

**Mapping urban networks**

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**Analysing and visualising the changing functional urban hierarchy in Germany and Switzerland**

Urban regions in Europe experience a reorganisation of functional division of labour in favour of the emerging knowledge economy. The requirements for knowledge creation drives companies to develop their location network as part of their overall business strategy, whereby highly specific human resources and core competencies are combined in order to create innovation. The locational strategy considers both the location of the firm's internal functions and the location of suppliers and customers. These internal and external linkages are woven across physical space, not only connecting firms and parts of firms together, but also more or less dispersed cities and towns. Agglomeration economies result from the clustering of these knowledge-intensive firms in certain areas enabling them to benefit from geographical proximity (Boschma, 2005; Torre & Rallet, 2005)), urbanisation and localisation economies (Boix & Trullén, 2007; Henderson, 2003; Hoover, 1937; Jacobs, 1969)) as well as from traded and untraded interdependencies (Storper, 1997)). At the same time, the functional logic of the knowledge economy has significant impacts on network economies, since companies spread their activities globally in order to source inputs and gain access to emerging markets (Cabus & Vanhaverbeke, 2006; Simmie, 2003)). Since knowledge intensive firms tend to optimize their value chain in order to have access to information and knowledge, urban systems undergo a constant alteration. The cyclical nature of the financial crisis in 2008 displays an additional cause to reorganize the value-added process within knowledge generation. Even though the economic crisis in Germany and Switzerland may not have caused a sustained recession, the structural change towards a knowledge economy has brought about structural challenges for the two economies in the long term. Furthermore, regions' development differs within upswing and downturn phases and therewith change their relative positions within the urban system (Schwengler & Loibl, 2010).

As the size, the organisational complexity and the geographical spread of knowledge-intensive firms increase, intra-firm networks between their geographically dispersed parts are becoming highly significant. Through their attempts to provide a seamless service to their clients across the globe, many knowledge-intensive firms have created multi-location networks of offices in cities around the world. The flows between these offices – e.g. information, data, instructions, ideas, people – link cities and regions together. In this sense, firms can be understood as “inter-lockers” of cities and regions based on their business practice (Taylor, 2004)). This idea has been taken-up by the interlocking network model, developed by the Globalisation and World Cities Study Group (GaWC) (Taylor, 2004). This model forms a two-mode network in which the co-presence of firms links cities. Collecting information on intra-firm networks of multi-branch, multi-location enterprises, the model estimates potential flows of knowledge-creating information between cities (Derudder & Taylor, 2005)).

Taking a relational perspective, we examine how the crisis is affecting the networks of multi-branch, multi-location firms and changes the form of the functional urban hierarchy. Spatially, this is reflected in an increasingly functional urban division of labour. One can assume that the economic crisis has acted as a catalyst in the global regrouping of value-added chains, with mobile production factors tending to boost the competitive edge of particular locations. According to Derudder, Hoyler and Taylor (2011), the economic crisis is a catalyst of a subjacent structural change (Derudder, Hoyler, & Taylor, 2011, p. 173). We can therefore assume that systemic ruptures in the network of value chains will first become visible in financial centres. Aalbers (2009), for example, expects the emergence of secondary financial centres like Hong Kong, Dubai, Shanghai, Mumbai and Singapore to be encouraged by the economic crisis. However, the decline of primary financial locations like New York and London is unlikely (Aalbers, 2009, p. 73)). Moreover, the national context seems to play a crucial role in how these regions perform during the economic crisis. This calls for a multilevel analysis that takes the functional importance of regions into account (Dijkstra, Garcilazo, & McCann, 2015).

The aim of this paper is twofold: Firstly, we use a data set from the years before the crisis with 480 firms of the knowledge economy with more than 2500 locations worldwide. This produces a complex network that links German and Swiss city regions with global locations. This gives insights into the spatial patterns of these networks of knowledge intensive firms in Germany and Switzerland and which spatial scales these firms operate on. We combine this relational analysis with information about employment changes in knowledge intensive sectors. Secondly, based on these preliminary results we present a framework to examine the impacts of the crisis. This development is reinforced by the continuing rise of the Asian national economies, above all China and India. The High-Tech sector has already positioned itself fairly strongly in these markets. Knowledge-intensive services are bound to follow this trend with those fields that are open to the industrialization of business processes. Thereby the interdependencies between the “new Asian centres of globalization” and the metropolitan areas in Germany and Switzerland will increase. On a national scale, the functional urban hierarchy is likely to become steeper. Metropolitan areas in contrast, with a strong knowledge basis and intense connectivity with the emerging markets in Asia, should exhibit a stronger resilience to economic crises than peripheral economic areas.

Our analysis is complemented by methods and tools of visualisation, in particular Social Network Analysis (SNA), Geographical Information Systems (GIS) and spatial statistics. Therewith, we combine and relational and geographical data and analyse them simultaneously. We finally suggest that methods of visualisation should be used as integrative part of the research design.

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