

Divergence of coastal cities in the Baltic region by knowledge production capabilities

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Abstract

Coastal cities are the focus of academic research for being the attractors of a significant share of human, entrepreneurial, and financial resources. The advanced development of coastal territories is a widely known phenomenon called coastalization. Given the favourability of coastal zones, we assume that human intelligence accumulated in coastal cities greatly increases their intellectual capital, strengthening the knowledge production capability. Our focus is on academic knowledge, which is an important input to a territorial intellectual capital that drives innovation development via knowledge commercialization. We aim at testing the hypothesis on the superiority of coastal over the inland type of cities by their capacity to generate knowledge. The study sample is 479 cities of 10 countries located in the Baltic region with different levels of socio-economic and innovative development. Spatial scientometrics is applied as a research method for processing a large volume of bibliometric data. Research results indicate significant differences between coastal cities in their ability to undertake research and produce knowledge. Coastalization has not proven to be a determining factor for academic productivity. The overall level of innovation development of the country and the functional role of the city has a greater impact. The advantages of the coastal position are related to unique marine-related research developed in coastal cities and agglomerations with an enabling atmosphere for academic knowledge production.



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1. INTRODUCTION

Scholars who share the idea of coastalization (or ‘thalasso-attractiveness’) hypothesize that coastal cities and metropolitan areas excel in innovation development due to the gradual concentration of a significant amount of intellectual resources, population, and industry. It is projected that coastal areas will continue to enjoy a rapid expansion of human activity with the accelerated development of coastal cities (Salvati, 2014; Stojanovic and Farmer, 2013). According to Bell et al. (2013), Small and Nicholls (2003), and Suarez de Vivero and Rodriguez Mateos (2005), these statements are associated with the accumulation of human population, resources, infrastructure, and socioeconomic activities in the coastal zone around the globe. Research on population dynamics suggests that nearly half of the world’s population lives at a short distance of the shoreline (Burke et al., 2001; Tobey et al., 2010; Turner et al., 1996). In the context of Europe, 42% of the population resides in the coastal regions and 43% of the total gross regional product is produced (Mikhaylov et al., 2018). Mee (2012) notes that coastal zones have historically been the areas experiencing a ‘boom and bust’ development. With coastal areas becoming over-crowded, over-developed, and over-exploited throughout the world (Hinrichsen, 1996).

Coastal areas are a flourishing locus that favors the concentration of population and are subjected to a rapid urbanization process in both developed and developing nations (Barragan and De Andres, 2015; De Andres and Barragan, 2016). Nowadays, many of the largest urban agglomerations are located in coastal areas (Small, 2001, 2004; Teka et al., 2017; Temmerman and Kirwan, 2015). According to Nicholls et al. (2007), 60% of the world’s metropolises are located within 100 km of the coast. Blackburn and Marques (2013) account for 16 out of 23 megacities with over ten million people each as for being located in the coastal zone. The five largest cities – Dhaka in Bangladesh, Lagos in Nigeria, Mumbai in India, Sao Paulo in Brazil, and Tokyo in Japan are also coastal (Pullen et al., 2008). However, not all coastal cities and agglomerations are centers of knowledge production.

Studies show significant differences between coastal areas by the level of social, economic, innovative, and infrastructural development. Alexiadis (2017) asserts that “competitiveness and prosperity depend on the capacity of the people and businesses located there [*in the coastal area*] to make the best use of all of territorial assets”. Moreover, the perceived quality of life, found to be different across European cities, sets the prerequisites for attracting migrants as well as retaining qualified labor force (Roşu et al., 2015). As previously noted by Balaguer et al. (2008), coastal areas are highly uneven and show strong divergence across multiple parameters of their systems. Meanwhile, the socio-economic projection on the impact of coastalization on coastal territories remains overlooked as compared to numerous environmental studies (Barker and Allmendinger, 2004).

In this regard, our study is designed to assess the differences between the coastal and inland cities by their knowledge production capabilities. The geographical scope of the study is the Baltic region – the first European macro-region to have a dedicated development strategy due to its coherence and historical integrity over the common Baltic Sea. Overall, the Baltic region represents one of the most advanced areas within Europe, often referred to as the world’s innovation flagship (Philipp et al., 2019). Yet, its internal composition is highly uneven as it includes countries of different levels of

innovative development (Mikhaylova, 2018), which is ideal for assessing the impact of coastalization.

Researchers focusing on innovation studies generally agree on generation and commercialization of knowledge being a systemic process that can be influenced by policies sensitive toward regional particularities, encouraging interaction between regional actors and interlinkage within global networks (Cooke, 2007; De Bruijn and Lagendijk, 2005; Doloreux and Parto, 2005; Ebersberger et al., 2014; Isaksen and Remøe, 2001; Njøs and Jakobsen, 2017; Rodriguez-Pose, 2013; Uyarra, 2010). Therefore, it is important to extend our knowledge on the various geoeconomic factors affecting socio-economic and innovative development elements of the milieu, with coastalization being one of the most prominent of them all.

The rest of the paper is organized as follows: in Section 2 we describe the research design and methodology for measuring the knowledge production capabilities across the coastal and inland cities of the Baltic region. In Section 3, we display the results of our analysis across the two city types and three country groups. Section 4 provides a brief discussion and our interpretation of the results. The paper concludes with the main findings of the study.

2. METHODOLOGY

The study focuses on the impact of the sea ('coastalization') on the patterns of knowledge production at the city level. The geographical scope covers 10 countries of the Baltic region: 4 Nordic countries (Denmark, Finland, Norway, Sweden), 3 Baltic states (Estonia, Latvia, Lithuania), Germany, Poland, and the North-Western Federal District of the Russian Federation (Fig. 1). Apart from being united within a single macro-region – the Baltic region was first to introduce a specific development strategy by the European Commission, there is a number of reasons that favor using this sample of countries. Firstly, all of these countries are classified as coastal, hence, should be exposed to the coastalization effect. Secondly, these countries are comparable by their geo-economic position and the institutional context for academic research for being compactly located within the boundaries of a single macro-region and predominantly composed of the European Union member states (excluding Norway and Russia). Thirdly, these countries present a diverse level of innovative development making it possible to evaluate knowledge production capabilities of coastal agglomerations depending on the maturity of the national innovation system. According to some earlier studies held by scholars of the Immanuel Kant Baltic Federal University (Fedorou, 2013; Mikhaylova, 2013), the Nordic countries (Denmark, Finland, Norway, Sweden) and Germany are the group of innovation leaders with high expenditure on research and development (R&D). The Baltic states (Estonia, Latvia, Lithuania) and Poland belong to the group of countries that are active in innovation development, although featuring modest scientific and technological (S&T) potential in comparison with the countries of the first group. The north-western Russia has a relatively high S&T potential against its poor commercialization, which puts it to a separate group. We, therefore, adopt the aforementioned classification for further assessment: Group 1: Denmark, Finland, Germany, Norway, Sweden; Group 2: Estonia, Latvia, Lithuania, Poland; Group 3: Northwestern Russia.

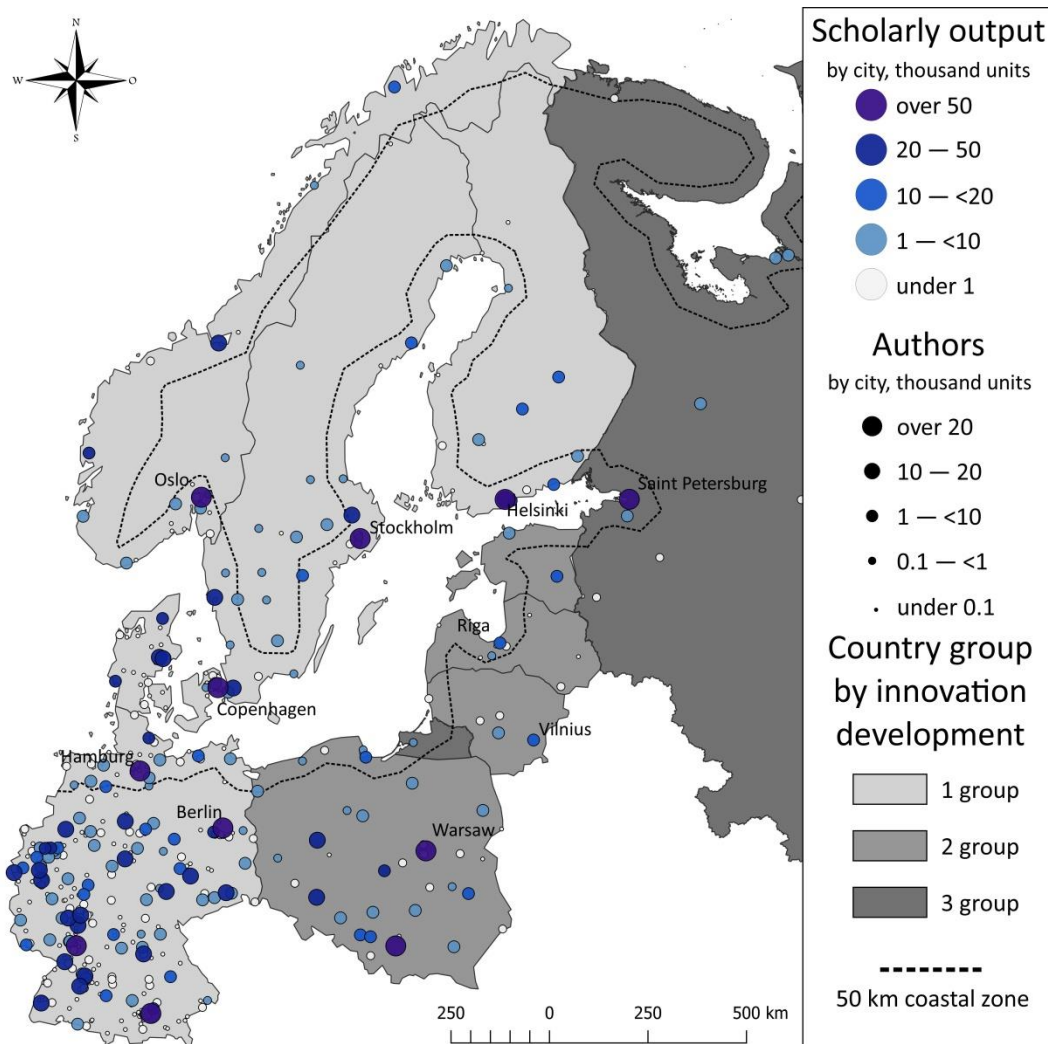


Figure 1. The geographical outreach of the study.

The knowledge production capacity of coastal agglomerations is evaluated using the method of spatial scientometrics at the city level. The data is sourced from Scopus – the largest international abstract and citation database of peer-reviewed literature by Elsevier. The advantage of this database for spatial scientometric research is its strong academic reputation for indexing high quality peer-reviewed sources, having a wide coverage of publications by geography and research areas, and, not the least, providing a reliable toolkit to identify scholarly output by location – country, region, and city. Data is sourced on January 25, 2020 and exported to a professional analytical tool SciVal (Elsevier). The sample of the study includes 479 cities of the Baltic region that fulfill the threshold criteria set – featuring at least 2 publications indexed in 2014-2020.

For obtaining a complete list of cities, the search query is done by combining requests on country, city, and individual institutions known to be located here. This secured allocating papers with no information on location city in the metadata. Using SciVal has, however, imposed some limitations on the scope of the study, as this analytical toolkit does not reflect the totality of cities available in Scopus. Therefore, some cities with extremely low values on scholarly output and unverified knowledge-generating institutions might be overlooked. Generally, these are university-hospitals, private sector

institutions, government bodies. Overall, all types of institutions are accounted – academia, business, government, and not-for-profit institutions, which puts in in line with the ideas of the ‘triple helix’ model (Leydesdorff and Deakin, 2011).

The delimitation criterion for allocating coastal cities is set by the geographical location in the 50 km wide coastal zone. This approach is applied in many studies on coastal zone management across the globe (Bezrukou, 2008; Cox et al., 2006; Jacobson et al., 2014; Kurt, 2016; Latha and Prasad, 2016; Lyth et al., 2005; Morrissey, 1988; Pak and Farajzadeh, 2007; Tye, 1988; Valev, 2009). A list of 117 coastal cities is identified as part of the sample. Table 1 presents data on the distribution of sample cities by country.

Table 1. The geography of coastal cities of the Baltic region

Country	Sample cities		Coastal cities	
	number	%	number	%
Total	479	100	117	100
Group 1	413	86.1	98	83.8
Denmark	48	10	44	37.6
Sweden	33	6.9	15	12.8
Finland	17	3.5	11	9.4
Germany	287	59.9	16	13.7
Norway	28	5.8	12	10.3
Group 2	54	11.2	13	11.2
Latvia	9	1.9	6	5.1
Lithuania	5	1.0	1	0.9
Estonia	2	0.4	1	0.9
Poland	38	7.9	5	4.3
Group 3	12	2.5	6	5.1
Northwestern Russia	12	2.5	6	5.1

Comparative assessment on the knowledge production capability of coastal agglomerations as compared to inland cities is done using a set of quantitative and qualitative indicators, including the following:

- *Scholarly output* shows the volume of scientific knowledge generated by research-intensive organizations of the city;
- *Citations* is the demand-oriented indicator that shows interest for the knowledge generated;
- *Authors number* enable to count people engaged in R&D and capable of producing knowledge;
- *Citations per paper (max. value)* reflect the highest research productivity among the research-intensive organizations of the city;
- *Citations per paper (avg. value)* reflect the average level of research productivity among the research-intensive organizations of the city;
- *Field-Weighted Citation Impact (FWCI)* measures the impact of research on a global scale in the context of a specific field of research (FWCI equals 1 stands for a global average level);
- *Institutions number* is the quantity of organizations located in the city that are engaged in advanced research (with an output published in prestigious sources indexed in Scopus);

- *Institution* type differentiates between four major groups of institutions: academic, government, corporate, medical, and other. This data outlines the functional structure of the knowledge production system of the city.

3. ANALYSIS

The sample of 479 cities located in the Baltic region is analyzed, including 117 cities being identified as coastal. In the 50-km coastal zone, there are 406 organizations engaged in research with 303.1 thousand active scholars, which is less than a third of the inland territory of the Baltic region. *At the first stage of the study*, we analyze whether there are differences between a typical coastal and inland city for the entire range of selected indicators (Fig. 2). In general, coastal cities of the Baltic region are characterized by higher scientific productivity than inland ones. The average coastal city with a lower concentration of research-intensive institutions and a similar number of authors demonstrates higher rates of publication activity, the number of citations, the ratio of citations per paper, and the FWCI compared to inland city type. It is noteworthy that in terms of the maximum value of citations per paper, the aggregate data for coastal cities are more than twice ahead of inland cities. This indicates that in the coastal zone there are knowledge-generating institutions with an output of high demand by the global research community.

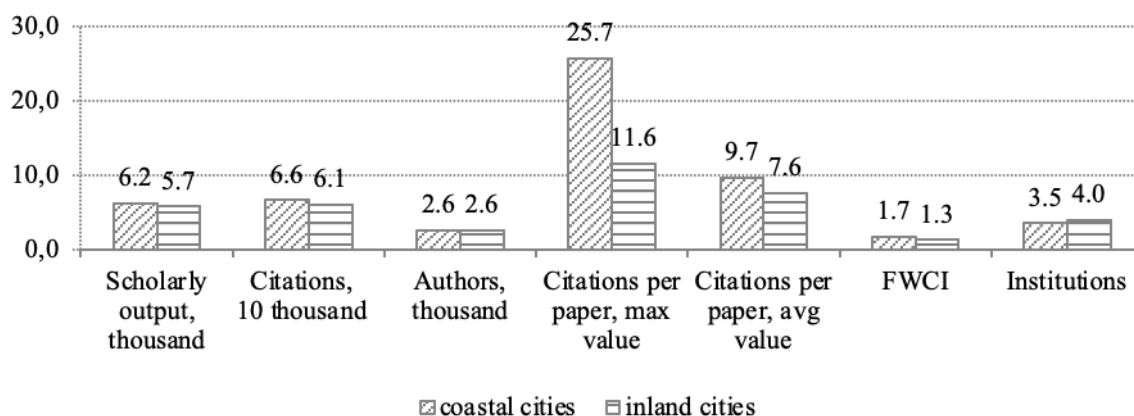


Figure 2. Average scientometric portrait of coastal and inland type of cities of the Baltic region, 2014-2020

Assessment of the distribution of institution types between coastal and inland cities of the Baltic region has not revealed any strong differences. A similar structure is found for both coastal and inland types of cities with the prevalence of corporate sector organizations, and in second place – academic institutions (Fig. 3). Such a distribution is typical for most European countries, which is related to the general structure of national science systems and the ongoing scientific policy in these countries. The only exception is Russia, where the academic sector traditionally occupies the largest share of R&D. A distinctive feature of coastal cities is a higher proportion of other types of institutions, including NGOs.

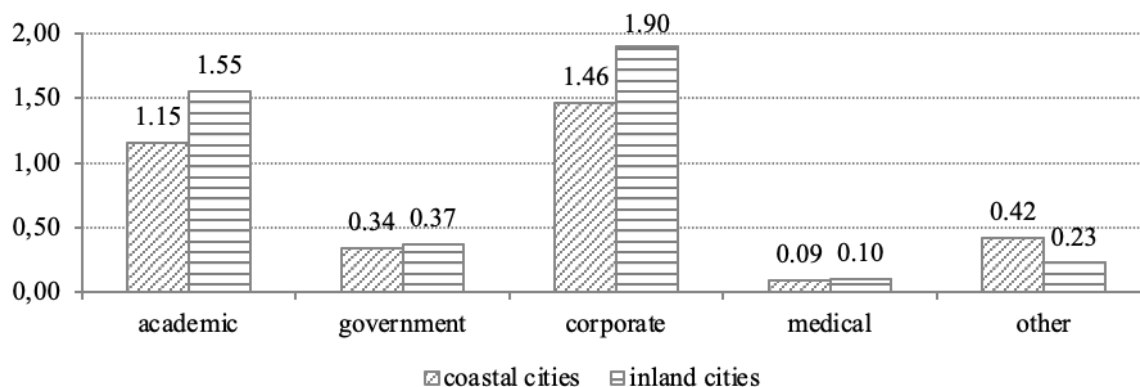


Figure 3. Average number of institutions per city type, 2014-2020

Figure 4 presents the distribution of coastal and inland types of cities by scholarly output. Most cities fall in the category of least performing with under 100 publications for the 2014-2020 period, being slightly dominated by the inland type of cities – 39.8% compared to 33.3% of coastal cities. The second-highest share by the number of cities is in the range of 100 – 999 publications – 29.9% of coastal cities and 24.6% inland cities. In general, more than 60% of both inland and coastal cities published on average less than 1,000 papers over the seven-year period, which is about 167 publications per year. Thus, more than half of the sample cities have a fairly low level of publication activity. A third of the inland and coastal cities of the Baltic region are cities whose institutions published a total of 1,000 to 49,999 papers. The smallest share of 2% in the city structure of the macro-region by scholarly output is occupied by highly productive cities with the number of publications from 50,000 to 153,528. These are 11 cities, including 3 coastal cities – Stockholm in Sweden, Copenhagen in Denmark, and Saint Petersburg in Russia. High publication activity in the case of these cities is less influenced by coastalization, but their role as capital cities. This is also true for Saint Petersburg, which has a status of a federal city of Russia (i.e. a city of federal importance) and has an unofficial title of the second capital of Russia.

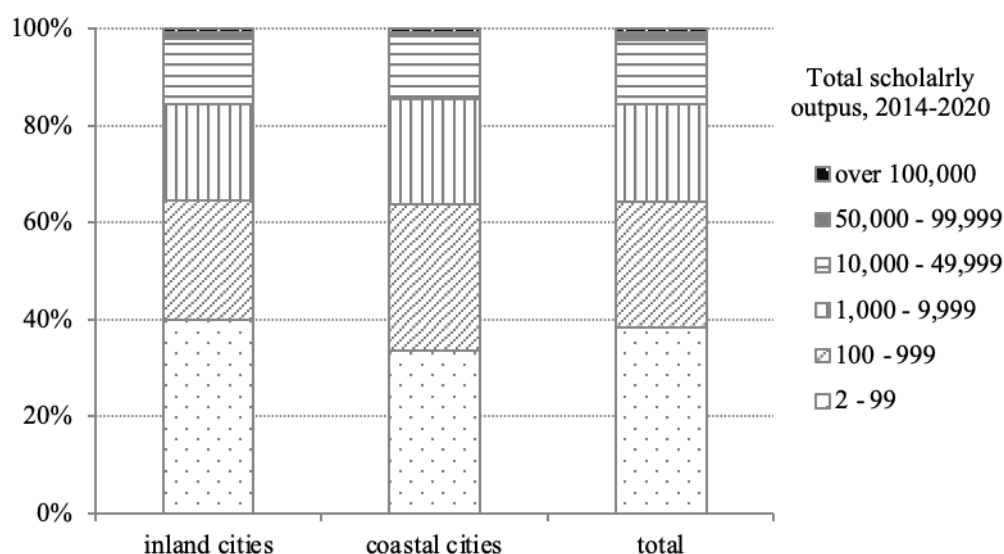


Figure 4. Distribution of coastal and inland cities of the Baltic region by Scholarly Output, %

At the second stage of the study, all cities are segregated relative to the volume of their scholarly output and one of the three development groups into which their country belongs (Table 1). Note that the vast majority of sample cities are concentrated in the developed countries of the first group, including 75% with scholarly output over 100,000 papers, 71.4% in the range from 50,000 to 99999, 84.1% with 10,000–49,999; 79.8% with 100–999, and 96.2% of cities with scholarly output under 100 papers published in 2014–2020. This applies to both inland and coastal city types.

Table 1. Averaged scientometric portrait of coastal and inland cities by country type, 2014–2020

Indicator	Country group	Scholarly output volume											
		over 100000		50000 - 99999		10000 - 49999		1000 - 9999		100 - 999		2 - 99	
		cities											
		I	C	I	C	I	C	I	C	I	C	I	C
Citations	1	1649806	1337070	773275	1111396	255422	285719	40558	42953	3938	2805	196	216
	2	1054433	-	490095	-	124212	95098	36679	37880	1232	2995	144	382
	3	-	-	-	321643	-	-	5032	20073	426	394	-	-
Authors	1	66487	39988	23552	34878	9593	9885	1825	1868	265	206	19	19
	2	53626	-	25853	-	6963	7104	3825	1448	178	231	36	17
	3	-	-	-	34305	-	-	1073	1149	171	267	-	-
Institutions	1	136	37	30	32	7	9	3	3	3	2	1	1
	2	97	-	25	-	8	15	4	4	1	1	1	1
	3	-	-	-	35	-	-	2	2	1	2	-	-
FWCI	1	1.51	1.58	1.92	1.95	1.59	1.73	1.57	1.63	1.24	1.53	1.32	1.23
	2	1.02	-	0.94	-	1.13	1.01	0.96	10.53	0.79	1.07	0.81	2.05
	3	-	-	-	0.84	-	-	0.67	1.00	0.47	0.74	-	-

Note: I – inland, C – coastal
Source: www.scopus.com

Table 1 shows that scholarly output is a consequence of the concentration of knowledge-generating institutions and researchers. The relationship of scientometric indicators with the country group is also notable. Cities of highly developed countries, on average, have stronger scientometric indicators than cities of countries in groups 2 and 3, which is maintained across cities with different scholarly output figures. The divergence between inland and coastal cities with the dominance of the latter are most noticeable for cities with small scholarly output volume.

4. DISCUSSION

The two-stage research design has enabled us to conduct a deeper analysis of knowledge production capabilities of cities located in the Baltic region countries. The results obtained at the first stage suggest the superiority of coastal cities over inland ones by scientometric indicators considered. However, by taking into account the cross-influence of other significant factors, primarily the level of development of the national innovation system and the status of the city in question (e.g. capital city, transportation hub, financial center), we see their significant impact on the favorability of the urban

environment for R&D and the extra-regional knowledge sourcing. As previously mentioned by Camagni et al. (2017), Druzhinin et al. (2019), and Mikhaylova (2018), the status of the city and its functional role within the national innovation system plays a decisive role in its development and global competitiveness.

Firstly, an assessment of the distribution of cities by several criteria at once (scholarly output volume, coastal position, country group by the level of development) revealed that the ability of a city to produce knowledge primarily depends on the country's development level. The higher the level of scientific, technological, and innovative development of the country the greater is the average value of scientometric indicators of the city relative to other cities with similar scholarly output. This is true for cities with any research performance and territorial location, both coastal and inland.

Secondly, the city's metropolitan functions have a significant impact on the scientometric portrait. Capital cities demonstrate higher scientometric indicators – at the level of cities with similar scholarly output but located in a group of more developed countries. A striking example is the capital of Estonia – Tallinn.

Thirdly, the strongest influence of coastalization can be found for cities with a small scholarly output volume of up to 1000 papers during 2014-2020. For some of these cities, there is some superiority in FWCI and citations. However, it is impossible to fully assert leadership among cities with low publication activity of coastal cities over inland ones in terms of their knowledge production capabilities. Rather, we can say that coastalization is an additional growth factor. Yet, the city may not realize this advantage in an unfavorable socio-economic and innovative environment.

5. CONCLUSION

The idea that coastal cities are more innovatively developed due to the influence of the coastalization factor and, therefore, are able to strengthen their intellectual capital by having strong knowledge production capabilities has not been fully confirmed. There are strong differences between the coastal cities of the Baltic region, which are determined by a significant number of factors. We have analyzed the following: the level of innovative development of the country, urbanization, and city size. We see that these factors have a greater impact on the knowledge production capabilities of a city than its proximity to the seacoast.

We have analyzed scientometric portraits of 479 cities in 10 countries of the Baltic region, of which only 24% are in the 50 km coastal zone. The research results show that most of these cities have a low level of publication activity. A large amount of scholarly output is characteristic primarily for metropolitan or other large cities, often performing metropolitan functions. Such cities, regardless of the proximity to the sea, act as attractors of a significant number of resources (human, financial, infrastructural, institutional, etc.) and are capable of continuously generating and accumulating knowledge. These cities have established a solid foundation of intellectual capital by hosting numerous research-intensive institutions – universities, academies of sciences, large and high-tech businesses, advanced hospitals, central public bodies, etc. The consequence of this is, firstly, the concentration of publishing scholars, and, secondly, the breadth of the developed areas of scientific knowledge and the possibility of interdisciplinary collaborations that provide additional publication growth.

The advantages of a coastal position in terms of knowledge production can be found for cities with small scholarly output. In our opinion, they primarily relate to a unique research specialization related to the sea and maritime activity (marine and ocean economy, coastal zone management, marine environment and biodiversity, coastal engineering, etc.). This generates scientific knowledge demanded by the world community, which is reflected in higher rates of maximum citations per article and FWCI for coastal cities. However, not all coastal cities realize their geographical advantage. Since the institutional environment is extremely important for establishing processes of scientific communication and the generation and diffusion of scientific knowledge.

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