COMMENT

A Critical Comment on the *Taylor Approach for Measuring World City Interlock Linkages*

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In the study of economic-geographic structures, the shifting focus from the national state to the city and its region has highlighted the lack of reliable interurban data sets. The abundance of usable data sets on international structures and flows has no counterpart when studying interurban relations, which makes it hard to draw any extensive conclusions regarding the structure of world city networks.

Instead of relying on available data sets, Peter Taylor has developed a method for generating data sets that, it is argued, can be used in research on the structure of the world city network. In this approach, actors are defined as cities with internal attribute service values, values reflecting the presence of different transnational service-producing corporations in each city. The structural values between each pair of cities are then established by a mathematical formula based on the service value of each firm in each pair of cities.

This procedure can be criticized on two accounts. First, although internal attributes on exceptional occasions can be used as a proxy and as a rough estimate for structural values, such studies must have a firm theoretical underpinning in order to be valid from a network-analytical perspective. If not, such generated structural values become nothing more than a function of internal attributes, thus losing the whole basic idea of social network analysis. Second, the Taylor function used for generating structural values can be questioned. Why should a large presence of TNC offices in a pair of cities imply a larger city interlock link than would be the case between a high-ranked city and a low-ranked city, as the city with the larger service value probably serves cities with a lower service value with economic command, control, and support functions?

1. INTRODUCTION

At the Globalization and World Cities Study Group and Network (GaWC), Peter Taylor and his colleagues have developed a method for analyzing the world city network and its structural features through an analysis, and subsequent data processing, of office establishments in different cities of a set of transnational service-producing firms (Taylor 2001; Taylor, Catalano, and Walker 2002). Due to the lack of available

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data sets on interurban flows and structures (Short et al. 1996), Taylor and his colleagues explicitly prefer to generate structural data instead of relying on scarce existing sources (Beaverstock et al. 2000, p. 44).

There is no doubt that the data acquisition of such service-producing firms is relevant and a valuable contribution for understanding certain aspects of the network of world cities and the workings of the world system at large. Studying the interconnectedness of these firms using network-analytical concepts and tools should most certainly give us valuable insight into contemporary globalization processes. However, by deconstructing the procedure and the formal specification of the approach to the world city network presented by Taylor and his colleagues, it becomes quite clear that the specification put forward by GaWC has some serious methodological and conceptual flaws.

2. ACTORS AND STRUCTURES IN ECONOMIC GEOGRAPHY

When analyzing socioeconomic systems, the focus and the accompanying research methodology has overwhelmingly been actor-oriented. By focusing on the internal properties of the actors in a system, the implicit assumption is made that an overarching understanding of a system can be reached by studying and understanding its component parts. This approach is very much evident in neoclassical economic theory where relevant variables, such as supply, demand, preferences, and utility-maximizing functions, are all attributes of the actors making up the system; external aspects that are deemed relevant in such studies are often internalized into the actors. In economic geography, this tendency can be seen in locality studies (Massey 1984) as well as the flexible production paradigm (e.g., Scott and Storper 1986), where the internal attributes of actors are deemed more paramount than the structures connecting such actors.

The network-analytical approaches in economic geography, as presented by Haggett (1965) and Haggett and Chorley (1967; 1969), did address structural properties, but similar to most quantitative methods in economic geography such studies did lose significance in the turbulent postmodernist revolution that struck the discipline (Barnes 1996). Although there are trends for a renewed interest in network concepts in economic geography, such as Sheppard's call for positionality analysis (Sheppard 2002), the advances done in network-analytical methodology are not (yet) very well reflected in contemporary economic geography. A similar, although perhaps more newborn than reborn, interest in quantitative network analysis can be found in neoclassical economic research, motivated and exemplified by Nagurney (1999, p. xvi): "The identification of the network underlying an economic problem provides an added dimension to the analysis and computation of equilibria. [...] The network framework, therefore, provides not only a mechanism for the visual representation of economic problems and a means for viewing their similarities and differences but, in addition, a novel theoretical approach."

3. SOCIAL NETWORKS AND ECONOMIC GEOGRAPHY

A network consists of a set of nodes and a set of edges connecting pairs of nodes. Each node represents an actor of the system, and each edge represents a relation between a pair of actors. A relation can have a structural value attached to it and can be either directional or nondirectional. Networks can be represented as graphs or matrices. The directional network in Figure 1 is structurally equivalent to the data in Table 1.

The "novel theoretical approach" of network analysis is the explicit focus on structural data. Although actors, of course, have internal attributes and properties, aspects

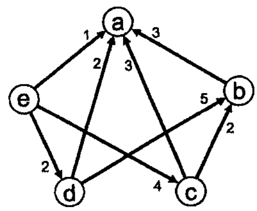

FIG 1. Graph Representation of a Network

TABLE 1
Matrix Representation of a Network.

	a	b	c	d	e
a	0	0	0	0	0
b	3	0	0	0	0
c	3	2	0	0	0
d	2	5	0	0	0
e	1	0	4	2	0

that in social network studies often are just as relevant as their structural counterparts, the novelty is all about the relational structures between actors.[1]

In economic-geographical contexts, actors often take the form of spatially defined entities on different scales and scopes, ranging from the body to the globe. However, the availability of structural data significantly depends on the geographical scale in which we choose to define these actors. The lack of data sets on the flows and structures on the intercity level has indeed hampered studies on this geographical level, thus making world city research agendas more adjusted to means than to ends.

4. TURNING APPLES INTO ORANGES: TRANSFORMING ATTRIBUTES INTO STRUCTURAL VALUES

In Taylor's specification of the world city network (Taylor 2001), cities are modeled as actors, each with its own subnodal network of transnational corporations. Based on the presence and properties of offices in each city, a "service value" v_{ij} is estimated for each firm j in each city i. In the example accompanying the formal specification, the internal service-value attributes are set to values between 0 and 3 depending on the status, size, and importance of the offices at each place.[2]

By using these attributes, represented as a matrix $\mathbf{V}$ with n rows of cities and m columns of firms, a matrix $\boldsymbol{R}$ consisting of "relational elements for each pair of cities" is created using the following formula (Taylor 2001):

$$r_{ab} = \sum_j (v_{aj} \cdot v_{bj}) = v_{a1} \cdot v_{b1} + v_{a2} \cdot v_{b2} + \ldots + v_{am} \cdot v_{bm} \tag{1}$$

1. See Wasserman and Faust (1994) for a more detailed description of basic concepts, methods, and terminology in social network analysis.

2. Although Taylor is himself critical of the way these service values are measured (Taylor, Catalano, and Walker 2002, p. 2370ff), I assume in this paper that these values are accurate: my criticism is only concerned with how this data, assumedly correct, are processed further in order to generate structural network data.

Where r_{ab} is the "aggregate city interlock link," *a* and *b* are cities, and *j* is the index of the *m* firms where v_{ij} is the service value of firm *j* at city *i*.

The values of these aggregate city interlock links are further normalized in a matrix ***P***, and a "social distance" matrix ***D*** is created by taking the identity matrix[3] minus the ***P*** matrix, thus ending up with a matrix where low values indicate a tight bond between pairs of cities.

The fundamental flaw with Taylor's approach is how attributes, that is, internal properties of the actors, are transformed into the matrix ***R*** in what looks like, and subsequent treated as, structural data. However, the matrix ***R*** does not contain structural data; instead it contains the product of internal attributes for pairs of cities. Treating such values as structural data misses the whole point with network analysis: instead of using the scarcely available structural data, the specification proposed by Taylor artificially creates something that looks like structural data, although it is not.

By breaking down equation (1), it is apparent that the ***R*** matrix is the sum of the "interlock link" matrices for each respective firm;let us label these separate firm interlock matrices $\boldsymbol{Q}_j$ where *j* is the firm index. By using Taylor's own example data (Taylor 2001, Table 1) we can then create such an interlock matrix for an individual firm (Firm I). Using this data, excluding the cities where the firm's service value is zero, we get the service value matrix for Firm I, ordered by service value, as presented in Table 2.

Intuitively, both from the firm's viewpoint and from a world-system perspective, it would be conceivable that the Paris–Milan connection would be larger than the Paris–Chicago or Milan–Chicago connection. It would also seem reasonable that both of these European cities would have far stronger ties to London than they would have to Los Angeles, based on the hypothesis that London, having the firm's largest service value in Europe, would act as a command and control center for the firm's activities in Europe. Following this reasoning, the Chicago–New York and Chicago–Los Angeles connection should also be larger than Chicago's connection to London, just as the Paris–London connection would be larger than the Chicago–London connection.

In Table 3, the firm's interlock linkage matrix ***Q*** is presented, demonstrating the inherent problem with the generation of structural data through internal attributes. While the relational value between Paris and Milan is only 1, the Paris–Chicago and the Milan–Chicago links are 2 respectively. The Paris–London interlock link is of magnitude 3, while the Chicago–London interlock has a value of 6. The triad of London, New York, and Los Angeles all are connected with interlock linkages of 9, surprisingly being three times the interlock linkage value between London and Paris. These conceived anomalies are made the more obvious when dividing the gross

TABLE 2
Service Value for Firm I.

	Service Value
London	3
Los Angeles	3
New York	3
Chicago	2
Milan	1
Paris	1
Tokyo	1
Sum	**14**

NOTE: Extract from Taylor (2001,Table 1)

3. The identity matrix (often called ***I***) is filled with zeros except for the diagonal that contains unity (1).

TABLE 3
City Interlock Links for Firm I.

	London	Los Angeles	New York	Chicago	Milan	Paris	Tokyo
London	(9)	9	9	6	3	3	3
Los Angeles	9	(9)	9	6	3	3	3
New York	9	9	(9)	6	3	3	3
Chicago	6	6	6	(4)	2	2	2
Milan	3	3	3	2	(1)	1	1
Paris	3	3	3	2	1	(1)	1
Tokyo	3	3	3	2	1	1	(1)
Sum	**42**	**42**	**42**	**28**	**14**	**14**	**14**

connectivity of the firm in each city (Table 3, last row) with the firm's total service value (Table 2, last row): we then end up with the original service value for each city, which proves that these oranges are still very much apples, and the ranking of the gross connectivity is the same as the service value ranking of the cities.

Although the above reasoning is done for a single example firm in only a handful of cities, equation (1) tells us that the conceptual and methodological problems are in no way ironed out if we add more firms and cities. On the contrary, the underlying flaw with Taylor's procedure is instead hidden behind the vast volume of generated artificial interlock data. When Paris and Tokyo swap places in the ranking order of total service value and gross connectivity (Taylor, Catalano, and Walker 2002, Tables 2 and 3), this only tells us that Paris has a wider variety of firms, although with a mean service value for each firm less than Tokyo, all based on the workings of equation (1). As a matter of fact, this comparison between actors' attributes can be readily seen in the original matrix **V** consisting of the actors' internal attributes before the transformation into the so-called structural data.

Taylor uses an algorithm based on the multiplication of pairs of this specific actor attribute, i.e., the "service value" of firms for each pair of cities, an approach motivated as follows (Taylor 2001, p. 186): "The conjecture behind using these values [the service value matrix] is that the larger the office the more connections there are with other offices in a firm's network. This needs to be empirically investigated, here it is treated as a plausible assumption as long as large data sets are used to iron out idiosyncracies." There is, however, no theoretical explanation on why the interlock links are established through a multiplicative procedure. This is something that indeed must be theoretically underpinned: why two cities with large TNC presence are more closely knit in a geometric fashion to each other than the connection between two cities with a large and a small service value respectively, as exemplified by the values in the city interlock for a single firm (Table 3).

In network analysis, there are instances where internal attributes can be used as an approximation of a network's structural properties. In the behavioral sciences, qualitative interviews of individuals-as-actors regarding how they relate to other actors in a social system is directly targeted at obtaining structural properties through actor-based attributes, that is, actors' responses to questions concerning the actors' relationships to others. Carley (1991) uses a constructural method to derive "group characteristics" by analyzing the characteristics and behaviors of individual group members, thus conducting a similar transformation of internal actor attributes into structural values. Carley's transformation has a solid theoretical foundation attached to the process that, along with the type of actor attributes— the possession of information—combined with the high resolution of such attributes and the context of the study—information exchange among interacting social groups—do result in a model where structural changes can be predicted successfully.

5. CONCLUSION

Economic geography does indeed suffer from a lack of data suitable for analyzing intranational and supranational structures. Compared to the data availability when it comes to international structural data, such as trade flows in global commodity networks, structural analyses of interurban systems are faced with a multitude of piecemeal data sets of varying quality. It is definitely problematic to acquire structural data between and within transnational corporations than what is the case regarding national economies, thus making it difficult to conduct quantitative studies of the network of world cities and how it evolves in time and space.

Social network analysis is a perfect structural-analytic complement to the traditional actor-oriented research methods in science in general and economic geography in particular, the latter in which locational attributes perhaps have been too emphasized in the modeling and the understanding of spatial economic structures. Several such studies have been conducted, mostly on the international scale (Snyder and Kick 1979; Smith and White 1992; Sacks, Ventresca, and Uzzi 2001; Kick and Davis 2001) but increasingly also on interurban scales—Mitchelson and Wheeler (1994) using Federal Express shipment data, and Smith and Timberlake (1995; 2001; 2002) using airline passenger data.

However, the lack of structural interurban data sets cannot be alleviated by generating artificial data sets based on internal attributes of the actors: by doing so, the whole novelty of network analysis is discarded. Although the data mining done by Taylor and his colleagues of course can be criticized with regards to accuracy, it is still a valuable contribution to the accumulation of information about the *attributes* of actors in the world city network. Nevertheless, such data should be treated for what it is and not transformed into structural pseudodata. There are exceptions where artificially generated structural data based on actors' attributes can be a viable substitute for structural data, but such exceptions must rest on solid theoretical and conceptual foundations.

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