Urban Studies, Vol. 42, No. 9, 1593–1608, August 2005

Leading World Cities: Empirical Evaluations of Urban Nodes in Multiple Networks

Peter J. Taylor

[Paper first received, July 2004; in final form, January 2005]

Summary. This is an empirical paper that uses an interlocking network model to evaluate the importance of leading world cities within contemporary globalisation. Cities are treated as locales through which four globalisations—economic, cultural, political and social—are produced and reproduced. Sixteen sets of data describing agents of global network formation, such as global service firms, NGOs and UN agencies, are analysed to measure cities' overall network locations and sub-net articulator roles. Analyses are synthesised in a taxonomy of leading world cities that identifies five classes of 'global city' and types of other world cities.

Introduction: Return to Leading World Cities

In the globalisation literature, important cities have come to be known by two different names: world cities and global cities. For some, the two terms are interchangeable; the classic case is Anthony King's (1990) book entitled *Global Cities* wherein all chapter headings refer to 'world cities'. Saskia Sassen (1991), on the other hand, in her *Global City*, makes a case for using this new term to distinguish contemporary leading cities from past 'world cities': it is *global* cities that are unique to our age. However, one problem of this latter usage has been to imply that globalisation is the preserve of just the major cities across the world. Hence, Marcuse and van Kempen (2000) coined the term 'globalising cities' to make the point that globalisation processes are to be found operating across many more cities than just a few 'global cities'. Taking the latter point on board, I prefer to use the phrase 'cities in globalisation' and in empirical studies of large numbers of such cities I use a model I call the 'world city network' (Taylor, 2004a). This eschewing of Sassen's widely used concept does not necessarily mean that I reject her argument for the existence of special leading cities that we may identify as 'global'. The world city network most certainly is not a collection of largely equal cities; it exhibits strong hierarchical tendencies in its formation. Therefore, I have reserved the right to return to this matter and explore the existence of 'global cities' in the sense of especially important cities in the world city network (Taylor, 2004a, p. 42).

I have used the term 'leading world cities' in my title to indicate an initial neutral stance in the question of global cities. An important criticism of the impact of Sassen's (1991) study was that it encouraged research on just a few leading cities at the expense of many others. At GaWC,[1] we responded to this situation by carrying out studies involving large numbers of cities, with data covering more than 300 cities (Taylor *et al.*, 2002a), and most analyses are of over 100 cities (Taylor *et al.*, 2002b), with some over 200

Peter J. Taylor is in the Department of Geography, Loughborough University, Loughborough, LE11 3TU, UK. Fax: 01509 223 930. E-mail: p.j.taylor@lboro.ac.uk.

0042-0980 Print/1360-063X Online/05/091593–16
DOI: 10.1080/00420980500185504

(Derudder *et al.*, 2003). In this paper, I return to focusing upon leading cities but this does not mean that such large perspectives are being abandoned. Quite the contrary, in fact: leading cities can only be identified and understood in the context of their relations with myriad other cities across the world. That is to say, if London is indeed to be interpreted as a 'global city' it will be because many other cities, through their dependences and interdependences with London, make London special. This paper provides empirical evaluations of cities within the world city network to find nodes that appear as notably important.

The empirical focus is based upon a theoretical perspective that emphasises intercity relations. Although most urban/city theory deals with the internal relations of cities, this can only provide a partial understanding of cities. Cities, historically and today, operate together in groups that form networks of activities. Whether it is early modern diasporas of merchants across European cities from the Mediterranean to the Baltic, or contemporary multinational corporations with their multilocation global policies centred on cities world-wide, every city exists as a cluster of activities that are interlinked to clusters of activities in other cities. In other words, cities form interlocking networks; under conditions of contemporary globalisation these are world city networks (Taylor, 2004a). It is such networks that are my subject-matter here.

The paper builds upon previous empirical papers that have evaluated cities in terms of economic relations (Taylor *et al.*, 2002a and 2002b); the distinctiveness of this paper is that the evaluation extends beyond economic globalisation. Data are derived and analysed for cultural, political and social globalisation processes to define several networks of cities in globalisation. This is important because 'cities as economic centres' is only part of their contribution to contemporary global practices. As Allen *et al.* have pointed out

> There is not simply one network of cities 'out there', but rather various networks with different paths of development (Allen *et al.*, 1999, p. 5)

This is also, of course, in keeping with Castells' (1996, p. 224) concept of the middle strata of his space of flows in which Sassen's economic flows through global cities is but one of many types of networks. Thus 'multiple networks' are the key feature of this paper, bringing together results from different global realms of social activity into a single argument.

The paper divides into five sections. It begins with an outline of an interlocking network model upon which all analyses are based. The model defines the data needs and these are addressed in the second section. These data are then analysed in two distinctive ways to evaluate the importance of cities in world-wide networks. In the third section, cities are measured in terms of their nodal characteristics within networks. Two measures are involved: computing the size of the city as a node in the network, which is the quantity of network agency that is found within a city; and computing how these network agencies link the city to other cities, which is the network connectivity of the city. These measures represent the site and situation properties of a city within a network as previously defined (Taylor, 2001, pp.184–187). In the fourth section, cities are measured as 'articulators' of particular processes within the network; this identifies cities as critical nodes within the operation of sub-sections of a world network. The idea of articulation is taken from Friedmann (1995); principal components analyses are employed to measure this process as previously deployed (Taylor *et al.*, 2004; Taylor, 2004a). In the final substantive section, results from both analyses are brought together to create a taxonomy of cities to provide a composite picture of leading world cities in the original spirit of Peter Hall's (1966) functionally comprehensive concept.

The Model: Interlocking Networks of Cities

This model has been outlined in detail elsewhere (Taylor, 2001, 2004a) and here I provide a basic outline followed by a simple

example of the first two measures, nodal size and interlock connectivity.

The model defines a process of world city network formation. The agents of this formation are institutions that use cities as networks in the everyday pursuit of their goals. Among the agents used below are financial and business service firms, non-governmental organisations and media conglomerates. The world city network is constituted as the aggregate of agents' office networks (offices are where the practice of network formation is on-going). The model defines an 'interlocking network' because the agents 'interlock' cities through their activities (Knoke and Kuklinski, 1982). For instance, global law firms in the practice of providing services for corporate customers will use offices in different cities through which flows of information, knowledge, instruction, ideas, plans, strategies, personnel, etc. will flow. The world city network is constituted as an aggregation of myriad such intrafirm connections.

The basic empirical problem in measuring this interlocking network is that information on the flows that create the intercity relations are not available: the data collection effort to identify and quantify such flows would be enormous for studying the whole world city network, even if enough institutions allowed such outside access to their operations which is highly unlikely. Thus it is necessary to derive indirect measures of the flows. This requires finding related data that are available and then feeding this information into a carefully specified model so that flows can be estimated. The interlocking model has been specified with just this goal in mind (Taylor, 2001). Data can often be found on the office networks of institutions and these can be inputted into the model to provide indirect measures of flow. I use Table 1 to illustrate this modelling. It is made up of artificial data that describe the number of partners in six law firms across offices in five cities.[2] From an interlocking network perspective, these data describe six transnational office networks that collectively constitute a transnational city network of legal services.

The interlocking network model is specified as follows. There is a set of n institutions with offices across m cities, wherein the activity of institution i in city j is v_{ij}. In the pedagogic case study (Table 1), $n = 6$ and $m = 5$, and v_{ij} is given by the numbers of partners. Partners are typically the basic units through which work flows in law firms and therefore it is a reasonable assumption that the numbers of partners working in a city is a good measure of a law firm's activity in that city. Given this information, there are two basic ways in which the importance of cities within the network can be measured. They are stated formally as follows.

1. Size of a node as measure of city site. The simplest measure of importance is the total activity within a city, which defines the size of the node in the network. Thus

$$S_a = \sum_i v_{ia} \tag{1}$$

where, S_a is the nodal size of city a.

This is a site measure because size incorporates information only on city a and no other city. This is a simple sum of the rows in Table 1 as listed in the penultimate column. Obviously this shows that New York is by far

Table 1. Pedagogic case study I: nodal size and interlocking connectivity

	Law firms							
City	1	2	3	4	5	6	Site (size)	Situation (connectivity)
New York	5	3	5	2	4	5	24	193
Hong Kong	4	3	2	3	2	3	17	165
Frankfurt	2	5	2	2	5	2	18	162
Boston	1	2	0	5	2	2	12	117
Manchester	2	0	1	1	0	0	4	45

the most important node in our small transnational city network and Manchester is the least important. In other words, New York has the most legal work activity going on (i.e. it has most partners) and Manchester has least activity.

2. Connectivity of a node as measure of city situation. Interlocking connectivity is the main measure of importance of a node in this model. It assumes that the quantity of flows between two cities generated by an institution is a function of that institution's activities in each city. Flows between pairs of cities are estimated from the intercity products of their institutions' activities. The reason for using this multiplicative function can be understood by referring again to Table 1. Consider Law Firm 3. Manchester's 1 partner has potential links with no partners in Boston, 2 partners in Amsterdam and Hong Kong, and 5 partners in New York. On the other hand Amsterdam's 2 partners each have these numbers of partner links—for instance, producing 4 potential links (2 × 2) between Amsterdam and Hong Kong and 10 (2 × 5) between Amsterdam and New York. Summing all such products for all institutions in a city across every other city in the network defines interlocking connectivity

$$C_a = \sum_j \sum_i v_{ia} \cdot v_{ij} \quad \text{(where } a \text{ does not equal } j\text{)} \qquad (2)$$

where, C_a is the interlock connectivity of city a.

This connectivity of city is a situation measure because it relates city a to all other cities within the network. The results of applying equation (2) in the pedagogic case study are shown in the final column of Table 1. Note that the ranking of cities is different between this measure and nodal size: Hong Kong and Amsterdam swap places. This shows that, although Amsterdam has more overall activity than Hong Kong, Hong Kong has more connections. In general, cities with large nodes made up of institutions with relatively few other city offices will have less interlocking network connectivity than a smaller node whose institutions have offices in a very large number of other cities. Therefore, although the site and situation measures are by no means independent, they are distinctive in their measurement of a city's importance within a network.

As noted above, the model has been developed to be easily operationalised. The data requirements for such a model consist of an 'activity value matrix' that arrays cities against institutions. In each cell, a score indicates the activity in a city by an institution pursuing its usual business. Table 1 displays just such a set of data. However, beyond legal services, it is very difficult to obtain such a specific measure of city office activity as the number of law firm partners. Thus, other various forms of information have to be deployed to indicate the importance of a city office within an institution's office network. This generates very diverse information across institutions, a result that requires standardisation across institutions to make analyses possible. For instance, in studying advanced producer service firms, the importance of cities to each firm has been scored between 5 (headquarter location) and 0 (no office in the city), with scores of 1, 2, 3 and 4 allocated using a variety of indicators of office importance.[3] The artificial data in Table 1 can be interpreted in this way: New York has 3 headquarters of law firms, Amsterdam 2, and Boston 1 with Hong Kong and Manchester having no headquarters; Manchester has 2 very minor offices (scoring 1), and so on. It is just such activity value matrices that are used for analyses in this study.

Data for Multiple Networks

The interlocking model was initially developed to measure the world city network using advanced producer service firms following Sassen's (1991) identification of the latter as key agents of global city formation. This research produced site and situation measures from a 315 cities × 100 global service firms matrix (wherein 'service values' ranging from 0 to 5 indicated the quantity and quality of service provided by a firm in a

city, as just described in the last section (Taylor *et al.*, 2002a; Taylor, 2004a)). Results from this work are reported in this paper alongside new results from 7 other datasets similarly constructed plus 2 datasets from other researchers. The latter were not collected for measurement within the interlocking network model but do produce comparable results as will be shown below. All datasets used in this paper are listed in Table 2.

I have divided the datasets into four broad spheres of activity that define economic, cultural, political and social globalisations respectively. Of course, any scrutiny of this division of activities will show it to be quite fuzzy, but it is a useful starting-point because it emphasises the wide range of data that are brought together in this paper. And, importantly, the datasets, although varying in size, are all relatively large. This is vital for measuring nodal size and interlock connectivity which both involve aggregating activity values: the more institutions the less particular idiosyncrasies of particular institutions are reflected in the results.

The economic datasets are from two sources. First, there are the original GaWC data on advanced producer firms previously analysed in detail in Taylor (2004a). Here, I break down the data into six sectors to explore patterns below the general producer service level. Secondly, I will report on results from Alderson and Beckfield's (2004) study of firms in cities. They use data on headquarters and subsidiaries of 446 of the world's 500 largest corporations for which they could find the necessary information.[4]

The cultural datasets also comprise two separate information gatherings. First, I use data collected by Stefan Krätke (2002) on media conglomerates and previously analysed in Krätke and Taylor (2004). These data record the number of affiliates each conglomerate has across cities. Secondly, data on design professional firms in engineering and architecture have been collected as activity matrices (i.e. like Table 1).[5] From these data, architectural firms have been identified and analysed separately (see also Knox and Taylor, 2005).

There are three separate political datasets that represent the scales at which governance primarily operates. At the global scale, data have been collected on UN agencies that operate through cities across the world.[6] At

Table 2. Datasets for interlocking network modelling

Sphere of activity (globalisations)	Network formation agents ('interlockers')	Number of cities	Year of collection
Economic	100 global advanced producer services firms, of which:	315	2000
	18 global accountancy firms/groups	315	2000
	15 global advertising agencies	315	2000
	23 global banking/finance corporations	315	2000
	11 global insurance companies	315	2000
	16 global law partnerships	315	2000
	17 global management consultancy firms	315	2000
	446 multinational enterprises from *Fortune*'s "Global 500"[a]	3692	2000
Cultural	33 global media conglomerates	185	2000
	44 global architectural-engineering firms, of which:	234	2002
	21 global architectural partnerships/groups	234	2002
Political	76 UN agencies	405	2003
	195 national diplomatic embassies/offices	320	2003
	3 city government global organisations	2133	2003
Social	63 global NGOs (humanitarian/environmental)	149	2002
	2 768 615 scientific papers[b]	70	1996–98

[a]Data collected for a different analysis by Alderson and Beckfield (2004) and adapted for interlocking modelling.
[b]Data collected for a different analysis by Matthiessen *et al.* (2000) and adapted for interlocking modelling.

the national scale, the representations of states through cities across the world are recorded as presences in capital cities and other important cities.[7] Finally, at the local level, memberships of three world-wide organisations of cities are recorded—WACLAC (World Alliance of International Associations of Cities and Local Authorities) which engages mainly in UN lobbying (including ATO (Arab Towns Association) with 384 members, CITYNET with 114 members, EUROCITIES with 113 members and Metropolis with 78 members); Global Cities Dialogue with 142 members; and World Federation of United Cities with 1380 members. Only the first two datasets constitute activity matrices; the latter data are included to indicate local-level processes but only limited analysis is possible as detailed below.

The social globalisation material encompasses two contrasting datasets. First, NGOs have been selected from the *2001–2002 Yearbook of International Organisations* from categories that relate to social movements: human rights, humanitarian and environmental. From these lists, NGOs for which adequate information could be found were used to create an activities data matrix (for further details and analysis see Taylor, 2005b).[8] Finally, I draw upon the comprehensive study of scientific papers by Matthiessen *et al.* (2000) who analyse millions of scientific papers and their citations. I focus upon multi-authored papers in their work that show academic connections between cities and their universities across the world.

These 16 datasets and subsets each allow me to estimate the importance of cities in terms of size attributes and situation relations. Although three of the datasets (multinational enterprises, city government organisations and scientific papers) are not in the form required for a GaWC analysis, results from these data are adapted to indicate the importance of cities through their site and situation. Thus I am able to provide a uniquely comprehensive assessment of the importance of leading world cities across four spheres of globalisation. This is the prime contribution of this paper.

The Site and Situation of Leading Cities in World-wide Networks

I present empirical results from all 16 datasets in the same way to facilitate comparison. For both site and situation, the top five cities are identified and ranked. Also for each set of five cities, the levels of size and connectivity of the cities ranked from 2 to 5 are presented as proportions of the top city's scores. This allows evaluation of degree of top city dominance across different spheres of activity. In this section, results are reported and briefly commented upon; overall assessment of the results is left to a later discussion wherein sub-net articulation cities are also included. Results are presented by spheres of globalisation.

Economic Globalisations

General indications of the leading world cities in economic globalisation are shown in Table 3. It is noteworthy that four cities appear in every top five: London, New York, Paris and Tokyo. This is entirely consistent with the consensus on leading world/global cities in the literature. But there are important differences between the listings. In advanced producer services, London and New York clearly dominate in both size and connectivity but for multinational corporations it is Tokyo that dominates for size and New York for connectivity, with London a distant second and Tokyo falling to fourth. The latter result shows that, while Tokyo has more corporations, those in New York have more links across the world. Breaking down the advanced producer services results into sectors also shows a variety of city lists (Table 4). As expected, London and New York dominate all lists with New York overhauling London for advertising and management consultancy. Tokyo joins with London and New York to form a troika at the top of the banking/finance sector lists. Hong Kong, as gateway to the booming Chinese producer service market, is also prominent across several lists.

Table 3. Sites and situations of leading cities in economic globalisations

Site (nodal size)			Situation (network connectivity)		
Rank	City	Score	Rank	City	Score
100 Advanced producer services					
1	London	1.00	1	London	1.00
2	New York	0.97	2	New York	0.98
3	Hong Kong	0.69	3	Hong Kong	0.71
4	Tokyo	0.66	4	Paris	0.70
5	Paris	0.64	5	Tokyo	0.69
Fortune *Magazine's "Global 500"* [a]					
1	Tokyo	1.00	1	New York	1.00
2	New York	0.71	2	London	0.76
3	Paris	0.70	3	Paris	0.66
4	London	0.54	4	Tokyo	0.53
5	Düsseldorf	0.35	5	Los Angeles	0.38

[a]From Alderson and Beckfield (2004, Table 3); site is defined by 'outdegree', connectivity by 'indegree'.

Cultural Globalisations

Although the categories comprising this activity sphere are quite different, their top five lists show similarities (Table 5). Again, London and New York dominate. However, in media they are rivalled in importance by Los Angeles and Paris. In architecture, other US and Pacific Rim cities come to the fore (but not Hong Kong). This reflects the importance of the Pacific Asian urban development market serviced from both the US and Australia. However, overall, the dominance of London in architectural activities is quite exceptional.

Political Globalisations

The results for the three scales are quite distinctive (Table 6). At the global scale, UN agencies bring in 'Third World' cities for the first time. The particular differences between site and situation are also noteworthy in this case. Whereas New York and Geneva totally dominate the site measures, for situation Geneva is number one and New York is not in the list (it is actually ranked sixth). New York in the UN network is the clearest case of an exceptionally large node whose connections are less than expected. For the national scale, diplomatic missions are pretty well as expected, with Washington, DC topping both lists followed by capitals of major countries and New York because of its UN HQ function. The list for organisations of local governments is totally distinctive mixing European and 'Third World' cities. Although different from the cities listed for UN connectivity, this does suggest that it is regions outside the Americas that spawn cities with political practices that are global.

Social Globalisations

Although London tops three of the four listings in Table 7, two quite distinctive patterns emerge. For NGOs, 'Third World' cities appear again and, in fact, dominate when it comes to connections. These results do tend to imply that in this 'global civil society' wherein NGOs are seen as pioneering, large nodes are in the 'First World' (control centres) with highly connected nodes in the 'Third World' where the practice necessarily is (Glasius and Kaldor, 2002). In contrast, academic links most obviously do not include 'Third World' cities. Two features are noteworthy here. First, there is the identification of two large Japanese nodes. However, the nodal size of Japanese cities does not translate into leading connected cities. Secondly, in terms of connectivity, here we have US

Table 4. Sites and situations of leading cities in economic globalisations: disaggregated by service sectors

Site (nodal size)			Situation (network connectivity)		
Rank	City	Score	Rank	City	Score
Accountancy					
1	London	1.00	1	London	1.00
2	New York	0.88	2	New York	0.87
3 =	Chicago	0.62	3	Paris	0.68
3 =	Paris	0.62	4	Los Angeles	0.66
3 =	Toronto	0.62	5	Toronto	0.65
Advertising					
1	New York	1.00	1	New York	1.00
2	London	0.83	2	London	0.79
3	Hong Kong	0.61	3	Hong Kong	0.60
4	Amsterdam	0.58	4	Toronto	0.58
5 =	Sydney	0.55	5	Sydney	0.57
5 =	Tokyo	0.55			
Banking/finance					
1 =	London	1.00	1	London	1.00
1 =	Tokyo	1.00	2	New York	0.98
3	New York	0.98	3	Tokyo	0.94
4	Hong Kong	0.87	4	Hong Kong	0.85
5	Singapore	0.81	5	Singapore	0.80
Insurance					
1	London	1.00	1	London	1.00
2	New York	0.72	2	New York	0.74
3	Hong Kong	0.66	3	Hong Kong	0.71
4 =	Chicago	0.53	4	Los Angeles	0.60
4 =	Singapore	0.53	5	Paris	0.59
Law					
1	London	1.00	1	London	1.00
2	New York	0.98	2	New York	0.89
3	Washington, DC	0.76	3	Frankfurt	0.68
4	Hong Kong	0.66	4	Hong Kong	0.67
5	Frankfurt	0.62	5	Washington, DC	0.66
Management consultancy					
1	New York	1.00	1	New York	1.00
2	London	0.95	2	London	0.87
3	Paris	0.75	3	Paris	0.76
4 =	Milan	0.69	4	Madrid	0.73
4 =	Stockholm	0.69	5	Stockholm	0.72

cities at last appearing to 'punch their weight' within world city networks.

The results above are summarised in Table 8. Cities are listed that have more than two mentions in the above tables—i.e. they must appear in at least two activities. Just 15 cities are thus identified and London and New York stand out.

Sub-net Articulator Cities

The measures deployed so far have been summaries of importance of cities over the whole network. Such measures may miss out important cities that are at the centre of sub-networks within the larger whole. All our descriptions of the world city network have indicated that

Table 5. Sites and situations of leading cities in cultural globalisations

Site (nodal size)			Situation (network connectivity)		
Rank	City	Score	Rank	City	Score
Media					
1	London	1.00	1	London	1.00
2	Los Angeles	0.69	2	New York	0.74
3	New York	0.65	3	Paris	0.74
4	Paris	0.60	4	Los Angeles	0.68
5	Berlin	0.54	5	Milan	0.65
Architecture and engineering (composite)					
1	London	1.00	1	London	1.00
2	New York	0.92	2	New York	0.66
3	Singapore	0.86	3	Beijing	0.61
4	Hong Kong	0.83	4	Singapore	0.57
5 =	Washington, DC	0.78	5	Shanghai	0.56
5 =	Chicago	0.78			
Architecture					
1	London	1.00	1	London	1.00
2	New York	0.51	2	Sydney	0.52
3	San Francisco	0.51	3	New York	0.52
4	Singapore	0.49	4	Singapore	0.52
5	Los Angeles	0.49	5	Washington, DC	0.51

Table 6. Sites and situations of leading cities in political globalisations

Site (nodal size)			Situation (network connectivity)		
Rank	City	Score	Rank	City	Score
UN agencies					
1	New York	1.00	1	Geneva	1.00
2	Geneva	0.93	2	Brussels	0.66
3 =	Bangkok	0.30	3	Addis Ababa	0.64
3 =	Washington, DC	0.30	4	Cairo	0.60
5	Brussels	0.25	5	Bangkok	0.58
National diplomatic missions					
1	Washington, DC	1.00	1	Washington, DC	1.00
2	New York	0.83	2	Tokyo	0.97
3	Tokyo	0.81	3	London	0.95
4	London	0.79	4	Paris	0.88
5	Berlin	0.70	5	New York	0.87
Local government global organisation					
1 =	Manila	1.00	1	Rome	1.00
1 =	Rome	1.00	2	Lyon	0.50
3	Bangkok	0.83	3	Barcelona	0.25
4 =	Lyon	0.67			
4 =	Mumbai	0.67			
4 =	New Delhi	0.67			
4 =	Paris	0.67			

Table 7. Sites and situations of leading cities in social globalisations

Site (nodal size)			Situation (network connectivity)		
Rank	City	Score	Rank	City	Score
NGOs (humanitarian/environmental)					
1	London	1.00	1	London	1.00
2	Washington, DC	0.79	2	Geneva	0.93
3	Geneva	0.74	3	Washington, DC	0.89
4	Nairobi	0.74	4	Nairobi	0.82
5	Manila	0.70	5	Manila	0.80
Scientific research collaboration					
1	London	1.00	1	London	1.00
2	Tokyo	0.98	2 =	Los Angeles	0.83
3	San Francisco	0.73	2 =	San Francisco	0.83
4	Paris	0.72	4	Boston	0.75
5	Osaka	0.69	5 =	Basle	0.58
			5 =	Geneva	0.58
			5 =	New York	0.58

there are key cities that are strategically positioned in the network at the intersections of regional locations and functional activities (Taylor 2004a; Taylor *et al.*, 2004). To identify such cities requires techniques that divide the overall network into coherent parts wherein key cities can be identified. The method I use is principal components analysis.

Principal components analysis is a technique that reduces a data matrix to its major dimensions (Rummel, 1970). With an activities matrix, the locational strategies of n institutions—the geography of their office network—are reduced to k common service patterns, where k is appreciably less than n. Basically institutions are clustered into groups on the basis of like geographies. It is this technique—R-mode principal components analysis with varimax rotation—that has been applied to the advanced producer service data to good effect (Taylor, 2004a; Taylor *et al.*, 2004). The results consist of component loadings to show which institutions belong to which dimension-cluster of institutions, and component scores which show which cities are important within the common locational strategy. The latter are given as standardised measures so that, if the scores are normally distributed, results appreciably above two should be relatively rare. One of the features of using this technique with activities data matrices is that scores are generated that are very much larger than two. This indicates very strong concentrations of activity in particular cities. These are interpreted as sub-net articulator cities, cities where concentrations of activities exist within specific parts (dimensions/components) of the world city network.

Table 8. Leading world cities by site and situation (number of mentions in Tables 3–7)

City	Site	Situation	Total
London	14	14	28
New York	13	13	26
Paris	7	7	14
Hong Kong	6	5	11
Tokyo	6	4	10
Washington, DC	5	3	8
Los Angeles	2	5	7
Singapore	4	3	7
Bangkok	2	2	4
Brussels	2	2	4
Geneva	2	2	4
Chicago	3	0	3
San Francisco	2	1	3
Sydney	1	2	3
Toronto	1	2	3

The technique is illustrated in Tables 9 and 10 where the data from Table 1 are subjected

Table 9. Pedagogic case study II: data for principal components analysis

City	Institutions (e.g. firms) 1	2	3	4	5	6
New York	**5**	3	**5**	2	4	**5**
Hong Kong	4	3	2	3	2	3
Frankfurt	2	**5**	2	2	**5**	2
Boston	1	2	0	**5**	2	2
Manchester	2	0	1	1	0	0

Note: Cities with HQ functions (values of 5) are **emboldened**.

to such an analysis. The data matrix is reproduced in Table 9 to facilitate interpretation. In this case, the geographies of the six initial institutions are reduced (Table 10) to three common patterns (i.e. $n = 6$ is reduced to $k = 3$). From the loadings, it can be seen that component I represents law firms 1, 3 and 6; component II represents law firms 2 and 5; and component III represents just law firm 4. In this paper, I am interested particularly in the scores. These show for component I that New York has by far the largest score—note that the three institutions loading on this component have activity values of 5 for New York. In other words, New York is the articulator city for this sub-net. Similarly, Frankfurt is the articulator city for component II and Boston is the articulator city for component III. Again, there is a simple relation to these two cities having activity values of 5 with the law firms making up the component. In a larger analysis, relationships between data and scores will be more complex but the general principle will hold: the network can be divided into sub-nets of city–institution relations within which component scores identify important cities in the sub-net that can be identified as a sub-net's articulator city. Note that, since we would expect approximately 95 per cent of standardised scores (19 out of every 20) to be below ± 2 in a typical normal distribution, the 15 scores from this simple analysis are all relatively low. With larger analyses, some scores will be found above 2, some appreciably so, and it is the latter that imply very hierarchical sub-net structures.

This principal components technique has been applied to 8 of the 16 datasets shown in Table 2. For economic globalisation, I use the whole producer services data (from Taylor *et al.*, 2002b; and Taylor, 2004) plus the subset for banking/finance (other sectors have two few firms). For cultural globalisation, I use the media data (from Kratke and Taylor 2004a) and both architecture-engineering and the architecture subset (from Knox and Taylor, 2005). For political globalisation, I use the UN agency data and the diplomatic offices data (from Taylor, 2005c). Finally, for social globalisation, I use just the NGO data (from Taylor, 2005b). Other datasets are not of the required structure for this exercise. Nevertheless, there is a good range of analyses covering all four globalisations. I do not provide full details of these analyses here, just the scores to identify articulator cities.

In Table 11, all such scores over 4 are listed from these 8 analyses. For a standardised

Table 10. Pedagogic case study II: sub-net articulator cities

Component I				Component II				Component III			
Institution loadings		City scores		Institution loadings		City scores		Institution loadings		City scores	
1	**0.96**	*NY*	**1.54**	1	0.05	NY	0.19	1	−0.21	NY	−0.19
2	0.15	HK	0.50	2	**0.97**	HK	−0.22	2	0.07	HK	0.36
3	**0.88**	FF	−0.74	3	0.30	*FF*	**1.51**	3	−0.34	FF	−0.60
4	−0.14	BT	−0.66	4	0.06	BT	−0.22	4	**0.99**	*BT*	**1.52**
5	0.27	MC	−0.3	5	**0.95**	MC	−1.26	5	−0.00	MC	−1.08
6	**0.88**			6	0.39			6	0.27		

Notes: High loadings and scores are **emboldened**; articulator cities are *italicised and underlined*.

Table 11. Ranking of articulator cities within globalisations

Standardised scores	Articulator city or cities	Realm of activity (globalisations)	Network formation agents
10.7	Geneva	Social	NGOs
10.2	Washington, DC	Social	NGOs
9.8	New York	Social	NGOs
9.7	London	Cultural	Media conglomerates
9.7	London	Social	NGOs
8.6	Brussels	Social	NGOs
8.5	Vienna	Political	UN agencies
8.1	New York	Political	UN agencies
8.0	Paris	Cultural	Media conglomerates
8.0	Tokyo	Social	NGOs
7.7	Washington, DC	Political	UN agencies
7.5	Geneva	Political	UN agencies
7.4 & 5.1	Munich and Berlin	Cultural	Media conglomerates
7.4	Manila	Social	NGOs
7.1 & 6.2	New York and Los Angeles	Cultural	Media conglomerates
6.9	London	Cultural	Architecture and engineering firms
6.7 & 4.7	Hong Kong and Washington, DC	Political	National diplomatic
6.6	Rome	Cultural	Media conglomerates
6.3	Beijing	Political	National diplomatic
6.3, 5.5 & 5.3	Paris, Washington, DC and Brussels	Political	National diplomatic
6.2	Bangkok	Political	UN agencies
6.0	Ottawa	Social	NGOs
5.9 & 4.1	Toronto & Sydney	Social	NGOs
5.8, 5.0 & 4.3	Stockholm, Copenhagen & Oslo	Cultural	Media conglomerates
5.7, 4.7 & 4.0	Tokyo, New York and Islamabad	Political	National diplomatic
5.6 & 5.2	New York and Washington, DC	Economic	Advanced producer service firms (US law)
5.5	Nairobi	Social	NGOs
4.9	San Francisco	Cultural	Architectural partnerships
4.8	New York	Cultural	Media conglomerates
4.7	Moscow	Social	NGOs
4.3	London	Economic	Advanced producer service firms (accountancy)
4.3	New York	Cultural	Architectural and engineering firms
4.2	Melbourne	Cultural	Architectural and engineering firms
4.1	Singapore	Political	National diplomatic
4.0	Zurich	Economic	Banking/finance corporations

value, 4 is an extremely high number and indicates very high concentrations of sub-net activity. However, using this high threshold still generates 46 cases of articulator cities. These are ranked by size in Table 11. The top 10 cases, all with scores of 8 and above, illustrate the results quite well: there are subsets of media conglomerate activities heavily concentrated in London and Paris, subsets of UN agency activity activities heavily concentrated in Vienna and New York, and, dominating the top of the table, there are six subsets of NGO activities heavily concentrated in Geneva, Washington, New York, London, Brussels and Tokyo. The latter six show the fragmented nature of the NGO networks

centred on leading 'First World' cities. Note that Vienna, which did not feature in the site and situation analyses, has its own sub-net that it dominates. There are eight instances where the articulation is shared between cities: for instance, New York articulates a media sub-net with Los Angeles and a law sub-net with Washington, DC.

One feature that is particularly interesting from these analyses is the fact that economic articulations have lower scores, less concentrated activity, than political, cultural and social articulations. This implies that the world city network of economic globalisation is more cohesive and has less hierarchical tendencies than the other city-based globalisations (most producer service analysis scores do not meet the threshold of 4). Put another way, non-economic globalisations appear to create very hierarchical sub-nets whereas economic globalisation sub-nets suggest a more horizontal network pattern. This is an important finding for debates over the nature of globalisation and its future (Taylor, 2004b).

A Provisional Taxonomy of Leading World Cities

The nature of contemporary globalisation is, of course, a highly contested question. But at the heart of most debates there is the notion of an acceleration of transnational activities and transactions that has (the potential) to change the spatial configuration of society. In Castells' (1996) terms, there is a dominance of spaces of flows over spaces of places in a new network society. Cities appear in this argument as prime grounding points, locales where globalisation is produced and reproduced. Short and Kim have provided the best succinct expression of this argument

> Globalisation takes place in cities and cities embody and reflect globalisation. Global processes lead to changes in the city and cities rework and situate globalisation. Contemporary global dynamics are the spatial expression of globalisation, while urban changes reshape and reform the processes of globalisation (Short and Kim, 1999, p. 9).

Cities have always projected their influence over surrounding regions economically, culturally, politically and socially, and today such projections have become global. Thus Jacobs' (1984) influential model of the projection of economic processes through cities can be adapted to interpretation of contemporary world cities in a global economy (Taylor, 2004a). Similarly, contemporary concepts of global civil society and global governance have been interpreted as processes operating in and through cities (Sassen, 2002; Taylor, 2005b and 2005c). This is the theoretical context within which the results above should be interpreted. However, this paper is essentially an empirical contribution and therefore I will use the method of taxonomy to provide a provisional means of thinking how results link to theory.

Taxonomies are orderings of objects that reflect their similarities and differences thus supplying basic suggestions about the processes of their construction. By looking at objects in the whole, taxonomies provide critical first steps towards understanding. In the case of contemporary leading cities, such a method allows me to return to the terms 'global city' and 'world city' and suggest a differentiation. Hierarchical tendencies have always appeared prominently in analyses of the world city network (Taylor, 2004a) and this is strongly represented in the results above. Thus I suggest use of the term 'global city' to describe the top echelons of these hierarchical patterns. This is identified in two ways: first, important global contributions across a range of spheres of activity; and, secondly, very strong global contributions in a particular sphere of activity. The remaining leading world cities also consist of two groups: sub-net articulator cities and cities with world-wide contributions in particular spheres of activity. In allocating cities, I have used results above supplemented by some findings that did not reach the high thresholds I have used: for top site and situation cities, I have considered top 10 positions. The final taxonomy is shown in Table 12.

Five levels of global city are identified. First, and clearly above all others, there are London and New York. All previous research

has highlighted the dominance of these two cities in the world city hierarchy (Taylor, 2004a) and they emerge here as the most important functionally comprehensive global contributors. They are followed by three cities slightly less important but still functionally comprehensive and with particular cultural strengths: Los Angeles, Paris and San Francisco. Finally, among the functionally comprehensive cities, there are seven incipient global cities identified in Table 12. In the second category of global niche cities, the three leading Pacific Asian cities are critical economic nodes in the world city network and there are also three critical nodes that are non-economic: Brussels, Geneva and Washington, DC. Thus a total of 18 cities are deemed to be global, actual or incipient.

The remaining world cities encompass articulator and niche cities. The former are focused upon sub-nets and there are 13 distributed between the 3 non-economic spheres. Classic examples are Vienna at the centre of a UN agency sub-net and Nairobi at the centre of a NGO sub-net. There are 21 niche world cities identified of which 7 have important concentrations of economic activities and 14 concentrations of non-economic activities. Frankfurt is typical of the first group with its concentration of banks while Manila is typical of the second group with its concentration of NGOs.

These two sets of cities represent the upper echelons of the hierarchical tendencies in world city networks. To reiterate a point made in the introduction, they do not encompass all globalisation processes, all cities as so involved, but they are the key locales that network formation agents are using in their everyday activities that are creating world city networks.

Concluding Comment

This paper has been a heavily empirical treatise. I make no apology for this. World city research has been notorious for its evidential deficit (Short *et al.*, 1996; Taylor, 1999; Alderson and Beckfield, 2004). In this paper, I have show some pathways taken in overcoming this problem so that it is possible to begin to say something empirically sound about world cities and their interrelations. To be sure, the techniques used are crude and basic and the same can be said for the data. Certainly, I do not pick up key processes that are important: any analysis that does not identify such specifically important world-cultural flows as those to Las Vegas, Mecca and Rome must be suspect. Thus, whereas this paper includes more data than have

Table 12. Taxonomy of leading cities in globalisation

Global cities
Functionally comprehensive global cities
(1) Leading duo: London and New York
(2) Smaller contribution and with cultural bias: Los Angeles, Paris and San Francisco
(3) Incipient global cities: Amsterdam, Boston, Chicago, Madrid, Milan, Moscow and Toronto

Global niche cities—specialised global contributions
(1) Economic: Hong Kong, Singapore and Tokyo
(2) Political and social: Brussels, Geneva and Washington, DC

World cities
Sub-net articulator cities
(1) Cultural: Berlin, Copenhagen, Melbourne, Munich, Oslo, Rome and Stockholm
(2) Political: Bangkok, Beijing and Vienna
(3) Social: Manila, Nairobi and Ottawa

World-wide leading cities
(1) Primarily economic global contributions: Frankfurt, Miami, Munich, Osaka, Singapore, Sydney and Zurich
(2) Primarily non-economic global contributions: Abidjan, Addis Ababa, Atlanta, Basle, Barcelona, Cairo, Denver, Harare, Lyon, Manila, Mexico City, Mumbai, New Delhi and Shanghai

appeared in any previous text on the subject, it is self-evidently not a comprehensive study of its subject. My study is preliminary in both technique and data—it is hoped both are greatly improved upon in the near future—but it does represent a first evidential step to understanding cities and their interrelations at a reasonably comprehensive level. In Short and Kim's (1999, p. 9) terms, I hope I have helped to bring understanding of globalisation down from ideas "pitched at . . . a stratospheric level" to a concrete illustration of how activities are producing and reproducing global spaces of flows.

Notes

1. The Globalisation and World Cities (GaWC) Study Group and Network is based at Loughborough University (UK) and collaborates with world city researchers across the world.
2. I have used law firms for this simple example because data on partners across offices are typically available.
3. Specifically, a typical office for each firm was identified in terms of such features as number employed and was scored 2, particularly small offices were then designated 1 and particularly large ones scored 3, finally those with important extra-locational functions (such as regional headquarters) were scored 4 (for further details, see Taylor *et al.*, 2002a).
4. For a comparison between this research and GaWC researches, see Taylor (2005a).
5. Collected for the Metropolitan Institute, Virginia Tech, by Erin Milfeit.
6. Collected for the Metropolitan Institute, Virginia Tech, by Clare Blake.
7. Clearly, these data are international rather than transnational and therefore might be considered outside the scope of globalisation *per se*. However, any serious consideration of global governance must continue to treat states as major political players (Taylor, 2005c) and therefore their diplomatic intercity linkages through capital cities are included here.
8. Collected for the Metropolitan Institute, Virginia Tech, by Troy Gravitt.

References

ALDERSON, A. and BECKFIELD, J. (2004) Power and position in the world city system, *American Journal of Sociology*, 109, pp. 811–851.

ALLEN, J., MASSEY, D. and PRYKE, M. (1999) Introduction, in: J. ALLEN, D. MASSEY and M. PRYKE (Eds) *Unsettling Cities*, pp. 1–6. London: Routledge.

CASTELLS, M. (1996) *The Rise of Network Society.* Oxford: Blackwell.

DERUDDER. B., TAYLOR, P. J., WITLOX, F. and CATALANO, G. (2003) Hierarchical tendencies and regional patterns in the world city network: a global urban analysis of 234 cities, *Regional Studies*, 37, pp. 875–886.

FRIEDMANN, J. (1995) Where we stand: a decade of world city research, in: P. L. KNOX and P. J. TAYLOR (Eds) *World Cities in a World-System*, pp. 21–47. Cambridge: Cambridge University Press.

GLASIUS, M. and KALDOR, M. (2002) The state of global civil society: before and after September 11, in: M. GLASIUS, M. KALDOR and H. ANHEIER (Eds) *Global Civil Society 2002*, pp. 3–34. Oxford: Oxford University Press.

HALL, P. (1966) *The World Cities.* London: Heinemann.

JACOBS, J. (1984) *Cities and the Wealth of Nations.* New York: Vintage.

KING, A. (1990) *Global Cities.* London: Routledge.

KNOKE, D. and KUKLINSKI, J. H. (1982) *Network Analysis.* Beverly Hills, CA: Sage.

KNOX, P. L. and TAYLOR, P. J. (2005) Globalization of architectural practice, *Journal of Architectural Education*, 58, pp. 23–32.

KRÄTKE, S. (2002) *Medienstadt.* Opladen: Leske and Budrich.

KRÄTKE, S. and TAYLOR, P. J. (2004) A world geography of global media cities, *European Planning Studies*, 12, 459–477.

MARCUSE. P. and KEMPEN, R. VAN (2000) *Globalising Cities.* Oxford: Blackwell.

MATTHIESSEN, C. W., SCHWARZ, A. W. and FIND, S. (2000) Research gateways of the world: an analysis of networks based on biometric indicators, in: A. E. ANDERSSON and D. E. ANDERSSON (Eds) *Gateways to the Global Economy*, pp. 17–30. Cheltenham: Edward Elgar.

RUMMEL, R. J. (1970) *Applied Factor Analysis.* Evanston, IL: Northwestern University Press.

SASSEN, S. (1991) *The Global City.* Princeton, NJ: Princeton University Press.

SASSEN, S. (2002) Global cities and diasporic networks: microsites in global civil society, in: M. GLASIUS, M. KALDOR and H. ANHEIER (Eds) *Global Civil Society 2002*, pp. 217–240. Oxford: Oxford University Press.

SHORT, J. R. and KIM, Y.-H. (1999) *Globalization and the City.* London: Longman.

SHORT, J. R., KIM, Y., KUSS, M. and WELLS, H. (1996) The dirty little secret of world city

research, *International Journal of Regional and Urban Research*, 20, pp. 697–717.

TAYLOR, P. J. (1999) So-called 'world cities': the evidential structure within a literature, *Environment and Planning A*, 31, pp. 1901–1904.

TAYLOR, P. J. (2001) Specification of the world city network, *Geographical Analysis*, 33, pp. 181–194.

TAYLOR, P. J. (2004a) *World City Network: A Global Urban Analysis.* London: Routledge.

TAYLOR, P. J. (2004b) *Homo geographicus*: a geo-historical manifesto for cities, *Review* (Fernand Braudel Centre), 26, pp. 37–60.

TAYLOR, P. J. (2005a) Parallel paths to understanding global inter-city relations, *American Journal of Sociology* (forthcoming).

TAYLOR, P. J. (2005b) The new geography of global civil society: NGOs in the world city network, *Globalizations*, 1, pp. 265–277.

TAYLOR, P. J. (2005c) Political geography of global governance and global civil society, *Political Geography* (forthcoming).

TAYLOR, P. J., CATALANO, G. and WALKER, D. R. F. (2002a) Measurement of the world city network, *Urban Studies*, 39, pp. 2367–2376.

TAYLOR, P. J., CATALANO, G. and WALKER, D. R. F. (2002b) Exploratory analysis of the world city network, *Urban Studies*, 39, pp. 2377–2394.

TAYLOR, P. J., CATALANO, G. and WALKER, D. R. F. (2004) Multiple globalizations: regional, hierarchical and sectoral articulations of global business services through world cities, *The Service Industries Journal*, 24, pp. 64–82.

TAYLOR, P. J., CATALANO, G., WALKER, D. R. F. and HOYLER, M. (2002c) Diversity and power in the world city network, *Cities*, 19, pp. 231–241.