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# THE CHANGING TIDES OF PORT GEOGRAPHY (1950-2012)

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## ABSTRACT

Human geographers actively studied ports in past decades. However, the extent to which port geography constituted a specific research stream within human geography remained largely unanswered. By reviewing 399 port papers published in major geography journals, the authors critically investigated the trends and changing tides of port geography research. The findings point out the emergence of the core community shifting from mainstream geography research to increasing connection with other disciplines, notably transport studies. The paper offers a progressive view on human geographers' abilities to form a research community on port development, while identifying opportunities in the pursuit of collaboration between different academic disciplines.

**Keywords:** port geography; bibliometrics; citations; research trends; social network analysis

## I INTRODUCTION

Being the point of interaction between land and sea, ports traditionally served as the economic and cultural centres of cities and surrounding regions. However, the contemporary technological advancement in shipping, increase in international trade and the global division of labor had fundamentally transformed the nature of ports. Notably, the process of ‘terminalization’ of port operations greatly modified their roles in transport networks and global supply chains, which implied an increased spatial and functional segregation between port, urban and regional activities (Olivier and Slack, 2006; Ng, 2012). In this regard, human geographers were especially active in the description of port’s evolution and development, providing numerous theoretical/conceptual models and empirical cases in the past decades. The publication of influential books (for example, Bird, 1963; Hoyle and Hilling, 1984; Hoyle and Pinder, 1992; Pinder and Slack, 2004; Wang et al., 2007; Notteboom et al., 2009; Hall et al., 2011) and scholarly papers (to be further discussed) by transport geographers became increasingly important in defining the evolution and research trends of port geography alongside with other scientific disciplines, say, economics, finance, management science, to name but a few. Indeed, ports, as seen by Shaw and Sidaway (2011), are one of the potential tracks through which transport geography may improve its position within future geography research. In 2012, a special issue, entitled ‘The Geography of Maritime Transportation’ was featured in *Maritime Policy & Management* (volume 39, no. 2), a flagship journal in port and shipping research. This strengthened the proposition that human geographers, as well as geographical theories and concepts, could offer important contributions to port research, and that the experiences from ports could significantly contribute to progress discussions and debates in contemporary issues within human geography (Ng and Wilmsmeier, 2012). Several other special issues dedicated to ports were also published in mainstream geography journals, such as *Tijdschrift voor Economische en Sociale Geografie* (TESG) in 1996, *Geojournal* in 1986 and 2009, and *Environment and Planning A* in 2006 about the interrelations between economic and transport geographies, including a number of port articles at centre stage.

Despite such abundance, several challenging research questions have yet to be answered satisfactorily: to what extents do port geographers constitute a specific research body, and how have they adapted to changes in both port development and research? Were they, as claimed by Keeling (2007), stuck in the narrow confines of network structure and flows? While acknowledging the existence of previous reviews on port research, those overwhelmingly focused on the economic, management and performance aspects of ports and did not explicitly identify port geography papers as a distinct research arena (for example: Heaver, 2006; Pallis et al., 2010 and 2011; Suykens and van de Voorde, 1998; Woo et al., 2011)<sup>1</sup>, despite that port geography often (tried to) distinguished itself from port studies within other disciplines (cf. Ng, 2013). Hence, despite the featuring of nearly 400 port papers in major (human) geography journals since the 1950s, until now, there are inadequate systematic investigations on the nature, evolution and research trends of port geography, with Ng (2013) being the only notable exception to date. However, while he had reviewed the historical evolution of port geography papers since the late 1960s, still, important research gaps have yet to be filled: How did port geographers identify themselves? How was the nature and structure the port geography papers research community? What were the impacts of their works to human geography and other scientific disciplines? To what extent were they receptive to the ideas and contribution from other scientific disciplines, and how was such influence reflected in their research works?

More importantly, there is an urgent need to answer on whether diversification exists in authorships and citations throughout geography and other scientific disciplines, and whether port geography has a trend of following the latter, especially given the increasing interdisciplinary nature of port research through collaboration between scholars from diversified academic backgrounds (cf. Ng, 2013; Rigg et al., 2012). The extent of the influences and diffusion the research works by port geographers to human geography and other scientific disciplines - their 'social network' within the scholarly community, would be pivotal to provide a comprehensive insight to existing and future port geographers on future research direction.

Understanding such necessity, this paper analyzes the changing tides of port geography through a bibliometric analysis on 399 port geography papers published in major international scholarly geography journals between 1950 and 2012. It provides a general picture on the terrain of port geography papers research highlighting its key characteristics and transformation. Second, it applies Social Network Analysis (SNA) methods to investigate the cohesiveness of the port geography papers community internally and in relation with both human geography and other scientific disciplines, mainly based on citations and co-authorships. This study is a prompt response to the work by Ng (2013) who calls for further research on citation analysis so as to comprehensively understand the dynamics between port geographers, (non-port) geographers and scientists from other academic disciplines. By doing so, one can understand what have been the scope and influence of port geography research, while highlighting the most central publications and their linkages. It provides human geographers, and other researchers, a clearer view of their abilities to form a research community and to tackle crucial issues on port development, while identifying weaknesses and new opportunities in the pursuit of increased interactions between scholars from different scientific disciplines. The rest of the paper is structured as follows. The study sample, methodology and results will be described and illustrated in sections 2 and 3, respectively, while the analytical discussion and conclusion can finally be found in section 4.

## **II Study Sample**

To investigate the stated research questions, we reviewed a sample of most of the important peer-reviewed port geography papers published in internationally recognized geography journals. The listed journals in table 1 belonged to those which had featured at least one port geography paper between 1950 and 2012, recognizing that fundamental transformation of contemporary shipping and ports started to take root in the 1950s (cf. Heaver, 2002).

Table 1. Distribution of port geography papers by journal and period, 1950-2012  
[Insert Table 1 here]

Together the journals listed in table 1 featured 399 papers (co-)authored by 328 authors in 36 internationally-recognized (human) geography scholarly journals. See Appendix I for the full list of port geography papers included in this study. Also, the list only consisted of papers published in English, while other types of publications, e.g., books, conference papers, book chapters, theses, professional magazines, etc., were excluded.

Papers were chosen for their central focus on port-related issues while geography journals are those listed in the ISI Web of Science to which we have added *GeoJournal*, due to its international character. Papers addressing port-related issues in a very secondary manner were excluded, as in the case of some about shipping trends or urban waterfronts where ports themselves were not discussed in detail. Due to the fact that many papers about ports have been published in non-geographical journals, thus making the boundaries of port geography rather fuzzy, an "extended port geography" corpus of 268 papers has been selected on the basis of the following inclusive criteria:

- At least one citation of and/or by a core port geography paper;
- A central interest on port-related issues;
- The recognition of differences across space between locations.

The main difference between core and extended port geography is the importance given to geographical elements in the review process. Yet, some extended port geography papers may in reality more strongly develop spatial and/or geographical issues than some core geography papers giving privilege to other aspects such as policy, governance, and actors. The major journals which have published extended port geography papers in our study period are listed in Appendix II. Here it was not difficult to find that extended port geography papers concentrated in (maritime) transport (e.g., *Maritime Policy & Management*, *Maritime Economics & Logistics*, *Transport Policy*, etc.) and urban/regional planning journals (e.g., *Cities*, *Growth and Change*, *Urban Studies*, etc.). Over the entire period under consideration, 107 journals published 279 extended port geography papers, of which 50% concentrated in ten journals only where *Cities* and *Growth and Change* are the only non-transport journals. All disciplines are represented, from history to planning, business management, and even anthropology.

To facilitate our analysis, the study period has been divided either by decades or into four 'sub-periods' (1950-1974; 1975-1990; 1991-2001 and 2002-2012). Generally speaking, the former and latter two periods can be understood as the 'classical' and 'contemporary' ages in port geography papers research, respectively (Ng, 2013). Such a division was supported by Pallis et al. (2010) who indicated that the early 1990s served as a watershed where research interests in the port sector (both geography and non-geography) had grown substantially. The approach applied to our sample rests on collaboration (co-authorship) and citation analysis within and between papers. Collaborations are analyzed on the basis of authors having written together some of the articles, which allows for measuring the rate of single-authored papers and representing the network of co-authors at different periods in order to verify its underlying community structure. Although there are different reasons on why a paper should be cited, citations provide useful data to measure and map the evolution of inbound and outbound influences of a given corpus (Newman, 2010).

### **III Results**

#### **1 Production of Port Geography Papers**

Figure 1 illustrated the trend of port geography papers published in major geography and other journals between 1950 and 2012. Following a period of prominent activity in the 1950s and 1960s, there is a noticeable drop in the number of core port geography papers from the 1970s, while the production level goes back to the one of the 1960s only in the 2010s. This trend occurs in parallel with a regular growth of extended port geography papers, thereby making the total reaching unprecedented volumes in the last decade. Papers published outside geography journals have increased their share from about 4% in the 1950s to 58% in the 2010s, thereby becoming dominant in the total. In fact, core port geography has remained somewhat stable along the period in comparison with extended port geography. This underlines a very important shift with a moving away of port geographers towards more specialized journals and a lesser interest for geographical thought from other port specialists.

Figure 1. Production trend: core port geography vs. extended port geography papers, 1950-2012

[Insert Figure 1 here]

Certain geography journals published port geography papers only during the early years (before 1990). Among them, AAG had 31 such papers between 1950 and 1979, while GEG had 33 between 1950 and 1989. On the contrary, some geography journals featured more port geography papers recently, say, EPA, EPS, GEF, GEJ, to name but a few. For example, since 1980, EPA and GEJ had featured 12 and 23 such papers, respectively. At the same time and despite a certain decline, there was also a rather stable distribution of port geography papers in particular geography journals, such as TEG, GRV and ECG. For example, a roughly even distribution of port geography papers could be found in TEG between 1950 and 2012. Until the time when this study took place, it had 73 papers on port geography research. ECG and GRV have 22 and 17 papers respectively throughout the indicated period. Also, it was interesting to note that JTG possessed the largest number of port geography papers. Though only being established in 1993 (very recently when compared to many other geography journals), it featured 60 port geography papers since its establishment, and had become a very important geography outlet for port geography papers in the past two decades. The rest appears to have had a relatively minor role in port geography papers production, except for EPA (of which a special issue was published in 2006), PRG (until the 1990s), and CAG. This suggests a retreat of port geography papers from major general geography journals that cover a wide diversity of issues and focus on innovative research, and a concentration upon second-tier or more specialized journals keeping a demand for more classical topics such as ports. As seen from Table 1, geography journals were more advanced in the production about ports but they have become quantitatively secondary compared with the total of other journals since the 1980s. JTG is largely responsible for the maintained production of core port geography and its slight 'recovery' during the 2010s, without which this field would have simply disappeared from geography journals, as it concentrated 23, 28, and 69 percent of all core port geography production since the 1990s. Such trends may be explained by three main and complementary factors:

- Geographers once interested in ports have shifted their interest towards other topics more in accordance with mainstream geography, notably with the decline of the quantitative turn during the 1980s affecting transport geography in general (Waters, 2006), and the increasing preference for other transport modes such as railway and airlines, people mobility, communication and more 'virtual', rather than freight, flows

(Hall and Hesse, 2012). Some renowned scholars are identified in the core port geography corpus in the early period, such as a paper by the French geographer Jean Gottmann (1961) on the port of Baltimore, published the same year than his seminal work where the concept of megalopolis was first proposed based on the case of the United States' northeastern seaboard urban concentration;

- Geographers interested in ports have strengthened the applied dimension of their works by publishing in other journals such as transport journals, with a tendency to address spatial and territorial issues in a secondary manner compared with economic and management issues, while promoting spatial and territorial issues towards other non-geographic fields. This trend occurred in parallel of the former whereby most of the geographers once interested in ports shifted their focus toward wider urban and mobility issues, while others such as James Bird led a radical "crusade" against the ignorance of port activities and functions by urban spatial models such as the central place theory, and proposed general books where the port received foremost attention alongside other locally grounded activities (see Bird, 1977);
- Perhaps, this also implies that port geographers have found it increasingly difficult to innovate in human geography itself while getting closer to their specific industry of interests. In relation with the former factors, the growing specialization of port specialists and the growing distance from general discussions on mobility, flows, space, and scale for instance, accelerated their retreat from geography journals that in the meantime had to strengthen their audience, with a growing importance of impact factors and innovative approaches.

Alongside such trends, there also has been an evolution of the geographic coverage of the corpus both in terms of affiliations and study focus (Figure 2). One major tendency is the decrease and increase of African and Asian research, respectively, while Europe has gained grounds compared with the Americas and Oceania. Europe constitutes about 70% of affiliations and 50% of research foci in the early 2010s. This situation is the inverse of the one in the 1950s with the notable exception that American ports have never attracted as much attention as European ports. Europe has indeed been a fertile ground for studies of port competition but also supply chain management in relation to ports, as well as urban waterfront redevelopments. Another explanation is the wider context of those studies: de-colonization is largely responsible for the decline of port-related African studies, while many theories and models used by geographers originate from African regions, such as the ideal-typical sequence model of corridor development by Taaffe et al. (1963). The growing interest for Asia mainly comes from the close connection of export-oriented and free zone policies with port development across the region that also comprises many of the world's major ports such as Hong Kong and Singapore, but also Korea and China. Such trends indicate that the evolution of port geography well illustrates the evolution of the world economy and of human geography as a whole, notwithstanding certain gaps to be further addressed in the following sections.

Figure 2. Geographic coverage of port geography papers, 1950-2012  
[Insert Figure 2 here]

## 2 Collaborations: The Emergence of a Community?

As suggested by Newman (2004), the mean number of authors per paper, as well as the percentage of single author papers, is an interesting indicator to look at when considering a given scientific corpus and its collaboration dynamics. In the case of port geography papers (Table 2), there has been a continuous increase in the total and average number of authors since the 1950s as well as a constant decrease in the share of single-authored papers. However, still in the 1980s, 66 percent of all port geography papers were single-authored, half in the 1990s, before a sudden drop in the 2000s (31%) and in the 2010s to 6 percent. Such trends are comparable amongst core and extended port geography, with a slightly more collaborative profile for extended port geography due to its higher average number of authors, but core port geography keeps a lower share of single-authored papers than the latter along the period.

Table 2: Bibliometric indicators on port geography papers, 1950-2012  
[Insert Table 2 here]

Mapping the collaborations (Figure 3) among authors at distinct periods confirms the fragmentation of research during the first phases (1950-1974, 1975-1990) where collaborations are in minority, followed by the emergence of larger - albeit still small and isolated - subgroups in the period 1991-2001, and of a giant component connecting the majority of researchers in the last period 2002-2012. In the latter period, 45 of the 102 authors are connected directly or indirectly thus forming a community. The rest of the authors form separated cliques (or isolates), as they have never formally collaborated with the central community.

An interesting trend is that the largest - albeit very small - component in 1991-2001 rests on some authors being well represented in the second period (i.e., Slack, Rodrigue and Comtois). This Canadian clique forms in the second period a larger ensemble connected directly with Asian and French colleagues. Calculating the 'betweenness' centrality of authors in the network (grayscale) confirms the strong correlation with the number of collaborations (size) as well as to identify the main brokers (Newman, 2004). While Slack, Ducruet and Notteboom are the most collaborative, the overall structure is strongly dependent upon the 'brokering' role of Frémont between those three subgroups. The latter author has notably pioneered a biannual meeting of port geographers welcoming most of the connected researchers (Le Havre 2003, Hong Kong 2005, Antwerp and Rotterdam 2007, and Montreal 2009). This large community is largely French speaking, though it collaborates mostly in English and the three aforementioned main poles broadly correspond to France-Canada-Asia (Slack and Frémont), Belgium-Netherlands (Notteboom), and Europe-Asia (Ducruet). The extent to which this community will be maintained, further integrated or disintegrated will depend on upcoming publications in the field as well as on further collaborative efforts. At present, the relatively strong density of the core community as reflected by an average clustering coefficient of 0.64 is in fact dependent upon a few large nodes having distinct subgroups and limited transversal linkages.

Figure 3. Graph illustrating port geography research co-authorships, 1950-2012  
[Insert Figure 2 here]



### 3 Port Geography Papers Citing: Background and Imports

The counting and classification of citations by port geography papers works by decade clearly underlines a trend of background diversification (Figure 4). A first period is characterized by a dominance of geographical inspiration, but from the 1970s onwards, the share of geography journals (of which core port geography papers) is constantly dropping, from 85% of all citations in the 1950s and 1960s to about 35% in the 2010s. Transport journals have become dominant in the last period, from 8% in the 1960s to 28% in the 2010s. Although citations to core port geography papers have dropped from 43% in the 1950s to 22% in the current decade, the combined share of core and extended port geography remains somewhat stable along the period, from 48% in the 1950s to 39% in the 2010s. On the one hand, port geographers shifted their knowledge sources towards more specialized works in various fields (e.g., economics, business, management, transport and logistics), but on the other hand, they have valued port geography papers itself and the spatial approach to ports outside their original nest (geographical journals). It may have become necessary for port geographers to confront their own views with the ones of transport specialists while adopting concepts and methods from other mainstream research arenas. Such results are largely influenced by the aforementioned shift of port geographers towards transport journals.

Figure 4. Distribution of journal papers under different disciplines cited by core port geography papers, 1950-2012  
[Insert Figure 4 here]

Another way to better understand the changing scope and nature of port geography papers is to build a database of papers cited by port geographers. Choosing papers as the unit of analysis rather than authors (or journals) avoids the problems of multiple authors. The resulting directed graph of citations based on port geography papers citing other papers contains 2,698 papers and 4,507 links among them when the whole period (1950-2012) is considered. However in the graph, citations between core port geography papers were removed so as to better understand the connecting role of other papers between them. This operation is also useful to make the graphs more readable, to lower the probability of self-citations in the corpus that would inflate papers' centralities, and to test whether the citations graph remains connected and how despite the removal of internal links. Papers are differentiated by a different color according to their main research areas as in the previous figures, and the size of nodes represents the betweenness centrality of the papers, i.e. their overall accessibility as measured by the number of occurrences on possible shortest paths across the entire network. This indicator has been preferred to in-degree (number of times a paper is cited) in order to better identify bridge positions: it better expresses whether a paper is pivotal in the circulation of knowledge within the entire corpus, regardless of its volume of citations, as the top papers are usually known by scholars in the field. However, betweenness centrality may be artificially inflated in the case of papers being at the edge of the network while being the only

access to it for a few other papers. A Gem-Frick visualization algorithm (TULIP software) is applied to represent the results with most central papers in the middle of figures and less connected papers at its periphery, while topological proximity in the graph might in fact illustrate other proximities such as geographical and/or disciplinary. This analysis is useful to detect key papers and to verify the role of disciplinary belonging in network formation and knowledge diffusion: how is port geography papers dependent from other scientific disciplines as well as from their own, and how homogenous is its scientific background?

The four stated periods are compared in Figure 5. In the first period (1955-1974), most connected papers forming two important subgroups belong to core port geography and constitute the backbone of the network, among which the two seminal essays of Weigend (1956, 1958) on port geography and the spatial model of port evolution provided by Rimmer (1967) with an application to Australia as well as his work on port classification (1966). The fact that the largest component is centered upon a geography paper, the ideal-typical phased model of corridor development by Taaffe et al. (1963), is emblematic of this "classic" period during which port studies were well integrated with wider geographical approaches. The rest of the network, however, which still concentrates the majority of works, remains rather dispersed. A distinct community appears, however, with the works of Hanse and Van Dongen (1956, 1958) on African ports. The works of Mayer (1955) on Chicago, Bird (1965) on Australia and on theoretical aspects (1970), Hilling (1969) and Ogundana (1972) on Africa also tend to have developed in relative autarchy. There seems to be a strong regional specialization among port geographers in complement to a number of general approaches, reflecting upon Figure 2 with a high share of research on Africa during this period. Even same authors' papers remain disconnected, such as Hoyle's work on African ports (1967, 1968). Other isolates are better explained by their original approach outside the "mainstream", such as the work on images of colonial Port Royal by Kovacik and Rowland (1973) and the one of Fordham (1970) on port-airport interactions. Interestingly, there is a tendency for isolated papers to focus more on non-geographical sources rather than port geography itself.

The second period (1975-1990) provides a similar network pattern with a core community centered upon port geography papers and some isolates or peripheral papers with a more diversified background. The model of Taaffe et al. (1963) remains central to port geography papers for the aforementioned reasons. Most central papers are still general surveys and discussions, such as the one of Bird (1980) on gateways, Hayuth (1981) on load centers, Hilling (1983) on developing countries, Hoyle (1989) on the port-city interface, but also Slack (1980) on technological changes in sea transportation. Future evolutions of port geography papers seem to have given privilege to the second influence, namely the economic dimension rather than spatial analysis. Some papers remain rather central although they barely connect with other port geographical works, such as Hoare (1986) on British ports, Miklius and Wu (1988) on forecasts, while some other papers are not connected at all. The latter are, again, characterized by case studies on developing countries such as Hoyle (1978, 1986), Omiunu

(1989), and Stanley (1990) on African ports, as well as McCalla (1990) on free zones. Another characteristic of isolates is their dominant economic focus, such as Slack (1989) on the port service industry, but also Wallace (1975) on Canadian ports, Kinsey (1981) and Stevens et al. (1981) on impact multipliers and economic effects of port activities, West (1989) on economic rents, and Suykens (1989) on port-city economic relationships, while others are more characterized by historical approaches (Pred, 1984) and recreational issues (Sant, 1990). Most case studies still remain very much Western-focused, such as Slack (1990) on US inland load centers, Hayuth (1988) on the US container port system, O'Connor (1989) on Australia, with the exception of Marti (1985) on Chilean ports.

The third period (1991-2001) is defined by a significant reduction in the number of isolates and by an overall diversification of papers' background (Figure 4). One dominant community contains the majority of papers. One drastic change is the highest centrality of case studies on ports outside Western countries, such as East Africa (Hoyle and Charlier, 1995), Hong Kong (Wang, 1998; Airriess, 2001), and Singapore (Airriess, 2001), but also China outside the largest component (Todd, 1993, 1997). Other core papers continue to develop classical issues such as on urban waterfronts (Norcliffe et al., 1996; Hoyle, 2000) with a central focus on Western ports such as Notteboom (1997) and Charlier (1996) on the European and Benelux port systems, respectively. General papers are not the most central but keep important positions as seen with the discussion by Van Klink and Van den Berg (1998) on gateways and intermodalism, Van Klink (1998) on port networks, and Cullinane and Khana (2000) on the geographical implications of growing vessel sizes. As in the previous periods, 'peripheral' papers are those having a distinct focus such as geo-historical (Waite and Hartig, 1997; Herod, 1997, 1998; Groote et al., 1999; Castree, 2000), cultural (Stevenson, 1996), or discussing specific issues such as clusters and spillovers (Oosterhaven et al., 2001) without sharing same references with other port geography papers. Important papers outside the port geography paper category are in fact the work of port geographers, such as Charlier and Ridolfi (1994) on intermodalism. Friedmann (1986) on the world city hypothesis is one of the rare non-geographical works to stand out but it remains at the periphery.

Finally, the fourth period (2002-2011) is marked by a high network complexity due to the large number of papers being considered and their intricate relations. The main trend is the highest centrality of papers offering a synthesis to port geography papers; they innovate by either providing new concepts, such as Olivier and Slack (2006) on the 'terminalization' of ports, Lee et al. (2008) on global hub port cities, Lee and Ducruet (2009) on spatial glocalization, Notteboom (2010) on multi-port gateway regions, , Ng and Pallis (2010) on institutions and port governance, Jacobs and Notteboom (2011) on evolutionary perspectives, or through large-scale empirical applications of classical methods such as Ducruet and Notteboom (2012) visualizing and measuring the worldwide maritime network of container shipping. Papers standing out while being well-connected with the core are thus those making links with other fields outside port geography papers, other examples being Fowler (2006) on

networks, Ng and Tongzon (2011) on dry ports and regional development, O'Connor (2010) on global city regions and logistics, Franc and Van der Horst (2010) on hinterland service integration, and Wang and Ducruet (2012) on the emergence of the Shanghai-Yangshan multilayered gateway hub. One major difference with former period is the highest centrality score attributed to an extended port geography paper about port regionalization (Notteboom and Rodrigue, 2005). Transport papers have gained enormous importance in the network compared with previous periods, such as Robinson (2002) on ports in value-driven chain systems, Slack et al. (2002) on strategic alliances, and Notteboom and Winkelmanns (2001) on structural changes in logistics. Most peripheral port geography papers are in fact much closer to urban-related issues as they principally focus on waterfronts (for example, Oakley, 2009) or on specific issues such as remote sensing (Kaiser, 2009). The graph is in fact organized by regions, with waterfront and social issues on the left having more connections with geographical issues and less with the transport field, and transport issues on the right being less connected with geography and other fields. By no means port geography has evolved from a scattered community to a more tightly connected one in terms of shared ideas and concepts, but the reference to geography has shifted to the periphery while transport studies have become more central in the graph.

Figure 5. Graph illustrating citations by port geography papers, 1950-2012  
[Insert Figure 5 here]

#### **4 Port Geography Papers Cited: Diffusion and Exports**

The distribution of papers citing port geography papers exhibits a very similar trend with the previous analysis, with an increasing share of transport and other journals compared with geography and port geography papers (Figure 6). Yet, the proportion of transport journals has reached only 13.5%, and geographical journals (of which core port geography papers) are still occupying a 41% share in the 2010s. There is clearly a significant imbalance between citing and being cited by others, and this suggests that port geography has widened its scope (previous analysis) in greater ways than its influence towards other disciplines. Another difference with the previous analysis is the growing interests for port geography papers by geographical research until the late 1970s, which decreases gradually since the 1980s. This can be attributed to the behavioral turn in geography having increasingly disregarded transportation issues due to their close affinity with spatial analysis (Waters, 2006). Except from the 1970s, port geography as a whole (core and extended) oscillated around 45-50% of all citations, which is far above the 34-39% level for the previous analysis. This imbalance between imports and exports remains a weakness of port geography since it is more cited by itself than by other fields.

Figure 6. Distribution of papers under different disciplines citing port geography papers, 1950-2012  
[Insert Figure 6 here]

The network analysis of papers citing port geography papers is applied in the same way than the previous analysis. It excludes, however, citations from port geography papers because this would provide similar results. Each port geography paper has been retrieved via Scopus and Google Scholar, and all citations to those papers were compiled while keeping only the peer-reviewed journals. As a complement to the previous analysis in the last sub-section, it aims to reveal which papers have attracted most attention from other disciplines at different periods as well as the existence of one or several communities with shared issues and backgrounds (Figure 7). Periods are identical to the previous analysis and they are based on the publication year of citing papers.

Figure 7. Graph illustrating citations of port geography papers, 1950-2012  
[Insert Figure 7 here]

During the first period (1955-1974), the network of citations remains rather small and fragmented, containing mostly geographical journals (of which port geography papers). The group of connected papers is a chain-like structure thus having few transversal linkages. The most central paper by Smith (1970) concerns commodity flow analysis and it quotes a bunch of port geography papers about hinterland and foreland traffics having in common methodological issues. Isolates are characterized by groups of papers focusing on a specific terrain, such as New Zealand (Rimmer, 1967), Australia (Solomon, 1963), and Sierra Leone (Jarrett, 1955). This period thus shares a similar structure with the one of citing papers: a core composed of theoretical/methodological papers and isolates specialized on specific areas of the world (developing countries).

Another similarity with the previous analysis is the emergence of a larger core community during the second period (1975-1990). Most central papers outside port geography papers are, in fact, published by port geographers (Airriess, 1989; Marti and Krausse, 1983), focusing on modeling, while Airriess (1989) and Robinson and Chu (1978) connect principally papers on Asian and African ports outside port geography papers. The seminal works of Weigend (1958) on theoretical aspects and Hayuth (1981) on load centers have a pivotal position. Specialization also appears around the works of Hoare (1988) on British ports and on ports' forelands and external relations (Von Schirach-Szmigiel, 1973; Britton, 1965). At this period, port geography papers had thus been attractive due to their special focus on developing countries and their provision of concepts and methods. Isolates are, in general, original contributions on historical geography (Pred, 1984), on gateways (Bird, 1983), on economic impacts (Stevens et al., 1981), on European ports (Bird, 1967) or the work of Rimmer (1967) drawing attention on other issues than ports.

Despite the growth in citations and papers, the third period (1992-2001) consists of a less integrated network. Most central papers are connected by very few links, which denotes a dispersion of research interests due to the lack of central themes: globalization and transport in Africa (Pedersen, 2001), waterfronts (Hoyle, 2000), trading flows (Hoare, 1993), notwithstanding the stability (Hayuth, 1981) and emergence (Fleming and Hayuth, 1994) of theoretical discussions on transport hubs with strong focus on ports, as well as a noticeable shift towards behavioral aspects of port selection and port strategies (Slack, 1990). Among the isolates, the work of Weaver (1998) about the historical geography of trade competition and

route development quotes port geography papers on Africa, while the one of Hoyle (1999) and Stevens et al. (1981) have their respective subgroups focused on waterfront redevelopment, economic impacts, cultural aspects, and port-city economic relations. This period is a transition phase focusing from case studies, theoretical and methodological works to policy issues.

The fourth period (2002-2012) provides a very complex network of citations structured by a large connected component and few isolates. While most of core papers are from port geography papers, a good number of them are from transport journals and locate near the center; geographical papers remain more central in the graph than in the previous analysis of outward citations, while "other" papers locate more at the fringe of the figure thereby suggesting the existence of specialized communities. Yet, transport journals had a central role in forging this scientific community rather than other journals. Among the most central port geography papers, there is a wide diversity of approaches, with a mix of classic, theoretical works (Olivier and Slack, 2006; Hayuth, 1981), general discussions on transport hubs and gateways (Fleming and Hayuth, 1994; Van Klink and Van den Berg, 1998), waterfronts (Hoyle, 2000), but also empirical studies of global networks (Frémont, 2007). Strong connections with geography journals are the result of transport geographers mostly (Wilmsmeier et al., 2011; Ducruet et al., 2011) notably through general discussions on the trends affecting transport geography itself (Keeling, 2009). Unsurprisingly, the strong position of some transport papers is generally explained by the fact that most are published by port geographers as well through papers focusing on ports, which confirms the shift of port geography papers towards transport journals. The absence of port geographers from non-geographical journals also reinforces the idea according to which transport journals have been privileged by port geographers, and perhaps more accessible and opened to their views than other journals, e.g., business, management, economics, planning, history, natural sciences, operational research, etc.

Hence, there are significant disparities between the first (1950-1990) and final (1991-2012) two periods. In the first two periods, port geography research was still largely knitted by generally accepted (port) geography theories and models, and applied to different parts around the world. Complementing Ng's (2013) argument, port geography research during this period closely followed the focus and approach of mainstream human geography, largely being geographers who focused on port-related problems. However, in the third period, a transitory process took place where old theoretical models started to become obsolete while port geography papers research began to move away from geography to transportation and other scientific disciplines. Yet, the ratio between the respective numbers of inward and outward citations has remained highly unbalanced: port geography always imports more than it exports. This suggests a follower rather than a proactive, or even innovative, profile of port geography, notably towards transport and other non-geographical journals. Over the whole period, transport papers have the widest discrepancy between inward and outward citations both in terms of number (0.48) and share (0.67), followed by other studies (0.50 and 0.71), geography (0.73 and 1.03), core port geography (0.90 and 1.26), and extended port geography (1.03 and 1.44). Thus, the affinity for transport is largely imbalanced, as this field does not seem to compensate port geographers for their repeated efforts to make their work more practical and applied. Core port geography is thus the biggest importer of core port geography, and this is partly explained by the migration of some scholars to non-geography journals citing their

works published in geography journals. Yet, such measurements do not include citations of extended port geography papers by transport (and other) journals. It is thus logical that the gradual shift of port geographers towards non-geographical journals had the effect of lowering the influence of geography journals towards other fields when it comes to port-related research. Given that the most influential port geography papers were published in geography journals, such results remain valid in pointing at a certain weakness of this corpus towards non-geographers. In some way, core port geography remains closer to geography because geographers that do not publish about ports still recognize port geography (almost) as much as port geography recognizes them.

Analyzing the changing share of port-related citations in the total of all citations made by geography and other papers was impossible due to obvious constraints of data collection and availability over the whole academic spectrum. However, such a trend also denotes the ability and necessity to borrow concepts and methods from a vast panel of research fields due to the inherent trans-disciplinary nature of port research. Another positive dimension to be underlined is the regularly growing ratio between the respective cited and citing shares of other journals, from 0.21 in the 1960s to 1.04 in the 2010s, which could suggest a growing recognition of core port geography towards other social and natural sciences outside the transport field. One example is the study by Frémont (2007) of the port network of Maersk, the world's largest shipping line, being cited by a physics paper (Hu and Zhu, 2009). This is part of a wider trend by which natural sciences increasingly took over classical research fields of social sciences, such as transport network analysis, due to stronger computational power and modeling techniques, but often without quoting the original works done, among others, by geographers (Ducruet and Beauguitte, forthcoming). In the total citations network comprising all inward and outward citations over the entire study period (Appendix III), most central papers are compared by their betweenness centrality and in-degree centrality, while each table includes (III.1) or excludes (III.2) citations between core port geography papers themselves. In the first table, the work by Olivier and Slack (2006) ranks first, as it addresses profound changes in the meaning of the concept of the port itself following the reorganization of terminal operations by global players. It is followed by papers offering large syntheses as well, such as Lee et al. (2008) adding an Asian variation to the mostly Western-focused models of ports' spatial evolution, and Ng and Pallis (2010) discussing the impacts of institutions on port reform and governance. Unsurprisingly, only few papers in this top 30 come from outside core or extended port geography, such as Sager (2011) on neo-liberal planning policies, Turnbull (2006) on the power relations within the port industry, and Notteboom and Rodrigue (2005) about the regionalization of ports. The second table offers a relatively identical list of papers despite some changes in their ranking, with Taaffe et al. (1963)'s classic model ranking first and Notteboom and Rodrigue (2005) ranking third. Both papers mainly focus about the concept of 'port system', which still nowadays continues to occupy a very central focus in port geography (Wang and Ducruet, 2013), but in a relative isolation from similar concepts such as cities systems or systems of cities developed in urban geography (see for instance Bretagnolle et al., 2009). Papers outside core or extended port geography differing from the previous list are those of Notteboom and Winkelmanns (2001) and Robinson (2002) on strategic changes in logistics and value chains. Although the position of papers in such a graph can be anachronical due to the intermingling of periods, it confirms how port geography, as a whole, remains fragmented between social, planning, economic and transport issues, as well as somewhat self-sufficient due to the rarity of centrally located papers from outside this specific research field.

#### **IV Discussion and Conclusion**

Despite the rapid transformation of the maritime industries posing significant implications on the roles and functions of ports, there is a scarcity of analysis on the research trend of port geography papers. Recognizing such deficiencies, through a bibliometric analysis on 399 port papers featured in 36 journals (co-)authored by 328 researchers between 1950 and 2012, this paper investigated the evolution and research trends of port geography papers.

A number of observations can be identified. First, there has been an increasing production of port geography papers in recent decades after a period of relative slowdown, which demonstrates that port geography is not a fading research field. On the contrary, it has managed expanding, reaching new frontiers and diversifying its horizons, notwithstanding certain weaknesses. In fact, core port geography has increased not as fast as extended port geography, the latter being published outside geography journals. Second, the analysis of citations concludes to the coexistence of three ‘systems’ within port geography papers: a ‘traditional’ system composed of core papers addressing classical issues of transport flows and networks but without strong recognition from outside, a “specialized” system with high recognition from outside but weak linkage with the traditional system and transportation, and finally, an “innovative” system more concerned by societal and methodological issues connecting other social sciences and having wider external impacts. Such imbalance between inward and outward citations suggests a recurrent weakness of port geography that is to import to more than it does export from other research fields and disciplines. Yet, other methods such as co-citations could be applied to refine the analysis of imports and exports, where two or more papers are linked in the network when they cite same papers (Newman, 2004). This is subject to further research. Nevertheless, our results point at the difficulty for port geography to attract non-port specialists, which results in a certain lock-in among port geographers.

This lock-in is about to change given the recent publication of many papers connecting wider theoretical fields (e.g. governance, networks, globalization) that may attract further attention from outside. The shift from port as a place to the port in networks of all kinds (firms, flows) has been identified as a crucial meeting point with wider concerns in economic geography and transport studies, also backed by the renewal of network analysis conceptually and methodologically since the late 1990s (Ducruet and Lugo, 2013). However, port geographers increasingly struggled to re-identify a core research direction. Although attempts were made to fill in this gap (for example, Fleming and Hayuth, 1994), the migration of port geographers to other disciplines had weakened the self ‘bonding’. This process was completed during the fourth period where the ‘bonding’ between port geographers seemed to be even more remote, especially given with increasing collaboration between geography and non-geography scholars. As noted by Ng (2013), there was a lack of general consensus (yet) on the appropriate theoretical replacements for port geography papers research in view of this migration process, especially within human geography. Hence, port geography is in danger of being relegated to a normal science (cf. Kuhn, 1962) rather than innovative contribution to paradigm shifts. Moreover, there was a worrying indication that the increasing popularity of the so-called ‘innovative system’ also led the gradual decline of certain traditional areas, notably the inter-dynamics between port, development and well-beings of its surrounding regions with the core



geography journals. Indeed, it was shocking to found that there were increasing number of port-city relationship and port-regional development papers - traditionally important topics within human and transport geographies - being published in non-geography journals, with a significant decline in the number port-regional development papers being published in geography ones. Instead, geography journals are now increasingly dominated by 'innovative' topics (a trend similar to non-geography journals), notably port choice and competition, port, intermodal transportation and supply chain, as well as port management, policy and governance (Table 3) <sup>2</sup>.

Table 3. The research themes of port geography papers published in geography and non-geography journals before and after 1990  
[Insert Table 3 about here]

The change in research theme is a reflection of the redefinition of what (in human geography terms) 'the relations of and across space and place' mean among port geographers nowadays, i.e., from the relationship and interaction between human activities (port) and the (built) environment to the more 'industrial' meaning between port and other transport modes, production process and inter-port relationship. From a spatial perspective, port geography research had further highlighted the gradually segregated relationship between ports and their surrounding areas (and spatial planning), being replaced by a more practical (at least from the industrial point of view), profit and efficiency-oriented meaning, like 'trade corridors', 'supply chains' and 'competitiveness', of which the approach and methodologies also tended to be more positivist and quantitative, respectively.

However, perhaps this should not be deemed as surprising. Technological revolution, notably the use of containers, and the persistent increase in international trade and globalization, had transformed port evolution and development, like the increasing intensity of inter-port competition. It is well documented that, especially since the 1980s, shipping lines often pressurized ports to enhance efficiency (Hayuth and Hilling, 1992; McCalla, 1999). Slack (2004) argued that such fundamental changes had led to the growing similarity between shipping lines, leading to the phenomenon that while winners won more, losers would lose even more. As a result, ports were forced to find ways to sustain and enhance their competitiveness (Meersman and van de Voorde, 1998), notably through enhancing their performance, service quality, and network position (Ducruet, 2013), as well as identifying major port choice factors (Ng, 2006; Sanchez et al., 2011). Strengthened by the strong wave of neoliberalism in pushing economic policy and development during the same period (Harvey 2005), ports needed to be 'responsive' to customer requirements, thus pushing them to focus on efficiency enhancement (within port itself and between ports and other transport modes), devolution, public-private partnership of port (or terminal) ownership and operations (Heaver, 2002; Wang et al., 2004; Ng and Pallis, 2010), and the search for quick results (thus over-emphasis on quantitative, easily-measurable indicators). The above had transformed port's role and functions so much which posed significant challenges to port researchers, including geographers, to conceptualize and interpret them (Wang et al., 2007).

In addition, analysis from this study further strengthened the proposition that the 'geographical' identity of port geography papers had been significantly diluted in the past

decades (cf. Ng, 2013). The morphology from core geographical research towards transportation due to an increased specialization of port geography papers on transport issues, however, does not necessarily contradict the emergence of a new phase with more diversified goals and perhaps, more fundamental ones. Indeed, port geography research had evolved from an encyclopedic, secondary nature of geography researchers to become more specialized and primary research interests. The emergence of a connected community in the last decade or so could have been one positive factor for port geographers to exchange ideas faster than in former period of isolation and fragmented collaborations. Indeed, the formation of a single and well-connected community clearly paves the way towards further innovation in the field, although the future of this community will depend on maintained scientific interactions and the development of more transversal linkages among port geographers. New ways of linking port/transport issues with wider theoretical and methodological backgrounds will both profit the port industry and mainstream scholarly research.

Hence, further research is urgently required to comprehensively understand the extent of which port geography papers interact with other scientific disciplines, and to search for the aforementioned new ways. Important topics include the analysis of knowledge interactions between locations through the port geography papers corpus - are port geography papers offering a different pattern than other sciences? Also, further analysis of citations and co-citations based on the categorization of port geography research would allow to verify whether papers discussing similar topics have formed distinct communities, and the “bridges” between them, in relation with the homophile concept in social networks. Internal trends may reflect the evolution of certain ‘schools’, such as the French one more focused on maritime forelands and the Dutch one better discussing hinterland distribution, towards more global and transversal approaches, but such a study shall integrate domestic journals (of which in other languages) and book publications. Clustering methods could also be applied to verify the influence of geographic or other proximity among authors in the pattern of collaborations and citations, as well as other graph-theoretical approaches such as bipartite (or 2-mode) networks and multilevel networks where author, paper, and journal levels are considered. Finally, there is an equally important need to investigate whether port geography papers research has increasingly focused on the major ports along the major international trade axis, rather than secondary or regional ones. This will help to verify the proposition on whether international trade and globalization has ‘bent’ the focus and efforts of port geographers towards the ‘cores’ while missing out the ‘peripheries’.

Despite its relatively small field, our analysis has clearly advanced the debate of the role of transport geography in the human geography discipline. The analysis partly confirms the applicability of the rather “ghettoized” dimension of transport geography (cf. Goetz et al., 2003; Keeling, 2007) in general to port geography papers given the somewhat limited impact of its core papers externally and its growing specialization within transport research moving away from mainstream geographical research, except for the top cited papers that have actually limited connections with classical port geography papers. Yet, this study has identified a recent production of more innovative papers connecting both classical port geography papers and wider research fields, backed by the emergence of a connected community of port specialists. Thanks to such collaborations and investigations, port geographers have added a spatial dimension, and an appreciation of institutions and place, to port and other aspects of maritime studies, that otherwise would be a field entirely dominated

by operational research and business approaches. While port geography still evolves in a relative autonomy that creates disconnection with wider approaches in economic geography for instance, it has been able to integrate important conceptual and methodological shifts such as globalization and networks. Further research is therefore needed to better evaluate the gaps between human and port geographies from a more contents perspective. To sum up, this paper offers invaluable insight on the trends and evolution of port geography research, helping researchers in preparing future research agendas in searching for their new identity as a valuable sub-theme within the human geography, transport and other academic disciplines.

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### **Notes**

1. For example, among the 395 port papers published in various journals between 1997 and 2008 reviewed by Pallis et al. (2010 and 2011), based on our sample (Appendix I), at least 50 papers published within the same period had been overlooked. Among them, only two were published in *Journal of Transport Geography*, while all the others were published in the more general (human) geography journals.
2. For details on the categorization of research themes, see Ng (2013). The author gratefully acknowledged the constructive advice from Cesar Ducruet, Kevin O'Connor, Brian Slack and James Wang in the categorization process.

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**Table 1. Distribution of port geography papers by journal and period, 1950-2012**

Journal	1950s	1960s	1970s	1980s	1990s	2000s	2010s	Total
Annals of Regional Science						1		1
Annals of the Association of American Geographers	19	8	4					31
Applied Geography				1		1		2
Area			1	1	2			4
Asia Pacific Viewpoint					2	2		4
Australian Geographer		3	1	2	1	1	1	9
Canadian Geographer	2	1	1	3	1	4		12
Economic Geography	5	8	4	2	1	2		22
Environment & Planning A				1	1	8	2	12
Environment & Planning C				2				2
Environment & Planning D				1	1			2
Eurasian Geography & Economics							1	1
European Planning Studies					4	2		6
Europe-Asia Studies						1		1
Geoforum			2	8	6	4		20
Geografiska Annaler - Series B: Human Geography		1	1	1	1			4
Geographical Review	6	3	2	1	3	2		17
Geography	8	12	8	4	1			33
GeoJournal			2	6	10	7		25
Global Networks							2	2
International Journal of Urban & Regional Research						5		5
Journal of Historical Geography			1	1		1		3
Journal of Transport Geography					14	22	24	60
Landscape & Urban Planning					1			1
New Zealand Geographer			1			1		2
Papers in Regional Science	1					1		2
Political Geography					1	1		2
Professional Geographer		5	2	3	1			11
Progress in Human Geography				1				1
Regional Studies			1			1	3	5
Scottish Geographical Journal	3	6	1			1		11
The Geographical Journal		4	2			1		7
Tijdschrift voor Economische en Sociale Geografie	24	23	4	5	9	6	2	73
Transactions of the Institute of British Geographers		2			1			3
Urban Geography						2		2
Zeitschrift für Wirtschaftsgeographie						1		1
Total	68	76	38	43	61	78	35	399

**Table 2: Bibliometric indicators on core port geography papers, 1950-2012**

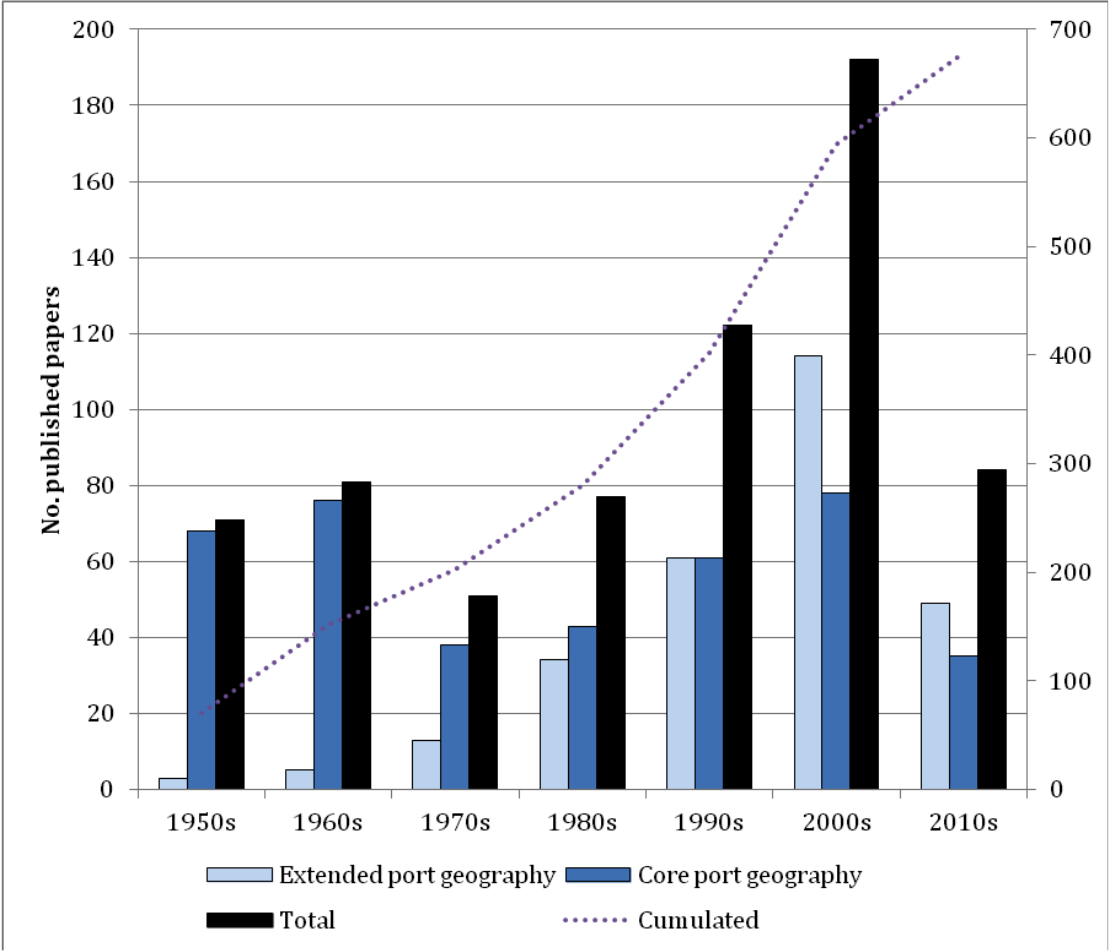
Period	Mean number of authors per paper		Share (%) of single authored papers	
	CPG	EPG	CPG	EPG
1950-1959	1.09	1.00	83.78	100.00
1960-1969	1.05	1.00	90.00	100.00
1970-1979	1.11	1.08	80.95	92.31
1980-1989	1.23	1.15	66.04	84.85
1990-1999	1.33	1.37	53.09	73.68
2000-2009	1.67	1.92	30.77	37.27
2010-2012	2.29	2.36	6.25	17.02
1950-2012	1.35	1.72	53.89	51.87



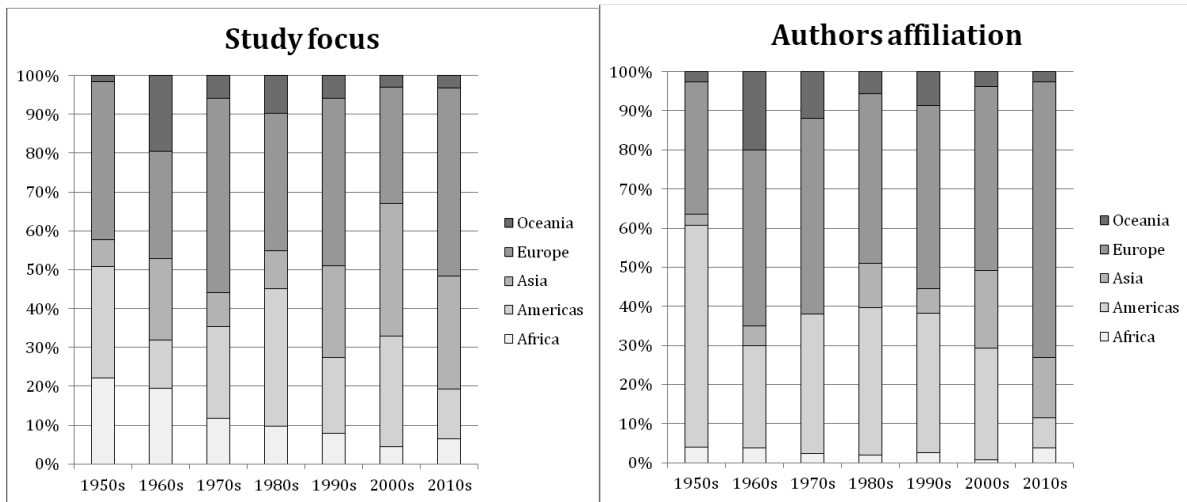
**Table 3. The research themes of port geography papers published in geography and non-geography journals**

		Philosophy and Epistemology	Port Connectedness	Inland/Satellite Terminals	Port Operation	Catchment Areas and Supply Chain Linkages	History and Location	Port and Regional Development	Port, Intermodal Transportation and Supply Chain	Port System	Port Choice, Competition and Cooperation	Port's Place in Shipping Strategies and Networks	Management, Policy and Governance	Evolution Overtime	Port City Relation	Total
Core port geography	1950-1974	10	8	1	2	18	17	18	8	9	3	4	2	49	19	167
	1975-1990	0	1	1	4	2	1	10	3	7	1	4	5	8	19	64
	1991-2001	0	0	1	1	1	3	3	4	13	7	4	7	2	24	69
	2002-2012	0	2	5	2	2	6	4	19	11	6	14	8	4	19	99
	Total	10	11	7	9	23	26	34	34	39	17	26	22	63	80	399
Extended port geography	1950-1974	0	0	0	0	1	3	1	0	0	2	1	6	5	5	24
	1975-1990	0	2	2	1	0	3	3	4	7	7	4	4	8	9	54
	1991-2001	0	1	1	6	1	7	2	4	0	10	10	17	9	27	95
	2002-2012	0	1	10	12	12	0	8	14	10	23	19	20	6	21	156
	Total	0	4	13	19	14	13	14	22	17	42	34	47	28	62	329
Grand total		10	15	20	28	37	39	48	56	56	59	60	69	91	142	728

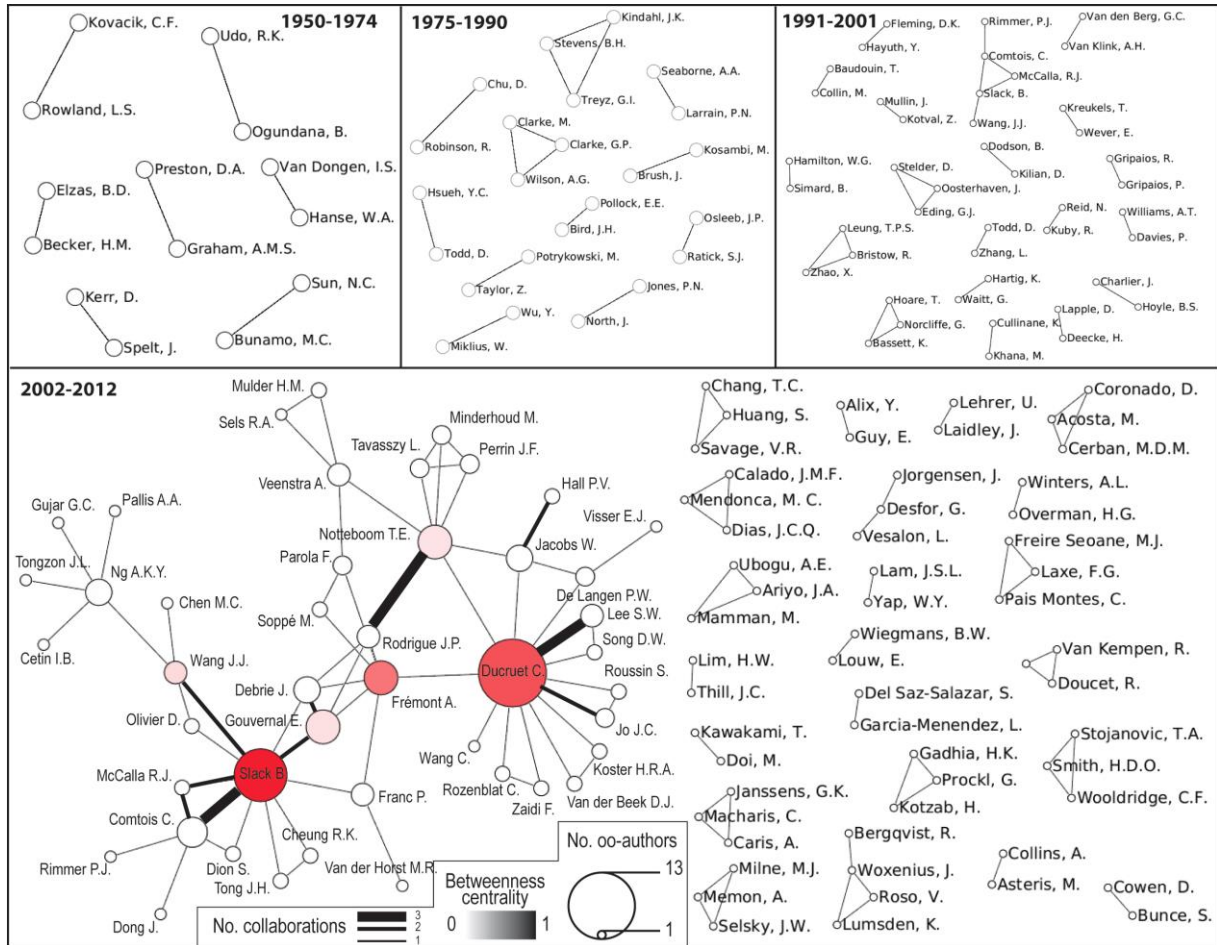
**Figure 1. Production trend: core port geography vs. extended port geography papers, 1950-2012**



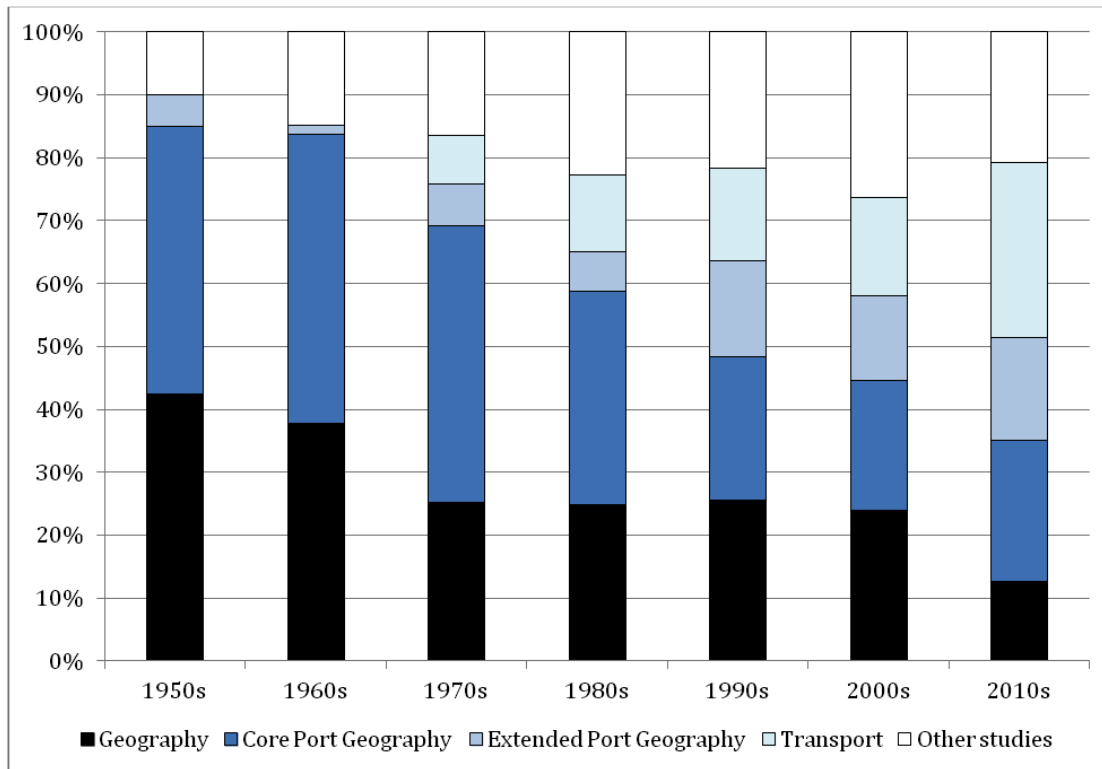
**Figure 2. The geographical coverage of port geography papers, 1950-2012**



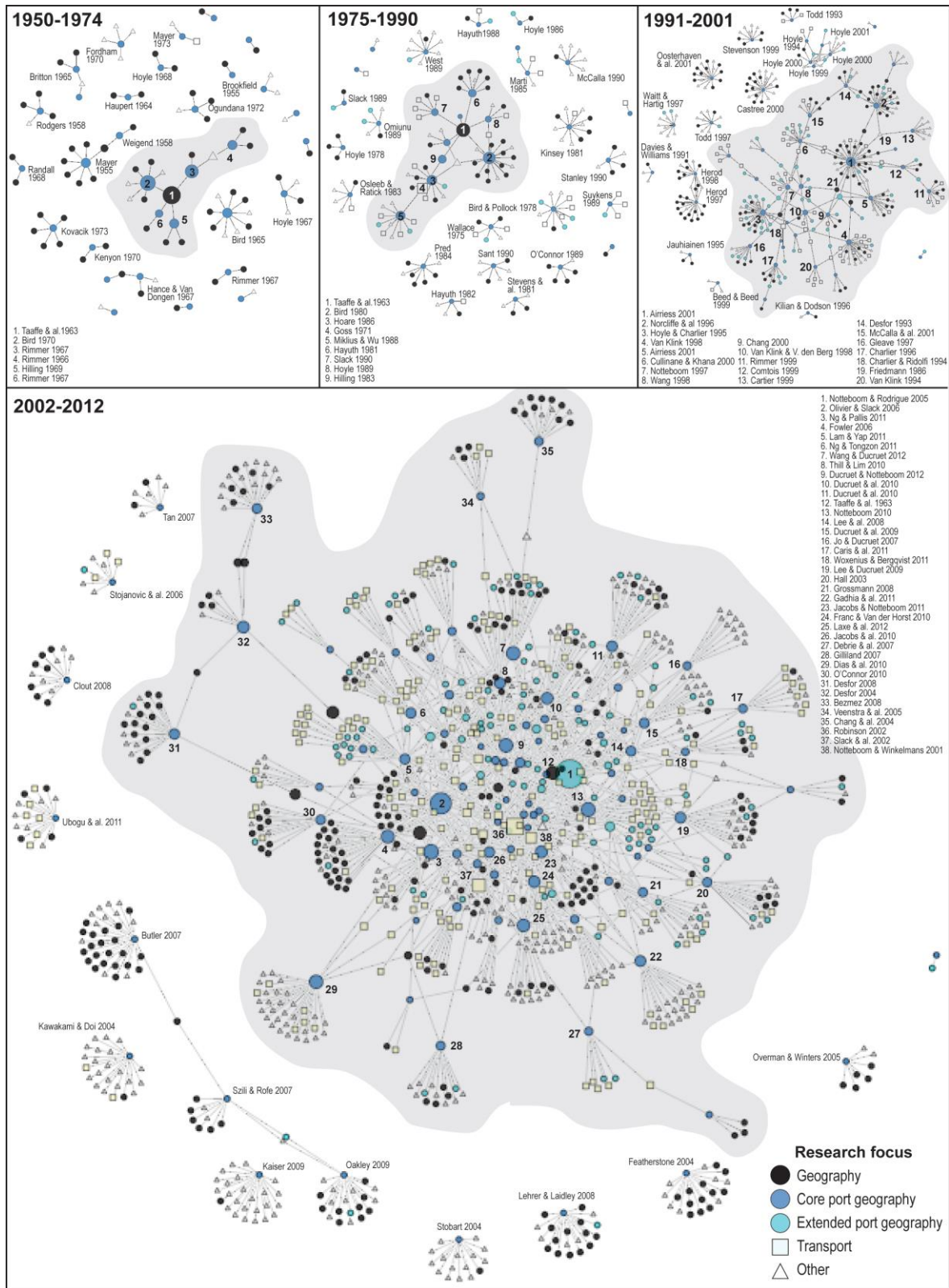
**Figure 3. Graph illustrating co-authorships across core port geography papers, 1950-2012**



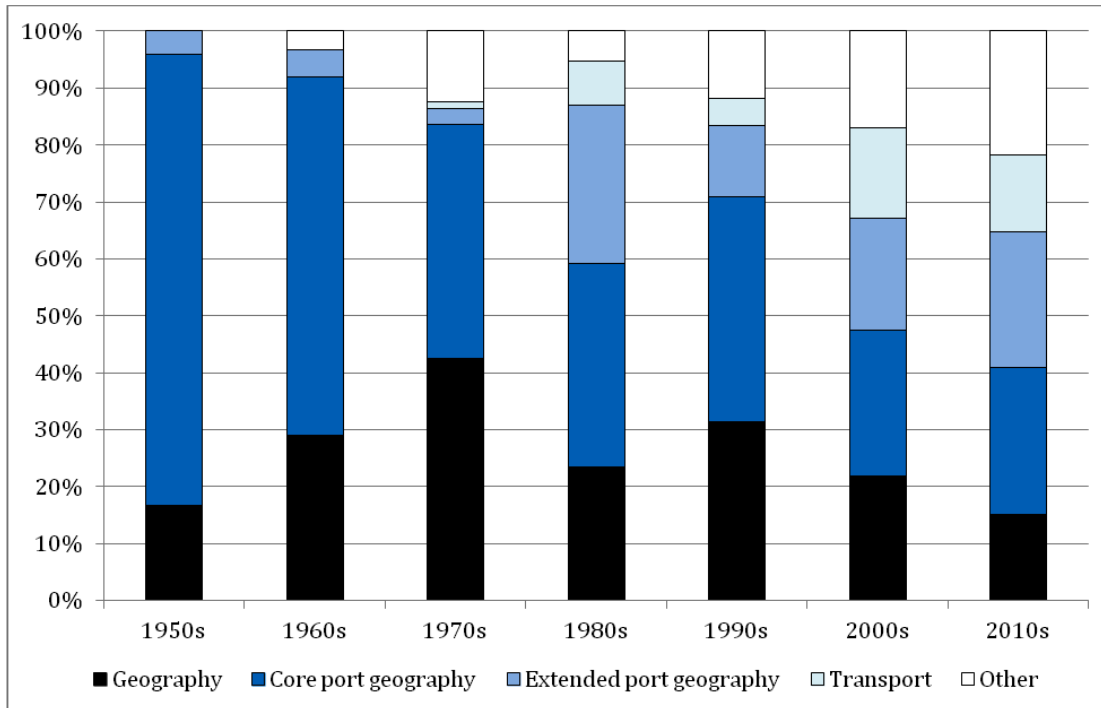
**Figure 4. Distribution of journal papers under different disciplines cited by core port geography papers, 1950-2012**



**Figure 5. Graph illustrating citations by core port geography papers, 1950-2012**

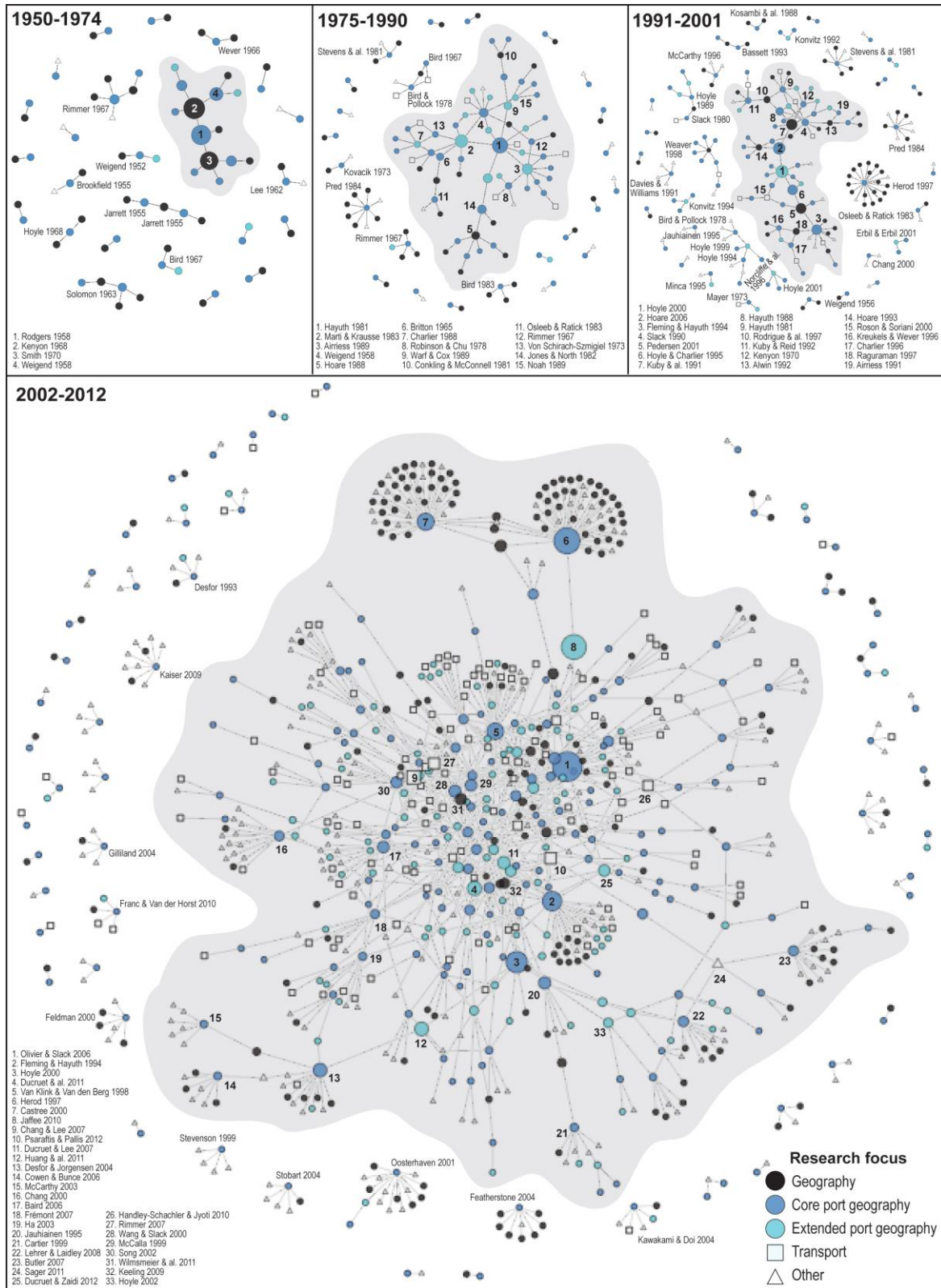


**Figure 6. Distribution of papers under different disciplines citing core port geography papers, 1950-2012**





**Figure 7. Graph illustrating citations of core port geography papers, 1950-2012**





## Appendix I

## Port Geography Papers Included in this Study

1. Acosta M, Coronado D and del mar Cerban M (2011) Bunkering competition and competitiveness at the ports of the Gibraltar Strait. *Journal of Transport Geography* 19: 911-916.
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**Appendix II The list of major journals which have published extended port geography papers, 1950-2012**

Journal Name	No. of papers published	%
Maritime Policy & Management	85	25.8
Maritime Economics & Logistics	33	10.0
Cities	9	2.7
International Journal of Transport Economics	9	2.7
Ocean & Coastal Management	9	2.7
Transport Policy	8	2.4
Transport Reviews	8	2.4
African Urban Quarterly	5	1.5
Growth & Change	5	1.5
Journal of International Logistics & Trade	5	1.5
Journal of Transport Economics & Policy	5	1.5
Transportation Research Part A	5	1.5
Urban Studies	5	1.5
European Journal of Transport & Infrastructure Research	4	1.2
Handbook of Terminal Planning	3	0.9
Journal of the Eastern Asia Society for Transportation Studies	3	0.9
Journal of Transport History	3	0.9
The Dock & Harbour Authority	3	0.9
Town Planning Review	3	0.9
Urban History Review	3	0.9
Top 20 journals subtotal	213	64.7
Other journals subtotal	116	35.3
Total	329	100.0

### Appendix III 30 Top Positioned Papers in the Graph Combining Core Port Geography's Inward and Outward Citations, 1950-2012

#### III.1 Including citations among core port geography papers

Author(s)	Year	Journal	Betweenness centrality	In-degree (k)
Olivier & Slack	2006	Environment & Planning A	861627	33
Lee, Song & Ducruet	2008	Geoforum	617629	23
Ng & Pallis	2010	Environment & Planning A	617553	4
Norcliffe, Bassett & Hoare	1996	Journal of Transport Geography	424859	16
Herod	1997	Political Geography	402831	70
Hayuth	1981	Economic Geography	398309	70
Fowler	2006	Environment & Planning A	383426	2
Castree	2000	Economic Geography	372852	47
Brenner	1998	Environment & Planning D	346815	3
Fleming & Hayuth	1994	Journal of Transport Geography	343972	70
Hoyle & Charlier	1995	Journal of Transport Geography	342499	17
Ducruet & Notteboom	2012	Global Networks	315295	0
Jacobs & Notteboom	2011	Environment & Planning A	314736	1
Sager	2011	Progress in Planning	306630	0
Weigend	1958	Geographical Review	286304	48
Lee & Ducruet	2009	Urban Geography	272755	5
Van Klink	1998	Environment & Planning A	267569	2
Ducruet, Koster & Van der Beek	2010	Regional Studies	259654	1
Notteboom	1997	Journal of Transport Geography	249122	40
Hoyle	2000	Geographical Review	241449	16
Butler	2007	International Journal of Urban & Regional Research	233877	14
Van Klink & Van den Berg	1998	Journal of Transport Geography	233869	53
Jaffee	2010	Growth & Change	229725	0
Hoare	1986	Geografiska Annaler B	225630	22
Airriess	2001	Geoforum	221322	9
Turnbull	2006	British Journal of Industrial Relations	218349	1
Notteboom & Rodrigue	2005	Maritime Policy & Management	197708	27
Taaffe, Morrill & Gould	1963	Geographical Review	196444	32
Rimmer	1967	Geografiska Annaler B	190960	24
Notteboom	2010	Journal of Transport Geography	188358	4

### III.2 Excluding citations among core port geography papers

<b>Author(s)</b>	<b>Year</b>	<b>Journal</b>	<b>Betweenness centrality</b>	<b>In-degree (k)</b>
Taaffe, Morrill & Gould	1963	Geographical Review	692061	32
Olivier & Slack	2006	Environment & Planning A	625649	19
Notteboom & Rodrigue	2005	Maritime Policy & Management	552420	27
Ng & Pallis	2010	Environment & Planning A	532574	2
Jacobs & Notteboom	2011	Environment & Planning A	421724	1
Herod	1997	Political Geography	377897	69
Fowler	2006	Environment & Planning A	368060	2
Sager	2011	Progress in Planning	335285	0
Lee, Song & Ducruet	2008	Geoforum	330285	13
Hayuth	1981	Economic Geography	305765	34
Turnbull	2006	British Journal of Industrial Relations	282187	1
Castree	2000	Economic Geography	281055	46
Hoyle & Charlier	1995	Journal of Transport Geography	280673	11
Van Klink & Van den Berg	1998	Journal of Transport Geography	269459	41
Butler	2007	International Journal of Urban & Regional Research	256594	14
Van Klink	1998	Environment & Planning A	252516	1
Fleming & Hayuth	1994	Journal of Transport Geography	251471	50
Norcliffe, Bassett & Hoare	1996	Journal of Transport Geography	228482	9
Airriess	2001	Geoforum	227528	6
Brenner	1998	Environment & Planning D	222676	3
Notteboom & Winkelmans	2001	Maritime Policy & Management	213766	11
Hoyle	2000	Journal of Maritime Research	189210	0
Jaffee	2010	Growth & Change	187488	0
Robinson	2002	Maritime Policy & Management	184823	20
Desfor	2004	European Planning Studies	182581	15
Wang & Ducruet	2012	Journal of Transport Geography	172690	0
Lee & Ducruet	2009	Urban Geography	172293	4
Dias, Calado & Mendoça	2010	Journal of Transport Geography	167667	4
Ducruet, Ietri & Rozenblat	2011	Cybergeog	166501	0
Notteboom	2010	Journal of Transport Geography	164827	2