Frontline soldiers of globalisation: port-city evolution and regional competition

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FRONTLINE SOLDIERS OF GLOBALISATION

PORT-CITY EVOLUTION AND REGIONAL COMPETITION

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ABSTRACT

This paper is an empirical attempt to measure the relative concentration of port-city functions in the context of globalisation. It reviews a number of urban and port issues regarding their complementary and contradictory aspects about the evolution of port cities. The main purpose is to verify how port function is more or less important to local economies, compared to other functions, through a temporal and global approach. Based on a matrix of port-city centrality and intermediacy, the main indicators available for international comparison are urban population and container throughput. An analysis of 653 places between 1970 and 2005 period is provided, using the relative concentration index proposed by Vallega. The appropriate geographical scale to measure the relative evolution of port cities at a global level is discussed. Results tend to question previous models which consider functional and spatial separation between the city and its port as an ineluctable process. The port-city evolution appears to be gradual rather than linear or chaotic, and in many cases largely influenced by regional factors and local strategies.

Keywords: Containerisation, Globalisation, Port city, Relative concentration index

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1. INTRODUCTION

The nature of the relationships between ports and port cities is an old question with few answers. Ports have become complex entities with various locations and functions that tend to exceed the responsibility of the port authority. Coastal cities may be torn between their maritime functions which are determined by specific maritime foreland trade relationships (Brocard 1988; Pearson 1998), and their other functions, that are dependent on predominantly land based urban system relationships. The equilibrium between these functions is becoming increasingly unbalanced. Thus, "many port cities (…) stand among the most environmentally degraded cities in the world" (OECD 2004).

These distinctions are reflected in the literature, where port and urban studies are often separate and distinct (Reeves 1989; Banister 1995). Considering port functions as one of many urban functions, like manufacturing and retailing, is one approach to the examination of the specificity of ports within urban systems. Over the last 40 years port sites have expanded (Lee et al. 2005), and may be considered as following and contributing larger urban trends which include the shift of activities outside city centres (Bird 1963). Manufacturing, commercial and sports activities have relocated in a significant way to the city's peripheral areas. The difference is that ports are responding to international market and technological changes, while the new pattern of urban functions is better explained by local conditions, such as changing accessibility and population distributions. Similar difficulties are encountered when trying to measure the relationships between the size and growth trajectories of port activity with those of the broader urban economy. In India, for example, the linear correlation between demographic size and port total throughput has diminished dramatically between 1911 and 1981 (Kidwai 1989), due to the emergence of specialised ports away from big cities (e.g. New Mangalore, Haldia, Kandla). In Europe, the growth rates of added value were identical for port cities and non-port cities between 1975 and 1985, but widened in favour of non-port cities between 1985 and 1994 (Lever 1995). In China on the other hand port-centred coastal industrial growth is widening the disparities with inland cities (Wang & Olivier 2003).

The gaps in the literature on port-city relationships are particularly extensive in that with an urban focus, with the important exception of waterfront redevelopment. Urban planners and geographers tend to see the port as some separate and alien activity (Bird 1973 & 1977; Boyer & Vigarié 1982). For port specialists there is recognition that maritime activity frequently takes place in an urban milieu, but the nature of that milieu is rarely considered (Goss 1990). Distinctions between the ports of Le Havre and Rotterdam rarely consider the contrasting urban environments. Traffic related to the city itself have become in many cases a residual share of total port activity (UNCTAD 1985). Furthermore, most of these port-focussed studies are limited in scale, usually applying to small regional sets or individual case studies. Finally, the lack of data on port and urban functions has restrained comparative studies to the national level (Slack 1989; O'Connor 1989; Gripaios 1999), but this has been partly overcome on a Europe-Asia scale (Ducruet & Jeong 2005).

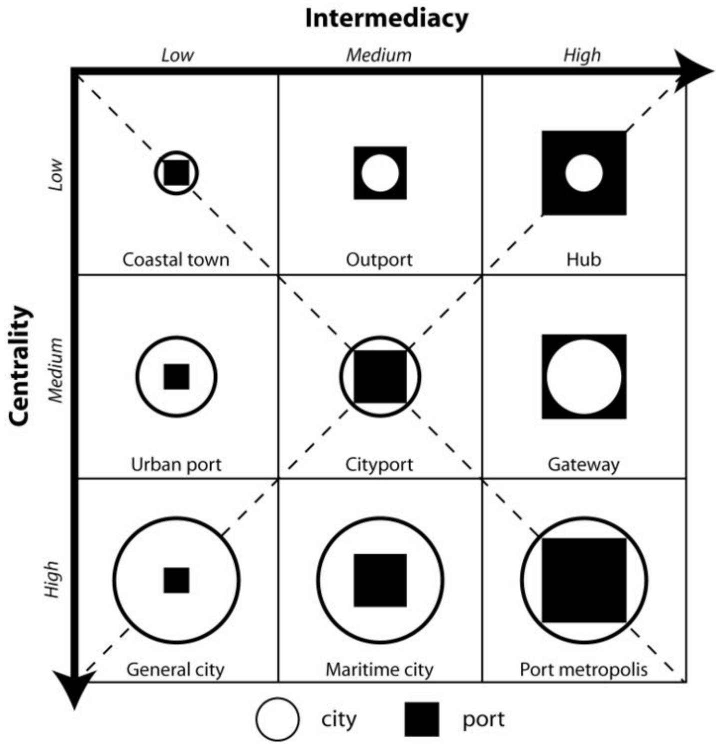
This paper seeks to confront these lacunae head on. It takes a global approach to the question of port-urban relations. It begins by presenting a typology of port-urban relations and then proposes a means of transcribing every type into simple quantitative expressions by using the relative concentration index proposed by Vallega (1979). The second and third sections raise important methodological issues, such as the pertinence of urban population and container traffic in transcribing city and port functions, and the dimension of the regional area within which port cities shall be compared. By measuring the degree to which port cities are dependent on port or other urban functions it is possible to obtain a global snapshot of the situation. The paper goes on to examine regional and temporal patterns, focusing on the largest port cities. This paper is seen as establishing a base upon which further investigation of port-city relations can be undertaken.

2. PORT-CITY RELATIONS

2.1 A matrix of port-city relations

Ducruet (2005) has produced a matrix of port-city relationships based on the concepts of centrality and intermediacy that had been developed by Fleming and Hayuth (1994). This matrix provides a useful starting point (see Figure 1). The matrix considers that centrality is an urban functional measure, while intermediacy is an essentially maritime-based measure.

Figure 1: A matrix of port-city relations



Source: modified from Ducruet, 2005.

One diagonal illustrates a progression from a ‘coastal town’ (e.g.: a small coastal port and village) to the ‘global hub port city’ where the two functional dimensions are of equal relative importance (e.g.: New York, Tokyo, Hong Kong, Singapore as business centers and major ports). The second diagonal shows the most imbalanced situations: from the port hub, with limited centrality (e.g.: Freeport, Gioia Tauro, Laem Chabang, Salalah) to the *general city* with limited intermediacy (e.g. Stockholm, Tunis, Baltimore, Calcutta). Where the two diagonals cross Ducruet uses the term the *cityport*, first employed by Hoyle and Pinder (1992), which is an intermediate condition. The model overcomes the difficulty of creating a single definition of the ‘port city’, as few places manage to keep a balanced combination of centrality and intermediacy. More likely are unbalanced profiles such as the *gateway* which is subdued to its hinterland and develops few activities apart from heavy industry and logistics (e.g. Le Havre, Genoa, Rotterdam); the *maritime city* where port functions are efficient in spite of an important urban environment (e.g. Barcelona, Marseilles, Capetown, Buenos Aires); the *urban port* which has some importance in the urban system but with limited port activity (e.g. Incheon, Bordeaux); and finally, the *outport* which is usually dependent on nearby cities and whose port functions do not act as a mechanism for developing its own urban economy (e.g. Fos, Felixstowe, Apapa).

It is important to recognise that port-city relationships vary over time. This is hinted at in some general urban evolutionary models. Murphey (1989), for example, suggests that the port city is destined to become a general city through successive stages of economic diversification. A first stage is defined by a high dependence of the urban economy on maritime and port functions. The second marks the attraction of additional activities (e.g. industrial) and the third corresponds to the development of a service economy, allowing the city to release itself from port dependence (Charlier 1988). In the final stage of their evolutionary model, Pesquera and Ruiz (1996) define the post-industrial period by the interdependency between urban metropolitan and port logistic functions.

2.2 Measuring port-city dependence

There are no universally accepted measures of urban development. Economic criteria, such as percentages employed in particular economic activities vary significantly across the development spectrum. Simpler measures employing demographic data offer better prospectives, since population totals are recognised as indicators of overall economic weight (Pumain 1997). However, great care must be applied in inferring relationships between population size and economic functions (Carriou 2002). Nevertheless, because population size is such an important dimension of urban development and because it is a parameter that is widely available it was used in this study as a surrogate for centrality.

Operationalising this measure for this study still presented numerous problems. The population of local administrative units may not reflect the true extent of the urban environment. Administrative boundaries are often mismatched (Verlaque 1979). The solution adopted here is to use data from the contiguous urbanised area. These data are drawn from the global urban data base 'Geopolis' (Moriconi-Ebrard 1994) which provides data on agglomerations over 100,000 from 1950 to 1990. These data were supplemented for cities under 100,000 and for the period after 1990 from other sources, such as the 'World Gazetteer' (Helders 2006) and others (Brinkhoff 2006; Lahmeyer 2006).

Port cities located in the same morphological urban area have been agglomerated into a single unit: Seattle-Tacoma, Los Angeles-Long Beach, Tokyo-Yokohama, Oakland-San Francisco, Osaka-Kobe. Ports located within the urban area of a distant city have been attributed to this city: Incheon-Seoul, Port Klang-Kuala Lumpur, Keelung-Taipei, Fremantle-Perth, Callao-Lima, Haydarpasa-Istanbul, etc.

While total port traffic, or lists of port equipment and the spatial extent of port infrastructures have been used to assess port hierarchies, container throughput has been selected as the dimension that best captures the status of ports in a global economy. We are aware of its limits. Although it embraces an increasing proportion of maritime trade, many ports depend greatly on bulk shipments. Furthermore container totals tend to be inflated because of transhipment, which containers are double counted.

Container data have several advantages because they are comparable at a world scale, using the same units of measurement (the twenty foot equivalent unit –the TEU). Moreover, they are intimately tied to globalisation and the rise of intermodality in supply chains. Competition in the container business is particularly keen, and is monitored closely by port-cities seeking to expand their roles. Of all goods by ports, general cargoes and full containers are most valued in terms of interaction and potential benefits for the local economy (Charlier 1994).

3. THE RELATIVE CONCENTRATION INDEX

The *relative concentration index* was used by Vallega (1979) to reveal how Mediterranean port regions and their related human settlements are organised. The author divided the regional share of throughput by the regional share of population among the total area. The resulting value is high for trading regions (e.g.: gateway or 'pivotal' regions), low for densely populated regions (e.g.: those remote from major shipping routes) and close to 1 for regions having a similar urban and port importance. This index is similar to the ones used by Vigarié (1968), to measure countries' *maritime dependence* (number of merchant marine tons per inhabitant), and Kenyon (1974), to measure the relative importance of *transit function and urban magnitude* amongst US port cities (number of general cargo tons per inhabitant). It is a close relative of the location quotient that has been used extensively in economic studies of urban activity. We propose applying the relative concentration index to determine the type of relation between port and urban functions. It represents the first time it has been applied using container traffic at a world scale and over a period of time. However, it raises a series of methodological questions: geographical limits of the referential area, thresholds of the resulting values to determine the type of port-city relations.

3.1 The geographical framework

An important question is over which geographic scale should relative concentration measure be applied? Using the global scale would mean that all cities and ports are competing at this level, which is not perfectly true in all cases, even though countries and regions can be seen as competing within "*one (and only one) global market*" (Song 2003). There is a different logic according to urban functions and port functions (Table 1). On one side, in the urban hierarchy, it can be argued that only global cities are competing at a global scale, and secondary cities are only concerned by their regional and national urban system. For cities, therefore, the global scale is relevant only for those which are capable of competing for international finance, major companies' headquarters and tourism more appropriately reflected by air transport flows. On the other hand, for the port hierarchy, even the so-called global ports are in fact competing with their neighbouring competitors within a regional area. Ports compete locally as well as regionally against other ports because they serve the same hinterland inland areas.

The application of the relative concentration index then becomes very complex according to the functions involved. The limits of regional areas are difficult to fix, as the radiance area of cities and ports varies according to their rank and throughout time. For example, some cities may have a stable relative position in their national urban system, but ports are submitted to very unstable levels of throughput, depending on a variety of factors such as the strategies of port authorities and the level of accessibility. In the case of Liverpool, does it compete only with British ports, or within the Atlantic Arc, or the Northern Range? Gothenburg in Sweden is often placed within the Northern Range (Le Havre-Hamburg) although the city is competing with Stockholm on a national scale. Busan is Korea's major port but its role increasingly is to connect main trunk lines between Asia and the other major poles, rivalling Chinese, Taiwanese and Japanese ports (Lee et al. 2005).

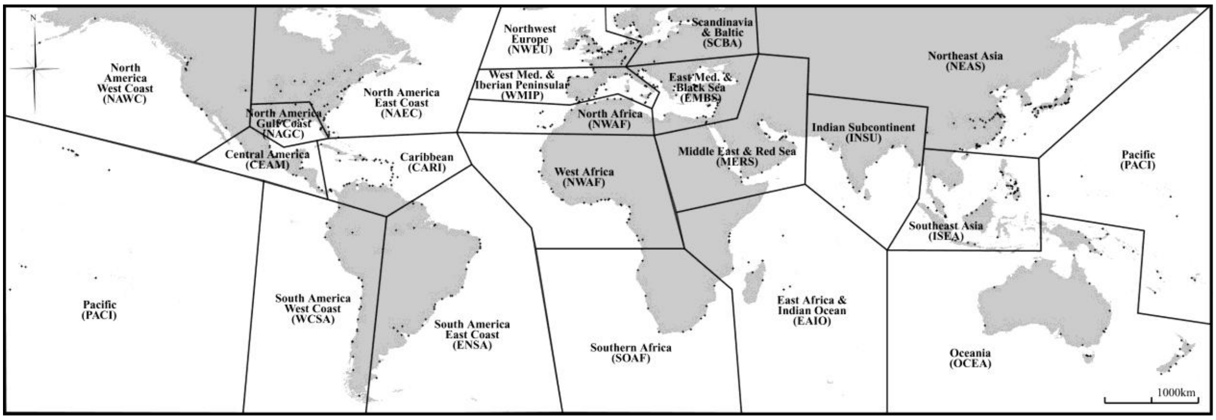
Table 1: Geographical scales for port-city concentration measurement

Scale	Urban concentration		Port concentration	
	Advantage	**Inconvenient**	**Advantage**	**Inconvenient**
Provincial	Immediate rivalry between closely connected cities	May ignore the country capital city; administrative boundaries do not fit with a coherent urban system	No	Small number of ports
National	Covers the territorial planning area	Ignores the close foreign cities	Covers the national maritime and port policy framework	Countries with only one port; countries with several maritime borders
Macro-regional	Includes cross-border competition among cities	Ignores physical disrupts (e.g. sea or mountain); area's limits are subject to multiple criteria	Area of intense competition for gateway and hub functions	Cut from the pendulum services (interregional trade and foreland of global ports)
World	Includes the global city paradigm	Too much hierarchical at the expense of smaller cities	Includes the global regular maritime services	Doesn't fit with port competition reality

Source: own realization

The RCI calculation is based on regional areas defined by *Containerisation International Yearbook* as a 'trading region' where ports and cities compete beyond their national boundaries (Figure 2). As showed in Table 1, this geographical scale is the most convenient when analysing urban and port dynamics simultaneously.

Figure 2: Port regions of the world



Source: own realization based on Containerisation International

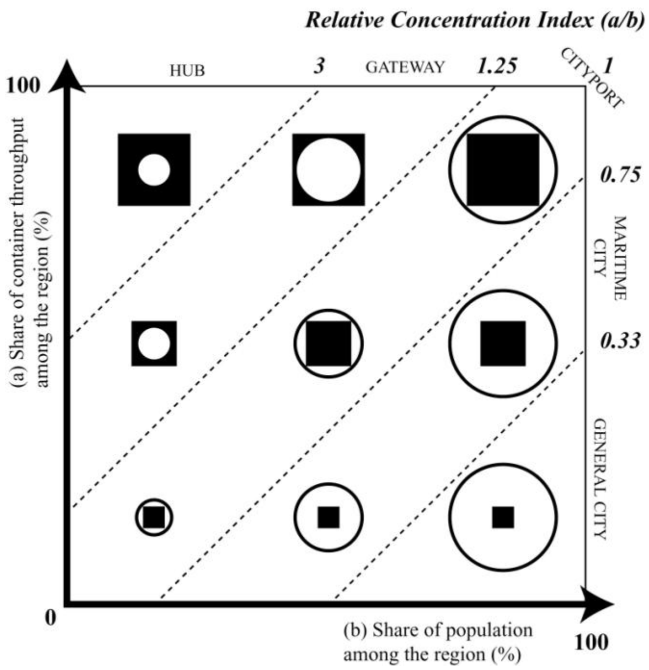
3.2 The functional framework

We propose to illustrate the meaning of the expected results in a systematic way, by relating the index to the matrix of port-city relations described in Figure 1. As the transcription of port-city types into quantitative values is an essential component of the methodology, the definition of the thresholds needs careful attention.

As showed in Figure 3, the necessary limit to help distinguish how different are port cities from each other has to be an arbitrary number for several reasons. First, previous scholars have never specified how many times port and urban functions should be relatively concentrated to establish a realistic typology. Second, several extreme values coming from high port traffic without much urban development (e.g., Gioia Tauro) hamper the application of usual classification methods to determine the thresholds, because RCI values do not follow a normal statistical distribution.

For any scale, any period and any port city, the values of the relative concentration index (RCI) which are close to “1” (between 0.75 and 1.25) express an equilibrium between the port and the city. This means that container traffic and urban population are of equal importance locally compared to the other nodes of the regional area. Thus, the coastal town, the cityport and the port metropolis share the same logic of port-city relationships, though they differ in terms of absolute size. The other thresholds are difficult to fix because other types than the cityport have no universally recognised definition. For example, how can hubs and gateways, general cities and maritime cities be distinguished from the cityport? Basically, any value higher than 1.25 will be interpreted as port specialisation and any value lower than 0.75 will be considered urban magnitude. It is thus proposed to consider that hubs and general cities, situated at both ends of the port-city spectrum, are concentrating respectively more than three times container traffic and population (above 3 and under 0.33). Consequently, gateways and outports are considered of being in the same category (between 1.25 and 2.99), like maritime cities and urban ports (between 0.33 and 0.74). Those types are different in terms of size but not in terms of function. In such respect, the nine types are changed into only five possible categories of port-city relationships.

Figure 3: Methodology of RCI measurement



Source: own realization

Table 2 shows to what extent the application of Figure 3 gives a relatively coherent distribution over time. The cumulated frequency is very close to the theoretical values, on a 20 percent basis for each of the five categories, even though it tends to lean towards urban magnitude. Thus, although the boundaries between the chosen categories may not perfectly satisfy the quantitative transcription of the conceptual framework, they are kept to enable a homogenous and global comparison.

Table 2: Cumulated frequency of RCI values, 1970-2005 (Unit: %)

	1970	1975	1980	1985	1990	1995	2000	2005
0.00 < 0.32	20	19	23	27	25	29	30	31
0.33 < 0.74	38	36	47	43	44	47	50	49
0.75 < 1.24	51	58	59	57	59	63	60	57
1.25 < 2.99	72	75	77	75	75	77	74	74
3.00 <	100	100	100	100	100	100	100	100

Source: own realization

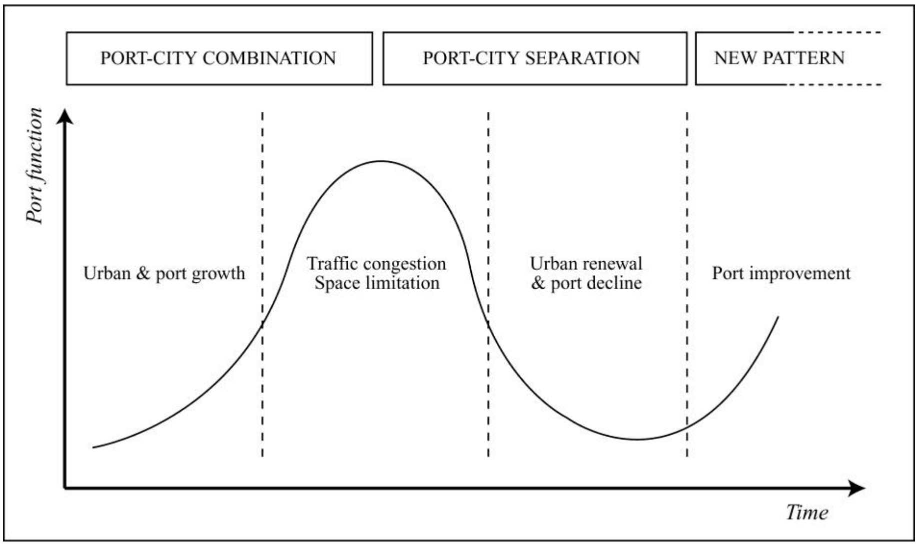
3.3 The temporal framework

On a time basis, RCI will change according to multiple factors such as urban growth and uneven port activity due to port competition (exogenous factors) and strategy (endogenous factor). This is more difficult to interpret as a wide variety of possibilities emerge from the framework. The observation of RCI change can help to address a number of implications, as showed in Figure 4.

Interpreting changes of RCI scores is difficult because it is the result of simultaneous phenomena: urban constraint and spatial growth, port expansion and competition, congestion at the port-city interface, lack of space, logistic costs, uneven industrial growth and location, natural disasters and geopolitical change.

The decrease of RCI can be explained by the reducing importance of port functions for the local economy. In developing countries, urban growth has strongly affected port concentration, while in developed countries, the limited nautical accessibility of inner quays and the lack of space for urban development have forced modern terminals to shift outwards. In both cases, it also means that port activity has become less competitive for several reasons including handling costs and distance to ships and markets. What is more difficult to address is the fact that in advanced economies, some cities have refined and enhanced their port activity beyond the physical handling function to broader services in the tertiary sector. Thus, although port traffics decrease, port functions as a whole are kept through maritime insurance, banking, ship management, chartering and brokering. Moreover, some port cities may develop alternative strategies by supporting their port functions rather than redeveloping them through systematic urban-oriented waterfront schemes (Charlier 1992).

Figure 4: Logics of port-city spatial and functional evolution



Source: adapted from Hoyle (1989) and Murphey (1989).

The increase of RCI values at a final stage may reveal a successful port policy, resulting in the attraction of shipping lines, port operators and freight forwarders for cargo handling and distribution, sometimes beyond the needs of the city itself. The improvement of the efficiency of cargo handling operations and the betterment of the management of flows at the port-city interface could allow in some cases to overcome congestion and restore port dynamics within the port city, creating a new pattern. This can also reflect the absence of strong urban dynamics like in advanced economies, where urban growth is rather slow compared to developing countries. Such argument reinforces the need to compare port cities within homogenous areas instead of at a world scale which would embrace very dissimilar issues.

4. RELATIVE URBAN-PORT CONCENTRATION WITHIN 653 PORT CITIES

4.1 Preliminary outcomes

A total of 653 port cities has been collected from *Containerisation International Yearbook* between 1970 and 2005. Total port container traffic represents 80 (1980), 84 (1985), 94 (1990), 92 (1995), 100 (2000) and 93 (2005) percent of the world total according to Drewry Shipping Consultants (Rodrigue et al. 2006). Coastal urban population represents 76 percent of the world total in 1990 calculated by Noin (1999). The number of port cities varies because new ports emerge and others decline over time (Table 3). Another reason is the unevenness of statistics. At the end, 653 different port cities constitute the database.

In table 2, the correlation between city size and port traffic is increasing until 1990, and declines since then. It is assumed that containerisation has spread among the existing urban hierarchy, according to a hierarchical diffusion process (Saint-Julien 1985). Because of limiting factors such as lack of space for port expansion and rising handling costs, container traffics have developed in non-urban locations for facilitating the concentration of shipping lines, allowing the formation of hub-feeder networks and backed by new port policies throughout the world. Thus, the relationship between urban and port hierarchy is put in question.

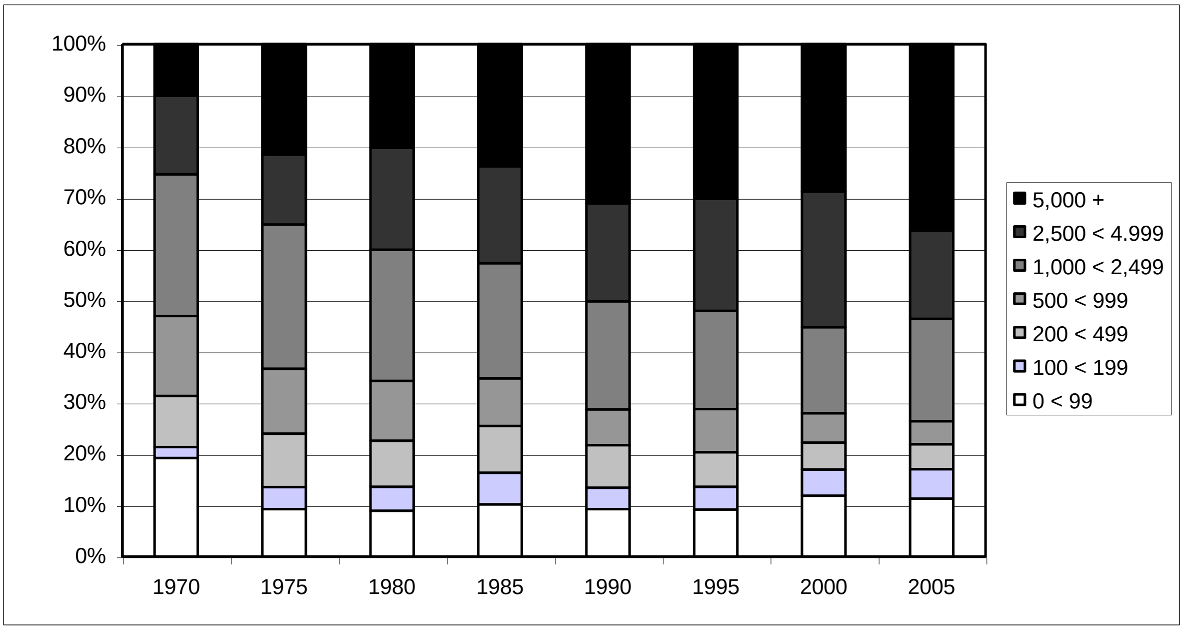
Table 3: Population and container throughput, 1970-2005

	1970	1975	1980	1985	1990	1995	2000	2005
Correlation coefficient	0.126	0.582	0.587	0.592	0.485	0.422	0.405	0.389
Total container throughput (TEUs)	4,393,305	14,676,815	34,985,348	52,475,730	85,632,458	138,700,101	233,466,385	300,514,048
Total urban population (000s inhab.)	127,816	173,046	314,770	362,094	458,427	442,680	640,823	665,180
No of port cities	72	110	256	322	368	403	481	470

Sources: own realization based on Containerisation International, Geopolis, World Gazetteer, Populstat, Citypopulation, port authorities.

The same phenomenon is showed differently in Figure 5, with three major trends. First, the most populated port cities (over 1 million inhabitants) are increasing their dominance among the port system, from 53 percent to 73 percent of total container traffic. Second, intermediate port cities (200,000 to 1 million inhabitants) show a decline from 25 percent to 9 percent and third, the less populated port cities (0 to 199,000 inhabitants) rise from 13 percent (1975) to 17 percent. Due to economies of scale, large port cities may easily keep their eminent and powerful position. On the other hand, the increase of small port cities may reflect new opportunities to raise their economy (De Langen 1998) and new port projects permitted by the 'challenge of peripheral ports' (Hayuth 1981) as a mean to limit port concentration and solve environmental problems in old port cities. Although this shows the importance of global port cities among the world hierarchy, some ports operated within vast urban areas were in fact forced to shift their main activity towards suburban areas, like in the case of New York (Rodrigue 2003). The limitations of this analysis in inferring individual trends shall be overcome by looking at the evolution of RCIs.

Figure 5: Evolution of world container throughput by city size, 1970-2005 (Unit: %)



Sources: own realization based on Containerisation International, Geopolis, World Gazetteer, Populstat, Citypopulation, port authorities.

4.2 General trends of RCI evolution

Based on Figure 3, the total number of port cities is redistributed among the five different port-city types. It appears that for every type of port city, the share of port cities remaining in the same category is higher than the share of port cities shifting to different categories (Table 4). On an average basis, general cities and hubs are the most stable, what confirms their situation at the extremities of the port-city spectrum. As stated by the aforementioned models of port-city evolution, the general city is an ultimate stage when port functions are not likely to increase (Murphey 1989). The hub symbolises the inadequacy of modern logistics and urban development (Stern & Hayuth 1984; Fujita & Mori 1996). This broad figure is very important to address the general mechanisms of port-city evolution.

Table 4: Port-city evolution, 1970-2005 (Unit: % change by type of port city)

From	To	1970-1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	Average
MARITIME CITY	HUB	0.0	0.0	1.6	1.9	0.0	0.0	0.0	0.5
HUB	GENERAL CITY	0.0	0.0	1.9	0.0	1.1	2.2	0.0	0.7
GENERAL CITY	HUB	0.0	0.0	1.8	0.0	0.0	1.7	2.1	0.8
HUB	CITYPORT	5.0	0.0	0.0	1.2	2.2	1.1	0.0	1.4
HUB	MARITIME CITY	0.0	4.2	1.9	3.6	1.1	0.0	0.8	1.6
GENERAL CITY	GATEWAY	0.0	9.5	1.8	1.3	1.1	0.0	0.7	2.0
GATEWAY	GENERAL CITY	7.1	0.0	4.0	1.8	1.5	0.0	1.3	2.3
GENERAL CITY	CITYPORT	0.0	0.0	8.8	5.0	3.2	0.9	0.0	2.6
CITYPORT	GENERAL CITY	0.0	0.0	5.7	5.8	3.7	5.0	0.0	2.9
CITYPORT	HUB	0.0	4.5	2.9	0.0	1.9	11.7	2.0	3.3
GATEWAY	MARITIME CITY	14.3	0.0	2.0	9.1	6.2	3.2	6.7	5.9
MARITIME CITY	GATEWAY	7.7	15.8	6.6	5.8	4.3	8.3	5.3	7.7
HUB	GATEWAY	30.0	4.2	9.3	14.5	10.9	7.7	4.1	11.5
GENERAL CITY	MARITIME CITY	7.1	28.6	14.0	12.5	11.8	13.7	9.6	13.9
GATEWAY	CITYPORT	28.6	26.1	8.0	16.4	20.0	12.9	4.0	16.6
MARITIME CITY	CITYPORT	23.1	26.3	23.0	19.2	14.5	12.5	7.4	18.0
MARITIME CITY	GENERAL CITY	15.4	10.5	23.0	23.1	23.2	19.4	21.3	19.4
GATEWAY	HUB	7.1	34.8	34.0	16.4	12.3	22.6	16.0	20.5
CITYPORT	GATEWAY	40.0	27.3	20.0	21.2	9.3	20.0	16.0	22.0
CITYPORT	MARITIME CITY	20.0	45.5	11.4	28.8	18.5	21.7	18.0	23.4
CITYPORT	CITYPORT	40.0	18.2	48.6	36.5	50.0	33.3	36.0	37.5
GATEWAY	GATEWAY	35.7	30.4	42.0	47.3	44.6	53.2	54.7	44.0
MARITIME CITY	MARITIME CITY	46.2	47.4	36.1	40.4	46.4	50.0	43.6	44.3
GENERAL CITY	GENERAL CITY	71.4	47.6	57.9	58.8	55.9	56.4	57.5	57.9
HUB	HUB	60.0	75.0	79.6	68.7	71.7	78.0	76.9	72.8

Source: own realization

Another important aspect is that the most important changes happen between close types of port cities (e.g., cityport to gateway or gateway to hub). It means that port-city evolution is a gradual phenomenon rather than a sudden disrupt. This is confirmed by the lowest values attributed to changes occurring between very dissimilar types (e.g., hub to general city and general city to hub). Although transport players, like shipping lines, have a growing influence on port activity and, in turn, can indirectly modify the spatial pattern of port networks, they are still dependent on the regional structure of spatial systems. Also, the effects of technological change (e.g., growing size of container ships) are gradually affecting ports and cases of disrupt evolution are a very minority among port-city trajectories. Such trends are confirmed by Lemarchand (2005) in his comparison of the size and growth rates of port throughputs. He concludes that although recently created container ports generate massive cargo volumes, they also have unstable and important growth variations due to the absence of a sufficient economic base and local community that would stabilize their traffics. Inversely, large ports in developed countries have lower but more stable growth rates because of a higher maturity in local governance which help them depending less on their intermediacy.

Finally, cityports are the most likely to see their profile modified because their equilibrium is a very unstable state. Among port-city types, cityports have the lowest share of stability on an average basis (37.5 percent), while they have the highest percentage of change to another profile (23.4 percent become maritime cities and 22.0 percent become gateways). Moreover, cityports are among the lowest shares of transformation into hub ports and general cities. Once one function has become dominant, the port city is not likely to go back to a symbiotic state, but follows a trajectory of either urban diversification or port specialisation. Oppositely, the transformation of the cityport goes through successive stages rather than through sudden disrupt. The total share of port cities reaching the category of cityports has been one of the largest until 1995, and then became the lowest, illustrating the changes in global transportation, with ports and shipping lines seeking efficient logistics rather than depending on local economies.

4.3 Individual trajectories

As it is beyond the scope of this paper to analyse in detail every single trajectory, Table 5 focuses on the most populated places. The evolution of individual RCIs is a good indicator of how some port cities match general trends and, notably, how they contradict or not existing models of port-city evolution.

Table 5: RCI evolution at the world's most populated port cities

AREA	PORT CITY	1970	1975	1980	1985	1990	1995	2000	2005	AREA	PORT CITY	1970	1975	1980	1985	1990	1995	2000	2005
NEAS	Tokyo-Yokohama	0.41	0.43	0.59	0.81	0.61	0.48	0.40	0.28	CARI	Havana								0.19
NAEC	New York-New Jersey		1.42	1.01	0.99	0.59	0.46	0.63	0.75	EMBS	Izmir					0.29	0.76	0.49	0.81
NEAS	Incheon-Seoul				0.11	0.04		0.07	0.07	NEAS	Ishikariwan Shinko								0.02
INSU	Mumbai (Bombay)				1.03		0.72	0.31	0.10	NEAS	Qingdao				0.18	0.36	0.83	1.94	3.08
SEAS	Tanjung Priok-Jakarta		0.07	0.17	0.23	0.25	0.25	0.30	0.28	NEAS	Nanjing					0.09	0.17		
NEAS	Osaka-Kobe	1.52	1.10	0.77	1.21	1.13	0.49	0.49	0.37	NAWC	Portland OR		0.60	0.58	0.47	0.44	0.77	0.26	0.26
SEAS	Manila		0.87	0.51	0.56	0.42	0.33	0.45	0.27	WEAF	Dakar					0.85		1.11	
NAWC	Los Angeles-Long Beach	0.39	0.41	0.73	0.91	1.00	1.02	1.14	1.38	SCBA	Copenhagen-Malmo	0.24	0.29	0.50	0.26	0.83	0.74	0.33	0.22
NEAS	Shanghai				0.20	0.24	0.42	1.08	1.36	SAEC	Belem					0.42	0.47	0.33	0.20
INSU	Kolkata (Calcutta)			0.11	0.21	0.27	0.16	0.12	0.15	NAWC	Vancouver BC		0.72	0.73	0.68	0.75	0.99	1.29	1.40
SAEC	Buenos Aires			0.89		0.65	0.37	1.12	0.43	CARI	Maracaibo				0.05			0.02	0.04
SAEC	Rio de Janeiro			0.18	0.23	0.15	0.24	0.25	0.26	SEAS	Belawan-Medan				0.11	0.23	0.28	0.29	
INSU	Karachi				1.48	0.99	0.97	0.70	0.58	CARI	Barranquilla					0.02		0.07	0.08
EMBS	Haydarpasa-Istanbul				0.05	0.10	0.16	0.07	0.06	CARI	San Juan		1.93	1.59	2.33	2.75	1.73	1.62	1.86
SEAS	Bangkok			0.56	0.66	0.65	0.45	0.26	0.22	NEAS	Zhongshan							0.61	0.66
WEAF	Lagos-Apapa			0.78	0.99	1.11	0.74	0.37		EMBS	Beirut			0.38	0.15		0.52	0.38	0.46
NAEC	Chicago	0.05	0.01		0.00					MERS	Dubai			0.47	1.92	2.95	3.24	2.89	2.18
NEAS	Nagoya	1.36	0.24	0.37	0.61	0.74	0.62	0.52	0.42	NEAS	Hiroshima							0.15	0.15
NAEC	Milwaukee	0.02	0.01	0.01	0.00					SEAS	Haiphong						0.20	0.26	0.36
NEAS	Hong Kong	1.50	2.82	3.36	4.17	4.97	6.27	5.13	5.35	OCEA	Brisbane				0.58	0.68	0.68	0.75	0.78
NEAS	Keelung-Taipei		3.08	1.49	2.07	1.64	1.00	0.57	0.43	MERS	Shuwaikh (Kuwait City)			0.44	0.22	0.08	0.12	0.13	
SAWC	Callao-Lima				0.31	0.22		0.30	0.46	SOAF	Maputo			0.04	0.06		0.24	0.08	0.10
NAEC	Baltimore		0.43	1.73	1.49	0.67	0.48	0.29	0.37	WEAF	Conakry				0.29		0.56	0.41	
NAWC	Oakland-San Francisco	1.41	1.32	1.23	0.92	0.77	0.83	0.51	0.51	CARI	Port-au-Prince			0.12	0.11	0.12	0.09	0.08	
NEAS	Guangzhou (Canton)					0.12		0.47	0.86	SAEC	Montevideo			0.46	0.23	1.46	1.92	2.14	1.82
NAEC	Boston	0.41		0.38	0.37	0.21	0.15	0.09	0.10	WEAF	Douala			0.68	2.51	1.55	1.77	1.38	0.69
INSU	Chennai (Madras)				0.67	0.41	0.56	0.58	0.56	NEAS	Sendai						0.00	0.19	0.12
NEAS	Tianjin			0.03	0.26	0.30	0.34	0.58	0.84	SCBA	Stockholm		0.29	0.37	0.09	0.22	0.13	0.09	0.08
NAEC	Philadelphia	2.26	0.61	0.91	1.01	0.38	0.32	0.14	0.10	WMIP	Leixoes-Porto	0.45	0.38	0.55	0.47	0.54	0.45	0.35	0.34
SEAS	Port Klang-Kuala Lumpur			1.99	2.13	1.37	1.54	1.55	1.42	SAEC	Santos		1.00	8.99	12.72	13.24	11.66	6.52	8.91
NAEC	Toronto	0.14	0.13	0.02		0.00			0.03	NOAF	Tunis				0.25			0.03	
SEAS	Ho Chi Minh City (Saigon)							0.27	0.52	SEAS	Makassar						0.23	0.27	0.25
NOAF	Algiers					0.18		0.06	0.23	NAEC	Virginia	11.58	4.97	3.83	3.51	4.50	3.91	3.67	4.13
NEAS	Ningbo						0.39	0.39	0.90	MERS	Dammam			2.47	1.65	1.29	0.75	0.41	0.32
NAGC	Houston		0.87	0.70	0.82	1.03	1.16	1.27	1.21	SAEC	Manaus				1.36			0.71	0.65
SEAS	Singapore	1.00	3.18	5.93	5.59	7.30	8.13	7.99	6.29	WMIP	Marseilles			1.90	1.80	0.61	1.09	0.71	0.74
NAEC	Miami-Port Everglades	1.71	0.31	0.50	0.72	1.09	1.56	1.39	1.47	SEAS	Penang		0.82	1.79	2.33	1.63	1.43	1.32	0.80
WMIP	Barcelona		0.90	0.38	0.41	0.49	0.48	0.53	0.47	NEAS	Fuzhou						0.44	0.60	0.68
SCBA	St Petersburg			0.19		0.13	0.10	0.30	0.51	WMIP	Valencia			0.74	1.10	1.24	1.36	1.39	1.83
WEAF	Abidjan			1.12	1.84	1.41	2.02	1.91	0.95	SAEC	Vitoria							0.82	0.90
NAWC	San Diego			0.01	0.01	0.01	0.01		0.04	NWEU	Clydeport	0.15	0.20	0.16		0.07	0.02		
NWEU	Liverpool	0.77	0.39	0.22	0.19	0.28	0.34	0.21	0.08	WEAF	Port Harcourt			4.96	0.27	0.24	0.10	0.16	
NEAS	Busan			2.17	3.13	3.21	3.16	4.07	4.01	NWEU	Amsterdam	0.17	0.09	0.11	0.11	0.07	0.07	0.02	0.02
OCEA	Sydney-Port Botany	0.60	0.88	0.86	0.89	0.43	0.85	1.22	0.67	OCEA	Fremantle-Perth	1.04	0.93	0.50	0.70	0.83	0.76	0.56	0.76
EMBS	Alexandria			0.28	0.47	0.36	0.39	0.48	0.34	INSU	Cochin			3.80	2.31	1.00	1.15	1.13	1.04
INSU	Yangon				0.02	0.03	0.34	0.14		NWEU	Tyne			0.02	0.01	0.01	0.01	0.02	0.02
SOAF	Cape Town			0.82	0.74	0.53	0.70	0.59	0.57	INSU	Visakhapatnam				0.02		0.29	0.18	0.14
NEAS	Kitakyushu			0.69	0.91	0.90	0.81	0.23	0.18	WEAF	Tema			0.08	0.31	0.78	1.23	10.43	
NEAS	Hakata-Fukuoka				0.50	0.44	0.44	0.28	0.23	NWEU	Rotterdam-Europoort	1.21	2.90	3.16	3.10	3.02	2.86	2.85	4.07
SEAS	Tanjung Perak-Surabaya					0.38	0.42	0.54	0.73	NEAS	Masan-Changwon								0.06
WMIP	Naples		0.21	0.36		0.20	0.21	0.16	0.16	SAEC	Rosario								0.06
NAWC	Seattle-Tacoma	2.44	3.01	3.17	3.26	3.00	3.15	1.60	1.67	SEAS	Davao				0.79	0.39		0.26	0.27
SAEC	Porto Alegre							0.01	0.08	NAGC	New Orleans	1.00	1.16	1.57	2.07	2.16	1.55	1.13	1.19
EMBS	Piraeus-Athens	0.59	0.39	0.61	0.64	0.86	0.86	1.46	1.27	NEAS	Shenzhen						1.06	8.51	14.12
NOAF	Casablanca			0.41	0.42	0.59	0.34	0.65		WMIP	Seville					0.13	0.13	0.10	0.11
OCEA	Melbourne	1.31	1.39	1.24	1.21	1.45	1.23	0.91	1.11	NEAS	Ulsan							0.48	0.43
INSU	Chittagong					2.03		1.50	1.54	MERS	Mina Zayed			0.16	0.22	0.30	0.79	0.39	
NAEC	Montreal	2.03	1.06	1.34	1.74	1.49	1.22	1.40	1.27	NWEU	Bremen-Bremerhaven	1.39	1.57	1.67	1.64	1.49	1.37	1.51	1.73
SAEC	Recife			0.05	0.14	0.15		0.10	0.25	SOAF	Port Elizabeth		1.05	1.23	0.80	0.89	1.10	1.22	1.01
NEAS	Wuhan						0.03			SEAS	Cebu			0.78	1.12	0.75	0.41	0.71	
INSU	Colombo			2.92	3.42	3.81	4.38	8.51	7.11	SCBA	Helsinki	0.41	0.54	1.30	1.05	2.10	2.11	1.55	1.49
SAEC	Salvador			0.17	0.37	0.32	0.33	0.37	0.47	NAEC	Jacksonville		10.64		1.78	1.58	5.92	2.83	2.36
SAWC	Guayaquil			0.32	1.61	2.01		0.95	0.92	EMBS	Odessa					0.19	0.34		0.41
NWEU	Hamburg	0.22	0.50	0.82	0.85	1.06	1.13	0.83	1.27	SAEC	Natal							0.06	
NEAS	Dalian			0.01		0.29	0.42	0.73	1.10	WMIP	Bilbao		3.29	0.66	0.60	0.86	0.85	0.69	0.57
SAEC	Fortaleza					0.29	0.21	0.30	0.22	NWEU	Antwerp	1.29	1.15	1.48	1.93	1.64	1.79	2.72	3.30
SOAF	Durban		0.97	1.63	1.88	1.68	1.79	2.43	2.23	OCEA	Auckland	0.79	0.50	0.71	1.18	1.59	1.63	1.23	3.95
CARI	Santo Domingo							0.01	0.02	OCEA	Adelaide	0.50	0.87		0.15	0.23	0.25	0.30	0.28
NEAS	Taichung			0.03	0.06	0.24	0.42	1.23	1.02	EMBS	Haifa	3.61	3.20	4.70	4.23	15.65	5.86	3.56	2.93
MERS	Jeddah			2.07	1.65	0.93	0.65	0.53	0.51	NAEC	Richmond VA					0.37	0.28	0.19	0.17
NAEC	Cleveland OH			0.01						NWEU	Dublin			0.33	0.23	0.26	0.26	0.28	0.33
EAIO	Dar-es-Salaam			0.22	0.39	0.41	0.31	0.26	0.26	NEAS	Shantou							0.06	
WMIP	Lisbon		0.59	0.37	0.32	0.50	0.29	0.23	0.30	CARI	Cartagena			0.07	0.15	0.20	0.38	0.82	1.26
NEAS	Kaohsiung		3.38	5.21		7.59	5.82	6.75	5.99	SAEC	Maceio							0.04	
NAGC	Tampa				0.03	0.02	0.02	0.02	0.01										

Source: own realization

A first group of cities matches previous models as they show a continued loss of RCI along the period. Thus, those large cities gradually develop urban functions to the expense of port functions. Mumbai, Manila, Karachi, Port Klang-Kuala Lumpur, Chittagong, Davao, Osaka-Kobe, Kitakyushu, Hakata-Fukuoka, Jeddah, Dammam, Chicago, Milwaukee, Baltimore, Oakland-San Francisco, Boston, Philadelphia, Toronto, Tampa, Richmond VA, Belem, Manaus and Port Harcourt are in this category. Among them, port competitiveness has faced the lack of space and accessibility for further port growth, resulting in the precedence taken by urban strategies over port activities, as seen in several US port cities (e.g., Boston's Charlestown Navy Yard redevelopment). Another group of cities show a similar trend, although less regular: Seattle-Tacoma, Portland OR, Buenos Aires, Port-au-Prince, Melbourne, Adelaide, Fremantle-Perth, Cochin, Barcelona, Bilbao, Marseilles, Lisbon, Amsterdam, Copenhagen-Malmö and Stockholm. This sub-category is seeking to maintain port functions although they have become less important for the local economy, but cannot avoid the declining trend. For example, 'Port Vell' in Barcelona and 'Euroméditerranée' in Marseilles are urban-oriented redevelopment projects resulting from a negotiation with port authorities to sustain cargo handling close to urban areas. Another similar trend is a successive growth and decline of RCI scores, showing cities for which port-urban combination has reached a limit and port activity is likely to decline continuously: New Orleans, Tokyo-Yokohama, Nagoya, Keelung-Taipei, Tanjung Priok-Jakarta, Penang, Yangon, Calcutta, Bangkok, Visakhapatnam, Sydney, Haydarpasa-Istanbul, Haifa, Mina Zayed, Naples, Liverpool, Clydeport, Lagos-Apapa, Abidjan, Dar-es-Salaam and Guayaquil. A possible explanation is that those cities have been the inevitably dominant nodes of ports and urban systems until the dimension of their urban area has become a constraint for port concentration, reflected in the Japan case by the increase of cargo handling charges. For Liverpool, 'this was due to the loss of its function of being the primary port for the UK's exports as the majority of goods switched to being directed to the continental Europe' (Cheshire & Hay 1989). A few other cities show a growth and decline in a more complex way: Montreal, Jacksonville, Virginia, San Juan, Dubai, Alexandria, Kaohsiung, Cebu, Douala, Port Elizabeth, Santos and Leixoes-Porto. Although their RCI score returned to its original value after a period of growth, their concentration of container traffic has not declined dramatically.

A second group of port cities is marked at the contrary by a continuous increase of RCI scores. The most regular evolutions are those of Los Angeles-Long Beach, Shanghai, Shenzhen, Canton, Tianjin, Ningbo, Dalian, Qingdao, Fuzhou, Zhongshan, Taichung, Tanjung Perak-Surabaya, Haiphong, Ho Chi Minh City, Belawan-Medan, Colombo, Brisbane, Valencia, Hamburg, Odessa, Cartagena, Barranquilla, Vitoria and Tema. The majority of Chinese cities is revelatory of their recent role for container trade, with the end of Hong Kong, Busan and Kaohsiung's monopoly in this sector and the considerable economic growth stemming from the Open Door Policy. Others could have profited from new opportunities like the European enlargement for Hamburg's hinterland, and the proximity of a major sea corridor like Gibraltar, Panama and Malacca. Another category shows a similar but more uneven trend: Hong Kong, Singapore, Busan, Houston, Miami-Port Everglades, Vancouver BC, Helsinki, Antwerp, Auckland, Durban, Salvador and Montevideo. Most of them have a very peculiar situation favouring intermediacy, but the lack of space is altering their trajectory as hub or hinterland ports. In addition to those cases, a last possibility as showed in Figure 4 is the growth of RCI after a period of decline: New York-New Jersey, Incheon-Seoul, Callao-Lima, Algiers, Casablanca, Rotterdam, Bremen-Bremerhaven, St Petersburg, Piraeus-Athens, Dublin and Shuwaikh. Those port cities have implemented a number of measures in order to avoid losing their port competitiveness, such as the attraction of hub functions in Piraeus, the extension of hinterland connections, developing strategy and institutional change in New York's port authority, the Europoort project in Rotterdam, the 'Pentaport' project in Incheon combining free-trade zones, new towns, new airport and container port facilities.

5. CONCLUSION

This paper has applied the relative concentration index to a sample of 653 port cities for the period covering the emergence, spread and growth of containerisation (1970-2005). It has proposed to calculate RCI from the population of cities and the container throughput of ports, at the scale of trade regions. One advantage of the method is the trans-scalar dimension of the results, which give evidence about simultaneous phenomena on a local, regional and global scales. In this respect, it allows international comparison from identical concepts and overcomes the usual difficulty to interpret simultaneously the global and local forces of contemporary trends. Using the Relative Concentration Index is one possible and fruitful way to overcome the separate study of port and urban dynamics through international comparison. Based on such methodology, the database allows a verification of previous models of port-city evolution.

First of all, there is no universal evolution of port-city relationships. The trends of port-city separation described by Murphey (1989) based on colonial Asian cities and the model of Hoyle (1989) based on European port cities are confirmed on a world scale, but several cases do not match. Highly urbanised port cities may have seen their port function decline over time, but many of them have managed to overcome the difficulties of port competition and urban growth, thanks to efficient planning policies and exceptional locational advantages, as seen in the Asian consolidation model of Lee (2005) based on Hong Kong and Singapore. However, although there is a common achievement in avoiding port decline, addressing a new model of port-city relationships is difficult, because there is a subtle combination of local and regional factors during the adaptation to globalisation.

Second, port-city evolution appears to be gradual, and there are only few examples of sudden change like from general city to hub port and vice-versa. In terms of policy implications, this evidence argues in favour of long-term urban and port strategies. This also has an academic implication, referring to the works of Rodrigue et al. (1997) on transportation and spatial cycles applied to maritime systems. The redistribution of flows between different types of port cities over time indicates important regional shifts within the world system but, also, shows the ability of local players in inserting efficiently their place in evermore complex trading and logistic networks. Although containerisation has spread globally, the continuous growth of world trade and maritime traffics shall not blur the very uneven adaptation of local and regional structures to the global pattern. Thus, this study could have highlighted different stages of port-city evolution based on the somewhat contradictory intervening of three temporalities: the long term of cities, the short term of maritime networks and the middle term of ports. 'Successful' port cities are not necessarily those who increase their traffics in absolute numbers or create an attractive waterfront, but those who manage to sustain an equilibrium between different temporalities, different functions and different scales. In this respect, further research on port cities shall focus on the broader issue of the resilience of spatial systems in globalisation processes.

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