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The Leontief Model in Research into the Economic Importance of Small Seaports: A Case Study

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Abstract:

Purpose: *The article defines the economic importance of the seaport of Kołobrzeg, a local port located in the western part of the Polish Baltic coast. The study has distinguished three effects, direct, indirect, and induced, which constitute a full spectrum of the seaport's impact. The effects were discussed in terms of the output, the gross wages, and the employment figure. The subject matter discussed in the article is an introduction to a more extensive study, which is to be conducted on a representative group of local seaports.*
Design/Methodology/Approach: *The port's significance in Kołobrzeg was determined using the Leontief model. The scope of the economic impact of the port was related to the Koszaliński subregion, a territorial unit at the NUTS 3 level. Regionalization of the national input-output table was performed using the Flegg Location Quotient (FLQ). The study was based on available statistical data, information obtained from the Main Statistical Office (GUS), and survey results.*
Findings: *The importance of the port of Kołobrzeg is determined by the multiplier value, which is lower than in previous studies due to the reference area being narrowed down, and by the use of the FLQ formula reducing the self-supplying ability of the Koszalin subregion. The induced and direct effects had the most significant impact on the economy of the subregion, with the indirect effect being of a minor significance.*
Practical Implications: *The study provides the decision-makers with information on the scope of impact and the economic significance of the Kołobrzeg port. They allow for a concentration of investment funds in the areas with the most significant impact on the local economy.*
Originality/Value: *In foreign literature, the are no studies on the importance of a seaport following the format: local port – regionalization of the national table using the FLQ – reference area below the NUTS 2 level. In the case of Polish seaports, no author has comprehensively determined their economic importance.*

Keywords: *Seaport, local and regional development, Leontief model, input-output flows, location quotients.*

JEL codes: *C67, D57, R12, R15.*
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1. Introduction

Seaports are generally considered to be essential for the development of their economic environment. They should therefore be of central interest to the public authorities and the institutions responsible for their development. However, decision-makers often lack reliable knowledge of sports' role in stimulating economic development, making strategic decisions more difficult (Danielis and Gregori, 2013; Dooms, Haezendonck, and Verbeke, 2015). There is extensive literature describing attempts to identify seaports' benefits (Coto-Millán, Mateo-Mantecón, and Castro, 2010; Danielis, 2011; Merk, Manshanden, and Dröes, 2013; Bottasso, Conti, Ferrari, and Alessio, 2014; Santos *et al.*, 2018). However, the vast majority of such studies focus on the transport function of large seaports. Researchers have neglected small seaports, despite often being structures of fundamental importance to the local economies. Due to the different business profiles of small seaports, with tourism and fisheries being relatively more important there, the extent of their impact on the local economy may diverge from that exerted by large seaports.

Seaport research is a relatively new research area. No theories or theoretical models have been developed specifically for seaports. Researchers have used several methods and techniques borrowed from other disciplines (Su-Han *et al.*, 2011; Dooms, Haezendonck, and Verbeke, 2015). One of the rather frequently used methods is the Leontief model based on input-output tables. This approach allows for a determination of the importance of the investigated subject to its economic environment. The Leontief model allows for three complementary effects to be distinguished – direct, indirect, and induced – and, therefore, for the full spectrum of the impact exerted by the subject under investigation to be captured. Although the method itself has been known for several decades, the regionalization of the national input-output table does pose a challenge, as ordinarily statistical authorities do not publish its regional or, especially, local counterparts. Regionalization is done using different methods, with location quotients being the most popular. However, their older versions carry some faults. To remedy such difficulties, Flegg proposed an improved formula of the location quotients (Flegg, Webber, and Elliott, 1995; Flegg and Webber, 1997; Flegg and Webber, 2000). The formula includes the delta parameter, which accounts for the self-supplying ability of the region as related to its size. The prime difficulty lies in choosing the appropriate value of the delta parameter, which is determined by empirical studies. So far, few authors have estimated the delta, mainly due to the absence of regional input-output tables.

Considering the difficulties in determining the economic importance of seaports, this article attempts to answer the following research questions:

- how will a use of the FLQ coefficient affect the self-sufficiency of a studied area, and thus the economic importance of the port in Kołobrzeg?
- is the limitation of the research area of local ports to NUTS 3 level sufficient?
- what are the relationships between direct, indirect and induced effects?

With reference to the research issues, the main aim of this article is to define the importance of the small seaport in Kołobrzeg for the economy of the Koszalin subregion (NUTS 3). The port of Kołobrzeg is in the western part of the Polish coast of the Baltic Sea. The article puts an emphasis on the regionalization of the national input-output table to a lower-level territorial entity, i.e., the aforementioned Koszalin subregion (NUTS 3), using the Flegg location quotient (FLQ). According to the best knowledge of this paper's author, no one has yet examined the importance of a seaport following the format, local port – regionalization of the national table using the FLQ – reference area below the NUTS 2 level. The national literature provides even scarcer material. So far, no author has used the Leontief model to study Polish seaports. In fact, quantitative methods have rarely been adopted to study the significance of Polish seaports. Given the above circumstances, the author of the present paper decided to attempt and enrich the knowledge of the impact that small seaports have on local economic development.

The research was narrowed down to a case study, focusing on the seaport of Kołobrzeg, one of the largest local ports. It is an introduction to broader research, which will comprise a representative group of small seaports from among the several dozen ports along the Polish coast.

As regards the layout of the paper, the introduction setting out the main reasons for choosing the subject to investigate is followed by the materials and methods, literature review, results, discussion, and conclusions sections. The first section presents the sources of information used in the research and discusses the research method, accounting for the numerous assumptions made within it. The review of literature starts with a presentation of the current state of research on seaports. Particular attention is paid to the popularity of the Leontief model, the sizes of the ports examined, the territorial scope of the comparisons, and the way in which the national table is regionalized. The review is divided between foreign and Polish sources. The subsequent section presents an organized set of statistical data necessary to determine the economic effects of the activity of the port of Kołobrzeg. The following section interprets the research results and discusses the difficulties encountered along the way. The last part is a synthetic summary of the most important results.

2. Literature Review

The literature on the subject of seaports is quite extensive. However, only a tiny part of such studies use quantitative methods. There are even fewer reports available that assess the importance of seaports to their surrounding economies. The probably most comprehensive literature review on port research methodologies conducted by (Su-Han *et al.*, 2011) shows that only 6% of scientific papers discussed the economic importance of seaports. Among those, the dominant research method used is the Leontief model based on the input-output table. However, such research focuses almost exclusively on large port structures. Research into smaller ports, on the other hand, is scarce (Bryan *et al.*, 2006; Guerrero, Selva, and Medyna, 2008; Sakalayen,

Shu-Ling, Chen, and Cahoon, 2017), which may be due to their limited impact on their economic environment and the lower availability of statistical data. However, it should be pointed out that smaller ports often have fundamental importance for the development of the local, and sometimes regional, economy.

Regarding the availability of statistical data, the information published on input-output flows required by the Leontief model is usually provided at the national level. The data, therefore, requires regionalization to lower levels, i.e., NUTS 2 or NUTS 3, and in some cases even the level of the port cities. The insufficient data forces researchers to make estimates or resort to inadequate comparisons, i.e., to examine the impact of seaports on lower levels of the economy using tables made for higher-level territorial units.

Research into the economic importance of Polish seaports has been even less popular than in foreign literature. Most authors confine their research to finding that owning a port does bring benefits but do not attempt to quantify them. Some of the few authors who have quantified the importance of seaports are Dunin-Kwinta (2000; 2010), Luks (2001), Zarzecki (2007), Biernacki (2007; 2012; 2014), Matczak (2016) and Nowaczyk (2017; 2018). However, the only quantitative method used in these studies is the cost-benefit analysis, Zarzecki (2007), Bernacki (2012; 2014), and Nowaczyk (2017; 2018). Other authors have identified the economic importance of seaports based on the value-added or the correlations between the port and its economic background. As well as foreign authors, Polish scientists' primary focus has been on the ports of fundamental importance to the national economy, i.e., Szczecin with Świnoujście, Gdańsk, and Gdynia, neglecting the importance of smaller port structures.

As already mentioned, the authors of research into the economic importance of seaports have mainly relied on input-output tables. In their cases, narrowing the territorial scope of the ports' impact required regionalization of the national table, as statistical authorities do generally not publish data at levels lower than national. Such regionalizations have usually been carried out using location quotients. Three types of location quotients can be distinguished, which are, chronologically, the superficial location quotient (SLQ), the cross-industry location quotient (CILQ), and the Flegg location quotients coming in two forms: classic (FLQ) and augmented (AFLQ). The first two localization quotients do not take due account (SLQ) or any account at all of the region's size (CILQ), thus overestimating its self-supplying ability.

As a result, the output is rarely balanced with value-added and intermediate consumption estimated using location quotients. The fixed values adopted by the traditional location quotients are used to prevent any adjustment. In response to these imperfections, Flegg, Webber, and Elliott proposed a new formula (1995), followed by its augmented version (Flegg and Webber, 1997). They overcame the deficiencies of the location quotients used before. They accounted for the region's size, while the variable value of δ enabled intermediate consumption and added value to be balanced

with output in the columns. The value of δ, dependent on the region's size, has allowed other authors to assume identical values in their studies or has been used as the starting point for their estimations.

Polish literature contains few examples of input-output tables being used to assess the importance of economic structures. Among the few authors who have done so are Zawalińska and Rok (2017), Tomaszewicz and Boratyński (2003), Welfe, Świeczewska, Florczak, and Karp (2008), Godyń (2012), Chrzanowski (2013) and Torój (2016). However, Zawalińska has been the only regionalizing the national table using AFLQ for all Polish provinces (NUTS 2). The correlations between the values of δ and the sizes of Polish regions were as expected (the more significant regions showed higher values of δ), but with much more significant variance than in the studies by Flegg and Tohmo (2010) for Finnish regions and Kowalewski (2015) for individual industrial sectors of the German state of Baden-Württemberg. This confirms the need to apply much caution in assuming the value of δ based on the former research. They still scare empirical material may constitute a starting point for estimating the unknown value of δ. Other authors have used the location quotients SLQ or CILQ to regionalize national tables.

According to the best knowledge of the present paper's author, the only researcher to have used the Flegg location quotient AFLQ for port research is Danielis (2011). However, he did not calculate δ but instead assumed its value as per the research carried out by Flegg and Tohmo (2010), building on the criterion of the size of the studied region. Romeo Danielis analyzed the economic importance of three large ports in the north-eastern part of Italy (Trieste, Monfalcone, Porto Nogaro) to Italian regions (NUTS 2). The input-output table was therefore consistent with the reference area analyzed.

Coto-Millán, Mateo-Mantecón, and Castro (2010) regionalized the national table using simple localization quotients. He then assessed the impact of the large port of Santander on the local, regional (NUTS 2), and interregional (NUTS 1) economies. However, as mentioned above, using the regional table to assess the impact on the local economy may raise some concerns due to the lower self-supplying ability of port cities and the resulting overestimated outcome.

Santos *et al.* (2018) regionalized the national table based on the location quotient but did not specify which version of the quotient they used. They then determined the importance of the large port of Lisbon to the development of the nearest region (NUTS 2) and the country.

Guerrero, Selva, and Medyna (2008), Merk, Manshanden, and Dröes (2013), and Merk (2015) created a regional input-output table based on available statistics. Guerrero then referred to the economic importance of local ports to port cities. Similar to Coto-Millán *et al.* (2010), he used the regional table to assess the impact on the local economy. Merk assessed the impact of the large seaports of Marseille, Mersin,

Rotterdam, Antwerp, Hamburg, and Le Havre on the development of the port regions (NUTS 2). The regional table used in his study was therefore consistent with the reference area.

As mentioned multiple times above, no one has yet used input-output tables to assess the economic importance of seaports in Poland. In this context, this paper is the first to examine the importance of Polish ports (the port of Kołobrzeg) based on the input-output model.

3. Research Methodology

The study of the importance of the Kołobrzeg seaport was narrowed down to the body managing the port, i.e., ZPM Kołobrzeg, which trades as a company. Difficulties in accessing statistical data dictated the limitation of the scope of the study. However, ZPM Kołobrzeg (Kołobrzeg Seaport Authority) is one of the largest port operators. In addition, the company managing the port is one of the very few entities involved in developing the capital-intensive port infrastructure, which has been thoroughly modernized over several years. However, the author of the present paper is aware that concentrating the analysis solely on an entity managing a port does not reflect the full importance of that port.

The extent of the impact of the port of Kołobrzeg was referred (extended) to the Koszalin subregion classified as a NUTS 3 unit according to the Nomenclature of Territorial Units for Statistics. The availability of statistical data dictated the choice of the reference area. Although the seaport of Kołobrzeg is among the essential local ports, most of its users are located within the municipality or county, and thus the research area should correspond to the area of these territorial units.

In determining the importance of the port of Kołobrzeg, three effects, i.e., direct, indirect, and induced, were distinguished. The direct effect pertains to the suppliers of products and services to ZPM Kołobrzeg. The second, i.e., indirect, effect relates to the entities whose activities are linked to those included in the first group of businesses. The last of these effects are linked to the investment activity of ZPM Kołobrzeg and the consumption expenditure of its employees.

The effects were discussed in terms of the output, the gross wages, and the employment figure. The initial value was related to the level of ZPM Kołobrzeg expenditure on, respectively, products and services, investment, and gross wages.

The Leontief (1970) model was used to determine the direct, indirect, and induced effects. The model requires the regionalization of the national input-output table, as information on the consumption of the factors of production at a lower level of aggregation is unavailable. The Polish statistical authority (GUS, or Statistics Poland) publishes its tables every five years. The latest available edition shows the input-output flows for 2015. Table 1 presents a simplified input-output flow diagram. It

consists of three parts describing intermediate consumption, gross value added, and demand for products and services. The last two columns of the table were complemented with ZPM Kołobrzeg's demand for the products and services of the i-th industry "Yport_i" and the i-th industry's demand for products and services resulting from investment and consumer expenditure "〖Yport(i+c)〗_i." These formulae were used to determine the direct, indirect, and induced effects, respectively.

Table 1. *Simplified input-output table used to determine the economic effects of ZPM Kołobrzeg activity*

i	X_i	Input-output flows x_{ij}					Demand		
		1	2	3	…	n	Y_i	$Yport_i$	$Yport(i+c)_i$
1	X_1	x_{11}	x_{12}	x_{13}	…	x_{1n}	Y_1	$Yport_1$	$Yport(i+c)_1$
2	X_2	x_{21}	x_{22}	x_{23}	…	x_{2n}	Y_2	$Yport_2$	$Yport(i+c)_2$
3	X_3	x_{31}	x_{32}	x_{33}	…	x_{3n}	Y_3	$Yport_3$	$Yport(i+c)_3$
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
n	X_n	x_{n1}	x_{n2}	x_{n3}	…	x_{nn}	Y_n	$Yport_n$	$Yport(i+c)_n$
Intermediate consumption									
W_j		W_1	W_2	W_3	…	W_n			
P_j		P_1	P_2	P_3	…	P_n			
T_j		T_1	T_2	T_3	…	T_n			
Other GVA		$OGVA_1$	$OGVA_2$	$OGVA_3$	…	$OGVA_n$			
Gross Value Added									
X_j		X_1	X_2	X_3	…	X_n			
Output									

Explanation:
i, j = 1,2,3,…,n – sector numbering
X_j – output of the j-th sector
x_{ij} – flows from the i-th sector to the j-th sector
W_{0j} – wages in the j-th sector
P_j – profit in the j-th sector
T_j – taxes in the j-th sector
Other GVA – the remaining amount of gross value added
Y_i – demand for the products of the i-th sector
$Yport_i$ – demand of ZPM Kołobrzeg for the products and services of the i-th sector
$Yport(i+c)_i$ – demand for the products and services of the i-th sector resulting from the investment expenditure of ZPM Kołobrzeg and the consumption expenditure of its employees.
Source: *Original study based on the available source literature.*

The Polish input-output table consists of 98 divisions. Before the table was regionalized, it was aggregated down to 19 sections corresponding to the PKD (Polish Classification of Activities) 2007 classification, dictated by statistical data for subregions being only available at the levels of a section or a group of sections. In addition, excessive disaggregation increases model complexity, which hinders result

interpretation. The national table was regionalized based on the Flegg location quotient expressed by the formula:

$$FLQ_{ij} \equiv CILQ_{ij} \text{ x } [\log_2(1+ \frac{TRE}{TNE})]^{\delta} \quad (1)$$

where:
FLQ_{ij} – the Flegg location quotient
TRE – regional employment (in all sectors)
TNE – national employment (in all sectors)
$CILQ_{ij} = \frac{SLQ_i}{SLQ_j} = \frac{REi/NEi}{REj/NEj}$, where:
RE_i – regional employment in the selling sector
NE_i – regional employment in the buying sector
RE_j – national employment in the selling sector
NE_j – national employment in the buying sector
δ – the delta parameter whose value ranges within ($0 < \delta < 1$).

The location quotients were calculated based on the gross value added for each industrial sector (of the Koszalin subregion and the national economy). The location factors were then multiplied by the intermediate consumption values from the national input-output table. The value of δ was assumed to be 0.117 based on the only research conducted so far in Poland on the regionalization of the national input-output table using the Flegg location quotient (Zawalińska and Rok, 2017). Zawalińska's regionalization was performed at the province level. The value of 0.117 was calculated based on the regression function taking the weight of the Koszalin subregion in the gross national value-added as the independent variable.

Data on the value-added, wages, employment, and output for the Koszalin subregion were drawn from regional statistics (Główny Urząd Statystyczny – Bank Danych Lokalnych (GUS-BDL), 2015) and obtained from the regional statistical authority in Szczecin. The company's financial reporting department made data on ZPM Kołobrzeg's demand for products and services, its gross wages, the volume of its investment expenditure, and its employment figure.

In order to determine the induced effect, an assumption concerning household propensity to consume had to be made. Considering the wages at ZPM Kołobrzeg and the statistics published by the GUS (GUS, 2015b), consumption was estimated at 77.3%.

The statistics used for constructing the input-output table for the Koszalin subregion were not consistent because they came from different sources and periods. In order to remove this difficulty, the RAS (Stone, 1961) method used commonly to balance and update input-output tables had to be applied.

As already mentioned, the economic effects of the Kołobrzeg port were determined using the Leontief model, the main formula of which is the so-called Leontief inverse matrix, expressed as:

$$X_i = (I - Aij)^{-1} \quad (2)$$

where:
X_i – output of the i-th sector
I – unit matrix
$A_{ij} = \frac{xij}{Xj}$ – technical factors of intermediate consumption, where xij is the flow from the i-th to the j-th sectors
Y_i – demand for the i-th sector's products and services

The Leontief inverse matrix formula (1) can be broken down into two components to be used to determine the direct and indirect effects:

$$X_i = (I - Aij)^{-1} Y_i = (I + Aij) Y_i + (Aij^2 + Aij^3 + \ldots Aij^n) Y_i \quad (3)$$

The following formula is used to determine the direct effect:

$$E_{Di} = X_{Di} = (I + Aij) Y_i \quad (4)$$

where:
$E_{Di} = X_{Di}$ – the direct effect, i.e., the output resulting from the economy's demand for the i-th sector's products and services.

The following formula is used to determine the indirect effect:

$$E_{Ii} = X_{Ii} = (Aij^2 + Aij^3 + \ldots Aij^n) Y_i \quad (5)$$

where:
$E_{Ii} = X_{Ii}$ – the indirect effect, i.e., the volume of output in sectors linked to the activities of the entities constituting the source of the economy's demand for the i-th sector's products and services.

The indirect effect can also be determined by subtracting from the Leontief inverse matrix (1) the formula used to determine the direct effect (3), i.e.,:

$$E_{Ii} = (Aij^2 + Aij^3 + \ldots Aij^n) Y_i = (I - Aij)^{-1} Y_i - (I + Aij) Y_i \quad (6)$$

The induced effect can be determined by replacing in the Leontief inverse matrix formula aggregate demand with the volume of investment and consumer expenditure in the economy, i.e.:

$$E_{(ind)i} = X_{(ind)i} = (I - Aij)^{-1}Y(i + c)_i \quad (7)$$

where:
$E_{(ind)i} = X_{(ind)i}$ – the induced effect, i.e., the volume of output resulting from the investment expenditure and consumer expenditure in the economy.
$Y(i + c)_i$ – the volume of investment expenditure and consumer expenditure in the economy.

In the case of the Kołobrzeg port, the direct, indirect, and induced effects are calculated by replacing the demand of the economy with the expenditure of ZPM Kołobrzeg in the respective formulae (3), (4), and (6). The direct effect therefore adopts the following formula:

$$Eport_{Di} = Xport_{Di} = (I + A_{ij})Yport_i \quad (8)$$

where:
$Eport_{Di} = Xport_{Di}$ – the direct effect, i.e., the volume of output resulting from ZMP Kołobrzeg's demand for the i-th sector's products and services.
$Yport_i$ – the demand for ZMP Kołobrzeg for the i-the sector's products and services.
Next, the importance of the direct effect is determined by dividing the output resulting from the ZMP Kołobrzeg's demand for the i-th sector's products and services by the output resulting from the Koszalin subregion's demand for the i-th sector's products and services.

$$\text{Direct effect } port_i = \frac{Eport_{Di}}{E_{Di}} = \frac{Xport_{Di}}{X_{Di}} \quad (9)$$

The indirect and induced effects are derived in the same manner. Thus, the indirect effect takes the following form:

$$Eport_{Ii} = Xport_{Ii} = (Aij^2 + Aij^3 + \ldots Aij^n)Yport_i = (I - Aij)^{-1}Yport_i - (I + A_{ij})Yport_i \quad (10)$$

where:
$Eport_{Pi} = Xport_{Pi}$ – the indirect effect, i.e., the output in sectors linked to the activities of the entities constituting the source of ZPM Kołobrzeg's demand for products and services.

Thus, the importance of the indirect effect is determined using the formula:

$$\text{Indirect effect } port_i = \frac{Eport_{Ii}}{E_{Ii}} = \frac{Xport_{Ii}}{X_{Ii}} \quad (11)$$

The induced effect adopts the form of:

$$Eport_{(ind)i} = Xport_{(ind)i} = (I - A_{ij})^{-1}Yport(i + c)_i \quad (12)$$

where:

$\mathrm{Eport}_{(\mathrm{ind})\mathrm{i}} = \mathrm{Xport}_{(\mathrm{ind})\mathrm{i}}$ – the output resulting from the investment expenditure of ZPM Kołobrzeg and the consumption expenditure of the employees of the port company.
$\mathrm{Y(i+c)_i}$ – the investment expenditure of ZPM Kołobrzeg and the consumption expenditure of the employees of the port company.
And, respectively, the importance to the local economy:

$$\text{The induced effect port}_{(\mathrm{ind})\mathrm{i}} = \frac{\mathrm{Eport}_{(\mathrm{ind})\mathrm{i}}}{\mathrm{E}_{(\mathrm{ind})\mathrm{i}}} = \frac{\mathrm{Xport}_{(\mathrm{ind})\mathrm{i}}}{\mathrm{X}_{(\mathrm{ind})\mathrm{i}}} \tag{13}$$

4. Results

In the first stage of the study, the national input-output table was aggregated limited to 19 sections corresponding to the PKD 2007. Subsequently, values were adjusted to the lower NUTS 3 level using the Flegg location quotient. Table 2 compares the values of the CILQ and the FLQ. For the economy of the Koszalin subregion, the CILQ exceeded the FLQ by more than 49.34%. The self-supplying ability of the Koszalin subregion was 88.95% according to the CILQ and 59.56% according to the FLQ. Thus, the CILQ overestimated the self-supplying ability of this area by 29.39%.

Table 2. *Comparison between the CILQ and FLQ for the Koszalin subregion in 2015*

PKD 2007 sections	CILQ	FLQ
A	0.76688179	0.44774297
B	1.00000000	0.80715243
C	0.97732089	0.69964195
D	0.66986225	0.40256437
E	0.72814005	0.42597946
F	0.78474369	0.46108768
G	0.85662874	0.52916944
H	0.88124353	0.53644847
I	0.29875968	0.17430987
J	0.99989067	0.79147293
K	0.87261623	0.52337343
L	0.96340905	0.73418236
M	0.94860145	0.62067839
N	0.98265907	0.73942663
O	0.78549862	0.46123606
P	0.85204937	0.51582171
Q	0.85262758	0.50538085
R	0.76319998	0.4522565
S	0.69570276	0.41024075
Koszalin subregion	0.88949784	0.59563913

Source: *Original study based on GUS (2015a), GUS (2015b) and GUS-BDL (2015).*

Table 3 shows output indexes calculated using the Leontief inverse matrix. The sums in the columns are called multipliers, which vary between sections from 1.1 for public administration (section O) to 1.4 for industrial processing (section C).

The next step was to group ZPM Kołobrzeg expenditure by PKD 2007 sections, as shown in Table 4. The expenditure pertained to almost all sections, except two, i.e., A-agriculture, forestry and fisheries, and B-mining. The most critical sections in terms of expenditure volume were industrial processing (C-27.91%), energy (D-15.66%), administrative services (N-15.36%), and transport (H-14.89). These sections accounted for 73.82% of the total expenditure of the company managing the port.

Table 3. *Output multipliers for the PKD 2007 sections for the Koszalin subregion in 2015*

PKD 2007 sections	Section	Multiplier values
A	Agriculture, forestry, fisheries	1.295138
B	Mining	1.3495612
C	Industrial processing	1.430856
D	Energy	1.2193957
E	Water	1.1744121
F	Construction	1.2879573
G	Trade	1.223046
H	Transport	1.3054958
I	Catering & Hospitality	1.1056655
J	Information and communication	1.3486475
K	Finance and insurance	1.2432398
L	Real estate market	1.3667188
M	Scientific and technical activities	1.2944218
N	Administrative services	1.3366196
O	Public administration	1.0997324
P	Education	1.1139638
Q	Health	1.1912013
R	Culture and recreation	1.2352149
S	Other services	1.1403205

Source: *Original study based on GUS (2015a), GUS (2015b) and GUS-BDL (2015).*

Table 4. *ZPM Kołobrzeg expenditure (PLN and %) by PKD 2007 sections in 2015*

PKD 2007 sections	Section	Value (PLN)	Share in total expenditure (%)
A	Agriculture, forestry, fisheries	0 000	0.00
B	Mining	0 000	0.00
C	Industrial processing	1 655 584	27.91
D	Energy	928 459	15.66
E	Water	423 310	7.14
F	Construction	220 909	3.73
G	Trade	218 668	3.69
H	Transport	883 184	14.89
I	Catering & Hospitality	20 904	0.35
J	Information and communication	102 880	1.73
K	Finance and insurance	61 380	1.03
L	Real estate market	158 439	2.67
M	Scientific and technical activities	226 188	3.81
N	Administration services	911 168	15.36
O	Public administration	49 931	0.84
P	Education	18 208	0.31

Q	Health	1 420	0.02
R	Culture and recreation	42 038	0.71
S	Other services	8 200	0.14
Total	PKD 2007 sections	5 930 870	100.00

Source: *Original study based on ZPM Kołobrzeg data.*

Table 5 shows a breakdown of the gross value added and the employment figure for ZPM Kołobrzeg. The most important component of the gross value added was depreciation, which amounted to 50.36%. Wages accounted for 30.54%, while the share of taxes and levies was the smallest and amounted to 13.83%.

Table 5. *Gross value added (PLN) and employment (persons) of ZPM Kołobrzeg in 2015*

Values	Categories of added value			Sum	Jobs
	Gross wages	Depreciation	Taxes and fees		
	2 144 492	3 016 146	827 921	5 988 559	22
Share in added value	35.81	50.36	13.83	100	

Source: *Original study based on ZPM Kołobrzeg data.*

Below Table 6 shows the structure of the consumption expenditure of persons employed with ZPM Kołobrzeg by individual PKD 2007 sections. Trade was found to have by far the largest share in expenditure (G-37.91%). The structure of the remaining expenditure was more fragmented across the PKD 2007 sections.

Table 6. *Volume of consumption expenditure (PLN) incurred by ZPM Kołobrzeg employees by PKD 2007 sections in 2015*

PKD 2007 sections	Section	Expenditure	Share in total expenditure
A	Agriculture, forestry, fisheries	27 972	1.98
B	Mining	0 000	0.00
C	Industrial processing	45 372	3.21
D	Energy	44 222	3.13
E	Water	44 222	3.13
F	Construction	44 222	3.13
G	Trade	536 075	37.91
H	Transport	125 517	8.88
I	Catering & Hospitality	62 575	4.43
J	Information and communication	72 240	5.11
K	Finance and insurance	27 972	1.98
L	Real estate market	52 944	3.74
M	Scientific and technical activities	44 210	3.12
N	Administration services	44 222	3.13
O	Public administration	9 860	0.70
P	Education	15 078	1.06
Q	Health	86 582	6.12
R	Culture and recreation	96 741	6.84
S	Other services	33 913	2.40
Total	PKD 2007 sections	1 413 939	100.00

Source: *Original study based on ZPM Kołobrzeg data and GUS (2015b).*

Table 7 shows the volume of ZPM Kołobrzeg's investment by PKD 2007 sections. More than 99% of the investment outlays were classified as section F, associated with constructing the port infrastructure. However, the conceptual work required for any further investment – section N – represented less than 1% of the investment volume.

Table 7. *Volume of investment (PLN) by ZPM Kołobrzeg by PKD 2007 sections in 2015*

Investment	PKD sections		Total
	F	N	
	4 820 624	47 211	4 867 835
Share in investment	99.03	0.97	100

Source: *Original study based on ZPM Kołobrzeg data.*

The final step of the study was to determine the importance of ZPM Kołobrzeg for the Koszalin subregion using the Leontief model. Table 8 shows the initial value of the economic boost and the economic effects, which were then compared with the size of the Koszalin subregion economy. In the case of the output, the direct and indirect effects (PLN 7 806 700) exceeded the initial value (PLN 5 930 870) by 31.63%, i.e., by the multiplier value, while the total effect (PLN 15 839 066) exceeded the initial value (PLN 5 930 870) by 167.06%. The most significant importance was observed for the induced (PLN 8 032 366) and direct (PLN 7 365 824) effects. The importance of the indirect effect, however, was low and amounted to PLN 440 876. In terms of the output, the importance of the Kołobrzeg seaport for the Koszalin subregion was 0.000603%. Similar correlations were found between wages and employment. However, the importance of the port about wages was slightly higher, while it was slightly lower about employment.

Table 8. *Importance of the Kołobrzeg seaport for the Koszalin subregion with regard to output, wages, and employment*

Aspect studied	Initial value (PLN)	Direct effect (PLN)	Indirect effect (PLN)	Induced effect (PLN)	Total effect (PLN)	Total effect/ Koszalin subregion (%)
Output	5 930 870	7 365 824	440 876	8 032 366	15 839 066	0.000603
Wages	2 144 492	1 370 713	82 043	1 494 751	2 947 507	0.000604
Employment	22	31	2	35	68	0.000601

Source: *Original study based on GUS (2005a), GUS (2015b), GUS-BDL (2015) and ZPM Kołobrzeg data.*

5. Discussion

The regionalization of the national table using the FLQ underestimated the self-supplying ability of the Koszalin subregion by almost 30%, which is in line with theoretical assumptions and the practice to date (Flegg and Tohmo, 2010; Kowalewski, 2015). The FLQ, unlike the CILQ, accounts for the size of the region. The Koszalin subregion analyzed in the present paper is classified as a NUTS 3

territorial unit, thus having relatively little economic potential on the national scale, hence the low values of the FLQ. Consequently, the output multipliers calculated using the Leontief model have adopted low values, ranging from 1.1 to 1.4 depending on the given PKD 2007 section. In the former research into seaports, multipliers ranged in values between 1.13 and 2.47 (Merk, 2015; Santos *et al.*, 2018). Narrowing the reference area only to Kołobrzeg county should be expected to reduce the multiplier values further. However, extending the research to include other port functions, such as sailing, which is a dynamically developing part of this port's operations, would probably reduce the value of the economic boost. Due to the relatively high self-sufficiency of the visiting sailors, links between nautical tourism and the local economy are weak, as reflected in tourism expenditure (Hacia and Lapko, 2020; Nowaczyk, 2020).

However, the impact of the port of Kołobrzeg was much stronger than the multiplier values for the Koszalin subregion would indicate, which was due to the structure of ZPM Kołobrzeg's expenditure. More than 73% of the expenditure was concentrated within four PKD 2007 sections with high multiplier values, i.e., sections C = 1.43, N = 1.34, H = 1.31 and D = 1.22. In section C, the prevailing types of expenditure were on infrastructure renovation and inspection, section N on the protection of port facilities, section H on transshipment services, and section D on the supply of heating to buildings. The Ports Act obligated ZPM Kołobrzeg to maintain and protect the port – hence the expenditure in sections C, D, and N. On the other hand, the statutory ban on engaging in an operational activity necessitated outsourcing transshipment services – the section H expenditure. ZPM Kołobrzeg has, therefore, a relatively strong impact on the region's economy. On the other hand, like most service providers, it has a high share of gross value added, which in 2015 was over 50% of the output, weakening the multiplier's impact on the region's economy. The high share of added value was due to the above-average wage levels and to ZMP Kołobrzeg using a large part of the port infrastructure and facilities, resulting in high depreciation costs.

As a result, ZPM Kołobrzeg's expenditure of PLN 5 931 870 increased the production of goods and services in the subregion's economy by more than PLN 7 806 700, i.e., by 132%, which was the value of the multiplier. It is worth pointing out that the most critical impact on the subregion's economy was exerted by the direct effect, which was responsible for more than 94% of the increase in production, with less than 6% exerted by the indirect effect. The negligible importance of the indirect effect was probably not so much due to the lack of economic links as to the suppliers being located outside the Koszalin subregion. For example, most operators providing input for section D – energy generation, which accounted for more than 16% of ZPM Kołobrzeg's expenditure, were located outside the Koszalin subregion.

In determining the importance of a seaport, account should be taken not only of the initial economic boost resulting from ZPM Kołobrzeg's demand for goods and services but also of the secondary boost (the induced effect) from the investment and the consumption expenditure. In the case of the port of Kołobrzeg, the induced effect

exceeded the direct and indirect effects. However, the multiplier effect that turned out to be weaker (expenditure in sections with a weaker economic impact) than in the immediate boost was not responsible for the prevalence of the secondary boost. It was the volume of consumer and investment expenditure that was crucial. In the former case, this was due to the relatively large share of wages in the structure of ZPM Kołobrzeg's costs, which amounted to 35.91%, corresponding to PLN 2 144 492. Wages in the port company were 50% higher than the average for the Koszalin subregion. However, the investment expenditure had the decisive importance to the development of the studied area, amounting to PLN 4 867 835. As a result, investment expenditure was responsible for more than 78% of the induced effect. At the same time, it should be added that ZPM Kołobrzeg is the port's principal investor, as required by the Ports Act.

The importance of the seaport of Kołobrzeg to the Koszalin subregion – in terms of output – accounting for the immediate boost (the direct and indirect effects) and the secondary boost (investment and consumption expenditure) was 0.000603%. The role of this port in the subregion's economy seems to be small. However, the scope of this study was limited to the entity that manages the port. ZPM Kołobrzeg's expenditure only accounted for a small part of various operators' demand for port products and services. In addition, the study showed that most of the port operators were in the county, and some even in the town of Kołobrzeg itself. If the reference area were to be narrowed, the importance of the port to the local economy would presumably increase.

The results obtained for gross wages and employment were like those obtained for the output. The differences between the individual effects were negligible and were associated with wage and employment disparities between the PKD 2007 sections. However, the share of wages in the subregion's economy was slightly higher than in the case of the output (0.000604% compared to 0.000603%), which was due to the already-mentioned above-average level of wages at ZPM Kołobrzeg and its service-related profile. In turn, the share of employment was slightly lower than the shares of the output and gross wages, which may have resulted from the minor labor-intensive character of ZPM Kołobrzeg's operations.

6. Conclusions

The present paper attempted to determine the importance of the small seaport of Kołobrzeg to the economy of the Koszalin subregion. In doing so, particular attention was paid to how the national input-output table could be regionalized and the reference area's choice. Regionalization of the national table using the FLQ reduced the self-supplying ability of the Koszalin subregion by 29.39% compared to the CILQ. The FLQ's tendency to underestimate the self-supplying ability of regions is in line with theoretical assumptions and the empirical studies carried out to date. The most challenging aspect of the FLQ application remains to determine an appropriate value of δ successfully. For this paper, its value was assumed based on the single available

national research, which used the outcome of Finnish regional studies as the point of departure. However, the assumed value of δ may be flawed due to the absence of Polish regional input-output tables and, therefore, it being impossible to verify the results obtained even more so because the results of the national research differ slightly from those reported in foreign papers. Although the national research confirmed the positive correlation between the size of the region and the value of δ, the differences between the regions were found to be greater than in the corresponding study on Finnish regions.

Given the size of the port analyzed in this paper and the prevalence of the local users, a lower-level territorial unit, i.e., a county or a municipality, would be a more appropriate benchmark for research into the small ports of the Polish coast. The importance of small seaports to the higher-level territorial unit is marginal, as confirmed by the mathematical analysis results. Unfortunately, due to the limited availability of statistical data, NUTS 3 is the lowest level allowing for the regionalization of the national table. In this context, it appears inappropriate to apply an input-output table for a higher-level territorial unit to a lower-level unit (e.g., a regional-level one to a local-level one) due to the different scales of their self-supplying ability, as this would otherwise impact the results, i.e., the importance of small seaports would be overestimated.

The results of the present study are in line with the research on the economic importance of seaports reported to date. The lower multiplier value is due to the reference area being narrowed to NUTS 3. For the same reason, relatively the highest importance was determined for the direct effect and a much lower one for the indirect effect. However, some consideration should be given to whether the specificity of port trading itself affects the scale of the economic links in the region. In turn, the equal importance of the induced and direct effects is due to the investment activity of the entity managing the port and to its above-average level of wages.

Future national research into the value of δ at the NUTS 2 and NUTS 3 levels should be updated. The possibility of estimating δ at a lower territorial-unit level, i.e., that of a county or a municipality, should be considered. Research should be extended to include other operators active in the port of Kołobrzeg and to cover other local ports.

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