



# Port economics, management and policy studies (2009–2020): a bibliometric analysis

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## Abstract

This paper analyses published research in port economics, policy and management (port studies) based on examining all relevant academic journal papers published from 2009 to 2020. The systematic review of all 1227 papers relies on quantitative and qualitative bibliometric tools to reveal the structures of the research community (i.e., authors' country of affiliation, number of authors involved, and international collaboration rates) and the themes and content of port research (i.e., research approaches, units of analysis, ports and commodities examined, levels of research localisation, port markets commonly (not) studied). It also presents a taxonomy of port studies based on a content classification of the themes and sub-themes examined. The paper concludes with a citation analysis that reveals the coherence of port research. The analysis is enriched by comparing the findings with similar studies focusing on the 1997–2008 timeframe. This unique monitoring of a period that expands over a quarter of a century offers a valuable tool for better understanding the research landscape and deciding directions for future research. From a theoretical perspective, the study provides evidence of the rapid transformation of port economics, policy and management into a mature research field.

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## 1 Introduction

This paper analyses published research in port economics, policy and management (hereafter termed ‘port studies’) based on examining all relevant academic journal papers published from 2009 to 2020. Reviewing the evolution of port economics, Heaver (2006) realised that after World War II, transport started gaining attention due to the needed investments in infrastructure and provided a literature review referencing 68 journal papers. Guided by this overview, Brooks and Pallis (2012) identified 246 papers published in 47 different journals in the second half of the twentieth century. The five most populated journals (*Maritime Policy and Management*, *Journal of Transport Economics and Policy*, *International Journal of Transport Economics*, *Tijdschrift voor Economische en Sociale Geografie* and *Journal of Transport Geography*) had published 68% of the papers; the top 10 had published 79%. This concentration in a small number of ‘core’ journals is in line with *Bradford’s Law* in bibliographic data studies, which applies in the case of the ‘pre-paradigmatic’ phase of a research field, characterised by the presence of several small research communities, each working on its own research questions; little reference to other researchers; and the lack of common problem designations, hypotheses, definitions and concepts.

In the twenty-first century, the interest in port studies expanded, leading, among others, to some further literature reviews. Two of them, published in the early 2010s, provided a bibliometric examination, a taxonomy and a content analysis of port studies published from 1997 to 2008: Pallis et al. (2010) and Pallis et al. (2011) identified 395 papers in 51 journals and acknowledged an emerging research field. Their analysis concluded that this research lacked coherence with international comparative research and international cooperation between scholars being limited.

Twelve years later, the increase in published studies on different research topics related to the port sector has been remarkable. Undoubtedly, the transformation of the port industries has been the foundation of this growth. The continuous increase of the annual maritime trade volumes, the expansion and restructuring of port-related supply chains, the expanding functional and spatial regionalisation of port forelands and hinterlands, the continuation of port policy reforms, and the revisiting of models and port authorities’ roles have generated further interest in studying a critical sector for the functioning of modern economies and the facilitation of international trade. At the same time, profound questions, such as how to measure the performance of the multifaced port industry and stakeholders’ involvement in port life, operations, and decision making, have been joined by questions on how to address emerging issues, such as technological advancements and automation, societal pressures, supply chain resilience and the sustainable growth of the various port markets.

The interest in reviewing and, thus, further understanding the evolution of the discipline also expanded. In the first half of the 2010s, Woo et al. (2011,

2012, 2013) studied trends, themes, methodologies and collaboration networks in seaport research going further back in time, i.e., since 1980. Notteboom et al. (2013), Papachristou reviewed those port studies published in the 40 first years of the *Maritime Policy and Management*, the scholarly journal that has published the most studies in the field. Since then, review studies of the field have focused on thematic analyses—such as advances in port geography (Ng 2013; Ng et al. 2014; Ng and Ducruet 2014), port competition (Lagoudis et al. 2017), competitiveness (Parola et al. 2017; Munim and Saeed 2019), port choice (Martínez Moya and Feo Valero 2017), performance tools (Ensslin et al. 2018), policy perspectives (O’ Connor et al. 2019), marketing (Mandjak et al. 2019), dry ports (Roso and Lumdsen 2010; Witte et al. 2019; Khaslavskaya and Roso 2020), port sustainability and climate change adaptation (Davarzani et al. 2016; Panahi et al. 2020), and the port-hinterland concept (Sdoukopoulos and Boile 2020) – on a comparison of research published in specific journals (i.e., the Korean ones: Lee and Shin 2019), on the foundations of port research, i.e., the contribution of the late R.O. Goss (Chang and Lee 2019) and co-authorship in port studies (Martino et al. 2022). At the same time, several authors have developed bibliometric studies in the broader field of maritime economics (see e.g., Talley 2013; Lau et al. 2017; Chen et al. 2018; Chang et al. 2018) and maritime logistics (Panayides and Song 2013). Yet, there has been no comprehensive review of the evolution of port-related research since the 2000s.

Building further on the methodological approaches in Pallis et al. (2010), the present study allows for a continuation of systematic monitoring of the efforts of the research community to study port economics, policy and management. It does so based on a review of all the peer-reviewed academic journal papers in port economics, policy and management published from 2009–2020. The analysis reveals the structures of the research community, the internationalisation of port studies, the themes and content of port research, and the port markets commonly (not) studied. It also provides a taxonomy of port studies based on the different themes and sub-themes examined.

The comprehensive analysis and classification of port studies are enriched by comparing the findings with the preceded studies that had studied the period 1997–2008 in a similar way (Pallis et al. 2010; 2011). The discussion provides a unique overview and monitoring of port studies in a period that covers over a quarter of a century. It offers the scholarly community a valuable tool for better understanding the research landscape (i.e., themes, questions, and methods (not) used, parts of the industry (under)studied) and, thus, deciding directions for future research. At the same time, from a theoretical perspective, the study provides evidence that port economics, policy and management have developed into a mature research field – as defined by the science philosopher Kuhn (1962), in a similar way that has been observed in related transportation studies (i.e., intermodal transportation research; see Macharis and Bontekoning 2003; Bontekoning et al. 2004).

## 2 Research methodology

The analysis of port studies from 2009–2020 is based on a database containing all peer-reviewed port studies published in academic journals by international publishers and with blind review methods. Contributions to edited books were omitted from the database; this is because they usually focus on specific themes, and review procedures are less clear. The same applies to conference papers, books, research theses, and in-house published journals. Port studies published in ‘open access only’ academic journals have also been excluded from the dataset. While it is acknowledged that the quality of publications in these journals has been upgraded in recent years, the integrity of reviewing and publication process is not met by all; thus, it would be impossible to analyse the relevant studies arbitrarily.

Papers were included in the database when they deal with ports for a substantial part. Thus, papers on the role of ports in maritime, logistics and intermodal transport networks are included, just as studies on logistics functions of ports, clustering of activities in ports, spatial developments in port regions, port performance, market structures in ports and so on. Papers on port engineering, terminal equipment, waterfront development and port history were not included. The vast literature on operational aspects of terminals (such as the berth allocation problem (BAP) and the yard allocation problem (YAP), or optimal terminal lay-out—see Steenken et al. 2004 for a full overview) were also excluded, as this operations research (OR) field is very distinctive from research on economics, management and policy questions in seaports.

The paper dataset covers 12 years (2009–2020), which is satisfactorily long to allow for content analysis and bibliometric research. This period is split into three four-year sub-periods (2009–2012, 2013–2016, and 2017–2020). The time span allows comparisons with similar studies examining the evolution of the same research field over the same 12-year time span (Pallis et al. 2010; 2011).

Search engines, such as Scopus, Eonlit, Google Scholar, JSTOR, and websites of the international publishers, were used to identify relevant published studies. We reviewed the content of all issues for over 150 relevant journals published since 2009. The references of the papers included in the database were scrutinised to identify additional studies on ports. This was also done for many (edited) books and conference papers on ports and related themes. Finally, keyword searches have been conducted via the software “Publish or Perish”. This software was also used for the citation analysis of the identified port studies. This process identified 1227 papers (the full list is available at PortEconomics 2023). The period 1997–2008, this number stood at ‘just’ 395 (Pallis et al. 2010).

## 3 Bibliometrics

The 1227 relevant papers were published in 140 academic journals from 2009 to 2020 (Table 1). The number of journals that welcomed port studies has almost tripled compared to 1997–2008 (51 journals). The two journals that deal explicitly

**Table 1** Published Port Studies per Journal (2009–2020)

	Journal	Code	No of Port Studies
1	Maritime Policy and Management	MPM	209
2	Maritime Economics & Logistics	MEL	103
3	Research in Transportation Business & Management	RTBM	88
4	International Journal of Shipping & Transport Logistics	IJSTL	78
5	Journal of Transport Geography	JTG	78
6	The Asian Journal of Shipping and Logistics	AJSL	64
7	Transport Policy	TP	60
8	Transportation Research Part A	TRpA	46
9	Transportation Research Part E	TRpE	41
10	Transport Reviews	TR	33
11	International Journal of Transport Economics	IJTE	32
12	Research in Transportation Economics	RTE	23
13	Transportation Research Part D	TRpD	20
14	International Journal of Logistics: Research and Applications	IJLRA	19
15	Case Studies on Transport Policy	CSTP	18
16	Transportation Research Records	TRR	17
17	Ocean & Coastal Management	OCM	14
18	Transportation Research Part B	TRpB	14
19	Journal of Transport Economics and Policy	JTEP	12
20	Marine Policy	MP	10
21	World Review of Intermodal Transportation Research	WRITR	9
22	European Journal of Transport & Infrastructure Research	EJTIR	8
23	Journal of Cleaner Production	JCP	8
24	Transportation Planning & Technology	TPT	8
25	WMU Journal of Maritime Affairs	WMU	8
26	European Journal of Operational Research	EJOR	7
27	European Transport	ET	7
28	Geojournal	GJ	7
29	Growth & Change	G&C	7
30	Environment and Planning A	EPA	6
31	Regional Studies	RS	6
32	Utilities Policy	UP	6
33	Applied Economics	AE	5
34	Expert Systems with Applications	ESA	5
35–39	4 journals <sup>a</sup>		4
40–51	10 journals <sup>b</sup>		3
52–63	13 journals <sup>c</sup>		2
64–140	79 journals <sup>d</sup>		1
	Total		1227

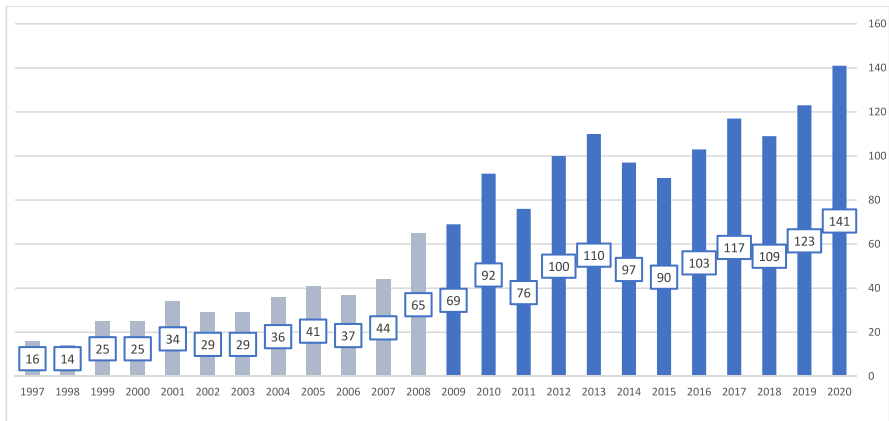
<sup>a</sup> Coastal Management; Journal of International Logistics and Trade; Polish Maritime Research; Public Management Review; <sup>b</sup> Applied Economics Letters; Global Networks; International Journal of Logistics Management; Journal of Transportation Security; Maritime Studies; Netnomics; Production Planning & Control; Tijdschrift voor economische en sociale geografie; Total Quality Management & Busi-

**Table 1** (continued)

ness Excellence; Transportation Science; <sup>c</sup> Australian Journal of Maritime & Ocean Affairs; Economic Papers; Energy Policy; Environmental Science & Policy; European Journal of Industrial Relations; Globalizations; International Journal of Decision Science, Risk & Management; International Journal of Physical Distribution & Logistics Management; International Journal of Sustainable Transportation; Journal of Marine Science and Technology; Papers in Regional Science; Regional Science Policy & Practice; Supply Chain Forum: An International Journal; <sup>d</sup> African Journal of Business; American Journal of Economics and Business Administration; Annals of Data Science; Annals of the Association of American Geographers; Applied Geography; Applied Sciences; Asian Geographer; Benchmarking; British Journal of Industrial Relations; Business Process Management Journal; Chinese Geographical Science; Cogent Business & Management; Current Issues in Tourism; Decision Analysis; Economics Bulletin; Environment and Planning C: Government and Policy; Euroasian Geography and Economics, European Journal of Government and Economics; European Journal of Marketing; European Journal of Training and Development; Expert Systems; Geoforum; Geopolitics; Indian Growth and Development Review; Information Technology and Management; Interfaces; International Journal Ocean Systems Management; International Journal of Environmental Technology and Management; International Journal of Globalization and Small Business; International Journal of Governance; International Journal of Hospitality Management; International Journal of Production Economics; International Journal of Risk Assessment & Management; International Journal of Services, Economics and Management; International Journal of Tourism Research; International Journal of Urban & Regional Research; International Regional Science Review; International Review of Applied Economics; International Review of Economics and Finance; Journal of Business & Industrial Marketing; Journal of Business Ethics; Journal of Contemporary China; Journal of Economic Geography; Journal of Economic Studies; Journal of Environmental Management; Journal of Industrial and Business Economics; Journal of Industrial Information Integration; Journal of Infrastructure Systems; Journal of Knowledge Management; Journal of Modern African Studies; Journal of Navigation; Journal of Ocean and Coastal Economics; Journal of Productivity Analysis; Journal of Shipping and Ocean Engineering; Journal of World Business; Labor Studies Journal; Management Accounting Research; Management Decision; Place Branding and Public Diplomacy; Problems and Perspectives in Management; Proceedings of ICE; Progress in Human Geography; Quality & Quantity; Review of International Economics; Singapore Economic Review; Social Responsibility Journal; Soft Computing; Supply Chain Management; Sustainability Science; Sustainable Development; The Professional Geographer; Tourism and Hospitality Management; Tourism Management; Transnational Corporations Review; Transportation Research Interdisciplinary Perspectives; Transportation Research Procedia; Urban Geography; Water Resources & Rural Development; Work Organisation, Labour & Globalisation

with maritime transport and are associated with the International Association of Maritime Economists (IAME) continued to publish most of these studies. Two hundred nine papers were published in *Maritime Policy and Management*, and 103 were published in *Maritime Economics and Logistics*. In absolute terms, these two journals combined published 115 studies more than the period 1997–2008. However, in relative terms, their combined share decreased from about half of all relevant studies published in 1997–2008 to a quarter (25.4%) in 2009–2020. Twenty journals published at least ten port studies. In total, 80% of all papers were published in these 20 journals. This concentration of articles on port economics, management and policies in a group of ‘core’ journals aligns with the well-established *Bradford’s Law* in bibliographic data studies (Fairthorne 1969) and denotes a distinctive research field.

In 2012, the number of port studies published within a year reached 100, a three-digit figure for the first time in history. In hindsight, this was not a temporary spike in research output caused by the turbulence of the global maritime trade in the aftermath of the financial crisis of 2008/9. Indeed, the annual total has remained higher



**Fig. 1** Number of published port studies (1997–2020)

than the 100 studies threshold since 2016, reaching record numbers in the two most recent years under examination, i.e., 123 port studies were published in 2019, and 141 in 2020 (Fig. 1).

The output of the first four years of analysis (2009–2012) amounted to 337 publications, followed by an uptick to 400 published papers in the next four years (2013–2016). The upward trend continued in the last four years (2017–2020), reaching 490 studies. The interest in examining ports continues to grow.

### 3.1 The research community

The 1227 port studies have been published by 1700 authors from 67 different countries. The community is four times bigger compared to 1997–2008 when 441 scholars from 44 countries were involved. The majority, i.e., 1175 authors, contributed to just one (69%; 1997–2008: 68%) or two papers (14%; 1997–2008: 17%). These authors do not necessarily specialise in port studies but have conducted applied research in the field before studying other research themes. The core of the research community has increased considerably in size. One hundred twenty-one (121) authors have published five or more papers in the past 12 years, a significant increase compared to 31 authors in 1997–2008.

Bibliometric norms indicate a high concentration of authorship and an expanding core research community. *Lotka's Law* describes the frequency of publication by authors and suggests that a few authors will be highly productive in any given scientific field. In contrast, relatively many authors produce just a single article. It states that the number of authors making  $x$  contributions is about  $1/x^n$  of those making one. The higher the value of  $n$ , the more concentrated the authorship. A low value implies the absence of a principal research group in a particular discipline. This generalised inverse power law distribution takes the form:

$$y_x = c/x^n$$

where  $y_x$  signifies the frequency of occurrence of a paper related to each member of a population ( $x = 1, 2, \dots$ ) that produces these papers, and where  $c$  and  $n$  are constants depending on the specific field.

The Lotka formula for port studies published in 2009–2020 equals (for the calculation, see: Appendix I):

$$y_x = 0.7537/x^{0.1849}$$

The  $n$  value of 0.7537 determines the presence of a relatively concentrated central core of researchers. In line with Lotka's Law, this core would be smaller if the exponent was higher, while a  $n > 3.78$  would signify the absence of a distinctive port research field.

A truly global research community has developed in the 12 years under examination (Table 2). Ninety-nine researchers affiliated with institutions in South and Central America (i.e., 88 more than in the previous 12-year period) contributed to more than 70 studies. The small African community increased in numbers; 25 researchers (1997–2008: 5) contributed to 17 studies. An active community is developing in the Middle East (32 members, 17 studies), and the Oceania community expanded to 49 scholars who contributed to 60 studies.

Researchers affiliated with European institutions in 24 countries represent the primary group of contributors. 48% of the research community is affiliated with European institutions, compared to 53% from 1997–2008. These 820 scholars contributed to 883 port studies or 72% of the total output. The lower contribution (67%) in the number of port studies published during the previous period (1997–2008) reveals an increasing presence of European researchers. Still, a fast-growing community has emerged in Asia; 559 scholars, or 35% of the worldwide research community, are affiliated with institutions located in 14 different countries in Asia; the respective percentage of the previous 12 years was 19.5%. Four out of ten scholars in the field are based in China. These researchers participated in 44.4% of the output, publishing 545 papers in the period under examination compared to just 87 during the 1997–2008 time span. The third biggest community is the North American one (207 researchers; 216 studies).

As expected, the largest and most expanding research communities can be found in countries and cities with significant ports and/or port systems with a vital role in the local/national economies. Among the biggest communities, we find China (241 scholars; 214 studies) and South Korea (113 scholars; 111 studies) in Asia, the Netherlands (130; 119), Spain (129; 112), the UK (107; 136), and Belgium (57; 116) in Europe. Brazil is the biggest community in Latin America and the Caribbean, Iran is the biggest one in the Middle East, and South Africa and Nigeria are home to the most significant research communities in Africa.



**Table 2** The Research Community

Country	No of Researchers involved	No of publications	No publications involving international collaboration	International Collaboration Ratio <sup>d</sup> (2009–2020)	International Collaboration Ratio <sup>d</sup> (1997–2008)
Africa (6 countries)	25	17	9	0.529	0.380
Egypt	4	4	4	1.00	
Ivory Coast	1	1	1	1.00	
Mauritius	2	1	1	1.00	
Nigeria	8	6	2	0.33	
S. Africa	9	4	1	0.25	
Tunisia	1	1	0	0.00	
Asia (14 countries)	599	545	325	0.596	0.437
China	241	214	137	0.64	
India	17	8	1	0.13	
Indonesia	9	5	2	0.33	
Japan	23	21	11	0.52	
Malaysia	28	18	9	0.49	
Pakistan	1	1	1	1.00	
Philippines	1	1	1	1.00	
Singapore	37	62	41	0.66	
South Korea	113	111	68	0.61	
Sri Lanka	1	5	5	1.00	
Taiwan	81	65	30	0.46	
Thailand	8	8	6	0.75	
Turkey	33	23	11	0.47	
Vietnam	6	5	4	0.80	
Europe (24 countries)	820	883	478	0.541	0.380
Austria	1	1	1	1.00	

Table 2 (continued)

Country	No of Researchers involved	No of publications	No publications involving international collaboration	International Collaboration Ratio <sup>d</sup> (2009–2020)	International Collaboration Ratio <sup>d</sup> (1997–2008)
Belgium	57	116	66	0.57	0.57
Cyprus	4	5	3	0.60	0.60
Denmark	17	12	8	0.65	0.65
Finland	6	4	2	0.50	0.50
France	47	69	53	0.77	0.77
Germany	22	30	23	0.77	0.77
Greece	54	59	35	0.59	0.59
Iceland	5	2	2	1.00	1.00
Ireland	13	6	2	0.33	0.33
Italy	72	85	45	0.53	0.53
Luxembourg	2	4	1	0.25	0.25
Norway	35	27	8	0.30	0.30
Poland	7	4	1	0.14	0.14
Portugal	55	39	7	0.18	0.18
Russia	4	2	0	0.00	0.00
Serbia	1	1	1	1.00	1.00
Slovenia	9	7	6	0.86	0.86
Spain	129	112	34	0.30	0.30
Sweden	36	43	27	0.62	0.62
Switzerland	2	2	2	1.00	1.00
The Netherlands	130	119	60	0.50	0.50
UK	107	136	94	0.69	0.69
Ukraine	5	1	0	0.00	0.00

**Table 2** (continued)

Country	No of Researchers involved	No of publications	No publications involving international collaboration	International Collaboration Ratio <sup>d</sup> (2009–2020)	International Collaboration Ratio <sup>d</sup> (1997–2008)
Middle East (8 countries)	32	17	8	0.471	0
Iran	11	4	0	0.00	
Israel	1	1	0	0.00	
Kuwait	5	3	2	0.67	
Lebanon	2	1	0	0.00	
Oman	6	4	3	0.75	
S. Arabia	4	2	1	0.50	
UAE	2	1	1	1.00	
Yemen	1	1	1	1.00	
North America (2 countries)	207	216	142	0.657	0.273
Canada	46	77	59	0.76	
USA	161	139	82	0.59	
Oceania (2 countries)	49	60	39	0.647	0
Australia	46	59	39	0.66	
New Zealand	3	1	0	0.00	
South America (7 countries)	91	64	39	0.609	0.571
Argentina	2	2	2	1.00	
Brazil	60	32	15	0.47	
Chile	15	20	17	0.85	
Colombia	10	7	4	0.54	
Peru	2	3	1	0.33	
Uruguay	1	1	1	1.00	
Venezuela	1	1	1	1.00	

Table 2 (continued)

Country	No of Researchers involved	No of publications	No publications involving international collaboration	International Collaboration Ratio <sup>d</sup> (2009–2020)	International Collaboration Ratio <sup>d</sup> (1997–2008)
Central America & Caribbean (4 countries)	8	9	8	0.889	
Mexico	3	4	4	1.000	
Panama	3	3	3	1.000	
Puerto Rico	1	1	1	1.000	
Trinidad	1	1	0	0.000	
All Regions					0.356

<sup>a</sup>Based on the author's affiliation at the time of writing; <sup>b</sup>More than 1702 authors, because authors moved to an institute located in a different country or are affiliated with more than one institution at the time of publishing; <sup>c</sup>More than the 1,227 publications reviewed, because 1084 articles are written by more than one author; <sup>d</sup>International Collaboration Ratio (ICR) = Number of outputs involving at least one author from the country and one author located in a different country divided by the total number of paper involving researchers of the country

### 3.2 Does the port research community collaborate?

A notable expansion of the levels of collaboration of researchers between countries and within countries has occurred over the past years.

The *International Collaboration Ratio* (ICR) represents the percentage of papers that are products of international collaboration. An ICR ratio close to 0 indicates a lack of international collaboration, whereas a ratio close to 1 indicates high levels of such cooperation. The overall ICR for the examined port studies is 0.529, a figure substantially higher than the ICR of the period 1997–2008 ( $ICR_{1997-2008} = 0.356$ ) (Table 2). The communities in the Americas and Oceania collaborate more than the others, with the increase in the levels of collaboration being substantial in all cases. In Asia, Europe, and Africa, more than half of the published research is also the product of international collaborations. Even in the Middle East, where the lowest ICR is observed ( $ICR_{ME} = 0.471$ ), the levels of collaboration stand considerably higher than the ICR of all port studies in the previous 12-year period ( $ICR_{total} = 0.356$ ).

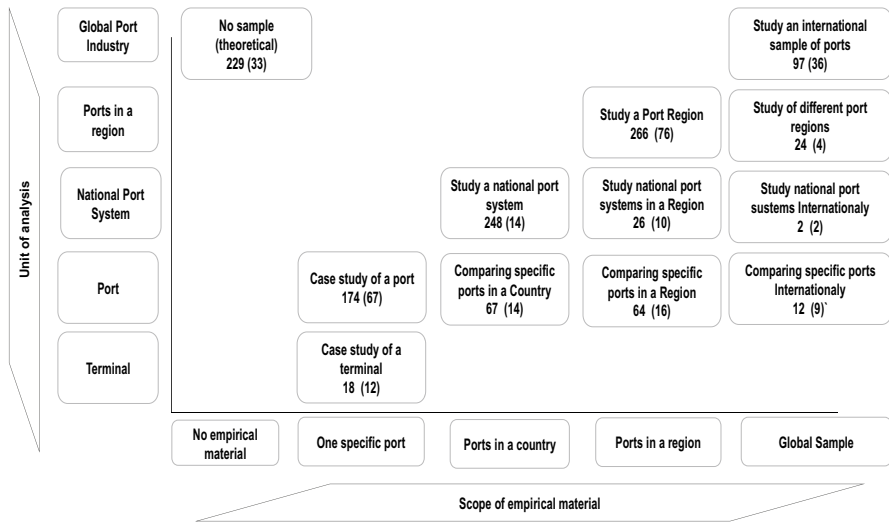
Over 88% of all articles are published by at least two authors (1997–2008: 62%). Four hundred twenty-seven studies, or 36% of these joint papers, involve researchers from different countries (defined as the country of affiliation, not the author's nationality) (1997–2008: 22%). In 84 cases (27.7%; 1997–2008: 18%), this collaboration involves researchers from three countries, and 23 more studies (2%; 1997–2008: 1%) include researchers from four or more countries. Researchers from around the world tend to collaborate more internationally than in the past.

### 3.3 Units of analysis and research approach

Port research can be categorised into different groups based on the *units of analysis* and the *scope of empirical research*. The unit of study ranges from *global* (i.e., analysing the international port system) to *regional* (analysis of an international port region; for example, the Caribbean or the Hamburg – Le Havre range), *national port system* (e.g., the Belgian port system), an individual *port*, or a *terminal* in a port. Some papers discuss port economics, management, and policy thematic in general terms and do not have a precisely defined unit of analysis.

Closely associated with this unit of analysis is the approach of empirical research, i.e., the scale used when approaching a research question. This varies from *port-specific*, *national*, or *regional* to *global*. Figure 2 shows the analysis and scope of empirical research of port studies published throughout the examined period.

In recent years, more pure theoretical papers have been produced (229 studies, or 19% of the total, compared to just 33 studies, or 8%, in 1997–2008). This entails a growing interest to (re)conceptualise ports in the light of the structural changes that have taken place and the emerging dynamic economic context. This development also points to the growing adoption and adaptation in port studies of conceptual/theoretical approaches from mainstream economic and management literature. On a note of caution, there might be challenging questions on the validity and relevance of some of the arguments and findings presented in studies lacking any empirical



**Fig. 2** Research approaches, units of analysis, and port samples 2009–2020 (1997–2008)<sup>a,b</sup>. **a** Numbers represent papers reviewed in each category for the period 2009–2020; **b** Numbers in parentheses represent papers reviewed in the 1997–2008 sample

verification. On the other hand, 97 studies rely on a large sample of ports with an international dimension to feed their empirical analyses, i.e., 2.5 times more than the 39 studies published in the period 1997–2008.

Furthermore, broad international developments in port reforms have attracted scholars' attention, and related topics have been widely touched upon. Still, the most frequently examined units of analysis are port regions (266 studies, 22% of the total publications) and national port systems (248 studies, 20% of the total publications). Eighty-nine of these studies, i.e., 49 studies comparing regional port systems, 28 comparing national port systems and 12 international comparisons of ports, use an intercontinental sample to reach their conclusions.

Researchers in Europe and Asia are most frequently involved in global research approaches. Scholars affiliated with European and Asian institutions produced respectively 51% and 34% of all empirical studies using the lens of the global port system. Along with North American scholars, who published another 14% of them, they have published 99% of these studies. The pattern is very similar in the case of the theoretical port studies; scholars from Europe, Asia and North America have developed 47%, 36% and 13% of these studies, respectively, or a total of 96%.

Of the studies analysing or comparing specific ports or terminals, the sample of the ports are located mostly in Asia (34%), North Europe (29%) and the Mediterranean (17%). Some studies of North and South America (15 studies, or 6% of the sample, in each case) also occur. The scientific community has rarely focused on the trends in specific ports in other world regions.

### 3.4 Is port research localized?

The relationship between the affiliation location of the authors and the port or port system of the empirical application is relatively strong. Most of the research community collects empirical data for their ‘own’ port, national port system, or port region. For instance, 93% of the papers that deal with *specific ports* are written by scholars from the country where that port is located (1997–2008: 70%). The same applies to studies of *national port systems* and *regional studies*. Almost 88% of the research is conducted by authors in the same country or region, as discussed in the respective paper (1997–2008: 84%). This observation, combined with the fact that 70% of ‘global’ studies do not present empirical material at all (1997–2008: 46%), leads to the conclusion that port research remains, to a certain extent, local—especially when placed against the very international character of port activities.

A *Research Localization Quotient* (RLQ) enables us to evaluate better the extent to which port research is localised. This quotient combines three components: first, the scope of the empirical data; second, the relation between the affiliation of the author(s) and third, the empirical data and the presence or absence of international cooperation. For publication, *i*, this RLQ is calculated as follows:

$$RLQ_i = PS_i O_i / C_i,$$

**Table 3** Localisation of research

Ratio (RLQ)	Total		2017–2020		2013–2016		2009–2012	
	No of papers	%	No of papers	%	No of papers	%	No of papers	%
0.055	67	5.5%	20	4.1%	26	6.5%	57	16.9%
0.125	111	9.0%	31	6.3%	44	11.0%	-	-
0.143	1	0.1%	1	0.2%	-	-	-	-
0.150	2	0.2%	1	0.2%	1	0.3%	-	-
0.167	1	0.1%	-	-	-	-	1	0.3%
0.188	19	1.5%	13	2.7%	3	0.8%	3	0.9%
0.200	3	0.2%	1	0.2%	2	0.5%	-	-
0.250	93	7.6%	25	5.1%	39	9.8%	29	8.6%
0.333	32	2.6%	13	2.7%	12	3.0%	7	2.1%
0.375	165	13.4%	74	15.1%	51	12.8%	40	11.9%
0.500	129	10.5%	64	13.1%	43	10.8%	22	6.5%
0.750	292	23.8%	134	27.3%	81	20.3%	77	22.8%
1	312	25.4%	113	23.1%	98	24.5%	101	30.0%
Grand Total	1227	100%	490	100%	400	100%	337	100%
Mean RLQ	0.582		0.596		0.553		0.596	
SD	0.324		0.305		0.331		0.341	
Variance	0.105		0.093		0.109		0.116	

where  $PS_i$  is an indicator of the geographical scope of the empirical material and takes value '1' for port-specific, national or theoretical studies, '0.75' for studies containing empirical material on a regional level (e.g. Europe) and '0.25' for studies with an international sample;  $O_i$  is an indicator of the match between author affiliation and location of empirical material and takes value '1' when at least one author is located in the area of the sample and '0.5' when none of the authors is located in the area of the sample; and  $C_i$  is the number of the authors' countries of affiliation. A ratio of '1' means highly localised empirical research. A ratio close to '0' implies very international empirical research.

The findings (Table 3) reveal a notable increase in the internationalisation of port research compared to 1997–2008. The RLQ for all the publications reviewed is 0.58, without any significant shift observed when comparing the three four-year periods. This is a notable decline from the respective quotient for the 1997–2001 time span (0.73) or the one observed in 2007–2008 (0.68). Patterns of localisation remain, but this happens in a more balanced way. In 49% of the papers reviewed, authors from one particular country write about the port(s) in their country, compared to a 60% equivalent match for the work conducted in 1997–2008. The research community is gradually interested in producing work focused on the global setting, though the local configurations remain relevant.

As detailed in Table 4, the empirical studies focusing on general cargo services are more localised ( $RLQ_{\text{general cargo}}=0.61$ ). For this cargo category, the levels of research localisation intensified in 2017–2020, as revealed by the average RLQ of 0.73 observed since 2017. Cruise port studies come next regarding research localisation, with an RLQ almost at 0.60. On the other hand, studies of container ports tend to be less localised ( $RLQ_{\text{Containers}}=0.53$ ).

The breaking down of the various research studies per country of researchers' affiliation reveals that North European scholars conduct the most localized research ( $RLQ=0.64$ ), with a similar pattern observed in North America ( $RLQ=0.61$ ). A lower localization of empirical research has been recorded in the studies of scholars affiliated with Asian institutions ( $RLQ=0.549$ ).

### 3.5 Commodities studied

Port research is also categorised into different groups based on the types of port services (and, thus, port cargo markets) on which empirical research focuses. The possible cases following the types of services include (1) *containers*, (2) *general cargo*,

**Table 4** Research Localisation per Selected Types of Cargo and regions (principal)

Type of Services	Total	2017–2020	2013–2016	2009–2012
Containers	0.535	0.538	0.517	0.550
General Cargo	0.610	0.729	0.542	0.604
Cruise	0.598	0.578	0.643	0.472
Multipurpose	0.597	0.580	0.634	-

*We did not identify any papers during the period 2009–2012 studying simultaneously multiple types of cargoes*



**Table 5** Relationship between a port sample and types of services or port markets

Sample	Container	General Cargo	Ro/Ro	Cruise	Passenger	Multipurpose <sup>a</sup>	Not Specific	Total
Global								
Pure Theoretical	92	3	1	2		3	128	229
Global Sample	67	3		1		4	22	97
Comparisons with a global approach	20	1		1		1	14	37
Regional								
Port Region	107	2	1	15	1	20	95	241
Comparisons with a regional approach	74	2	1	3	1	5	30	116
National								
Systems	140	4	1	4		12	87	248
Comparison of ports with a national approach	37	1		1		4	24	67
Port Specific								
Port Specific	72	6	1	10		10	75	174
Terminal Studies	14			3			1	18
Total	623	22	5	40	2	59	476	1227

<sup>a</sup> ≥ two types of services included into the analysis; <sup>b</sup> type of service(s) under examination is neither empirically researched nor explicitly stated

(3) *roll on roll off (ro-ro)*, (4) *cruise*, (5) *passenger*, and (6) *multipurpose*. Empirical research not focusing explicitly on any type of port services has been categorised as (7) *not specific*.

The analysis of the 1277 studies reveals the dominance of research and analysis focusing on container ports. Issues related explicitly to the economics, management, and policy of container activities in ports are the themes of 623, or 51% of the port studies under examination (Table 5). A similar pattern was recorded in the analysis of port studies published in 1997–2008, when 186 studies (47%) focused on container ports. The study of general cargo ports is centre stage in 22 papers only, with 476 papers, or 39%, studying ports as an entity rather than examining a specific type of service or a cargo market. A large share of this total, i.e., 128 papers, are purely theoretical studies that explore port economics, management and policies from a conceptual perspective.

Minimum attention has been paid to passenger ports other than cruise ports. Only two regional studies explored themes related to passenger ports. The cruise sector has gained momentum in the period under examination. A total of 40 papers examines themes related to cruise ports, with scholars using as the unit of their analysis mainly cruise port regions (15 papers) or a specific cruise port (10 papers). This is tenfold the number of papers published on the cruise market in 1997–2008. An uninterrupted growth and globalisation of the cruise industry, which lasted until the COVID-19 pandemic, has gradually led to the advancement of cruise ports and terminals, attracting scholarly attention on cruise port themes other than pure tourism studies, which are beyond the scope of the present literature review.

The analysis of container ports dominates the scene, with research based on different samples levels (Table 6). It includes comments on global samples (159 studies), regional analyses (107 studies), comparisons of port regions (28 studies), analysis of national port systems (140 studies) and comparisons of national port systems (17 studies), international or national comparisons of ports (49 and 37 studies respectively), analysis of individual ports (72 studies) and specific terminals (14 studies). A correlation exists between the size of a port market and the frequency of analysis of the respective port or region. Asian ports are the most analysed ones. North European and North American ports are also extensively studied. On the other hand, specific parts of the world remain understudied. African, Australian, and Latin American container ports feature in only a few studies, while studies on Caribbean and Middle East ports are even lower in number.

Similar gaps are present in the analysis of cruise ports. In this case, the absence of analysis of the Caribbean and North American ports is striking as these ports host a quarter of the global cruise passenger movements and cruise ship calls. The most analysed regions are the Mediterranean and the North European cruise ports, the second and third main port regions of the world. Some studies of the dynamic Asian market emerged in recent times.

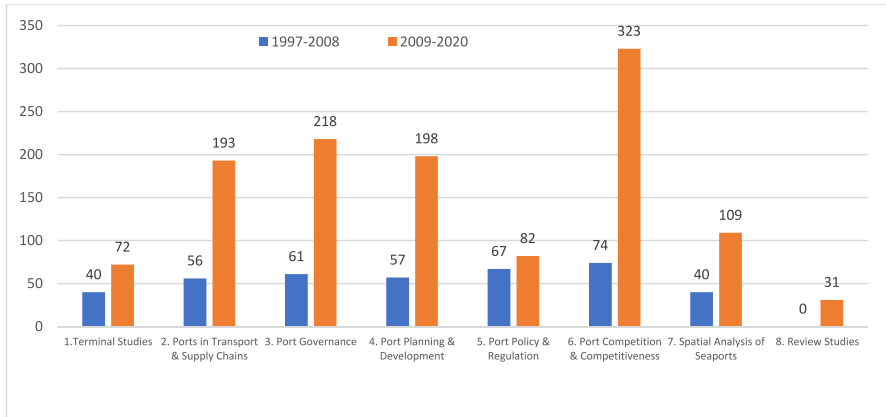
Overall, research with a regional scope mainly focuses on Asia (95 papers), emphasising the container market (53 papers). The same analogy in terms of geographical attention is encountered in the case of studies of national port systems; scholars have widely selected port systems of Asian nations as the unit of analysis (62 papers). Compared to the period 1997–2008, in terms of percentages, there is a

**Table 6** Port sample to which research applies (per type of services)

Global Port Region	Container	General Cargo	Ro Ro	Cruise	Passenger	Not Specific	Multipurpose	Grand Total
	159	6	1	3		150	7	326
Comparison of Port Regions	28	1		1		17	2	49
Africa	7					6		13
Asia	53	1	1	2		29	9	95
Australia/New Zealand	1					2		3
Caribbean						1		1
European Union	2					10	1	13
Indian Ocean	3					4		7
Latin America	4					1	3	8
Mediterranean	8			8		11	4	31
Middle East	2					1		3
North America	2					7	2	11
North Europe	26			5	1	23	1	56
National Port Systems	17	1				8	2	28
Comparison of National Port Systems	8					9		17
Africa	38	1				20	3	62
Asia	1					3		4
Australia/New Zealand				1				1
Caribbean								
Indian Ocean	8					2		10
Latin America	9	2				8	1	20
Mediterranean	12		1	1		14	5	33
Middle East	5	1				1		7
North America	20			1		9	1	31
North Europe	34			1		19	2	56
UK	5					2		7

Table 6 (continued)

Specific Port	Container	General Cargo	Ro Ro	Cruise	Passenger	Not Specific	Multipurpose	Grand Total
International Comparisons of ports	49	1	1	3	1	19	2	76
Comparing ports within a nation	37	1		1		24	4	67
Port	72	6	1	10		75	10	174
Terminal	14			3		1		18
<b>Total</b>	<b>623</b>	<b>22</b>	<b>5</b>	<b>40</b>	<b>2</b>	<b>476</b>	<b>59</b>	<b>1227</b>



**Fig. 3** Port Research Themes: A taxonomy (1997–2020)

clear shift from the study of European ports to Asia. Yet, the study of ports in both regions has increased considerably in absolute numbers.

#### 4 Content classification of port research

All papers reviewed have been classified into different categories to identify the main research themes. A double-digit taxonomy has been used. First, papers have been grouped using as a basis seven main research themes: (1) *Terminal Studies*, (2) *Ports in Transport & Supply Chains*, (3) *Port Governance*, (4) *Port Planning & Development*, (5) *Port Policy & Regulation*, (6) *Port Competition & Competitiveness*, (7) *Spatial Analysis of Seaports* (Fig. 3). This starting point benefited from the taxonomy developed by Pallis et al. (2010; 2011) and enabled the comparison of port research themes over a quarter of a century. Yet, when the content of each port study was classified, an emerging type of study was identified, incentivising us to create an additional category, i.e. (8) *Review studies* containing no less than 31 papers.

A rigorous procedure was followed to assign each paper to a category theme (two-digit classification). First, the authors independently categorised each paper into one main category and sub-category (see later) by carefully analysing keywords used in the title and the abstract and reviewing the research objectives, methodology, and empirical findings reflected in the content of each paper. In a second phase, the results of the first phase were compared among the authors given detecting inconsistencies between the authors' categorizations of the papers. In such cases, a discussion followed on each of these papers to converge towards one category only. If a paper touched upon more than one theme (e.g., a paper analysing the impact of port governance reform on port competition levels), the final categorisation relied on identifying the dominant research theme and methodological focus. The process was facilitated by the extensive and long-standing expertise in port economics,

management and policy of the most senior authors of this study, combined with the refreshing insights and diligence of a junior researcher.

*Port competition and competitiveness* (323 papers) and *Port Governance* (219 papers) remain the most dominant themes in port economics, management and policy research, with their share in the total of ports studies even further increasing. More than one out of four studies belong to the former category (26%; 1997–2008: 19%), and 18% (1997–2008: 61 papers or 15%) belong to the latter. The other themes broadly examined are *Ports in Transport & Supply Chains* (193 papers) and *Port Planning & Development* (198 papers). Given the ongoing spatial and functional expansion of seaports and related maritime supply chains (Notteboom and Rodrigue 2005; see also Notteboom et al. 2022), a notable increase is also noted in the case of studies examining aspects related to the *Spatial analysis of seaports*. The number of port studies focusing on *Port policy and regulation* and *Terminal studies* is also higher than observed in the previous 12-year period. Yet, in both cases, the increase did not occur at a pace similar to the other categories.

The main themes were further refined to a series of two-digit sub-fields to add a layer to the categorisation exercise and provide a more profound picture of the range of topics addressed in port studies (Table 7). While a detailed content analysis of these sub-categories falls beyond the scope of this paper, it is worth mentioning that the sub-categories build further on the themes identified in Pallis et al. (2011), aiming to realise the thematic evolution of port studies. The initial list of sub-categories per the theme of this previous study was reassessed based on its relevance and terminological quality in a contemporary setting. This exercise resulted in the reformulation of some sub-fields and the identification of new sub-fields:

- the insertion of a new sub-field “*Green port governance, sustainability and Sustainable Development Goals (SDGs)*” in Category 3,
- the revision of a sub-field in the examination of ports in transport and supply chains (Category 2) to become “*Digital transformation, information flows in supply chains,*” and
- the splitting of *port performance* studies into two sub-fields, focusing on “*Port performance: efficiency*” and “*Port performance beyond efficiency,*” respectively.

Table 7 provides a complete overview of the outcomes of the two-digit refinement in the paper categorisation process and a comparison per period of publication. The six sub-categories containing the highest number of port studies (2009–2020) include “*Port performance: efficiency*” (115 papers; 9.4% of total); “*Port models and port reform*” (97 papers or 7.9%); “*Hinterland chains, modal split, route choice, dry ports*” (76 or 6.2%); “*Port performance: beyond efficiency*” (64 or 5.2%); and “*Spatial studies of port networks*” and “*Green port governance, sustainability and SDGs*”, both with 60 papers or 4.9% of the total.

*Terminal studies* (Category 1) represent 5.9% of all papers reviewed. In recent years, the number of published studies in this category declined. In contrast, the emphasis in the last four years shifted from the “*Description of the strategies of*

**Table 7** Port Research: Categories, Sub-fields, Citations

Total Number of papers per period of publication		Citations of Papers published in the period 2009–2020											
		1997-2008 <sup>a</sup>	2009-2012	2013-2016	2017-2020	2009-2020	Category	No of Citations	% of citations	Papers with > 100 citations	Papers with > 50 citations	Average Cites Per Year	Papers with > 10 Cites Per Year
40	10.1%	23	28	21	72	5.9%	1. Terminal Studies	2789	4.5%	6	17	4.59	8
		13	16	9	<b>38</b>	3.1%	11-Performance measurement of terminals	1760	2.8%	5	12	5.30	6
		2	4	8	<b>14</b>	1.1%	12-Terminal operations	369	0.6%		1	4.07	
		8	8	4	<b>20</b>	1.6%	13-Description of (strategies of) TOCs	660	1.1%	1	4	3.60	2
56	14.2%	70	49	74	193	15.7%	2. Ports in Transport & Supply Chains	12076	19.5%	35	79	7.25	45
		14	4	19	<b>37</b>	3.0%	21-Shipping (networks) and implications for ports	2038	3.3%	6	14	6.16	7
		16	15	15	<b>46</b>	3.7%	22-Supply chain trends & implications for ports & PAs	2503	4.0%	8	18	6.13	9
		3	6	1	<b>10</b>	0.8%	23-Logistics activities in seaports	782	1.3%	3	5	7.02	4
		6	5	13	<b>24</b>	2.0%	24-Digital transformation, information flows in supply chains	1332	2.2%	5	8	10.19	6
		31	19	26	<b>76</b>	6.2%	25-Hinterland chains, modal split, route choice, dry ports	5421	8.8%	13	34	7.57	19
61	15.4%	38	71	109	218	17.7%	3. Port Governance	10822	17.5%	27	73	7.15	35
		13	32	51	<b>96</b>	7.9%	31-Port models and port reform	4105	6.6%	9	25	5.83	12
		4	9	9	<b>22</b>	1.8%	32-The role of the Port Authority	1529	2.5%	4	10	7.71	4
		6	5	8	<b>19</b>	1.5%	33-Industrial relations in ports; port labour	459	0.7%	0	1	3.91	0
		5	9	7	<b>21</b>	1.7%	34-The port community, cooperation in seaports	716	1.2%	0	7	4.15	1
		10	16	34	<b>60</b>	4.9%	35-Green port governance, sustainability and SDGs	4013	6.5%	14	30	11.13	18
57	14.4%	55	63	80	198	16.1%	4. Port Planning and Development	7301	11.8%	13	56	4.80	21

Table 7 (continued)

Total Number of papers per period of publication		Citations of Papers published in the period 2009–2020									
1997–2008 <sup>a</sup>	2009–2012	2013–2016	2017–2020	2009–2020	Category	No of Citations	% of citations	Papers with > 100 citations	Papers with > 50 citations	Average Cites Per Year	Papers with > 10 Cites Per Year
					Sub-field					Year	
10	2	14	26	2.1%	41-Trends and developments	805	1.3%	1	5	4.29	0
9	18	22	49	4.0%	42-Descriptive (case) studies of ports & port development	1232	2.0%	1	6	4.31	4
6	6	4	16	1.3%	43-Forecasting	634	1.0%	1	5	4.26	1
12	21	18	51	4.2%	44-(Economic) impact studies & cost estimates	2505	4.0%	6	22	6.13	10
4	6	9	19	1.5%	45-Port expansion projects	755	1.2%	2	5	5.20	4
14	10	13	37	3.0%	46-Tendering and concessions in ports	1370	2.2%	2	13	4.02	2
67	25	28	82	6.7%	5. Port Policy and Regulation	2542	4.1%	4	13	3.97	10
13	14	14	41	3.3%	51-Port pricing and state aid and national policy	911	1.5%	0	4	2.70	0
9	12	14	35	2.9%	52-Environmental, safety & security regulations in ports	1462	2.4%	3	9	5.75	10
3	2	1	1	0.1%	53-Anti-trust regulation; issues in ports	1	0.0%	0	0	0.25	0
74	91	122	323	26.3%	54-Supranational port policies	168	0.3%	1	0	2.64	0
22	14	10	46	3.7%	6. Port Competition & Competitiveness	16202	26.1%	44	114	6.29	64
7	21	17	45	3.7%	61-Port competition	2606	4.2%	7	24	6.14	9
35	39	41	115	9.4%	62-Strategy analysis	1510	2.4%	2	10	5.04	7
14	29	21	64	5.2%	63-Port Performance: efficiency	5593	9.0%	15	35	5.99	22
13	19	21	53	4.3%	64 Port performance: beyond efficiency	3654	5.9%	12	28	7.60	17
40	30	31	109	8.9%	65-Port Choice	2839	4.6%	8	17	6.52	9
3	3	48	3	0.2%	7. Spatial Analysis of Seaports	7755	12.5%	26	45	8.36	34
22	14	24	60	4.9%	71-Spatial change in seaports	143	0.2%	1	1	4.81	1
					72-Spatial studies of port networks	4837	7.8%	16	26	8.68	18



**Table 7** (continued)

Total Number of papers per period of publication		Citations of Papers published in the period 2009–2020									
1997-2008 <sup>a</sup>	2009-2012	2013-2016	2017-2020	2009-2020	Sub-field	No of Citations	% of citations	Papers with > 100 citations	Papers with > 50 citations	Average Cites Per Year	Papers with > 10 Cites Per Year
2	5	14	21	1.7%	73-Studies of spatial change of port cities & the port city interface	2028	3.3%	8	15	10.43	14
6	9	10	25	2.0%	74-Analysis of port hinterlands	747	1.2%	1	3	5.53	1
0	5	8	32	2.6%	8-Review Studies	2437	3.9%	10	16	11.11	13
4	3	10	17	1.3%	81-Review studies focusing on port economics, policy & management	1315	2.1%	6	8	9.61	6
1	5	9	15	1.2%	82-Review studies focusing on other port related fields	1122	1.8%	4	8	12.80	7
395	337	400	1227	.0%	TOTAL	<b>61924</b>	<b>100%</b>	<b>165</b>	<b>413</b>		<b>230</b>

Citations are based on Google Scholar as of June 10, 2023; the software Publish or Perish has been used to extract citations (a) Source of data for 1997–2008: Pallis et al. (2010; 2011)

*terminal operating companies (TOCs)*” to aspects of the economics and management of “*Terminal operations*”. “*Performance measurement of terminals*” has remained the most popular theme within the category throughout the 12 years under examination.

The analysis of “*Ports in transport and supply chains* (Category 2) has been the theme of 193 papers (15.7%). The evolution of “*Hinterland chains and the related developments in the modal split, route choice and dry ports*” has been the most popular sub-theme (76 papers), followed by the analysis of the “*Supply chain trends and implications for ports and Port Authorities*” (46 papers). The interest in “*Shipping (networks) and their implications for ports*” increased in the four most recent years under examination (37 papers since 2009), while the number of studies focusing on “*Logistics activities in seaports*” has been the theme of just ten studies.

An increasing share of port studies (219 papers, 17.8% of all) examines aspects of *Port Governance* (Category 3). The interest in related themes increased notably in the most recent years (2017–2020). As a result, this is the second most popular thematic category during the period under review. Almost half of them (97 papers) explore “*Port models and reform*”. Fifty-one of these studies were published in the period 2017–2020. While this reflects the changes that occurred in many countries worldwide (Brooks et al. 2017), this is also an explicit confirmation that the debate about what were/are the appropriate models for port governance remains inconclusive. Sixty of papers focus on “*Green port governance, sustainability and SDGs*”. The emerging contemporary agendas on sustainability have increasingly captured scholarly interest recently; 34 of these studies have been published since 2017. The number of studies on the “*Role of Port Authorities*”, “*Industrial relations in ports and port labour*”, and “*Port community and cooperation in seaports*” stands at 22, 19, and 21, respectively, with these themes being relatively understudied in the 12 years under examination.

Research in *Port Planning and Development* (Category 4) is the third most popular category (198 papers or 16,1%). The number of publications more than tripled compared with the studies of the category published in the period 1997–2008. Further value has been added mainly via studies on “*Economic impacts & costs estimates*” and “*Descriptive cases in port planning and development*” (51 and 49 studies, respectively). The dominant mode of private entry in the port industry, i.e., “*Tendering & concessions in ports*”, remains a popular research theme (37 papers). Comparatively, the other three sub-themes of the category, “*Trends and developments*” (26 papers), “*Port expansion projects*” (19 papers), and “*Forecasting studies*” (16 papers), have been less explored.

A research field that has little expanded since 2008 is *Port Policy and Regulation* (Category 5). The 82 identified papers equal 6.7% of all port studies in 2009–2020, the respective share of 1997–2008 was 16.9%. Seemingly, the controversial discussions at the European level (where a core part of researchers is located) in the 2000s were a key factor for the interest in the latter period. In the absence of such controversies and the shifting emphasis on port-level governance, the attention on these topics sustained but not increased. The vast majority of studies within this category examine two themes; “*Port pricing, state aid and national policy*” (41 papers) and “*Environmental, safety & security regulations in ports*” (37 papers), with interest in

environmental regulations increasing notably in the most recent years. On the other hand, the number of papers dedicated to the study of “*Supranational policies*” and “*Anti-trust regulation and related issues in ports*” is minimal (6 papers in total).

*Port competition and competitiveness* (Category 6) has always attracted most port research. However, the interest in these themes has exploded; since 2009, more than one out of four port studies examine related themes (323 papers or 26.3%). The most popular sub-fields are related to port performance, which represents a complex exercise with multiple components (Brooks and Pallis 2008; Notteboom et al. 2022): “*Port performance: efficiency*” (115 papers) and “*Port performance: beyond efficiency*” (64 papers). “*Port choice*” (53 papers), “*Port competition*” (46 papers) and “*Strategy analysis*” (45 papers) have also been popular research themes.

The *Spatial analysis of seaports* (Category 7) has been the focal point of 109 papers (8.9% of all). More than half of them are “*Spatial studies of port networks*” (60 papers). The “*Analysis of the port hinterland*” (25 papers) and “*Studies of spatial change of port cities and the port-city interface*” (21 papers) have been two sub-fields that became more popular in the most recent years of the period under examination. Minimal publications focus on the “*Spatial changes in seaports*” (3 papers).

The new category *Review Studies* (Category 8) contains a total of 31 papers (2.5% of all), which are either “*Review studies focusing on port economics, policy and management*” (16 papers) or “*Review studies focusing on other port-related fields*” (15 papers). There were no such studies in the 2000s, but the presence of an emerging research field led scholars to attempt to capture and structure the research progress. By revealing the existence of common themes, and the ways that scholars develop networks and interact conceptually and in authorship, these studies show but also contribute further to the transformation of port economics, policy and management to a maturing research field.

## 5 Citation analysis

Citation analysis enables the identification of port studies with the highest impact and the journals that publish the port studies with the highest impact. Most importantly, it provides insight into the coherence of the research (sub)fields by revealing how research relates to the broader community and how much the literature from a subfield is communicated to other subfields. Fragmentation in a research discipline occurs when specialised sub-fields become isolated and disconnected (i.e., not cited by other scholars), leading eventually to a lack of efficiency in research outputs (Entman 1993).

The 1227 port studies have already been cited 61924 times (as of June 15, 2023—Table 7). Assuming an average ‘publication time gap’ of two years between submitting a paper and the final publication, an assumption based on information available in some of the publications (i.e., the time between research submission and research publication), this number is in the course of a further increase. This aggregate number of citations indicates a maturing research field that is widely cross-cited by those examining related themes.

**Table 8** Most cited Research Themes and Sub-themes: Ranking per citations per year

Row Labels	Average of CitesPerYear			
	2009–2012	2013–2016	2017–2020	
82-Review studies focusing on other port related fields	12.80	10.53	13.08	
35-Green port governance, sustainability and SDGs	11.13	11.32	12.80	
8. Review Studies	<b>11.11</b>	<b>7.84</b>	<b>14.80</b>	
73-Studies of spatial change of port cities & the port city interface	10.43	6.69	10.07	
24-Digital transformation, information flows in supply chains	10.19	11.08	13.48	
81-Review studies focusing on port economics, policy & management	9.61	5.15	9.05	
72-Spatial studies of port networks	8.68	8.53	5.75	
7. Spatial Analysis of Seaports	<b>8.36</b>	<b>6.82</b>	<b>7.11</b>	
32-The role of the Port Authority	7.71	9.25	2.89	
64 Port performance: beyond efficiency	7.60	6.90	8.80	
25-Hinterland Chains, modal split, route choice, dry ports	7.57	6.66	5.87	
2. Ports in Transport & Supply Chains	<b>7.25</b>	<b>6.93</b>	<b>6.73</b>	
3. Port Governance	<b>7.15</b>	<b>7.27</b>	<b>7.63</b>	
23-Logistics activities in seaports	7.02	5.22	4.66	
65-Port Choice	6.52	6.11	6.23	
6. Port Competition and Competitiveness	<b>6.29</b>	<b>6.19</b>	<b>6.93</b>	
21-Shipping (networks) and implications for ports	6.16	8.27	4.47	
61-Port competition	6.14	6.98	9.51	
22-Supply chain trends & implications for ports & PAs	6.13	6.22	5.39	
44-(Economic) impact studies & cost estimates	6.13	8.01	5.03	
63-Port Performance: efficiency	5.99	5.87	6.36	
31-Port models and port reform	5.83	5.70	6.09	
52-Environmental, safety & security regulations in ports	5.75	5.18	7.43	
74-Analysis of port hinterlands	5.53	4.91	6.26	
11-Performance measurement of terminals	5.30	5.96	5.38	

**Table 8** (continued)

Row Labels	Average of CitesPer Year	2009–2012	2013–2016	2017–2020
45-Port expansion projects	5.20	5.97	6.53	3.97
62-Strategy analysis	5.04	2.02	5.31	5.93
71-Spatial change in seaports	4.81		4.81	
4. Port Planning and Development	<b>4.80</b>	<b>4.23</b>	<b>5.64</b>	<b>4.52</b>
1. Terminal Studies	4.59	4.03	4.72	5.03
42-Descriptive (case) studies of ports & port development	4.31	1.69	4.30	5.40
41-Trends and developments	4.29	4.09	3.81	4.50
43-Forecasting	4.26	5.93	1.29	6.21
34-The port community, cooperation in seaports	4.15	5.12	5.26	2.03
12-Terminal operations	4.07	2.43	3.10	4.97
46-Tendering and concessions in ports	4.02	4.62	5.50	2.24
5. Port Policy and Regulation	<b>3.97</b>	<b>2.96</b>	<b>3.83</b>	<b>4.98</b>
33-Industrial relations in ports; port labour	3.91	1.88	4.42	5.11
13-Description of (strategies of) TOCs	3.60	3.77	3.07	4.33
51-Port pricing and state aid and national policy	2.70	2.18	3.03	2.86
54-Supranational port policies	2.64	3.53	1.32	
53-Anti-trust regulation; issues in ports	0.25			0.25

Citations are based on Google Scholar as of June 10, 2023; the software Publish or Perish has been used to extract citations

The absolute number of citations is higher for the most popular category of studies, which are the 323 papers that examine ‘*port competition and competitiveness*’ (16202 citations). The second most cited category includes the 193 studies examining ‘*ports in transport and supply chains*’ (12076 citations). The least mentioned category are studies examining ‘*port policy and regulations*’ (2542 citations) and ‘*terminal studies*’ (2789 citations). As expected, review studies are also widely cited; the 32 studies in this category have been cited 2437 times, reflecting the transformation of port economics, management and policy to a maturing research field.

The average number of citations per publication per year (Table 8) suggests the interest generated per category and sub-field. According to this metric, and excluding the review studies, the most cited category is the papers dealing with “*Spatial analysis of seaports*” (8.36 citations/paper/year). This is due to the average number of citations per year of the papers examining spatial changes of port cities and the port city interface (10.43) and the spatial studies of port networks (8.86). Second and third in this hierarchy are studies of “*Ports in Transport and Supply chains*” (7.25) and studies of “*Port Governance*” (7.15). The former ranks second because of the evolution of citations of studies examining the *digital transformation and/or information flows in supply chains* (10.19) and studies of *hinterland chains, modal split, route choice and dry ports* (7.57). The latter ranks third because of the many citations that receive papers on *green port governance, sustainability and sustainable development goals* (11.13). and the examination of the role of port authorities (7.71) rather than those examining *the port community and cooperation in seaports (of ports)* (4.15) or *the industrial relations and labour* (3.91). The least cited category is the one containing studies examining “*Port Policy and Regulation*” (2.95), though here it needs to be noted that papers on the *environmental safety and security regulations in ports* (5.75) are cited considerably more than quite a few other categories of port studies. The total number of papers that since their publication have been cited more than ten times per year is 230. While the associated standard deviation partially diminishes the meaning of these metrics, this number is significant enough to confirm the thematic and research interaction within the growing research community.

Beyond the highly cited review studies (11.11 citations/year), the 60 papers examining *green port governance, sustainability and sustainable development goals* (11.13 citations per year), the 25 studies dealing with the *spatial change of port cities & the port city interface* (10.43 citations per year), and the 24 studies studying the *digital transformation* of port and, information flow in supply chains (10.29 citations per year) are the ones that are, on average, cited more than others, echoing the interest of the research community in these particular themes. On the other hand, the five studies examining supranational port policies and the 41 studies on aspects of *port pricing and state aid and national policy* are less commonly cited by other studies. Similar is the case of the informative *descriptive (case) studies of the (strategies of) terminal operating companies*.

One hundred sixty-five papers have been cited more than 100 times; 34 of them have been cited over 200 times. These publications are part of a larger group of 437 port studies cited more than 50 times. Table 9 lists the published papers that have

**Table 9** Most cited port studies per publication period

Category	Title	Citations
2009–2012		
Cat.2	Roso et al. (2009), The dry port concept: connecting container seaports with the hinterland	728
Cat.6	Tongzon (2009), Port choice and freight forwarders	561
Cat.2	Rodrigue & Notteboom (2009), The terminalization of supply chains: reassessing the role of terminals in port/hinterland logistical relationships	459
Cat.7	Ducruet & Notteboom (2012), The worldwide maritime network of container shipping: spatial structure and regional dynamics	456
Cat.3	Verhoeven (2010), A review of port authority functions: towards a renaissance?	435
Cat.7	Notteboom (2010), Concentration and the formation of multi-port gateway regions in the European container port system: an update	398
Cat.2	Rodrigue et al. (2010), Functions and actors of inland ports: European and North American dynamics	382
Cat.7	Rodrigue & Notteboom (2010), Foreland-based regionalization: Integrating intermediate hubs with port hinterlands	308
Cat.6	Gonzalez & Trujillo (2009), Efficiency measurement in the port industry: a survey of the empirical evidence	290
Cat.2	Petit & Beresford (2009), Port development: from gateways to logistics hubs	267
2012–2016		
Cat. 7	Rodrigue & Notteboom (2013), The geography of cruises: Itineraries, not destinations	363
Cat. 3	Lam & Notteboom (2014), The greening of ports: a comparison of port management tools used by leading ports in Asia and Europe	328
Cat. 3	Acciaro et al. (2014a, b), Energy management in seaports: A new role for port authorities	293
Cat. 3	Acciaro et al. (2014a, b), Environmental sustainability in seaports: a framework for successful innovation	267
Cat. 8	Davarzani et al. (2016), Greening ports and maritime logistics: A review	234
Cat. 3	Notteboom et al. (2013), Institutional plasticity and path dependence in seaports: interactions between institutions, port governance reforms and port authority routines	213
Cat. 6	Ishii et al. (2013), A game theoretical analysis of port competition	197
Cat. 6	Wang et al. (2014), Selecting a cruise port of call location using the fuzzy-AHP method: A case study in East Asia	195
Cat. 7	Daamen and Vries (2013), Governing the European port–city interface: institutional impacts on spatial projects between city and port	191

Table 9 (continued)

Category	Title	Citations
Cat. 4	Song & van Geenhuizen (2014), Port infrastructure investment and regional economic growth in China: Panel evidence in port regions and provinces	189
2017–2020		
Cat. 2	Heilig et al. (2017), Digital transformation in maritime ports: analysis and a game theoretic framework	230
Cat. 8	Parola et al. (2017), The drivers of port competitiveness: a critical review	191
Cat. 2	Heilig & Voß (2017), Information systems in seaports: a categorization and overview	172
Cat. 7	Schipper et al. (2017), A sustainability assessment of ports and port-city plans: Comparing ambitions with achievements	159
Cat. 6	Notteboom et al. (2017), The relationship between port choice and terminal involvement of alliance members in container shipping	150
Cat. 2	Molavi et al. (2020), A framework for building a smart port and smart port index	147
Cat. 3	Notteboom & Yang (2017), Port governance in China since 2004: Institutional layering and the growing impact of broader policies	146
Cat. 3	Aregall et al. (2018), A global review of the hinterland dimension of green port strategies	130
Cat. 3	Poulsen et al. (2018), Environmental upgrading in global value chains: The potential and limitations of ports in the greening of maritime transport	128
Cat. 3	Brooks et al. (2017), Revisiting port governance and port reform: A multi-country examination	125

*Citations are based on Google Scholar as of June 10, 2022*



generated more interest and have been valuable for the research progress and thus have been primarily cited in the extant literature. As this metric is time-sensitive, i.e., older papers have more citations, the outcome of three sub-periods is presented. Nine of the 30 most-cited port studies examine issues related to *Port Governance* (Category 3). Studies examining *Ports in Transport & Supply Chains* (Category 2), and *Spatial Analysis of Seaports* (Category 7) are represented in this ranking with seven and six papers, respectively. Five papers in this list examine *Port Competition & Competitiveness* (Category 6), one examines aspects of *Port Planning & Development* (Category 4), and two are *Review Studies* (Category 8). This list does not include any studies examining *Port policy and Regulations* (Category 5) or *terminal studies* (Category 1).

## 6 Conclusions

This paper identified, collected, and reviewed all journal papers on port economics, policy, and management published from 2009–2020. The bibliometric analyses of 1227 port studies, and the comparison of the findings with similar studies of the period 1997–2008, revealed the rapid transformation of port studies from emerging to mature research fields. This transformation came with a global research community of considerable size that is increasingly collaborating internationally (more than half of the reviewed studies are the product of international collaboration); the expansion of international approaches to the conducted research (i.e., units of analysis, comparison of international samples of ports, non-localized research); a core group of scholarly journals publishing frequently related studies, and scholars broadly citing research in the field conducted by colleagues and peers.

The research output increased remarkably in the most recent years of the examined period; the 490 papers published in 2017–2020 represent a 25% increase over 2013–2016. Along with the generated, or even imposed, questions by the recent pandemic crisis and its consequences on ports and related maritime supply chains, the expanding interest in analysing the various aspects of the multifaceted port industry seems almost inevitable.

The transformation of the past 12 years does not only include an increasing number of authors and, consequently, studies. The core of the research community, i.e., the number of scholars devoted to port studies, has also enlarged significantly. In addition, the significant expansion of the countries and regions where these researchers are affiliated has further contributed to the establishment of a more robust global research community. These findings support the argument that *port economics, management and policy* stands today as a mature research field.

Nonetheless, compared to mainstream economic and management disciplines, the core of the research community remains relatively small, and those that have contributed with just one publication are not few. A rational justification could be that this reflects an opportunistic ‘hit and run’ presence by scholars contributing to an exciting research field other than their specialisation. An alternative explanation is the presence of a considerable number of young researchers whose productivity is not yet mature enough or who only stay in academia for a relatively short period

(e.g., in the context of the completion of a PhD trajectory) before taking up staff positions in private and public entities in the port and maritime field. Whatever the case, these researchers have undoubtedly contributed to enriching port studies' themes, methods, and outcomes and building more vital bridges between academia and the business and policy world.

The study also revealed that the dominance of research and analysis focusing on container ports sustains. Issues related explicitly to the economics, management, and policy of container ports are the themes of 51% of the port studies under examination, a percentage similar to the one observed in 1997–2008. While the structure of global maritime trade makes this inevitable, opportunities continue to exist for broadening the scope of the research focus to other commodities and trade flows (i.e., bulk, fruit, vehicles, the cruise market, and passenger ships).

The content classification of the 1227 papers developed in this paper highlights the themes that have attracted the research community's interest, the adaptation of this community to the emerging questions, and the research themes in decline. Compared with past review studies, this paper details the thematic evolution spanning almost a quarter of a century (1997–2020). This classification provides the basis for further research.

Further analysis of the themes, the content, the methodologies applied, and the significant findings of these studies would undoubtedly enhance the understanding of the contemporary directions of research on port economics, policy, and management. Compared with recent trends in ports and the supply chains in which they are embedded, this content analysis would also allow elaborating on a future research agenda. In particular, the dynamics, diversity, and continuous evolution of modern seaports and port-related activities have transformed ports into a changing ecosystem generating a port agenda that contains both traditional and emerging issues. Inter alia, the list includes dealing with volatility and shifts in port demand; demonstrating higher flexibility and resilience while inserting ports in global production and logistics networks; developing appropriate functional and spatial strategies that bring a desirable mix of international and more regional functions; securing public support for seaport activities via well-balanced stakeholder relations management, corporate social responsibility (CSR) programs, and effective city-port interactions; leading the way in coordination and integration in supply chains; innovation, automation; technologies; circularity; and energy transition. High on the agenda are also the changing face of port competition; the importance of creating added value in conditions of shared hinterlands and large footloose port users, the multi-scalar approach of port performance; risk management; and the search for the right port governance while sustaining diversity and offering a functional and spatial clustering of port-related activities. That comprehensive content analysis of the identified port studies, the comparison of the content analysis with the emerging port agenda, and the identification of the relevant research gaps that need to be filled, fall beyond the scope of the present paper. However, it is a worthy exercise that will provide essential information for the port research community and valuable background to scholars interested in further developing research in port economics, policy and management.

## Appendix I.—Calculation of the lotka formula

Lotka’s law is represented in the following equation:

$$x^n * y = c$$

where ‘y’ is the number of authors making ‘x’ contributions to the subject and *c* and *n* are the two constants to be estimated for the specific set of data. In the present work, the linear least square (LLS) method as such defined by Pao (1985) has been used to calculate the value of *n*.

**Table 10** Calculation of components for the estimation of constants

No of pairs	No of publications (x)	No of Authors (y)	X (log x)	Y (log y)	X*Y	X <sup>2</sup>	x <sup>n</sup>	1/x <sup>n</sup>
1	1	1175	0.000	7.069	0.000	0.000	1.0000	1.000
2	2	243	0.693	5.493	3.808	0.480	1.6861	0.593
3	3	105	1.099	4.654	5.113	1.207	2.2889	0.437
4	4	56	1.386	4.025	5.580	1.922	2.8431	0.352
5	5	29	1.609	3.367	5.419	2.590	3.3638	0.297
6	6	20	1.792	2.996	5.368	3.210	3.8593	0.259
7	7	19	1.946	2.944	5.730	3.787	4.3348	0.231
8	8	10	2.079	2.303	4.788	4.324	4.7938	0.209
9	9	6	2.197	1.792	3.937	4.828	5.2388	0.191
10	10	6	2.303	1.792	4.126	5.302	5.6718	0.176
11	11	3	2.398	1.099	2.634	5.750	6.0943	0.164
12	12	6	2.485	1.792	4.452	6.175	6.5074	0.154
13	13	3	2.565	1.099	2.818	6.579	6.9120	0.145
14	15	1	2.708	0.000	0.000	7.334	7.6992	0.130
15	16	2	2.773	0.693	1.922	7.687	8.0830	0.124
16	17	4	2.833	1.386	3.928	8.027	8.4609	0.118
17	20	2	2.996	0.693	2.076	8.974	9.5635	0.105
18	21	1	3.045	0.000	0.000	9.269	9.9217	0.101
19	22	1	3.091	0.000	0.000	9.555	10.2758	0.097
20	24	2	3.178	0.693	2.203	10.100	10.9723	0.091
21	25	1	3.219	0.000	0.000	10.361	11.3152	0.088
22	26	1	3.258	0.000	0.000	10.615	11.6546	0.086
23	28	1	3.332	0.000	0.000	11.104	12.3242	0.081
24	34	1	3.526	0.000	0.000	12.435	14.2663	0.070
25	39	1	3.664	0.000	0.000	13.422	15.8206	0.063
26	60	1	4.094	0.000	0.000	16.764	21.8895	0.046
		<b>1.700</b>	<b>64.27</b>	<b>43.89</b>	<b>63.90</b>	<b>181.80</b>	<b>206.84</b>	<b>5.41</b>

**Table 11** Sample values of the exponent  $n$ 

Data pairs (N)	$n$
1	0.698
2	0.715
3	0.733
4	0.754
5	0.776
6	0.802
7	0.830
8	0.863
9	0.900
10	0.943
11	0.994
12	1.054
13	1.126
15	1.327
16	1.472
17	1.668
20	3.1199
21	4.7296
22	10.8113
24	-5.5305
25	-2.9508
26	-1.9441

} Median = 0.7537

### Estimation of the exponent $n$

Based on Pao's work (1985, 1986), the calculation of the constant  $n$  is straightforward and derives from the following equation:

$$n = \frac{N * \sum XY - \sum X \sum Y}{N * \sum X^2 - (\sum X)^2}$$

where,

$X$  is the logarithm value of 'x' i.e. number of publications.

$Y$  is the logarithm value of 'y' i.e. number of authors.

$N$  is the number of data pairs available for study.

In her work back in 1985, Pao explored the estimation of the best value of the constant  $n$  and follows Lotka's suggestion, to plot the logarithmic values of  $x$  and  $y$  to identify the approximate region of the cut-off to form a straight line. Alternatively, Pao in the same study (1985) suggests that one can develop several

computations of  $n$ , using different values of  $N$ . The median or mean then can be identified as the best fit.

Table 10 shows the calculations of the different components for the estimation of the constants  $n$  and  $c$ .

Table 11 shows the different values for our data pairs. It is clear that the data tend to fluctuate after the 7<sup>th</sup> point. Therefore, the constant  $n$  for our data derives as a mean from the seven (7) first calculations.

### Estimation of the constant $c$

The constant ' $c$ ' can be calculated by the following equation:

$$c = 1 / \sum (1/x^n)$$

$$\text{For } n=0.7537 \text{ then. } c = 1/\sum (1/x^{0.7537}) = 0.1849.$$

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