Cities 60 (2017) 84–90

Contents lists available at ScienceDirect

Cities

journal homepage: www.elsevier.com/locate/cities

Full Length Article

Asymmetric global network connectivities in the world city network, 2013

Xiaolan Yang [a], Ben Derudder [b,*], Peter J. Taylor [c], Pengfei Ni [d], Wei Shen [e]

[a] School of Economics, Central University of Finance and Economics, Beijing, People's Republic of China
[b] Department of Geography, Ghent University, B9000 Gent, Belgium
[c] Department of Geography, Faculty of Engineering and Environment, Northumbria University, Newcastle upon Tyne NE1 8ST, UK
[d] Chinese Academy of Social Science, Beijing, People's Republic of China
[e] Management School, Lancaster University, Bailrigg, Lancaster LA1 4YX, UK

ARTICLE INFO

Article history:
Received 4 March 2016
Received in revised form 4 July 2016
Accepted 8 August 2016
Available online xxxx

Keywords:
Connectivity
World city network
Producer services
China
New York
London

ABSTRACT

This paper builds upon world city network studies using the interlocking network model to introduce an additional way of measuring inter-city connectivity. Using firms' service values for cities to indicate directions of potential workflows, a new measure of asymmetric network connectivity is specified to include uneven power relations in the analysis. This is then employed in analyses of the latest service values matrix (175 firms × 526 cities) for 2013. Two types of analyses are performed. First, the aggregate measures of asymmetric network connectivity are computed and compared to the conventional measure of global network connectivity. Results show an accentuation of the hierarchical tendencies in the world city network. Second, the asymmetric connectivity is disaggregated into its three components - dominant, equivalence and subordinate - to produce a set of further measures. Results tend to distinguish dominant 'global places', often financial centres, from places where firms 'have to be', largely capital cities of medium-sized states.

1. Introduction

The subject of this paper is cities in globalization, and more specifically transnational inter-city relations. There has been a burgeoning literature on this topic over the last couple of decades, including many studies of these relations as direct infrastructural links in both real space (air travel, shipping routes) and cyberspace (the Internet), such as Choi, Barnett, and Chon (2006); Derudder and Witlox (2005); Ducruet and Lugo (2013); Mahutga, Ma, Smith, and Timberlake (2010); Matsumoto (2004), and Smith and Timberlake (2001). Other measures of inter-city relations adopted in this literature are derived from information on corporate command structures, specifically headquarter-subsidiary relations, which indicate flows of directive between cities in the manner pioneered by Pred (1977) (e.g. Alderson, Beckfield, & Sprague-Jones, 2010; Rozenblat & Pumain, 2007; Rozenblat Zaidi & Bellwald, 2016).

In a parallel stream of research, such direct measures of inter-city relations have been complemented by indirect measures based upon models of potential workflows between cities through their advanced service functions (Taylor, 2001; Taylor et al., 2010; Taylor & Derudder, 2016). Drawing on (1) the seminal work of Sassen (1991) on the 'global city' and the importance of advanced producer service firms therein, and (2) Castells' (1996) writings on 'spaces of flows' as the prime social space in economic globalization, in this literature an 'interlocking network model' has been devised to study contemporary cities as global service centres constituting a world city network (for the most recent overview of this on-going project, see Taylor & Derudder, 2016). This approach, one of the key streams of research carried out under the umbrella of the Globalization and World Cities (GaWC) research network, has become an established way of measuring and understanding inter-city relations. However, there remain many openings for new research developments by expanding the conceptual and operational remit of the interlocking network model (Derudder & Parnreiter, 2014). In this paper, we focus on one particular research development: that of a more nuanced – in this case: disaggregated – specification of inter-city relations. We apply this insight to revise the initial model specification and produce new results that complement our earlier understanding of cities in globalization.

The most commonly reported output from the interlocking network model is its measure of a city's global network connectivity. Couched in network analysis terminology, global network connectivity is a measure of *degree centrality*: the number of links incident upon a node (i.e. a city). This measure provides a general indication of the degree of integration of a city into the world city network. For instance, it has been shown that of Sassen's three archetypal global cities, London and New York appear to be much more *connected* than Tokyo (e.g. Taylor &

* Corresponding author.
E-mail addresses: yangxiaolan@cufe.edu.cn (X. Yang), ben.derudder@ugent.be (B. Derudder), crogfam@gmail.com (P.J. Taylor), nipf@cass.org.cn (P. Ni), wei.shen@lancaster.ac.uk (W. Shen).

http://dx.doi.org/10.1016/j.cities.2016.08.009
0264-2751/

Derudder, 2016, chap. 5). In this paper we retain our focus on cities' integration into the network but move on to consider the *nature* of that integration by re-specifying and disaggregating the degree centrality measure. In network analysis, the most common elaboration of degree centrality is to disaggregate it into *outdegree* and *indegree centrality*, respectively, and this depending on the 'direction' of the flows incident upon a city. These measures have been employed in parallel research on inter-city relations (e.g. Alderson & Beckfield, 2004; Alderson et al., 2010; Krätke, 2014; Rozenblat & Pumain, 2007; Rozenblat et al., 2016; Wall & Van der Knaap, 2011), but to date the research stream drawing on the interlocking network model has not really followed suit. In this paper, we explore how the directionality of flows can be incorporated in, and subsequently enrich the application of, the interlocking network model.

Recent research by Neal (2014, 2016) and Hennemann and Derudder (2014) has already started investigating the potential of refined and alternative measures of connectivity in the context of the interlocking network model. Here we complement these emerging efforts to extend quantitative research on world city networks by focusing on the asymmetries in relations between cities. To this end, we introduce the idea of asymmetrical global network connectivity in which the directions of potential work-flows are included in the measurement. To illustrate the new suite of measures, we compare them with the conventional measurement of connectivity using the latest data for 2013. Thus in addition to a conceptual contribution, the paper also has a basic empirical contribution through an assessment of asymmetries in inter-city relations within contemporary globalization.

The conceptual and empirical offerings are integrated in an argument that proceeds in three parts. First, we introduce the interlocking network model, summarize the original specification and operationalization, and discuss how it has been extended and amended. Second, we discuss the addition of the asymmetric component. Comparisons of results suggest that asymmetric connectivity, in which we distinguish between the centrality of cities in 'sending' and 'receiving' flows, accentuates hierarchical tendencies in the world city network. In addition, there appears to be a capital city and a world-regional patterning to the differences between the measures. Third, in a short conclusion we assess the importance of this model re-specification and its empirical results for research on inter-city relations within contemporary globalization.

2. Beyond the interlocking network model

2.1. The interlocking network model

In this paper, we focus on the GaWC research that has specified transnational inter-city relations as an *interlocking network created by producer services firms* (Taylor, 2001). The latter are identified, following Sassen (1991), as prime producers of connections between cities, through their financial, creative and professional work in multiple offices across the world (cf. Beaverstock, Smith, & Taylor, 1999). Our starting point is that producer service firms working through multiple knowledge-rich cities are essential to the operation of contemporary globalization. Although not the largest of firms in global terms, advanced producer services are nevertheless an 'indicator sector' in the complex ecology that is the global economy. Just like indicator species in nature demonstrate the wellbeing or otherwise of an ecology, this indicator sector shows the same for today's worldwide economic process. In other words, through our approach we are not describing economic globalization as a whole but rather focusing on some of the strategic places in its organization. Given this, in our description of results we resort to broad vignettes for interpreting cities' connectivity profiles as per our methodology and data.

The starting measure in this approach is a service value v_{ij} with information on the importance of the presence of firm j in city i. These observations can be arrayed as a service value matrix *V*. In network analysis, this matrix is commonly termed a two-mode network (Liu & Derudder, 2012). In contrast to one-mode networks (e.g. airline networks), where actors are directly interlinked, a two-mode network is characterized by connections between two separate sets of nodes (e.g. firms and cities). However, it is possible to infer one-mode networks from two-mode networks by applying a 'projection function' (cf. Neal, 2014). The interlocking network model is such a projection function, as it converts *V* so that it gives us insight in the interaction *between cities through firms* rather than simply taking stock of firms' presences in cities.

The projection function entails converting the service value matrix V into a relational matrix R of city interactions, and ultimately draws on seeking out co-presences of firms in cities. The basic measure is city-dyad connectivity CDC_{a-b} between cities a and b for each pair of cities and firms based on V:

$$CDC_{a\text{-}b} = \Sigma_j v_{aj}.v_{bj} \quad a \neq b \tag{1}$$

Network projections come with a specific set of assumptions (Neal, 2014). In the interlocking network model, the conjecture behind conceiving CDC_{a-b} as a surrogate for actual flows of inter-firm information and knowledge between cities is that the more important the office, the more connections there will be with other offices in a firm's network. A city's overall connectivity – which we term 'global network connectivity' (GNC) – can then simply be calculated by aggregating all possible links:

$$GNC_a = \Sigma_b CDC_{a\text{-}b} = \Sigma_{bi} v_{ai}.v_{bi} \quad a \neq b \tag{2}$$

Values for city-dyad connectivity CDC_{a-b} and global network connectivity GNC_a form the evidential basis on which much of GaWC's quantitative research is based.

2.2. Data production and results

The model specification detailed in the previous section clarifies that data gathering requires (i) identifying a set of global service firms, (ii) selecting a set of cities that likely make up the world city network, and (iii) finding or deriving service values that show the importance of each city to the office network of each service firm. The details of the latest data gathering exercise for 2013 are described in Taylor and Derudder (2016, chap. 4), here we summarize the main steps in the production of the data matrix of the services values of global service firms across world cities.

First, we selected leading firms in 5 different sectors: 75 financial services firms, 25 management consultancy firms, 25 advertising firms, 25 law firms, and 25 accountancy firms. The information on the location strategies of the 175 firms was gathered between October 2012 and February 2013. For each sector, the top-ranked firms were chosen based on sectoral rankings for 2012, which tended to be based upon 2011 data. We also identified substitute firms (i.e. ranked just below 75 and 25) to cover for situations where a firm had disappeared (e.g. been taken over) during the actual data collection. Although the data collection spans a 2012–2013 timeframe – we will refer to the data as being for 2013 for shorthand purposes.

Second, city selection is based on a number of overlapping criteria. In addition to the original 315 cities that featured in the initial data gathering described in Taylor, Catalano, and Walker (2002), we also included all cities with a population of more than 1.5 million inhabitants in 2008; all capital cities of states with a population of more than one million, and every city with a headquarter office of one of our selected firms. This led to the selection of 526 cities. It is this roster of cities that is used in recording information on the global service networks of 175 firms.