O tables from each member country. I-O tables can be defined either as product to product (product outputs) or industry to industry tables (industry outputs). The main data source, the OECD I-O tables database, uses an industry to industry approach. This approach has its own advantages, since it enables higher integration with pools of statistics collected by industrial activities such as R&D expenditure, employment, foreign direct investment and energy consumption. Furthermore, this database is beneficial for empirical analysis and the examination of the economic impact of industries at the international level since it emphasizes inter-industrial relationships involving all industries of the economy.[7]

The national I-O tables of Estonia and Finland, developed by the respective statistical offices, could be an alternative data source for the analysis. However, the I-O data collection and reporting procedures differ across the two countries, since the Finnish I-O table takes an industry to industry approach, while the Estonian I-O table takes a product to product approach[8]. Therefore, we have chosen to rely on the OECD I-O database, which provides a homogenous industry to industry approach for both countries. The OECD I-O database has a strong advantage, as it provides comparable data for both countries, and ensures that the cross-country analysis is consistent.

However, the OECD I-O database has a number of shortcomings. Although it provides homogenous statistical data for both countries, it lacks more detailed statistics and industry disaggregation. The number of sectors is relatively more limited in the OECD I-O tables, compared to the national I-O tables published by the Estonian and Finnish statistical offices. Moreover, the OECD I-O database covers data until 2011. Compared to the I-O tables which have been provided by the national statistics offices of Estonia and Finland, the OECD data is quite aggregated. Nevertheless, we suppose that the OECD database provides sufficient bases to achieve the aim of our empirical study and elaborate additional information for further development of industry-specific policies in the blue economies.

4. EMPIRICAL RESULTS

In this part of our research paper, we present the results of the analysis that relies on the OECD I-O table allowing to analyse the inter-industry linkages of a national economy. Backward linkages can identify the importance of a certain industry for a whole national economy in terms of inducing production effects. For instance, if blue sectors have higher backward linkages in comparison to non-blue sectors, it suggests that expansion of production in the blue industry is more beneficial to the whole economy in terms of stimulating productive activities. By contrast, if a blue industry has more intensive forward linkages than a non-blue industry, it would imply that its production is more sensitive to fluctuations in the national economy and

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

[8] Official Statistics of Finland (OSF): Input-output [e-publication]. ISSN=1799-201X. Helsinki: Statistics Finland [referred: 14.4.2018]. Access method: http://www.stat.fi/til/pt/index_en.html

its industries. Identifying these linkages enables policy makers and spatial planners to better analyse how sensitive the development of a whole economy is to changes in certain industries.

The OECD database comprises information on 34 sectors over the period 1995–2011. We specifically focus on eight sectors which are highly related to the blue industry: 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; and Transport and storage.

4.1. Backward and forward linkages of blue industries in Finland and Estonia

Tables 4.1 and 4.2 present the backward and forward linkage effects of the 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 developmental trends in these linkages. In general, there are no significant fluctuations of these linkages over the period under investigation in Estonia or 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 I-O table data 1995–2011.

In the case of Finland, forward linkage values have been lower than 1 for four blue industries, these are, (iv) Motor vehicles, trailers and semi-trailers; (v) Other transport equipment; (vi) Construction; (vii) Hotels and restaurants for period of 1995–2011. This implies that when economic activities are booming, the blue industries are less stimulated by overall industrial growth than other industries. Hence, these blue industries are not influenced much by business fluctuations. However, blue economy related industries, including (i) Agriculture, hunting, forestry and fishing, (ii) Mining and quarrying, (iii) Coke, refined petroleum products and nuclear fuel, (viii) Transport and storage, have forward linkage values higher 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 backward linkage values of industries higher than 1, which are (v) Other transport equipment, (vi) Construction, (vii) Hotels and restaurants, (viii) Transport and storage. The backward linkage value of the blue industry, Transport and Storage, fluctuated between 0.99 and 1.02 until 2005. Since 2005, we can see stronger backward linkage, as its value becomes higher than 1. One of the main developments during 2004 was the accession of many Eastern European countries, including Estonia, into the European Union. Entering the European Union could be one of the factors that increased the entirety of the blue sectors in the investment expenditures on the national economy.

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 I-O table data 1995–2011.

The case of Estonia demonstrates that forward linkage values have been lower than 1 for five industries related to the blue economy, these are, (iii) Coke, refined petroleum products and nuclear fuel, (iv) Motor vehicles, trailers and semi-trailers, (v) Other transport equipment, (vi) Construction, and (vii) Hotels and restaurants. This 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 in Estonia and thus form a relatively more stable segment of the economy. However, the other three blue industries, (i) Agriculture, hunting, forestry and fishing, (ii) Mining and quarrying, and (viii) Transport and storage, have forward linkage values above 1.

Although backward linkage values have been fluctuating over the years for some industries, we can observe a number of sectors with backward linkage values higher than 1: (i) Agriculture, hunting, forestry and fishing, (v) Other transport equipment; (vi) Construction; (vii) Hotels and restaurants, and (viii) Transport and storage.

Table 4.3 summarizes the details of the 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 and Estonia in 2011

		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	Finland	Transport and storage	Other transport equipment; Construction; Hotels and restaurants
	Estonia	Agriculture, hunting, forestry and fishing; Transport and storage	Other transport equipment; Construction; Hotels and restaurants
LOW BL (<1) less remarkable influence to other industries.	Finland	Agriculture, hunting, forestry and fishing; Mining and quarrying; Coke, refined petroleum products and nuclear fuel	Motor vehicles, trailers and semi-trailers
	Estonia	Mining and quarrying;	Motor vehicles, trailers and semi-trailers

Source: authors calculations based on OECD I-O Table 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 categorized into intermediate manufacture, intermediate primary production, final manufacture, and final primary production, depending on the values of the linkage's indexes. The industries can be classified into the categories according to how the backward and forward linkage effects are matched, resulting in the following four groups of sectors:

- high backward and high forward linkages: intermediate manufacture production;
- high backward and low forward linkages: intermediate primary production;
- low backward and high forward linkages: final manufacture production;
- low backward and low forward linkages: final primary production.

Therefore, according to Table 4.3, the Transport and storage and Agriculture, hunting, forestry and fishing industries in Estonia can be categorized 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. 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 the values of these two linkage effects are greater than one, these industries perform a crucial function in maintaining and development other industries, and their development is also remarkably influenced by the success of other industries that they are very strongly integrated with in the national economy. Therefore, creating favourable conditions for the development of the Agriculture, hunting, forestry and fishing and Transport and storage sectors should be particularly considered through the elaboration of industry-specific policies in the blue industries.

4.2. Output, Income and Employment Multipliers

Based on the I-O tables, it is also reasonable to calculate and analyse output and employment multipliers that reflect the effects of changes in output or employment upon all other activities throughout the economy (see Equation 9). Multipliers can provide additional quantitative information that considers 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 the role of these inter-industry relations in Estonia and Finland during the years 1995–2011. More details on the calculated output and employment multipliers for Estonia and Finland are presented in Appendices 1 and 2 and illustrated by Figures 4.1 and 4.2.

In our analysis, two types of multipliers can be distinguished: open and closed system multipliers. There are some differences in the values calculated in the open and closed system multipliers (see Figures 4.1 and 4.2 and Appendices 1 and 2). In absolute numbers, these values vary approximately between 1.5 and 3 euros, meaning a one-unit (euro) increase of final demand can increase output respectively from 1.50 to 3 euros in the analysed industries. In Finland, the difference between open and closed system output multipliers is as a rule higher than in Estonia. For instance, for the Hotels and restaurants sectors in Finland and Estonia, the actual 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 by the substantial wage differences between the countries. Taking into account that both Estonia and Finland are open economies, it is reasonable to focus on analysing and discussing the values of open system multipliers.

Figure 4.1. Output Multipliers for the 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 I-O data 2011.

Figure 4.1. depicts output multipliers for blue sectors in Estonia and Finland, respectively. According to Figure 4.1, the open system multipliers of blue sectors vary between 1.50 and 2 euros, and closed system multipliers respectively approximately between 2 and 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 1.73 and of Estonia by approximately 2 euros if it is spent in the Transport and storage industry (open system multiplier). The calculated output multipliers for the Hotels and restaurants sector show that an increase in final demand could have a remarkable effect on the output produced within the economy – respectively 1.86 euros in Estonia (in the case of an open system) and 1.83 euros in Finland. Also, income multipliers are rather high: 1.55 euros (open system) till 2.20 euros (closed system) in Estonia and respectively 1.59 and 2.42 euros in Finland. These results once again confirm that blue sector activities in the field of Hotels and restaurants have a high impact on the growth of blue industries. This sector has a strong effect on the production activities of other sectors in the overall economy. In addition to Hotels and restaurants, also Transport and storage, and Construction sectors have a high impact on total output in both countries (see Figures 4.1 and 4.2 and Appendices 1 and 2).

The comparison of the blue industries with non-blue industries reveals that, in general, the output and income multipliers of blue industries are slightly smaller than in non-blue industries. If we rank all sectors according to the output multiplier, Hotels and restaurants takes 4th place among all sectors in Estonia. In Finland, Construction has the best ranking position of blue sector output multipliers among all sectors (6th place). Analysing output, value added and income multipliers together, it is possible to summarize that threeblue economy related industries, such as Hotels and restaurants, Transport and storage, and Construction, belong to the top ten within the analysed 34 industries. Changes in final demand (income) will induce higher output growth in Hotels and restaurants, Construction, and Transport and storage, and will bring remarkable positive growth in output in these fields. Therefore, if investment policies in blue industries are aimed at foreseeing higher output results, these three sectors have good potential for future developments.

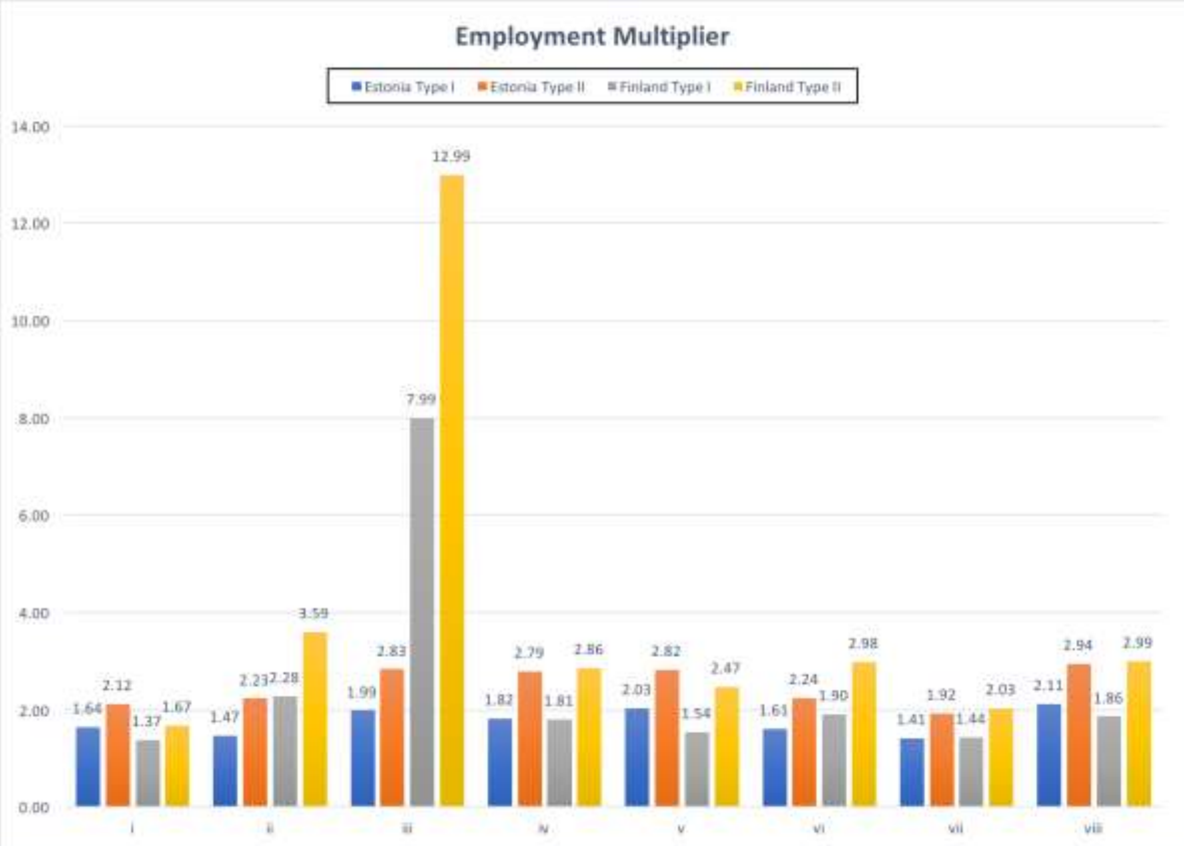

Figure 4.2. Employment multipliers for the economies of Estonia and Finland, 2011

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 I-O Table data 2011.

Results from the employment multipliers (Figure 4.2) will enable us to analyse the employment creating impacts of sectoral expansions and assist policy makers to tackle one of their main concerns about employment potential in the blue industries of Estonia and Finland. Furthermore, employment impacts in the different sectors are notable measures of the economic importance of these sectors.

Figure 4.2 illustrates type 1 and type 2 employment multipliers for Estonian and Finnish blue sectors for 2011. According to type 1 and type 2 employment multipliers, the Transport and storage sector has the highest number, 2.11 and 2.94 in Estonia and 1.86 and 2.99 respectively in Finland (Appendices 1 and 2). One can interpret these numbers that for every 100 thousand euros invested in Transport and storage, approximately 2–3 individuals will be additionally employed in Estonia. In Estonia, the employment multipliers are even higher in the case of the Coke, refined petroleum products and nuclear fuel and Other transport equipment sectors. This suggests that investments in these blue economy industries will induce remarkable additional employment in the blue regions of the country.

In the case of Finland, Coke, refined petroleum products and nuclear fuel has the highest employment multiplier amongst blue sectors, which is 7.99 (open system) and 12.99 (closed system). These are the highest indicators among all sectors. The second highest is the Mining and quarrying sector and the third highest the Transport and storage sector. According to these results, one can conclude that investments in the Coke, refined petroleum products and nuclear fuel sector will create the highest employment opportunities compared to other blue sectors in Finland. The Transport and storage sector has the highest employment multiplier among Estonian blue sectors, similarly the Transport and storage sector has the third highest employment multiplier among Finnish blue sectors. Even though Coke, refined petroleum products and nuclear fuel has a huge role in employment creation, the Agriculture, hunting, forestry and fishing industry should also be supported in order to increase employment creation. As the inter-industry linkages suggest, this type of blue industry has a significant function as an important intermediate primary production for Finland and as a strong intermediate manufacture in Estonia.

5. CONCLUSIONS AND DISCUSSION

Blue sectors constitute a vital part of the economy in the maritime region both in Estonia and Finland. We have identified blue industries based on the statistical classification of economic activities in the European Community. This study employs OECD input–output (IO) analysis to investigate the impact of the blue industries in the national economy of Estonia and Finland for the period 1995–2011. Based on the classification and definition of blue industries, we specifically focus to the sectors that are highly related to blue industries among the 34 sectors.

We have estimated the inter-industry linkages, such as forward and backward linkages, and output and employment multipliers for the purpose of addressing the impact of blue sectors on the national economies of Finland and Estonia. To do that, we exploited the I-O tables from the OECD for the period 1995–2011. The OECD database comprises information on several sectors of a national economy using an 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. Along with its strong advantages, the OECD I-O database has some shortcomings that should be considered when conducting the analysis and interpreting the results. Although it provides homogenous statistical data for both countries, the data on the Estonian and Finnish economies lacks more detailed statistics on industries: only 34 industries are involved; eight of them comprise activities related to blue economies (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).

The results of the I-O tables-based analysis show that blue industries generally are not very tightly related to the national economies of Finland and Estonia. Weak forward linkages yield less spill over effects from the national economy – both general economic growth and decline will be reflected to a lower extent in blue industries. Backward linkages are similarly weak, implying that investments and positive changes within blue industries weakly reflect on other economic sectors and the entire national economy. Therefore, negative dynamics within the blue economy yield only weak negative externalities on the overall economy. These findings suggest that blue industries are relatively independent within the 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 perform a crucial function in maintaining and developing other industries. Their development and sustainability are also notably influenced by the success of other industries in the countries' economies. These industries can be considered the intermediate manufacture production industries.

In addition, the inter-industry linkages of the blue industries in the two countries follow different patterns of change over time. Finnish forward and backward linkages have been stable between 1995–2011. In contrast, Estonian forward and backward linkages have varied more over the course of time, and for some years their value has been higher than 1 or lower than 1. It is possible to say that this difference has occurred because Estonia has experienced remarkably more reforms and changes during the aforementioned periods compared to Finland. In addition to this, the Estonian economy is relatively small and has experienced fluctuations across the business cycles.

The analysis using output and employment multipliers provides additional quantitative information that suggests policies and employment creation processes in industries related to the blue economy. A single-unit (one euro) increase in final demand (or income) brings particularly remarkable growth in output in Hotels and restaurants, Construction, and Transport and storage industries in both countries, Estonia and Finland (around 2–3 Euros). Therefore, these three sectors have good potential for future development, and creating favourable conditions for the development of their activities should also be considered through the elaboration of industry-specific policies for the blue industries. The analysis of employment multipliers shows that investments in Coke, refined petroleum products and nuclear fuel industries create remarkable additional employment – investments of 100 thousand euros can create 8 – 13 new jobs in Finland. In both Estonian and Finnish industries, employment multipliers are smaller but still remarkable: investments of 100 thousand euros can create on average 2–3 jobs. The Transport and storage sector has the highest employment multiplier among Estonian blue economy related industries.

Therefore, relying on the I-O analysis, it is possible to summarize that blue industries play a significant role in economic development and to a large extent drive the economic success of regional and national economies in generating new growth and employment in Estonia and Finland. Weak backward and forward linkages indicate that negative dynamics within the blue economy yield rather weak negative externalities for the overall economy, and by contrast, if the national economy as a whole is suffering from a crisis, the possible impact of that on blue industries is not so remarkable. These findings suggest that blue industries are relatively independent within the national economy, and thereby also create good preconditions for the stable development of cross-border cooperation between the maritime regions of both countries. The results of Input-Output analysis provide valuable information for the elaborating and implementing additional measures supporting cross-border cooperation of neighbouring countries that have a sea border.

REFERENCES

Aroca, P. (2001). Impacts and development in local economies based on mining: the case of the Chilean II region. Resources Policy, 27(2), 119–134.

Banker, R.D., Cooper, W.W., Seiford, L.M., Thrall, R.M. and Zhu, J. (2004). "Returns to scale

Beck, M., L.A. Mulkey, and T.O. Barnwell. 1994. Model Validation for Exposure Assessments — DRAFT. Athens, Georgia: United States Environmental Protection Agency.

Cai, J., & Leung, P. (2004). Linkage measures: a revisit and a suggested alternative. Economic Systems Research, 16(1), 63–83.

Cai, J., Leung, P., Pan, M., & Pooley, S. (2005). Economic linkage impacts of Hawaii's longline fishing regulations. Fisheries Research, 74(1), 232–242.

Cai, J., Leung, P., & Mak, J. (2006). Tourism's forward and backward linkages. Journal of Travel Research, 45(1), 36–52.

Charnes, A., Cooper, W. W., Rhodes, E. (1978). "Measuring the efficiency of decision making units." European Journal of Operational Research, Vol.2, pp: 429–444.

Charnes, A., Cooper, W. W., Rhodes, E. (1979). "Short communication: Measuring the efficiency of decision making units." European Journal of Operational Research, Vol.3, p. 339.

Chenery, H. B., & Watanabe, T. (1958). International comparisons of the structure of production. Econometrica: Journal of the Econometric Society, 487–521.

Collier, P. (2001). A Monograph Study of Offshore Fishing and Social Change in Kilmore Quay, Co. Wexford. Marine Resource Series, (15), I.

Dorfman, R. (1973). Wassily Leontief's Contribution to Economics. The Swedish Journal of Economics, 75(4), 430–449. doi:10.2307/3439154

Hirschman, A.O. (1958). The Strategy of Economic Development. Yale University Press, New Haven, CT, USA.

Isard, W., Azis, I.J., Drennan, M.P., Miller, R.E., Saltzman, S., Thorbecke, E., (1998). Methods of Inter-regional and Regional Analysis. Ashgate, Hants, UK.

Jones, L. P. (1976). The measurement of Hirschmanian linkages. The Quarterly Journal of Economics, 90(2), 323–333.

Kwak, S. J., Yoo, S. H., & Chang, J. I. (2005). The role of the maritime industry in the Korean national economy: an input–output analysis. Marine Policy, 29(4), 371–383.

Leontief, W. W. (1936). Quantitative input and output relations in the economic systems of the United States. The review of economic statistics, 105–125.

Lin, S. J., & Chang, Y. F. (1997). Linkage effects and environmental impacts from oil consumption industries in Taiwan. Journal of Environmental Management, 49(4), 393–411.

Miller, R. E., & Blair, P. D. (1985). Input-Output Analysis: Foundations and Extensions prentice Hall Inc. Englewood Cliffs, New Jersey, USA.

Miller, R. E., & Blair, P. D. (2009). Input-output analysis: foundations and extensions. Cambridge University Press.

Morrissey, K., & O'Donoghue, C. (2013). The role of the marine sector in the Irish national economy: an input–output analysis. Marine policy, 37, 230–238.

Ó Donnchadha, G., Callaghan, T., & Niland, C. (2000). A Socio-economic Study of Fisheries in Counties Cork, Donegal, Kerry and Galway.

Oosterhaven, J., Piek, G., & Stelder, D. (1986). Theory and practice of updating regional versus interregional interindustry tables. Papers in Regional Science, 59(1), 57–72.

Pérez-Labajos, C. A. (2001). Spending pattern of the recreational maritime sector and its impact on employment: the case of Cantabria, Spain. Marine Policy, 25(3), 187–196.

Pietroforte, R., & Bon, R. (1995). An input–output analysis of the Italian construction sector, 1959–1988. Construction Management and Economics, 13(3), 253–262.
Rasmussen, P. N. (1956). Studies in inter-sectoral relations (Vol. 15). E. Harck.
Rose, A., & Miernyk, W. (1989). Input–output analysis: the first fifty years. Economic Systems Research, 1(2), 229–272.
San Cristobal, J. R., & Biezma, M. V. (2006). The mining industry in the European Union: analysis of inter-industry linkages using input–output analysis. Resources Policy, 31(1), 1–6.
Schultz, S., & Schumacher, D. (1976). Key sectors in some underdeveloped countries: a comment. Kyklos, 29(4), 765–766.
Statistics Estonia, 2017a. Minifacts about Estonia 2017.
Statistics Estonia, 2017b. Quarterly Bulletin of Statistics Estonia 2/2017.
Yoo, S. H., & Yang, C. Y. (1999). Role of water utility in the Korean national economy. International Journal of Water Resources Development, 15(4), 527–541.
Yotopoulos, P. A., & Nugent, J. B. (1973). A balanced-growth version of the linkage hypothesis: a test. The Quarterly Journal of Economics, 87(2), 157–171.
Van Der Linden, J. A. (2001). The economic impact study of maritime policy issues: application to the German case. Maritime Policy & Management, 28(1), 33–54.

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

Estonia *CTOTAL: TOTAL*	*Output Multipliers*		*Value Added*		*Income Multiplier*		*Employment Multiplier*	
	Open	*Closed*	*Type I*	*Type II*	*Type I*	*Type II*	*Type I*	*Type II*
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 the blue economy and their multipliers are presented in bold.

Source: authors calculations based on OECD I-O 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

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*
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 the blue economy and their multipliers are presented in bold.

Source: authors’ calculations based on OECD I-O data 2011.

KOKKUVÕTE

Merendusega seotud majandussektorite sisend-väljund tabelite põhine analüüs: Eesti-Soome võrdlusuuring

Uurimistöö eesmärgiks on genereerida uusi teadmisi merendusega seotud majandussektorite rolli kohta Eesti ja Soome majandustes. Uurimistöö tulemusi saab kasutada mereäärsete piirkondade piiriülese majanduskoostöö arendamiseks ning arengustsenaariumide koostamiseks. Analüüs tugineb OECD sisend-väljund tabelites toodud andmetele 34 sektori majandusseoste kohta aastatel 1995-2011. Analüüsi läbiviimisel on kasutatud sisend-väljund tabelitele tuginevat modelleerimist, mis võimaldab kvantitatiivselt hinnata majandussektorite omavahelisi seoseid ning investeeringute võimalikku mõju uute töökohtade loomisele ning majanduskasvule.

Analüüsi tulemustest nähtub, et merendusega seotud sektoritel on oluline roll nii Eesti kui Soome majanduste arengus, samas toimivad need sektorid majanduslike seoste mõttes mõlemas riigis suhteliselt iseseivalt. Riikide majanduste tsükliline kõikumine mõjutab merendusega seonduvete sektorite majandustulemusi mõnevõrra nõrgemalt võrreldes kogu majanduses toimuvaga. Multiplikaatorite analüüsist nähtub, et investeeringud merendusega seotud sektoritesse võimaldavad luua uusi töökohti ning genereerida majanduskasvu. Näiteks 100 000 euro suurune investeering mõnedesse merendusega haakuvatesse majandussektoritesse võimaldab luua keskmiselt 2-3 täiendavat töökohta ja/või saada keskmiselt 200-300 tuhande euro eest lisatoodangut. Sektorite lõikes multiplikaatorite arvuline väärtus mõlemas riigis varieerub. Analüüsi tulemused on toeks Eesti ja Soome mereäärsete regioonide piiriülese koostöö, aga ka piiriüleseks koostööks vajalike regionaalsete andmebaaside arendamisel.