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Networks: An Integrative Perspective

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1. Aims and Scope

This contribution serves to set out some issues which may be relevant for a spatial orientation on networks. It provides some descriptions of the relevance of networks, their features and potential research fields. The synergy offered by networks creates various interesting features which go far beyond a traditional segment approach to networks. At the same time networks appear to function in different modes, with different technologies, in different regions (or countries), in different institutional configurations, under different regulatory regimes and in different financial ramifications. Furthermore, there are different ways in which networks can be linked together as a synergy phenomenon: interoperability, inter-connectivity and inter-modality. All such functions aim to improve the technological and economic externalities of networks, but their performance is highly dependent on the behavioural rules and competence of a multiplicity of actors. Therefore, a multi-function multi-actor approach is necessary in order to cover the most relevant issues in the network field. In this paper some integrative observations will be made which may help to achieve a synthesis of various research questions in network analysis.

2. Towards a Network Society

Many spatial development theories take for granted the existence of a uniform space in which a free movement of people or goods is taking place all over. Space is then simply the passive medium for transport and communication flows and does not have an indigenous possibility to influence spatial movements. Classical location theories (Weber, e.g.) provide for example, a stylized representation of a spatial structure, in which only discrete point locations in a continuous space act as signposts for locational behaviour (and locational constraints) of firms.

In recent years the recognition has grown that spatial development processes are shaped through a complex interplay of both a heterogeneous physical space and a multi-layer socio-economic stratum. Barriers and borders are evidently playing a very critical but often neglected role in spatial and socio-economic dynamics. Batten and Johansson (1991) offer various interesting historical examples which show that a removal of bottlenecks may have substantial impacts on the growth of regions or nations. For instance, the expansion of trade and the growth of cities in medieval Europe were prompted by drastic improvements in European transport infrastructures (inland waterways, coastal transport, roads) whose dilapidated state had for long prevented the emergence of an efficient production and trading system. Similarly, the rise of new commercial centres in Japan in almost the same period would not have taken place without the removal of trade barriers and the creation of new distributional concepts (e.g., scheduled periodic markets, new commercial areas in nodal points of the network, protected castle towns etc.). The authors suggest that the transition towards a **network economy** has been of decisive importance for the growth of

regions and nations. Thus multi-layer network formation with both interdependencies and hierarchies at all spatial levels seems to become the new model of western economies (see also Camagni 1993).

Impediments to network formation deserve therefore much attention (cf. Batten and Törnqvist 1990). Such impediments may take different forms ranging from institutional inertia or bureaucracy to lack of financial resources or missing infrastructure links. It is increasingly recognized that the rise and fall of nations or regions is often determined by the degree of overcoming these impediments (cf. Denison 1967; Olson 1982). This forms also the background of the deregulation movement which seeks to optimize network performance by removing unnecessary bottlenecks of a regulatory nature. Some authors (e.g., Fukuyama 1989) speak even of the 'end of history' as a stage in the history of the western world in which free competition and liberalism are the ultimate driving forces of the modern network economy.

In any case, the idea of **design** (or systems architecture) of a network seems to be more relevant than the notion of **control**: design is a structuring activity oriented towards change of form (including barriers), whereas control refers to optimization of key parameters under a given set of **fixed** constraints (or barriers).

As mentioned above, a barrier may have different meanings (cf. Nijkamp et al. 1990). According to the Oxford Dictionary a **barrier** is an obstacle or circumstance that keeps people or things apart, or prevents communication. The related term of a **border** has more a geo-political meaning: it is the line separating two political or geographical areas, especially countries. It is now an interesting research question what the relationship is between barriers and borders on the one hand and network performance reflected in regional development in the long run on the other. Furthermore, the removal of old borders - a situation we have witnessed regularly in the past years - provokes the question whether all related impediments are at the same time eliminated (Molle 1990). It is a fascinating research issue whether new borders may even create new barriers of a different nature.

3. Companies in Networks

Networks are specific organizational configurations of flows or transactions in a spatial economy. The pathway towards a network economy has already a long history in economic-geographical thinking, e.g., in the production systems approach (Hill 1989), the efficiency principle associated with transaction costs motives (Williamson 1985), the eclectic theory emphasizing internalisation, location-specificity and ownership-specific advantages (Dunning 1988), and the power principle focusing on company strategies (Dicken and Lloyd 1990). Most of these approaches investigate the critical success conditions for company strategies, especially those companies which have a great diversity of forward and backward linkages. In this context, the network position is an important phenomenon, as it reflects the strategic place of a company in a web of inter-

firm relationships and the role and importance of firms in comparison to other actors in the relevant force field (Johanson and Mattson 1987). As a consequence, strategic network orientation allows a firm to develop market assets in the form of investments in network positions. Externalisation based on e.g. subcontracting may be one of the results. Clearly, such network configurations are not universal but rather specific, as firms tend to operate in the framework of established relationships (Lagendijk 1993). In general, explanatory modes for firm behaviour in networks are based on elements from social exchange, resource dependence theory or inter-firm governance.

It turns out that the network concept may offer an interesting explanation for firm dynamics in space, as it allows for competitive behaviour in different spatial and institutional markets and different forms of inter-firm governance. At the same time it has to be recognized that networks are a vehicle for company strategies, so that also sometimes the building up of barriers in inter-firm networks may create competitive opportunities. Consequently, the issue of barriers in networks deserves thorough analytical attention.

4. Networks in Space

Network connectivity seems to become one of the prominent features of industrial economies, as it is able to combine decentralized decision-making with the benefits from synergy. In this respect both economies of scale and economies of scope can be satisfied to a maximum extent.

It is evident that there is a variety of networks. Examples are:

- physical networks (in which physical capacity, links, nodes, spatial configuration and service level are dominant features).
- immaterial networks (in which information and knowledge plays a critical role through transfer mechanisms such as central facilities, connectivity channels, capacity and receptivity).
- organisational networks (in which people act as nodes with many formal and informal linkages and communication channels, organisational objectives and coalition strategies).
- club networks (in which network externalities, new information technology and connectivity play a basic role).

The above networks can be either planned or spontaneous, but can all be typified according to the following features:

- material (e.g., links, capacity, fixed facilities or connectivity degree)
- structural (e.g., hierarchy, spatial lay-out, spatio-temporal evolution)
- economic (e.g., operational versus capital costs, scale economies, externalities, user charge principles etc.)
- behavioural (formal and informal use, actual versus perceived costs,

- price elasticity etc.)
- multi-layer (complementarity or substitution with other network, joint use, overlapping functions etc.)
 - decision-making (formal versus informal planning, decentralized versus centralized planning, budget versus profit principles, etc.).

Clearly, a network is essentially based on actor dependency. Kamann and Nijkamp (1991) distinguish in this framework the following dependencies in network relationships: technical dependency, knowledge dependency, continuity dependency, social dependency, logistical and administrative dependency, innovative dependency and financial dependency.

Networks do not have an aim in themselves, but are vehicles for achieving one or more goals of actors using the services or benefits rendered by networks. A necessary condition for the emergence of networks is **interaction** between different actors. Since usually actors are not characterized by spatial juxtaposition, networks have a clear **geographical** component. However, the geographical dimensions of networks are intertwined with order, organisation and coordination of such networks. The design, supply and organisation of networks should thus meet the **needs of the potential users**. Furthermore, these users have different expectation patterns regarding the services provided by a network, and hence in many cases we observe **different layers** of networks (e.g., roads, railways, waterways, airline connections etc.). Such networks follow also the **hierarchical structure** of central and less central places. Since there is no single network which can serve all needs, we observe in reality a complicated system of partly overlapping, partly complementary network segments. **Multimodality** is a good example of the latter phenomenon.

The **supply** side of a network is oriented towards fulfilment of demand conditions (market pull), but it is strongly influenced by technological changes (technology push) and by prevailing property and ownership regimes as well as by geopolitical interest. Since the beginning of this century network supply has often been a public government responsibility, but in recent years - after the recognition of market failures and government failures - we observe an increasingly commercial attitude towards network supply. This means that the organisation of the supply side of networks will likely drastically change.

The current popularity of network concepts is undeniably connected with the declining domain of public policy: networks tend to become the vehicles through which competition is flourishing. Both external megatrends and internal system's forces necessitate a market orientation paralleled by risk minimization strategies. Networks seem to offer more certainty in terms of expected consequences of strategic decisions and hence may be regarded as a major critical success factor in (inter)national competition.

Despite the socio-economic need for well performing networks, we also witness the environmental and safety conditions in network planning, construction and use. Network use will most likely have to materialize within ever increasing narrower limits. The recognition of such barriers requires rigorous

social science research on externalities, complementarities and scale economies.

The set of network policy actions that can be envisaged is vast and ranges from direct public supply or intervention to user charge principles or complete laissez-faire. A major challenge of network owners and operators will be to formulate strategic plans that convincingly incorporate non-zero-sum game strategies with gains for all parties involved. This may be illustrated by means of some examples.

The 'user charge' principle in transport policy has in particular become a success in those countries where suppliers and users of transport infrastructure were all enjoying benefits (e.g., suppliers by receiving more revenues from road charges, users by increasing their travel speed etc.). Likewise the question of intermodal substitution (e.g., from the car or lorry to the train) will critically depend on the willingness to implement such incentives.

International competitiveness is a necessary condition for enhancing the level of European economic performance after the completion of the internal market. Segmented and nationalistic infrastructure policy may at best serve the short-run interests of infrastructure owners, but is in the long run to the detriment of all network owners (and users) and affects Europe's economic position. Thus transportation and communication policy requires a balanced implementation of actions which ensure a consideration of both private and social costs, and a global orientation which exceeds country-based or segmented policy strategies. The current plans regarding the European high speed railway system are a clear case of creative action-oriented policy analysis, even though the technology policy underlying this system serves mainly the interest of individual countries.

Networks are at the same time vehicles through which nations (or regions) can control part of the international (or interregional) competition. Monopolistic and oligopolistic structures in space are the result. The socio-economic benefits of coordination and harmonisation are often neglected in favour of emphasis on narrow nationalistic interests. This opens much new research in the economic importance of the existence of (deliberate and coincidental) barriers in international networks (including the missing links and missing networks phenomena). This issue will be discussed in the next section.

5. The Role of Borders and Barriers

Borders were traditionally regarded as barriers to economic development: it is not surprising that many lagging regions were found near borders with other countries. Borders were in general creating impediments which hampered the economic gains of trade.

In the past years many old borders have vanished and new maps have emerged. Especially Europe has exhibited a fast dynamics in this respect, but also other continents (e.g., NAFTA in North-America) are gradually following the same trend. This means that the ongoing process of socio-economic integration and economic competition in an open network economy is creating new roles and new possibilities for national states, cities and regions. Barriers related

to former borders may disappear, but national self-interest may create new barriers. Thus renewal and establishment are coping with one another.

Governments find themselves in a different position as the deregulation paradigm prevents them from a direct intervention. Controllability via public agencies becomes thus more and more problematic. Cities and regions tend to form their own strategic alliances without too much consideration for the former borders of nation states. At the same time it has to be recognized that transborder cooperation may generate unexpected benefits, as the economies of scale of new strategic alliances across the borders are significant (see Ratti and Reichman 1993). Consequently, borders are no longer barriers to development, but also windows of opportunities. This does not only hold for commercial activities, but also for exchange of information and knowledge (cf. Schott 1988).

Borders and barriers lead in general to a lower performance of a network, a border because of geopolitical reasons and a barrier because of institutional, physical or human-made impediments. They form an obstacle in a free transfer of people, goods or information. Clearly, some of these impediments are given by nature (e.g., mountains, lakes), but most of them are man-made and created for the sake of convenience or protection or are unintended effects or spinoffs of other barriers. Examples of man-made barriers are: congestion, fiscal constraints, institutional rules, technical conditions, market regulations, cultural inertia, language barriers or information shortage.

Nevertheless, it should be emphasized that barriers may not only be impermeable and detrimental to development, but also semi-permeable and stimulating for development (e.g., the Swiss watch industry in the Jura) (Ratti and Reichman 1993).

Bennett and Chorley (1978) distinguish four types of spatial transfer processes which are relevant in our context:

- barrier processes
- hierarchy processes
- network processes
- contiguity processes

The corresponding spatial patterns are depicted in Figure 1.

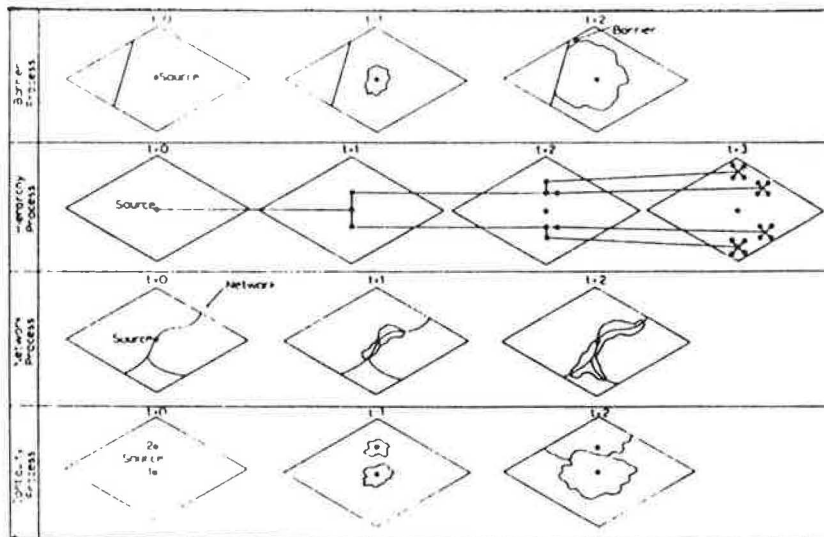


Figure 1. A typology of spatio-temporal patterns

The removal of bottlenecks in a network may have profound impacts on the spatial perception of distance. For example, if one compares the European railway map of 1987 - in terms of time distances - with the map in 2015 (after the widescale introduction at high speed trains), one obtains an interesting picture of Europe (see Figure 2).

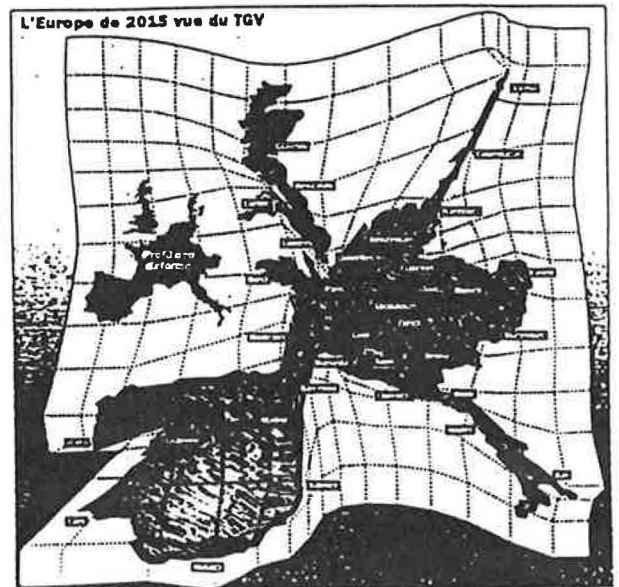
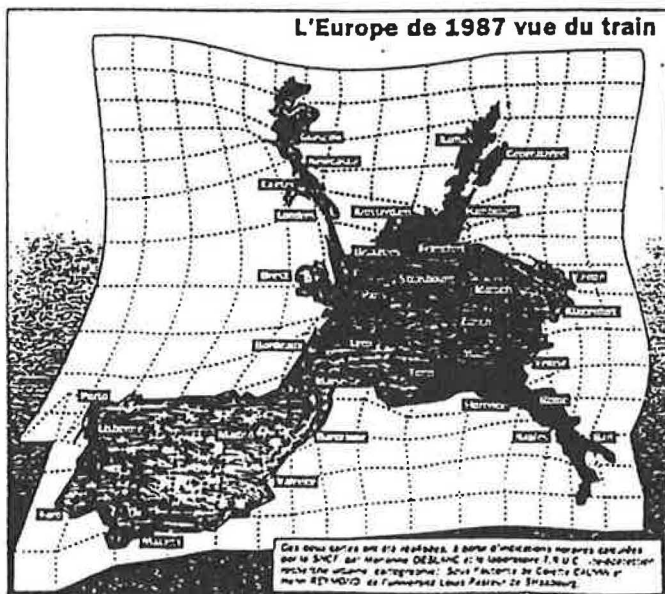


Figure 2. Europe before and after the introduction of high speed trains.

Because of globalization and other factors (including the need for higher and sustained economic growth), transportation in many countries has grown enormously, especially in recent years. As the supply of infrastructure - for various reasons - followed this trend only in part, existing infrastructure bottlenecks have been accentuated. This is a very serious problem, since economic development and infrastructural development have always been strongly interlinked. The full benefits of a network economy will only be reaped in case of effective (physical and non-physical) infrastructural adjustments. What is needed in this context, is supranational - and **not** national - thinking and action in infrastructural policy, based on knowledge of past successes and failures in infrastructural planning and of the future needs of the economy, and the constraints imposed by an (increasingly threatened) (natural) environment.

In the light of the previous observations, it is clear that there is a broad spectrum of questions which need to be addressed in policy formulation. The recognition of frictions and bottlenecks is the first stage in a policy life cycle. The policy agenda itself is of course much longer. In the past years where many countries have increasingly been faced with the negative externalities of the transport sector, social science research has been of critical importance for formulating issues that needed to be addressed in policy analysis. A simple illustration may clarify this statement.

The 'undesirable' outcome of a highly mobile society is - almost paradoxically - the result of rational and plausible actions of a great many individuals. Social science research has convincingly demonstrated that the neglect of social costs in individual decision-making must by necessity lead to a macro outcome that is far from optimal. This explains worsening quality of life conditions in major cities all over the world. At the same time cities are becoming nodes in a global network (Sassen 1991), especially because of their information gathering, processing and distributing power (Castells 1989).

Policy implementation in networks is thus not in the first place a clean application of instruments, but requires a fine tuning between goals, measures and social acceptance.

Such pro-active strategies require creative policy and social research, not only regarding technical solutions or financial means, but also regarding material resources, human responses etc. Those countries which have been able to develop and support such research have been rather successful in their policies. A particularly important, but often neglected factor in this context is the organizational and managerial setting that is necessary for making a policy strategy successful.

In the previous sections we have pointed out that the current geopolitical and socio-economic dynamics have dramatically influenced the traditional role of borders between regions or nation-states. In many regions and countries the economic meaning of borders is changing, although this does not imply that a 'border-less' economy is emerging. Changing borders provoke at the same time new issues which are of a socio-cultural and politico-historical nature, such as the sense of social identity, preservation of life style, economic survival, community sense and language. The pathway towards an open network may thus create new

barriers which may shape maps of regions and nations which may differ significantly from former administrative delimitations.

6. A Typological Approach to Networks

In this final section a simplified taxonomy will be used so as to be able to classify contributions to spatial network analysis. A distinction along three major axes will be made:

- (1) indigenous network features
- (2) geographical scale
- (3) external functions and roles

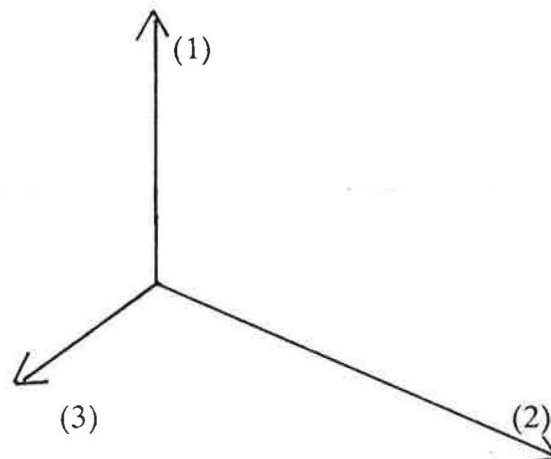


Figure 3. Three major dimensions of spatial networks

The axes (1) and (3) can be included in the following matrix scheme:

	roles of actors		barriers		synergy		
	demand	supply	demand	supply	inter-operability	inter-connectivity	inter-modality
indigenous features							
types of modes							
product orientation							
technologies							
organization							
regulatory regimes							
financing schemes							
pricing schemes							
product orientation							

Figure 4. A typology of indigenous features and external functions/roles of spatial networks

The taxonomy cannot only be used to typify various network studies, but also to raise various research questions:

- do we have a sufficient level of theoretical contents to study network behaviour?
- is there a need for a new network methodology?
- which are the most intriguing behavioural questions in network performance?
- is there a need for a focused policy analysis regarding networks?
- and finally - probably the most difficult question - how do we measure value added and synergy in spatial - economic networks?

The previous observations are by no means exhaustive analytical contributions, but have tried to clarify the analytical importance of network research. It is clear that a behavioural economic and geographic approach to network theory and methodology is still in its infancy and deserves much scholarly attention in the future.

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