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Reference

PFLIEGER, Géraldine, ROZENBLAT, Céline. Urban networks and network theory: the city as the connector of multiple networks. *Urban studies*, 2010, vol. 47, no. 13, p. 2723-2735

DOI : 10.1177/0042098010377368

Urban networks and network theory: the city as the connector of multiple networks

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Introduction

Since the early 1990s and the publication of *The Global City* (Sassen, 1991), followed closely by the formalization of the concept of space of flows by Manuel Castells (1996), research on global cities has abounded in several fields of urban studies. What emerges from this body of work is the sheer diversity of links that connect major metropolises to one another. This special issue showcase examples of research carried out in these fields, demonstrating their respective convergences and the contributions they have made to an improved understanding of the concept of space of flows. By comparing these fields, we are able to go one step further and capture the diversity of the networks that create interdependencies between urban spaces. One is able to identify the shape that these interdependencies take and their impact on the development of urban systems and the internal structure of metropolises. All these approaches place networks at the heart of the urban process, and consider the interaction between networks and cities as a process of co-development.

Unlike social networks or companies and their subsidiaries, urban and interurban networks do not simply link entities. Rather, they serve to connect distinct networks, each ones with their own organizational approach and dynamics. Urban sociology stresses that cities are not autonomous entities with specific bodies and functions, but serve rather as a support for and expression of human activity. In this sense, the urban space bears a greater resemblance to an agglomeration composed of many distinct networks – economic, social, political, technical or infrastructural – which intersect at a given point, providing the urban space with its own specificity. What differentiates one space from another is the particular set-up of each network. This in turn shapes the arrangement of various entities and functions within networks.

1- Significance and aims of the special issue

The originality and primary objective of this special issue is to demonstrate the mutual constitution of networks and cities. These links have already been explored in 2007 during a seminar organized jointly by the Annenberg Networks Network (ANN), the European Research Group S4 (Spatial Simulations for social sciences), rhe University of Lausanne and the Lausanne Federal Institute of Technology (EPFL). To understand how urban and interurban networks function, we focused on the specific features of social, economic and political networks at the urban level. There are a variety of scales and aspects which intersect, connect or overlap (Offner & Pumain, 1996), and function like networks. The central issue for research on urban networks is to identify, from a transdisciplinary perspective, how each of these networks interact in and through the urban space. Our comparison of the different dimensions of networks established by social sciences – geography, sociology, economics and urban studies – and by science in general is motivated by the aim of identifying the boundaries and the internal organization of those networks. In our opinion, this transdisciplinary approach is promising for the transfer of concepts and methods applied specifically to the city, in the same way as physicists and IT specialists have done for networks by applying them to different types of objects. Through interdisciplinary exchanges, one hope that each discipline will clarify its concept of network and the methods associated with it. For urban studies, this require an examination of the transition from networks of actors to networks of cities through the interlinking of different types of network:

- social networks and functional spaces which play an active part in the dynamics of the internal and external networking of cities;
- technological and organizational innovations and their dissemination in urban regions;
- infrastructure and technical networks which transform the spatial organization of cities.

The purpose of this introductory article is to show the positive contribution that network theory can make to the analysis of urban networks. Cities are linked by a considerable diversity of networks, which themselves differ in terms of type, scale and structure, but all of which interconnect in the urban space. This networking of the major regions of the world is also reflected in the far-reaching reconfiguration of the metropolitan space throughout the world. Historical and contemporary analyses of urban networks help to uncover the complex processes involved in the co-construction of cities and networks. This multilevel social structure that goes from the local right up to the global raises questions such as its power, its form and its place in the spatial organization of an increasingly complex economy and society. These approaches help to redefine the city as well as its cohesion and boundaries, to position urban development in global networks, to investigate how the levels of spatial and social organization interact, and to identify the implications of networks as a source of power for cities, organizations and individuals.

2-The city as a network of networks

All of the articles in this issue have the same starting hypothesis: cities exist through the networks that create them and the development of these networks is contingent on the characteristics of the urban space. All international metropolises, whether they are "global" cities or not, can be considered as a juxtaposition of networked entities that are both globalized and localized. However, their type of glocalization varies. This local-global positioning is closely linked to the economic, social, political and cultural networks that support the organization of cities, the scale and topology of these networks, their structure and functions, as well as their development over time. Individuals, networks and spaces are part and parcel of shared processes depending on a range of features which vary from one space to another. This local-global positioning depends on three main dimensions :

- Types of networks: the behavior of individuals, the organization of networks and the dynamics of spaces are based on networks of varying natures driven by actors who often belong to several networks. For social and organizational networks, these adjustments can take the form of cooperation, competition or exclusion, depending on the strategic investment of actors in the networks and on how power is organized within a single network or between multiple networks. These considerations raise the need to identify the multiplicity and structure of the networks that connect cities.

- Scale of networks: the position of a city is dependent on the place of individuals – human, economic or social entities – within the various specialized networks where they interact by exchanging or sharing. The integration of individuals in networks with different geographical scale leads to dissemination and exchange which will in turn influence the city by positioning it at the local level insofar the network is local, or alternatively positioning it within a regional, national or international network of other cities. Regardless of whether the scale of these networks is small or not, such integration changes the organization of the intraurban space, affecting mobility, technical networks and territorial organization.

- Connections between networks: in the words of Manuel Castells the space of flows integrates different networks that are interconnected in several places. Places are seen as spaces made up of flows and locations, whose structure, level of performance, and innovation dynamics has a bearing on the organization of the longest-range networks and distant locations. Conversely, at the local scale, the territorial

boundaries of interaction between different networks transform the organization of the city, its internal locations and its urban space. The city is not only viewed as an aggregation of multiples networks but as an interconnection node between networks.

The position of a city within a city network is closely linked to how a local entity and individuals are integrated in a larger network on the one hand, and to interactions between entities belonging to different networks within the same place, on the other. The city is characterized by the convergence of multiples networks of multiples scales and interconnected, or not, through various internal dynamics. Reciprocally, the existence of the urban environment constitute resources for the deployment and renewal of multiple networks.

Places and networks should no longer be considered as separate interactive processes but rather as forms of spatial organization that are intrinsically co-produced. The mutual influence of network dynamics raises the issue of the geographical scale on which interrelations between these networks develop. This process gives rise to a largely constituent cohesion of the "boundaries" of the city and its influence. Three factors appear to dominate the development of such cohesion:

- geographical (topographical) proximity which enables economies of agglomeration in each network ;
- proximity within the network (topological) which encompasses previous processes, but which can also transcend geographical distance to give rise more generally to network economies;
- the diversity of networks which at both the local and global levels enable the strengthening of nodes.

First, the spatial proximities of location (defined by the "day-to-day" space throughout history and in every cultural context) favor economies of agglomeration, which comprise economies of scale (increasing returns and greater productivity), ultimately leading to higher spatial concentration : companies locate close to labor and consumption markets, and in return individuals are attracted to these locations by job opportunities (Krugman, 1993). Spatial proximity also favor economies of location (internal to the given sector) that enable the establishment of cooperation/competition, and access to specific outsourcing. In turn, this leads to the creation of specialized employment and social infrastructure areas. Currently, the introduction of "business clusters" which geographically bring companies/education/research together aims to reinforce this type of process. In doing so, each city strives to show to best advantage its "specificity" in relation to other cities. Finally, economies of urbanization (general services for companies and individuals) are often generic (financial services, airports, cultural activities), but in themselves grow increasingly specific. At the local level, the interlinking of these three processes through the development of technical and social networks produces a certain "coherence" in intraurban networks and provides the "cornerstone" for the external influence which the city or metropolis can exert. This coherence also tends to strengthen long-range networks.

Secondly, at the local level, network economies shaped by topological proximity are part and parcel of the economies of agglomeration insofar as they are coupled with spatial proximity (topographical). However, they can also transcend this process: intercity exchange networks have long existed (rare products, cottage industries, technical and social innovation, territorial organization: empires) (Bairoch, 1985; Mumford, 1982). Today, technological advances, especially in terms of travel and communication, have bolstered the mutual interdependence of cities. Consequently the power as well as the social and economic features of one city are directly confronted with those of other cities due to the specialized interurban interaction which transposes codes, technological demands, and "cultures". These networks have accelerated the rate at which innovation, development and crises spread through city systems. Long-range networks also help strengthen

each type of movement or activity through new members who contribute, even at a distance, to the visibility and development of urban groups and local activities.

Thirdly, the position of each city in a system of cities depends largely on its abilities to remain stable and to renew. These abilities depend on the propensity of its populations, groups and networks to drive or to adopt major innovations, and are heavily influenced by past and present dynamics of the city and by its historical social and economic organization (Pumain, 1997). What differentiates one space from another is the specific arrangement of individual networks, which in turn organize the arrangement of different entities and functions on local and distant scales. The dynamics of these two scales are intrinsically linked. The diversity of networks creates an "entropic" system where interaction plays a multiplying role and serves as a source of renewal (through competition/cooperation) both on a local and global scale. This is the distinguishing feature of a highly specialized urban "cluster" (such as "industrial zones"), which is essentially multidimensional, multiform and multiscale. In the city, access to resources that are both specialized and diversified generates "risk insurance" (Veltz, 1996) for the development of the human population and their activities. Between cities, access to diversified and complementary resources contributes to the complementarity with distant resources, for example through the spatial division of labor (Aydalot, 1985). Whether within or between cities, different types of network interlink, compete and support each other by improving themselves and each other. Thus, through the interaction between networks and the domination of networks in socio-economic or communication structures, a number of networks impose their characteristics on others. More generally, through the reciprocal adaptation of different networks, scale produce "attractive" infrastructures for new emerging networks. Power networks provide mutual reinforcement at the decision-making level and in terms of their specific organization. The same is also true for national and regional territories, whose institutional networks "attract" and at the same time are strengthened by economic and social networks through language and identity, with the support and provision of transport and communication networks which feed the "territory".

The integration of individuals in both networks and places raises the question of intrametropolitan hierarchies, cohesion or fragmentation, an issue which has often been oversimplified and reduced to a mere local-global dichotomy. Network theory is useful to understand the relations between different scales through small worlds, aggregates, or connectors…. The redundancy of paths which pass through different routes between the same individuals in a given network reinforces direct or indirect interaction. This mutual interaction occurs primarily in "clusters" which can shape micro-societies within distinct cities or groups of cities which are closely connected due to the presence of particular groups, such as Diasporas or economic actors. In "The Strength of Weak Ties" by Granovetter (1973), a large number of weak ties structures the disparate network into "clusters" of strong ties. It is these clusters of social, economic and spatial proximity that enable economies of agglomeration to develop. However, it is in the weak ties between the clusters that the diversity can be found. This diversity enable cities to function and to renew themselves. Thus, the combination of strong and weak ties enables the urban system to reproduce and transform. In "clustered" networks, components that are disconnected from the rest of the network can readily occur: certain groups or "clusters" can be isolated without any links to the rest of the network – such as a socially isolated neighborhood within a city, or a city cut off from the rest of the urban system. This process of fragmentation is not only bad for the isolated cluster which is disconnected from the rest of the network, but also for the entire system due to the resulting loss of diversity. Individuals or bodies which have a bridging function (or connectors) can overstep these "structural gaps" to strengthen all "relational capital", but only after they have strengthened their own social capital first (Burt, 2005). These bridges enjoy a highly strategic and centralized position even though they boast few links (Guimera et al, 2005). In a metropolis, these "bridges" can be:

- physical, like road or public transport systems;

- cultural or political, through “interstitial” places where different social groups converge (markets, cultural events, participatory procedures);
- economic, such as companies working in different sectors;
- social, through individuals located at the crossroads of several groups or at the intersection of different networks.

Such individual positioning demands that networks have good mobility and a high degree of flexibility. However, if the hierarchy between hubs is too great, the system is stymied and individuals become excluded from the entire network. The boundaries of networks between what is integrated and what is not are powerful constituent elements of their functioning and development. This is what can happen in a city where a share of individuals is excluded from major networks. These individuals live there but are not truly integrated within its boundaries.

3. Cities in global networks

The articles featured in this special issue deal with four key questions surrounding urban networks:

1- Against the backdrop of globalization, how do cities maintain a certain degree of social and spatial coherence or cohesion? At what point do inter- and intraurban scales converge to create urban spaces, where the networks of each city are so entangled that they become indistinguishable?

2- How do cities develop and co-evolve through their interaction via networks?

3- How does the local production of internal networks in a city interact with its position within global networks?

4- How do cities facilitate the development of stakeholder and power networks?

3.1. The city as a source of spatial cohesion for social networks

The cohesion of cities is generated by the cohesion of their social networks, which are created through face-to-face meetings and supported by extant means of transport and communication. Two articles (Mok et al., and Dessemontet et al.) examine this issue by exploring how cohesion evolves and by looking at the influence of physical or social distance on the density of social relations. The first article, which looks at cohesion over time, shows the complementarities of different means of communication (face- to-face, telephone, post and email) for interpersonal relations. The second focuses on how private and public transport and commuting transform the scale of metropolitan cohesion.

The article by Diana Mok, Barry Wellman and Juan Carrasco (Does Distance Matter in the Age of the Internet?) is a diachronic analysis of the spatialization of social networks in one Toronto neighborhood (East York) between 1970 and 2000. The aim of the authors is to compare changes in interpersonal relationships pre- and post-internet. The most conclusive finding of this research is that the internet neither leads to the disintegration of cities nor mitigates the effects of physical distance between individuals. This casts doubt on the myth of the global village, which posits that citizens would develop greater links with physically distant individuals at the expense of fostering links with their neighbors or with family members who live close by. The surge in interpersonal communication thanks to email has not eradicated distance. Social networks still exist at local level, particularly through face-to-face and telephone contact. However, the prevalence of long-distance contact is high among the heaviest internet users. The authors demonstrate the importance of technical networks as regards the structuring of social networks by identifying the existence of a distance-based specialization in the medium of communication. Face-to-face contact is the most prevalent form of

communication at local level, while it is the telephone at regional level (less than 100 miles). Email is the most frequently used form of communication for long-distance transoceanic relationships. The authors conclude that internet has neither eradicated distance nor diminished the value of locality, or the "space of places" to use the concept of Manuel Castells. In fact, the internet tops up the existing modes of communication (face-to-face and telephone), as it allows the development of social relations with individuals who are very far away but without undermining local or regional networks. The internet has also transformed the metropolitan space. It has ceased to constitute a perimeter for social networks and has become a hub, which is characterized by a high density of contacts within its space that is conserved through the stability of face-to-face and telephone contact and through the strengthening of long-distance relations with relatives or friends living several thousand kilometers away. In East York, glocalized behavior emerges in parallel with changes in the demographic structure of the neighborhood and the arrival of migrant populations.

Pierre Dessemontet, Vincent Kaufmann and Christophe Jemelin (Switzerland as a Single Metropolitan Area? - A Study of its Commuting Network) concur with this observation of a city functioning as a hub. In their article they apply the network analysis method to the process of metropolization in Switzerland. In contrast to the broadly formulated hypotheses on the generalized metropolization of this largely urbanized country (Bassand, 2004), the authors show the existence of a structure that is not only polycentric as far as the major urban regions of Zurich-Basle, Geneva-Lausanne and Berne are concerned, but also maintains a functional separation between these metropolitan spaces. In their analysis of the mobility behavior of daily commuters between 1970 and 2000, the authors observed the presence back in 1970 of a spatial logic consistent with the models of Walter Christaller (1933), namely the presence of a hierarchy of large and small towns spread over the territory and functioning relatively autonomously as first- and second-degree polarities. In contrast, the year 2000 sees the organization of a polycentric urban region incorporating Zurich and its surrounding areas, and extending as far as Basle. The Geneva-Lausanne region too follows this trend, whereby existing polarities become increasingly interdependent. The originality of the article by Dessemontet *et al.* lies in the fact that it differentiates between the type of behavior of daily commuters depending on whether they travel by public transport or by car. While car use reflects a diffuse and non-hierarchical interconnection between polarities within metropolitan regions, the use of public transport reflects a hierarchical structure of hubs, shaped by the public transport system. The development of rapid regional public transport links has led to the expansion and consolidation of the hierarchical structure (hubs) of polycentric metropolises.

Regarding telecommunications, Mok et al. demonstrate how the internet has not led to fewer contacts at local level and how the different means of communications are used in a complementary manner to maintain relations. As regards the mobility behavior of commuters, Dessemontet et al. show how the density of mobility networks sustains cohesion within urban regions. Both studies show the rising importance of medium and long-distance relations, which in turn leads to a greater interconnectedness between cities. Dessemontet et al. show considerable insight by overturning the top-down hypothesis that usually considers that the global networking of major urban regions leads to a process of metropolization at the regional level. The authors posit that the construction of a highly efficient public transport network has led to Zurich qualifying as a global city by generating a rescaling process. They believe that the process of metropolization, which was kick-started by an efficient and densified rail network, strengthens the standing of this region in the network of global cities because a large catchment area is bolstered thanks to the cohesion of the polycentric metropolis of Zurich.

3.2. The co-evolution of world cities

The intensification of long-range networks increases cities interdependencies. The articles by Taylor et al. (External Urban Relational Process: Introducing Central Flow Theory to Complement), and Bretagnolle and Pumain (Simulating Urban Networks Through Multiscalar Space-Time Dynamics. Europe and United States, 17th-20th Centuries) examine the issue of the co-development of cities through the networks that they share. Both take classic Christallerian networks as their starting point but go further by linking them to networks related to the new globalized division of labor. Pumain and Bretagnolle describe the advances that are being made as regards the multilevel modeling of urban systems. Although their methodology differs, both articles concur on concepts. Cities are considered as processes that have always interacted not only because of their function as a central places but also as connector of multiple global flows. This interaction involves both competition and collaboration.

Peter Taylor, Michael Hoyler and Raf Verbruggen examine central flow theory and propose that a clear distinction is made between the process of central place (town-ness) and central flows (city-ness) in the analysis of the development of major urban regions. The authors use the concept of town-ness to refer to the historical processes identified since the work of Christaller, whereby the development and hierarchies of cities are founded on the local relations between towns and their hinterland, which constitute their catchment areas. Central place development is therefore the result of the local and contiguous dynamics of concentration. In contrast, the central flow and city-ness approach facilitate the analysis of the development of cities from the perspective of their inclusion in global networks and their relations with their hinterland and their hinterworld. The aim of these processes is the identification of the non-local dynamics at play in the growth of urban regions.

The historical modeling of the development of cities proposed by Anne Bretagnolle and Denise Pumain apply the concomitant dynamics of central places and central flows. Since the work of Fernand Braudel (2002), one know that the history of the major European cities during the 16th century was characterized by their ability to impose an intercontinental dimension on the structure of the world economy, as reflected, for example, in the power of Venice, Lisbon and Amsterdam to conquer and develop Asia and Africa. The work of Bretagnolle and Pumain bears out these continental and intercontinental processes, using them to explain the pattern that emerges with regard to European and North American metropolises. In their article, Bretagnolle and Pumain develop an urban development model that includes variables, which link in with central place dynamics and the town-ness concept defined by Taylor et al., namely cycles of innovation, the evolution of the degree and form of cities' economic and industrial specialization and the impact of transport and communication infrastructures. The interest in this historic modeling lies in the fact that it identifies the other factors behind development that were not originally included in the model. For European cities, these concern the central flow processes by emphasizing the weight of world cities identified by Fernand Braudel and the importance of long-distance trade and exchanges. In the United States, the development model required the addition of variables such as exchange functions that follow a development gradient, which begins with the spatial "colonial" conquest from East to West before climbing rapidly at the during the economic boom, spearheaded by major cities like New York, Los Angeles and Chicago.

With these two articles, three process levels are connected (a point which is explored in the Rozenblat article): the individual level of the creation of social and economic networks ("sub-nodal" according to Taylor et al., and "micro" according to Bretagnolle and Pumain, or Rozenblat); the city level ("nodal" or "meso") and the urban network level ("network" or "macro"). When Bretagnolle and Pumain model cities as agents, individual processes of exchange and networking are emerging, connecting the macro-process structures at the urban system level. Both articles also propose linking several concomitant dynamics, namely local relations (which Taylor et al. refer to as "town-ness") and global relations ("city-ness"). Bretagnolle and Pumain clearly demonstrate the need to link these dynamics and their interaction when

"reconstituting" prevailing networks in Europe and North America. They also use models to support the idea that links must be established between various levels and multiscalar model validations. Given their different histories, there are clear time shifts and differing intensities between the US and Europe. Their future quantification would facilitate a better understanding of the processes at play in cities, and in particular the quantification of the equilibrium between the local and global processes, as called for by Taylor et al.

Both articles show that the joint processes of central flow and central place have led to the consolidation of mega-city regions and polycentric metropolises (Hall & Pain, 2006) across the two continents. But within metropolises clusters and hierarchies give rise to potential dynamics of cohesion and fragmentation which can run counter to the sustainable development of urban systems. To understand the local adjustment between regional- and global-scale networks, one must cast a more discerning eye on how these metropolitan regions function depending on the role they play in the entire system.

3.3. The co-production of cities and networks at local and global scales

The local-global duality of the co-production of cities and networks is the subject of three articles (Castells, Rozenblat and Zeller) featured in this special issue. Manuel Castells (Globalization, Networking, Urbanization: Reflections on the Spatial Dynamics of the Information Age) begins with the following proposition: "the key spatial feature of the network society is the networked connection between local and global". He states that "there are not global cities but global networks that structure and change specific areas of some cities through their connections". Castells concentrates on describing the transnational multi-dimensional infrastructure of connectivity, knowledge sites and communication networks as attractors of cities. Manuel Castells stresses that new communication and transport technologies have led to the emergence of a space of flows on the global scale and of polycentric metropolises, which bring together sometimes distant spaces in a multipolar logic. According to a fractal-type logic, the global networking of mega-city regions is concomitant with networked metropolitan development. For Castells, the major metropolitan regions represent sites in which the hubs of multi-layered networks are concentrated, corresponding to the various convergent logics of spatial organization. The major metropolises become mega nodes, similar to the concentrations observed by Céline Rozenblat in the automobile and agrofood industries. At the metropolitan level, these mega-nodes develop according to a logic which is increasingly dissociated with the places of day-to-day life, thus clearly illustrating the parallel emergence of clustering and an inframetropolitan hierarchy in the organization of the economy and the global society.

Céline Rozenblat (Opening the Black Box of Agglomeration Economies for Measuring Cities Competitiveness Through International Firm Networks) evaluates local connections between different firm networks. Her article goes beyond an analysis of the presence of an urban region in a single network of firms by comparing the location strategy of multiple firm networks. Rozenblat tests the new outlooks generated by the crossbreeding of economies of agglomeration and economies of inter-urban networks. The figure of the hub once again appears to be a determining factor because the most dynamic cities, such as London, Amsterdam, Brussels, Philadelphia and New York, benefit from the agglomeration of multiple firm network hubs in both sectors. These cities all occupy a central location for firms and benefit from the presence of six multinational firms on their territory. They act as bridges at the core of increasingly diffuse networks linking European and North American cities through the localization of different subsidiaries. This first round of research shows the economies of urbanization and economies of scale, from which these global cities benefit, beyond – or perhaps thanks to – their dynamism in the financial and advanced services sectors.

Moving away from the individual level to the level of major pharma firms, the article by Christian Zeller (The Pharma-Biotech-Complex and Interconnected Regional Innovation Arenas) deals with a similar

network scale that extends from the metropolitan to the global. He demonstrates that the internal networks of the two major Swiss pharmaceutical firms (Novartis and La Roche) connect a small number of distant metropolitan spaces (the Basle region and the Rhine Valley, the east and west coasts of the United States, and Southeast Asia), while still managing to nurture their local sites. In doing so, a hub-and-spoke distribution emerges, with the spokes extending over very long distances. The dynamics of the network development of the two main pharmaceutical firms are concentrated in the structuring of a hinterworld that links the urban region of Basle with the east and west coasts of the US. This is therefore a practical example of the co-construction of places and flows. The reconversion of the Swiss pharmaceutical industry involved investment in innovation incubators located close to the Massachusetts Institute of Technology and Stanford University, while company development was driven by inclusion in existing biotechnology clusters, thereby contributing to the reinforcement of these sites of innovation. While the greater Basle region comes low in global cities rankings, it leads the way with regard to the geography of the innovative biotech industry, which has allowed this metropolitan space to enjoy rapid economic and urban growth for 15 years. The article by Dessemontet *et al.* shows that the Basle region is quite autonomous from the polycentric metropolis of Zurich but is nevertheless part and parcel of it. This inclusion therefore consolidate Basle place in the network of major metropolises.

All three articles complement each other, one theoretical and global in scope (Castells), the second methodological (Rozenblat) and the third empirical (Zeller). These three contributions show that cities create global networks through their ability to amalgamate their internal networks. The article by Céline Rozenblat focuses on the cities' capacity for synergy and interconnection. She suggests that the economies of agglomeration of cities are processes which are produced by micro networks. Consequently, she underlines how the internal networks of cities contribute to increasing their centrality in global networks. Christian Zeller also applies these principles to pharmaceutical industries and biotechnology research. He demonstrates two fundamental empirical ideas: how these cities are mutually reinforcing and how global networks affect the internal shape of cities. At first glance, this seem to contradict the claim by Castells that "the global network of scientific research does not overlap with networks of technological innovation". However, Zeller finds that this does occur but only in specific fields, thereby suggesting, like Rozenblat, that different networks co-exist to some degree in the same cities.

3.4. Who runs networks? The power issue

If we are to understand the relation between flows and places for inframetropolitan and intermetropolitan networks, we must address the issue of power. As Taylor et al. highlight, one shouldn't reify urban networks. The organizational choices and the strategies of the economic, social and cultural stakeholders shape urban and inter-urban spaces. Manuel Castells also reiterates that cities are not the hubs of global networks. They instead constitute a huge diversity of hubs of industrial, economic, social and cultural networks located in major urban regions. The deep exploration of inter- and intraurban networks repeatedly addresses the issue of power and the need to identify stakeholders that manage them. Christian Zeller underlined the considerable influence of the Swiss pharmaceutical industry in the transformation of the urban region of Basle and in the consolidation of the Greater Boston area in the US as an incubator of innovation. Local government action is implicitly addressed in the articles by Pierre Dessemontet *et al.* and by Manuel Castells, in particular their capacity to develop inframetropolitan communication infrastructures, which connect multiple polarities.

In his theoretical article John Allen (Powerful City Networks: More than Connections, Less than Domination and Control) notes that the power of cities is derived chiefly from their stakeholders. For example, London is powerful because of the ability of its financial centre to structure the global finance system. This observation by Allen casts a critical and fair eye on the tendency towards the reification of the domination of global cities

and underlines the spatial ambiguity as regards the power of cities. Allen further calls into question the notion of a world dominated by powerful cities. There is nothing to suggest that the power of cities is a zero sum game and that the privileged position of a few global cities is acquired at the detriment of the vast majority of urban spaces, which subsequently find themselves relegated to a subordinate position. The co-development of the financial centers of Frankfurt and London over the last decade shows that these highly interconnected cities knew how to capitalize on their interconnectedness and thus mutually reinforce their positions. No mention was made of the fact that the power of London's financial centre was diminished by the decision to set up the European Central Bank in Frankfurt. The place of cities in global networks is not a zero sum game and the interdependencies between spaces continue to grow stronger. The power of cities, therefore, is not contingent on their ability to dominate the world as was the case for Venice and Amsterdam in the 16th century. John Allen posits that their power may depend more on their ability to connect to one another or to remain connected. To express it another way, the power of cities rests in their ability to steer networks and "the power to hold the networked arrangements together".

Cities are powerful when they become the pivotal points of several networks and are highly connected to a large number of cities. This point is demonstrated very clearly in the article by Rozenblat, in which she identifies major hubs shared by the automobile and agrofood industries, such as Philadelphia, New York, London and Amsterdam. While John Allen exposes the ambiguity which has long weighed heavily on the phenomenon of global cities generally considered to be "naturally" dominant, his article also constitutes a call for further research on how urban stakeholders arrangements, including economic and political players, effectively manage to hold networks together. Technical infrastructures and networks can be determining for the consolidation of interconnectivity. Mirroring the position adopted by Manuel Castells almost twenty years before them, Dessemontet *et al.* claim that for Zurich the unprecedented advances in communication infrastructures has led to the re-organization of the metropolis thanks to intrametropolitan transport networks.

4- A research agenda

Rather than closing the book on the study of urban networks, this special issue demonstrates that much is still not known about the subject. Below we propose four possible leads for future research.

1- To advance our knowledge of the multiplicity of networks that render urban regions interdependent, future research could build on the work of Mok *et al.* and contribute to a better understanding of the spatiality of social networks. The analysis of urban networks to date has overly focused on the networks of industrial firms and service providers and has tended to underestimate cultural, social and political networks, which unite cities at the international level. As regards the study of social networks, the article by Mok *et al.* could be extended to cover both mail and social networking websites such as Facebook and Twitter with the aim to a better understanding how distance influences these new forms of interpersonal communication (Castells, Fernandez-Ardevol, Qiu, & Sey, 2007). Furthermore, a geographical approach to the networks of social movements, religious networks, diasporas and municipal/local authority networks could, for example, offer new ways to map the links between cities that go beyond individual relations and are aside from relations between economic players. This type of mapping would be essential to test the extent to which the organization of major metropolises in networks is also cultivated not only in the flows of capital accumulation but also in the spaces of social and political life. Dessemontet *et al.* show that there have been insufficient analyses of networks at the metropolitan level. The emergence of polycentric metropolises is the physical manifestation of social processes that have been partly decoded. Furthermore, a specific

analysis of the function of regional communication networks would facilitate our understanding of how local infrastructure networks support the inclusion of these spaces in interurban networks by increasing their size and reinforcing their connectivity.

2- Comparative research on the analysis of central flows and central places, as defined by Taylor et al., could build on the work of Taylor *et al.* and of Bretagnolle et Pumain to propose a more precise evaluation of the degree of interaction between the two processes. This research would also demonstrate how the inherited urban frameworks and path dependency interact with the new frameworks of innovation. In turn, methods could be developed with a view to endowing the historical models of urbanization by Bretagnolle and Pumain with a predictive scope as regards cities in the current glocalization process, described by Taylor *et al*. The awareness of past processes and their transformation should allow us, insofar as it is possible, to grasp the present and the near future of major urban regions.

3- Following, the results presented in the articles by Castells, Rozenblat and Zeller, the analysis of the connections between hubs of firm networks and the formation of mega-nodes in metropolitan regions opens up new horizons to re-examine economies of agglomeration. By combining micro, meso and macro levels, a particular focus could be an examination of local cooperation between firms that are active in different economic sectors but have chosen to locate their business in the same metropolitan space. Empirical research could inform the theoretical and methodological formalization of the links between various levels at which urban processes take place.

4- Finally, the hypotheses expressed by Allen demonstrate the need for greater research on urban networks from qualitative sociology and political perspective, which would supplement the work carried out in the field of geography. The key issue here is to understand the practical nature of relations between multiple networks which interconnect within cities. This deeper analysis of stakeholders - economic, social and political – under the networks' command should generate clear information on the processes and strategies which allow the mutually reinforcing of inter- and intraurban connections. The detailed analysis of the strategies adopted by the pharmaceutical industries carried out by Christian Zeller offer convincing support for the utility of focusing on the strategies of those stakeholders who reorganize this multiple networks.

All of the articles featured in this special issue constitute a coherent yet varied contribution to this field of research, their work are simultaneously overlapping and diverging. It is hoped that this will encourage greater interdisciplinarity in the field and stimulate a thought-provoking and conducive debate on issues related to cities and networks.

Bibliography

Aydalot Ph. (1985) Economie régionale et urbaine. Economica.

Bairoch P. (1985) De Jéricho à Mexico : Villes et économies dans l'Histoire. Gallimard.

Bassand, M. (2004) La métropolisation de la Suisse. Lausanne: PPUR/Savoir Suisse.

Braudel, F. (2002) The Wheels of Commerce (Civilization and Capitalism: 15Th-18th Century -Volume 2). Berkeley: University of California Press (1979 for the French édition).

Burt R. (2005) Brokerage and Closure: an introduction of social Capital. Oxford: Oxford University Press.

Castells, M. (1996) The Rise of the Network Society. Oxford: Blackwell.

Castells, M. (2008) The Networked City. In: G. Pflieger, L. Pattaroni, C. Jemelin & V. Kaufmann (Eds.) The Social Fabric of the Networked City, pp. v-xiii. Lausanne: EPFL Press / Routledge.

Castells, M., Fernandez-Ardevol, M., Qiu, J. L., & Sey, A. (2007) Mobile Communication and Society: A Global Perspective. Cambridge (MA): The MIT Press.

Christaller, W. (1933) Die zentralen Orte in Suddeutschland. Jena: Fischer.

Hall, P., & Pain, K. (2006) The Polycentric Metropolis. Learning from Mega-City Regions in Europe. London: Earthscan.

Granovetter M. (1973) The strength of Weak Ties, American journal of socology, 78, pp. 1360-1380.

Guimera R., Mossa S., Turtschi A., and Amaral L. A. N. (2005). The worldwide air transportation network: Anomalous centrality, community structure, and cities' global roles, PNAS vol. 102 no. 22 7794–7799. http://www.pnas.org

Krugman P. (1993) First nature, second nature and metropolitan location, Journal of regional science, 33, pp. 129-144.

Mumford, L. (1961) The city in History, its origins, its transformations and its prospects. New York: Harcourt, Brace & World.

Offner, J.-M., & Pumain, D. (Eds.) (1996) Réseaux et territoires. Significations croisées. La Tour d'Aigues: Editions de l'Aube.

Pumain D. (1997) Pour une théorie évolutive des villes, L'Espace Géographique, 2, pp. 119-134.

Pumain D. (2008) The Socio-Spatial Dynamics of Systems of Cities and Innovation Processes: a Multi-Level Model, in: S. Albeverio, D. Andrey, P. Giordano, A. Vancheri (Eds.), The Dynamics of Complex Urban Systems. An Interdisciplinary Approach, , pp. 373-389. Heidelberg: Physica Verlag.

Sassen, S. (1991) The Global City. New York, London, Tokyo. Princeton Princeton University Press.

Veltz, P. (1996) Mondialisation, villes et territoires : L'économie d'archipel. Paris: PUF.