TRANSPORTATION AND SPATIAL CYCLES: EVIDENCE FROM MARITIME SYSTEMS

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Abstract. The paper brings forward the concept of change and its impact on the geography of maritime transportation. Maritime systems are investigated from perspectives of constant contradiction between transport supply and demand, containerization and its spatial diffusion, and the adaptation capacity of transport networks in regards of changes. Central to these perspectives are cycles which provide a conceptual background for the analysis of the world economy and of the role of transportation.
Key words: Post-fordism, Maritime Transportation, Cycles, World Economy.

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INTRODUCTION: ECONOMIC CHANGES AND TRANSPORT GEOGRAPHY

Spatial structures are changing in ways that are diversified and heterogeneous. The global economy and international trade are characterized by transformations and mutations that arise on evolving economic, spatial and political systems. The states and structures of such systems are at the heart of a great deal of contemporary research in economic geography. But how much do the states and structures of systems reveal about the systems themselves? We argue that change itself has to be considered as a fundamental part of transport systems.

The idea of change is not as straightforward as one would to think. A mutation is not only a process leading from a state to another, but an inherent attribute at the root of the nature of systems. All systems carry with them the seeds of their own end. For instance, the international economy that prevailed until the late 60s was characterized by features such as the immobility of production factors, inter-industrial linkages, absolute advantages and the limited importance of transportation (at least in theories of international trade). Such an organizational structure fitted well within a fordist division of production and labour for mass production and consumption (Jessop, 1992). It was clear at the beginning of the 70s that fordism has reached its structural limits and was challenged as a model of industrial development and spatial accumulation. Of major factors behind changes of that period we may pinpoint decreasing productivity gains, globalization of the economy, growing social expenditures and new consumption patterns (Boyer and Durand, 1993). Fordism was replaced by an economic system based on mobile production factors, intra-industrial linkages (through multinationals), comparative advantages and multimodal transportation chains, where transportation logistics are of prime importance. Attributes behind the emergence of the global economy are thus preparing the emergence of “something else” that has still to be defined, although many refer to it as post-fordism.

The aim of this paper is to contribute to an understanding of contemporary territorial transformations of the global economy. Since maritime transportation is a major factor in the growing transfers of freight, its cycles might provide an indication of global changes in a broader economic environment. Following a post-fordist paradigm, we wish to contribute to an explanation of mutations in maritime transshipment points and ocean shipping. New routes, strategic alliances with other maritime and land transport companies, competitive tariffs and efficient logistics in view of a constant contradiction/fluctuation between services offered and demand are now common elements within the maritime system. Had maritime transportation followed the logic of economies of scale (mega-ships) and economies of agglomeration (mega-ports), the current maritime system would not have emerged. Technological changes, such as the adoption of containers and the specialization of maritime shipping, have induced new opportunities for maritime transportation and a re-organization of the maritime system. Smaller ports persit in the maritime system, by offering specific services and filling a niche in regional markets It is our intention to provide a conceptual background to the study of these economic changes and their implications for the geography of transportation.

CYCLES, SPACE AND TRANSPORTATION

The current post-fordist debate leans upon the identification, definition and quantification of emerging structures of the global economy, particularly industrial production (Elam, 1990). Three major theoretical backgrounds have emerged from this reconsideration of the principles of the economic globalization (Amin, 1994). First, the regulation approach, which aims to explain the paradox of the inherent tendency of capitalism towards change - with periods of crisis and instability - and towards stability - through a set of established rules, norms and institutions (Aglietta, 1979; Dunford, 1990). Continuous substitutions in periods of growth and recession having effects on regimes of accumulation[1] and modes of regulation[2] corroborate this approach. Second, the neo-Schumpeterian approach shares several similarities with the first with regards to regimes of accumulation and modes of regulation. However, more emphasis is placed upon the role of technology for initiating changes in the economy and separating different periods, like fordism and post-fordism (Dosi *et al.*, 1988). The transition from a period to another is dependent on technological innovation and its adoption through the production system and its institutions (Freeman and Perez, 1988). Third, the flexible specialization approach is a renewal of craft production, where a variety of customized goods are produced as opposed to mass production, which produces standardized goods (Piore and Sabel, 1984). This approach redefines economies of scale in view of the diversification of the economy, where mass production is not suitable in several cases. Central to these three approaches is the notion of change. We suggest that interpretation of the cycles of change provide a conceptual framework for analyzing systemic restructuration in the economy.

How can the idea of change in space, and particularly in the transport dimension of space be represented? Geographers often analyze the evolution of spatial systems vertically through what

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[1] The regime of accumulation refers to how capital is accumulated at the macroeconomic level. "It includes norms pertaining to the organization of production and work (the labour process), relationships and forms of exchange between branches of the economy, common rules of industrial and commercial management, principle of income sharing between wages, profits and taxes, norms of consumption and patterns of demand in the marketplace, and other aspects of the macroeconomy." (Amin, 1994, p.8).

[2] The mode of regulations refers to the set of institutions and the general context of capital reproduction. "It therefore refers to institutions and conventions which 'regulate' and reproduce a given accumulation regime through application across a wide range of areas, including the law, state policy, political practices, industrial codes, governance philosophies, rules of negotiation and bargaining, cultures of consumption and social expectations." (Amin, 1994, p. 8).

may be called time states by constructing geographical information matrices (see Figure 1). This is notably the result of a bias imposed by the temporal and spatial availability of geographical information and the way it is collected. But it ignores the continuum in which systems are evolving. We assume that all events are occurring over a continuum representing the outcomes as they unfold. Figure 1 illustrates that although time states (S_{t1}, S_{t2}, S_{t3}, and S_{t4}) may correctly present the situation at their given point in time, they are not necessarily - even not at all - depicting the time continuum involved. How do we arrive from S_{t1} to S_{t4}? Knowing S_{t1} may reveal limited information about S_{t4}, and even less about the process involved, that is how it passes through S_{t2} and S_{t3}. A static representation with a set of attributes (*at1*, *bt1*, ... *nt1*) cannot be used to model a dynamic system, notably if we are analyzing space and the role of transportation.

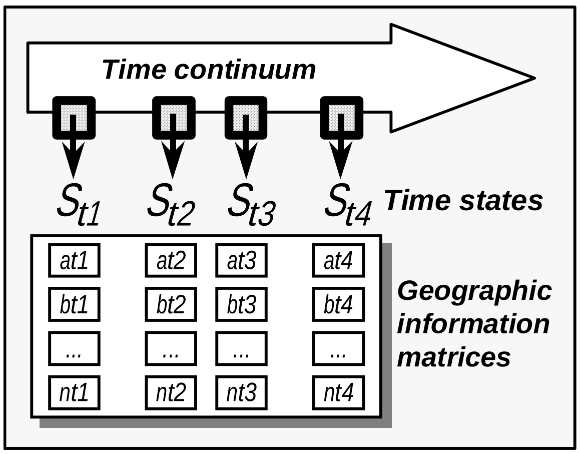

Figure 1: Time-States and the Time-Continuum

If the previous discussion is extended to graph theory - a basic abstraction of the territorial structure of transportation - its capacity to represent transportation networks at given points in time is acknowledged. But, the abstraction of its geographical attributes (nodes, links, traffic, etc.) is not an indication of the dynamics of the transport system, although, we suppose the existence of some relationships between the structure of a transportation network and its evolution. Several transportation development strategies have learned at their expense that an infrastructure does not necessarily guarantee traffic. This is even more true with maritime transportation that has a very flexible network structure, *including* the nodes (ports). As pointed out by Slack (1994a), ports are not the fixed and obligatory points of transshipment one would like to think, particularly when they are in competition with other ports at regional and global levels. Consequently, maritime companies have the choice of using several different infrastructures in a cost-effective way and according to their own strategies. This results in the tendency to frequently change the structure of the network and its services. The structure of maritime transportation thus has a limited capacity to explain changes, yet most the research has focused on this dimension.

Cycles

A cycle defines the period of the space/time continuum during which a system emerges and declines, while a transition is the period between two cycles. During a cycle, a set of relatively stable and predictable conditions are in operation, while during a transition, the parameters of the cycle in decline are still effective and those of the cycle in emergence are not yet fully in place. In such a period, the linkages between the parameters, and even the parameters themselves, are changing. It is a period of crisis, instability, and unpredictability of outcomes. A cycle is based upon the fact that a system, once in place, works according to a relative stability of its parameters and their dynamics in time and space. It is maintained as long as the contradictions between the parameters that have permitted its emergence and forces of change are not too acute and divergent. Cycles can be applied to a number of systems, but the following focus upon their implication for space and transportation.

Economic cycles, notably business cycles, have for long captured the attention of economists. Kondratiev was one of the first to suggest a cyclical behaviour of economic systems through his concept of long waves (Mager, 1986; Kondratiev, 1984), opening the door to several economic development and transition models (Goglio, 1991; Gibson and Horvath, 1983; Maddison, 1982; Vernon, 1966; Rostow, 1963; Burns and Mitchell, 1946; Schumpeter, 1939, to name a few). A popular author (Toffler, 1980) even advocated that cycles are the fundamental structure for changes in the society and the transformation of the economy. It is thus not surprizing to notice that cycles are central in explaining post-fordism. The emergence of the "fifth Kondratiev"[3] wave based on information technology, emphasises the economic impulses provided by new goods, new methods of production and transportation, new markets and new organizational structures (Schumpeter, 1979). Contemporary economic systems are in constant transition with the addition and removal (through obsolescence) of technologies, products, competitors and markets. This has the tendency to shorten the frequency of cycles and superpose periods of instability.

The business cycle can be considered within four stages (see Figure 2):

(1) *Introduction*. During this stage a new product is introduced, usually in a developed market. It is produced at a limited number of facilities having skilled labour in a near-monopoly position. This often implies short production runs with limited capital input.

(2) *Growth*. As a successful product gains acceptance over a wider market, several competitors jump in. The production becomes standardized, permitting economies of scale and high capital input production chains.

(3) *Maturity*. Cost cutting provides a major competitive edge when multiple competitors position themselves in a global market with a stabilized demand. Several stages of the production are implemented in places providing minimum costs on long production runs. For labour intensive stages, less developed countries are an attractive locational choice. These stages are well explained by theories of the international division of labour (e.g. Frobel *et al*, 1980).

(4) *Decline*. The product loses market share, notably in developed countries, while the price is the main comparative advantage. Production is therefore mostly focused in less developed countries with unskilled labour on long mechanized production runs.

[3] First Kondratiev wave: cotton and pig iron (industrial revolution, circa 1760-1800). Second Kondratiev wave: coal and steam-powered transportation (circa 1800-1880). Third Kondratiev wave: steel (circa 1880-1930). Fourth Kondratiev wave: petroleum and chemicals (circa 1930-1980).

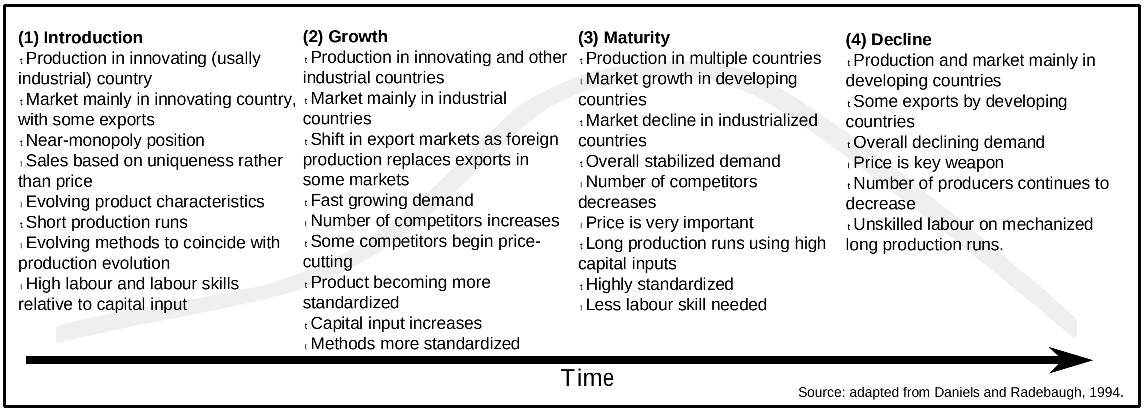

Figure 2: The Product Life Cycle

Economic systems are the expression of a transactional network where they provide, accumulate and distribute resources. Obviously, resources are not uniformly distributed in space, nor stable in their permanence in time. So, eventually an economic system will go through a cycle as the conditions within its organizations, institutions, technologies and territories are changing. “Creative destruction” underline a complex process where a system is replaced by another with new “techno-economic” paradigms; new organizational structures, new locational patterns, new growth sectors and new types of economies of scale (Perez, 1985). With this in mind, the cycle of an economic system can be seen to represent a period of growth and contraction of a transactional network.

Space

It is important to note that an economic (or business) cycle has a *transposition in space* where it diffuses a technology and its underlying production structures depending on how well this technology can be standardized. The general tendency as we progress through a cycle is to minimize costs, which is generally achieved by exploiting the comparative advantage of space with specialized economies of scale. Industrial location theories have investigated this concept and generally acknowledge the relationship between the product life cycle and the location of industrial activities, notably, but not limited to those of multinational corporations (e.g. Chapman and Walker, 1991; Harrington and Warf, 1995; Watts, 1987). As production technology becomes more standardized and markets saturated by several competitors, expanded geographic horizons enable lower production costs (see Figure 2). Concepts such as the global economy rely on this principle. Outside industrial and economic geography, the concept of cycles and space have seen limited applications.

Transportation

When an economic system is transposed in space, its reliance on transportation is likely to increase. Since transportation technology, notably maritime, is widely standardized, cycles can represent different scales of spatial change related to transportation. However, the concept of cycles applied to transportation requires some modifications, because its spatial structure is far more complex than the industrialized / developing countries model of Figure 2. Figure 3 shows an adaptation of the concept of cycles with a spatial dimension, where diffusion processes are central. Some transportation systems have limited potential for spatial diffusion, simply because of the scale of the geographical system they address, such as transit. It is important to note that we imply spatial diffusion in a segregative manner. Strategic locations are generally occupied first, with intermediate locations being selected afterwards. This is precisely the logic behind the hub-and-spoke network structure.

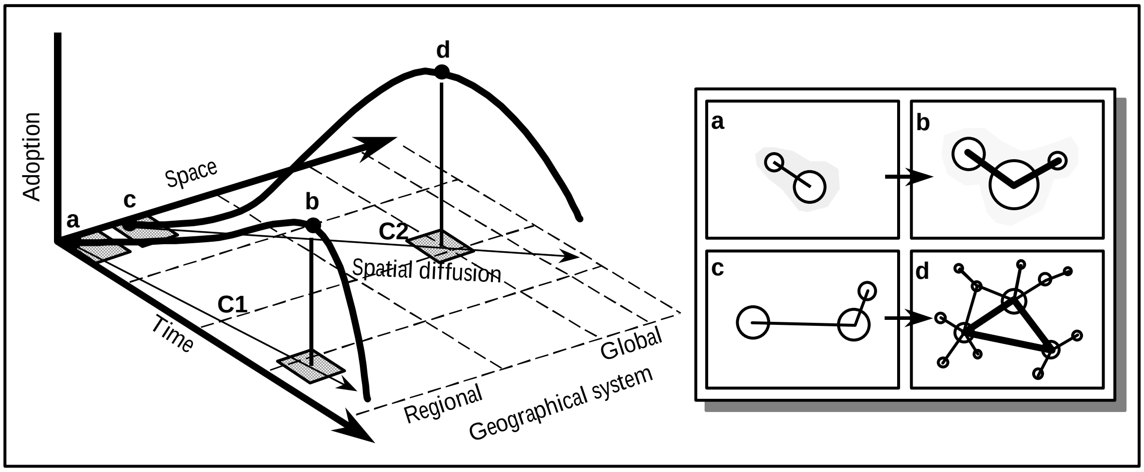

Figure 3: Cycles, Space and Transportation

Transport development and spatial diffusion are closely linked. The growth and contraction of the transport system is correlated with the hierarchical diffusion process (Brown, 1968; Hägerstrand, 1967) imposed by the structure of the network. As highly dynamic entities, networks are the agents, and, at the same time, recipients of the spatial diffusion of transport systems. Cycle C1 may represent the diffusion of a transit system closely linked with urban growth and decline, but also with competition from other modes like the automobile, which has its own cycles. From a to b, it experiences periods of introduction, growth and maturity, while after b, obsolescence and/or competition cause a decline in ridership. This has been the fate of public transit in a number of North American cities since 1960. Cycle C2 is more indicative of a transport system servicing international trade, like containers transportation. With an initial state effecting a service area of limited geographical coverage (c), growth and maturity provide a transportation system covering a global scale and tend towards cost minimization with a hub-like structure (d).

CYCLES AND MARITIME TRANSPORTATION IN A GLOBAL ECONOMY

It is surprising to find the limited importance put upon transportation, notably the distance factor in international trade theories (Daniels and Radebaugh, 1994; Lindert, 1989). Costs in trade are not ubiquitous, nor a simple function of the distance involved. For instance, while freight costs account for 34% of Australian international trade (for imports), 24% for Japan, 18% for the United States and 23% for Canada, they account only 2% for Belgium (Ahn Se-Young, 1988). Although the size of the nation and its location may be correlated with its freight costs in international trade, this share is more related to the nature of trade, to the trade partners involved and to the efficiency of transport services.

The theory of factor-proportions[4] is one of the most successful theories explaining trade

[4] Better known as the Heckscher-Ohlin theory of trade.

patterns between nations. Its main assumption is that nations trade accordingly to their factor-proportions, which are their endowments in capital, labour and land. So, nations having high proportion of labour over land will be marked by labour intensive activities while nations having low proportions of labour over land will tend to be more mechanized (Ohlin, 1933). Several nuances have been brought forward in view of this theory of trade in terms of commodities, types of specialization and labour productivity[5], but what about factor-proportions in terms of transportation?

Maritime transportation is basically a service, to the point that maritime shipping is a commodity. When a commodity is widely available in a global economy, price becomes the main advantage between the providers of this service on the transport market. In this view, cycles have successfully been linked with the evolution of maritime services, notably the strategies of maritime companies of "flagging-out" to fiscal paradises and new maritime countries (Sletmo, 1989). However, this has not changed the effective maritime factor-proportions which are clearly in the hands of industrialized countries and their main hub centres. In this view, port-industrial complexes emerged at points of high proportions of transportation supply over land supply (Hoyle and Pinder, 1981). Even if ports are linked with the cycles through their industrial activities (Hanappe and Savy, 1981), maritime transportation itself also directly affects cycles. This is the base of the interrelationships of transport with economic/regional development that have captured the attention of geographers for a long time (e.g. Gauthier, 1970; Hoyle, 1973; Taaffe, Morrill and Gould, 1963).

Long-Wave Maritime Cycles

The world economic and industrial balance is affected by adjustments that are changing equilibrium points, thus moving the "centres of gravity" of the world economy. When an attempt to identify places of spatial accumulation is undertaken, the tendency is to put them on a continental mass or more precisely in a specific region (e.g. Eastern United States or Western Europe). The result is a territorial typology of development with representations like centre/periphery (Knox and Agnew, 1994). However, since trade is at the base of world economic and industrial structures, it may be more appropriate to place the "centres of gravity" along axes of exchange. Maritime transportation, as the main agent (or vector) of international trade, put oceans at the "centre" of the global economy.

Since the global economy and the shift of importance between great industrial regions are long run processes that started during the industrial revolution, maritime transportation follows the economic transformations. A long-wave maritime cycle is thus a vast territorial shift of maritime services, in terms of means of shipment and transshipment, at the global scale. The time period concerned often covers several decades.

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5 see Lindert (1989), chapter 2.

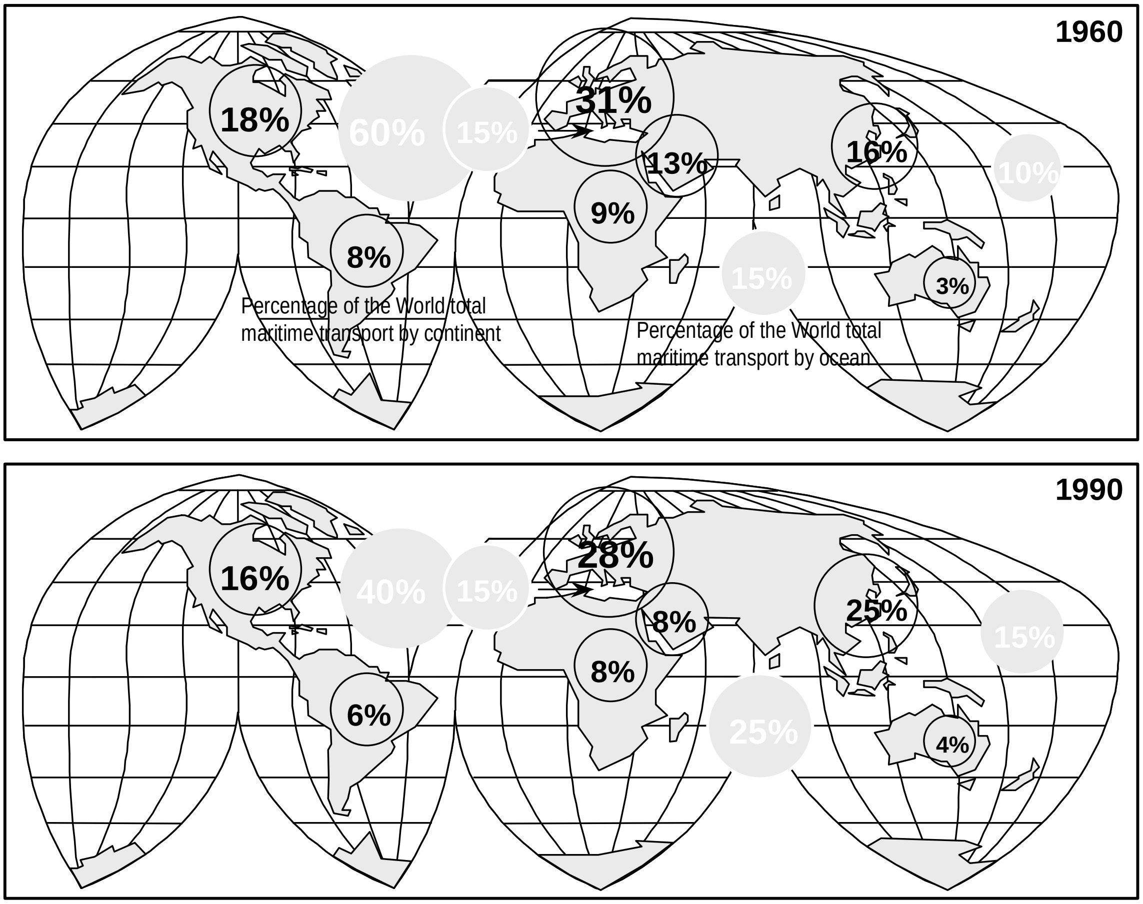

Figure 4: World Maritime Transportation, 1960-1990

Figure 4 illustrates this basic idea by showing the evolution of the world maritime transportation by ocean and by continent. From the 60s to the 90s, the maturity of maritime transportation technology has put a growing emphasis on price and efficiency. This, coupled with a cycle of economic growth in Pacific Asia (notably in new industrialized economies), and a greater reliance on petroleum, the weight of each ocean and continent in the world maritime transportation system has changed. The Pacific and Indian oceans have acquired a larger relative importance than the Atlantic ocean over the last 30 years. Several structural modifications of maritime transportation that may be associated with this long wave cycle are as follows:

(1) Greater economies of scale may reduce transportation costs, but limit the number of points of transshipment. These economies may be in shipping, such as super tankers and 4th generation container ships, and/or in transshipment infrastructures. However, this logic has not been followed completely and some processes of deconcentration of maritime activities were even observed (Hayuth, 1988). Why maritime transportation did not followed a continuous agglomeration of its productive factors in order to reduce costs? The answer may lie in a contradiction between the forces of agglomeration and the effective tendency of the maritime system towards the regulation approach. The regimes of accumulation in maritime transportation may point towards economies of scale and economies of agglomeration, but the modes of regulation are far from being homogenous. National/regional governments,

port authorities, and maritime companies all have their own rules of operation which are continuously modifying the advantages of port locations and the advantages of using large ports. Tariffs (trade agreements), subsidies, infrastructure, labour, markets, regional/national policies and services are far from being stable components of the modes of regulation. In view of the contradictions between regimes of accumulation and modes of regulation in the maritime system, maritime companies have no other choice than to minimize potential disruptions (uncertainties) by servicing more ports with smaller shipments.

(2) Maritime power has considerably shifted from OECD countries to New Maritime Countries (NMC; Taiwan, South Korea). While NMC have pursued aggressive development policies of maritime transportation, including shipbuilding, several developed nations have reduced operating costs by "flagging out". Strategic alliances are also more common among different shippers in order to provide more flexibility in services. Each element of the maritime system adapts itself to continuous modification in origins and destinations, while minimizing investments in infrastructure.

(3) The growth of international trade has been more important than the growth of productive forces within nations. Since early this century, the annual growth of maritime transportation ranged around 3% and accelerated after the Second World War with the globalization of the economy to about 5%. Figure 5 clearly indicates that global trade has grown significantly since 1984, even more than economic production. Since 1990 the relationship between production growth and trade growth is less clear and may indicate the beginning of a new long-wave cycle. It corresponds to improved trade conditions brought forward by trade agreements such the FTA (Free Trade Agreement) in 1989 (and NAFTA, North American Free Trade Agreement, in 1994) or the consolidation of established ones like the EU (European Union) and the ASEAN (Association of Southeast Asian Nations; liberalization of trade in progress since 1992). Also, if reflects processes of global specialisation in industrial production that do not necessarily imply high levels of growth in industrial production. The World Trade Organization (established in 1994), which replaces the GATT (General Agreement on Tariffs ands Trade), may reinforce greater discrepancies between production, trade and territories. The patterns of trade growth are still to be linked with those of production, but this process better fits within medium-wave maritime cycles.

Medium-Wave Maritime Cycles

An example of a medium-wave maritime cycle is the diffusion in space of a specific technology. This often extends over a 10 to 25 years period. When the technology is new, a limited number of ports and inland transport systems can provide the services, but as the technology become widely accepted most ports can compete. The cycle has reached maturity and price, service and efficiency, not innovation, become the main advantage of ports. The container is an excellent example of such a diffusion.

(1) *Introduction*. When containers began to be introduced as an innovative mode of freight transportation, a limited number of ports were able to position themselves in the emerging, but small market (Hayuth, 1981; Kuby and Reid, 1992). Over the years, the logistics of maritime shipping began to be affected (Figure 6). The conventional fordist approach assumes a single supplier, shipping agent and client. In a post-fordist maritime transportation

network, characterized by flexible specialization, several shipping services may each have their own services and suppliers.

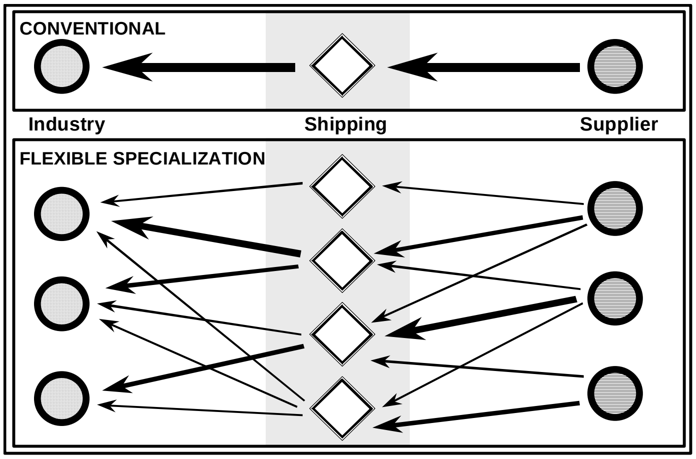

Figure 6: Flexible Specialization and Transportation

(2) *Growth*. As the container became a dominant mode of transportation, the demand grew and heavy investments were made in transport infrastructures, inland and maritime alike. Large and smaller ports were able to provide this investment, while a number of other ports stayed out of the emerging multimodal system. It is difficult to depict a pattern between the size of ports and the adoption of containerization. Ports such as New York have a long established hinterland while others like Felixstowe own their emergence strictly to containers. The success of several container ports may be explained as well as by the quality of their infrastructure and services and by their interface with inland distribution centres.

(3) *Maturity*. At the beginning of the 80s, the container technology became widely accepted and used by numerous segments of the industry. Inland container development through rail and trucking was an important aspect of this phase and containers were widely used outside the maritime mode (Slack, 1994b). Furthermore, some technological changes in inland maritime transportation, such as river-sea shipping, transformed the position of several ports as places of transshipment, notably at the European level (Rissoan, 1994).

Maritime container transportation has attained maturity in North American and European ports. There is, therefore, an intense competition between ports to gain an edge that will guarantee port calls by major maritime container companies. These companies have shown a high capacity to modify their services by origin, destination, port calls and maritime routes. We can see on Table 1 that container traffic of North American and European ports has grown significantly since 1976, but not as fast as Pacific Asian ports. North America and Europe account for only 36% of container traffic handled by the top 25 ports in 1993 while this part was 55% in 1982. Furthermore, the momentum of some large ports was less dynamic than smaller ports, notably along the American East coast where ports like New York have stagnated. This represents an environment where services are highly flexible and capable of supporting high fluctuations in demand. For instance, along the East and West coasts of the United States, there are no stable trends in port calls, but a continuous modification of port serviced and the frequency of services (Slack, 1995).

Table 1: Container traffic of top 25 ports by region (in TEU)

Region	1976	%	1982	%	1987	%	1993	%
North America	4974886	36.87	6347919	27.77	9620765	25.78	11764451	18.56
Europe	3571984	26.47	6299471	27.56	8485584	22.74	11416711	18.02
Pacific Asia	4291207	31.81	8995627	39.35	18612865	49.88	36955663	58.31
Other	654157	4.85	1216616	5.32	596922	1.60	3233920	5.10
Total	13492234		22859633		37316136		63372738	

Source: Containerization International Yearbook (various years).

In Pacific Asia, the economic system is growing strongly, creating a high demand for container transportation. A limited number of container ports were able to grow rapidly and exploit their regional niche without much competition, such as Singapore (Rodrigue, 1994), Hong Kong (Rimmer, 1992), and Pusan. This competitive edge was favoured by an early adoption of maritime container technology and strong links with the world economy. As the Pacific Asian maritime system reaches maturity, port competition is expected to grow accordingly. Already, several ports in the Pearl River Delta are emerging to gather movements generated by the exploding economy of the Guangdong Province. Farther north, Shanghai, the bridgehead of Central China is emerging as a major container port, but not without competition from other inland ports (e.g. Nanjing and Zhanjiagang). It must be noted that Pacific Asian ports are in very different stages of their respective cycles, such as Japan where maturity is attained, China where fast growth is experienced and other less developed economies where the container was just introduced (Vietnam).

Medium-wave maritime cycles may further be underlined by an analysis of the evolution of the rank of major container ports (Figures 7 and 8). Several fluctuations are observed in the rank of major ports, notably between 1976 and 1983 and between 1983 and 1987. The 1987-1993 period was far more stable, mainly because the prominence of major ports over their regional markets was established. East Asian ports reinforced their position considerably, accounting for 8 of the 25 major ports in 1976 but for 12 out of 25 in 1993. An overview of the evolution of the rank / size relationship for the 1976-1993 period (Figure 8) underlines the emergence of mega-hubs like Hong Kong, Singapore, Kaohsiung and Rotterdam which service vast hinterlands.

Short-Wave Martime Cycles

Movements generated by economic activities are not uniformly distributed in time, even over a short period. For instance, journey-to-work migrations reflect the socio-economic rhythms of a city. Short-wave maritime cycles consider the fluctuations of the services to accommodate the fluctuations in the demand. Several ports have a traffic that is relatively stable for each period of the year, while others will experience periods of peak activity and inactivity. The frequency and amplitude of short-wave maritime cycles can be linked to the characteristics of the port, the nature of its traffic, its size, and the nature of its hinterland and foreland (see Figure 10):

(1) Seasonality of shipments and trade. Some shipments are seasonal, like agricultural products (fruit shipments from South America and Africa), while others (industrial raw materials) are more or less continuous and require regular maritime services.

(2) Diversification of activities. The level of diversification in port activities may significantly reduce the amplitude of fluctuations in its traffic. Ports that are linked to a limited number of

commodities will fluctuate in accordance with changes in the supply and demand of those commodities. For instance, fluctuations in Rotterdam's traffic are far less variable than Prince Rupert.

(3) Nature of foreland and hinterland. The size and level of integration of a port to its foreland and hinterland will determine the stability of its transshipment activities. The port will be less dependent upon a commodity, but instead will be linked with the dynamics of territories, notably their economic functions. Shanghai services the vast economic hinterland of the Changjiang delta while the traffic of Sept-Îles is based largely on the links with iron mines in Labrador.

(4) Port size. Large ports tend to establish extensive links with vast market areas while small ports are generally linked to the traffic of one commodity. Thus, large ports are less influenced by short-wave processes (Slack *et al.*, 1993).

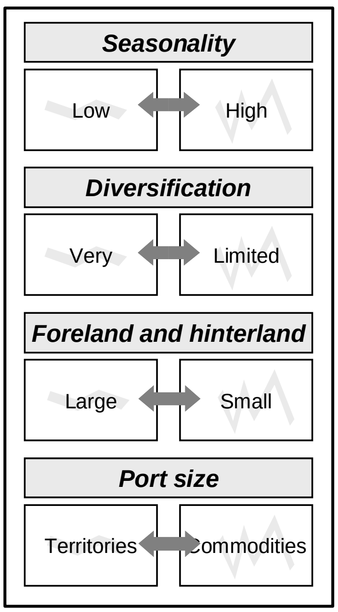

Figure 10: A Typology of Short-Wave Maritime Cycles

These factors result in the tendency for large and diversified ports to be exposed to less amplitude in their short-wave cycles than small and specialized ports. The worst case would be a small port with a high seasonality, depending upon a single commodity and a single client. Examples of short-wave maritime cycles include:

(1) Currency fluctuations and freight shipping. Freight routes tend to be adjusted in relation to monetary exchange rates between nations, but also in view of competition from other carriers. The price of some raw materials, notably petroleum, also influence foreign suppliers. In the case of the United States, oil prices are highly correlated to the reliance on foreign suppliers versus national sources. We can deduce from Figure 9 that the high value of the Yen influences trans-pacific shipping. Westbound shipping rates offered by conference and non-conference lines (South Korea, Taiwan, Hong Kong, and now China) are lower than

eastbound rates (The Economist, 1995).

(2) Cruise shipping. This industry is closely linked with the seasonability of tourism. In North America, ships are calling from circum-Caribbean ports during winter (Miami, Nassau, etc.) while in the summer season northern circuits, like Alaska, are serviced. Europe experiences a similar situation with the shift from the Baltic/Norvegian seas to the Mediterranean sea during winter (Charlier, 1995).

(3) Fluvial shipping in China. The importance of fluvial transportation to the Chinese economy is well established. Significant seasonal fluctuations are observed. In winter, vessels are employed handling coal from the interior to coastal cities to meet demands for heating fuel. In summer, part of the fleet is allocated to distribute agricultural products from the fields to urban market.

CONCLUSION

Ports systems and maritime transportation are good indicators of the spatial transformations and structural shifts of the global economy. Technological diffusion in maritime transportation enables the exploitation of economies of scale and economies of agglomeration at a global scale. Cycles offer an original perspective to understand mutations in the economy at different scales, and more importantly in space. Maritime companies are the main agents of the territorial dynamics of the maritime system. First, they must cope with the contradictions between the regime of accumulation and the modes of regulation of the maritime system. Second, they are agents of the spatial diffusion of logistical systems, such as containers. Third, they must continuously adapt to endemic changes within the maritime system, being flexible and specialized at the same time.

All the above raises the general question of transportation as a precursor of economic development or transportation as a follower of the structural shifts of the economy (and its cycles). Long, medium and short-wave cycles are interrelated, in the sense that what is happening at a scale will influence structures and processes at others. This can be seen from two directions, upward and downward. The first and most obvious is a trickle down process as the general condition of the economy influences ports and maritime systems. We must also consider that ports are often early adopters of innovations, and this may “climb up” to influence territorial development.

The relationships between space and transportation are therefore articulated by cycles where technological innovation, economic conditions, management strategies and policies influence development processes. All these parameters, when applied to maritime transportation, define the *maritime field* in which it evolves. In a global economy this maritime field is in constant state of change, being affected by and influencing the economic conditions.

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