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Measurement of the World City Network

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Summary. The purpose of this paper is to describe the construction of a set of data that can be used to measure intercity relations. Building on a specification of the world city network as an 'interlocking network' in which business service firms play the crucial role in network formation, information is gathered from global service firms about the size of their presence in a city and about any 'extra-territorial' functions of their offices. This information is converted into data to provide the 'service value' of a city for a firm's provision of its service in a 316 (cities) × 100 (firms) matrix. These data are used to measure the global network connectivity of the cities. In an initial analysis, the paper concludes with a simple correlation exercise that shows New York and London to be 'exceptions' rather than 'exemplars' amongst contemporary world cities.

Research on world cities has been hampered by data deficiencies (Short, *et al.*,1996). This is particularly the case for empirical evidence on intercity relations (Taylor, 1999). In this paper, we propose a solution to this problem by developing a set of data that meets the requirements of a particular specification of the world city network.

The variety of terminology used to refer to the spatial structure of world city relations indicates a lack of rigour in conceptualising contemporary intercity relations at a global scale. For instance, well-known examples are: "world city hierarchy" (Friedmann, 1986, p. 73), "global network of cities" (King, 1990, p. 12), "transnational urban system" (Sassen, 1994, p. 47), "world city system" (Smith and Timberlake, 1995, p. 94), and "global urban network" (Lo and Yeung, 1998, p. 10). In this paper, we draw upon a formal specification of a world city network (Taylor, 2001). This specification builds upon Sassen's (1991) treatment of advanced producer service firms as producers of 'global cities' which we extend to production of a world city network. Major global service firms operate through numerous offices in cities across the world to provide a 'seamless' service for their clients. Through this practice, they create a network of global service centres that we term the world city network. This specification treats the world city network as an 'interlocking network' with a three-level structure: nodal level (cities), internodal level (network) and sub-nodal level (business service firms). It is the latter that 'interlock' the cities through their myriad networks of offices to create the world city network (Taylor, 2001).

The new specification is an unusual network order not least because it is at the sub–nodal level that the prime players in

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world city network formation are to be found (Taylor, 2001). Thus this specification provides a new opening for a data collection that focuses upon firms, but from which measures of intercity relations can be derived. It is the purpose of this paper to show how this specification can be operationalised for empirical analyses.

Operationalising means finding information to convert into data from which measurements can be derived. In this case, all three stages are made difficult because of the particular focus upon the activities of large numbers of private firms. Most macrourban research has relied upon readily accessible public data, notably from censuses, for their large-scale analyses of urban patterns. Unfortunately, the sort of material available from such sources has little or no utility for investigating intercity relations within a network. New data are required and have to be produced. The specification is clear on these data needs: the starting-point for world city network analysis is a matrix **V** where v_{ij} is the 'service value' provided by firm j in city i (Taylor, 2001, p. 186). This paper describes the production of just such a data-set covering 100 firms and 316 cities.[1] The result is a cross-sectional snap-shot of the world city network in 2000.

The argument proceeds in four stages. First, the process of gathering the appropriate information is described. The method employed is described as 'scavenging' since any information that can inform the data needs is recorded. Secondly, the conversion of this multifarious information into comparable data across firms is described. The data are produced by devising a uniform scale of service value that is then applied separately to the specific information gathered on each firm. Thirdly, these data are used to derive specific measures of cities in the world city network. Measures of total service provision in cities and the global connectedness of cities are both computed and presented for the top 10 cities. Fourthly, the paper concludes with a simple analysis to show the basic utility of having measurement of the world city network. By computing correlations between cities, we provide a new contribution to the debate on which cities are exemplars and which are exceptional in the contemporary world economy.

Information Gathering

Without recourse to reliance on public data, the specific collection of a large quantity of information on private corporations is fraught with difficulty. The most obvious problem is confidentiality since, as a general rule, no corporation wants to reveal its strategies, including location decisions, to its competitors. However, advanced producer service firms are the focus of the information gathering here and they depart from this rule in one crucial respect. These firms provide knowledge-based (expert/professional/creative) services to other corporations to facilitate their business activities. Such corporate service firms have benefited immensely from the technological advances in computing and communications that have allowed them to broaden the geographical distribution of their service provision. For instance, law firms have been traditionally associated with a particular city and its local client-base—a 'New York law firm', a 'Boston law firm' and so on—but, under conditions of contemporary globalisation, a few firms have chosen to pursue a strategy of providing legal services across the world. In such a situation, locational strategy is an integral part of the firm's public marketing and recruitment policies. For instance, new potential clients from around the world will want to know the geographical range of the services on offer. Also, since these are knowledge-based firms, a global scope is very obviously an important advantage in signing up the best of the next generation of key workers. Hence among producer service firms, locational strategy is perforce quite transparent. Typically, the websites of such firms provide an option to select 'location' giving addresses of offices, often with a world map of their distribution, to emphasise their global presence. Advantage is taken of this transparency for information gathering.

The starting-point is to find basic information on where major service firms are present in order to select those firms pursuing a global strategy. Using experience from previous experiments in this field, a firm is deemed to be pursuing a global locational strategy when it has offices in at least 15 different cities including one or more cities in each of the prime globalisation arenas: northern America, western Europe and Pacific Asia (as identified in Beaverstock *et al.*, 1999a and 2000). Having met this condition, selection of firms is quite pragmatic. Starting with rankings showing the top firms in different sectors, firms are selected on the basis of the availability of information on their office network. In addition, since one obvious research interest is comparison across different service sectors, firms are only included in the data in sectors for which at least 10 firms can be identified. Using these criteria, 18 accountancy firms, 15 advertising firms, 23 banking/finance firms, 11 insurance firms, 16 law firms and 17 management consultancy firms have been selected. These constitute the "GaWC 100", the global service firms at the heart of this research exercise.[2]

Although the starting-point is firms, the information collected defines networks. Many global service firms exist as 'groups'. For instance, in accountancy, there are alliances of medium-sized firms constituted as networks in order to compete globally with the very large firms that lead this sector. In other sectors, take-over activity has led to a corporate structure of core firm plus subsidiaries with the latter providing distinctive services as an additional dimension to the main service provision—for instance, as the investment arm of a mainstream bank. Sometimes the latter structure straddles the sector boundary, as in the case of banks owning insurance companies. Such firms are treated here as a single network and allocated to the core company's sector. Basically, the networks are defined by the world-wide service contacts provided for clients on a firm's website. Thus the GaWC 100 constitutes a large sample of global service networks.

In selecting the cities to be included in the data collection, the main concern has been to avoid excluding any city that may have important global service functions. Thus we have selected many more cities than we expect to use in subsequent detailed analysis of the data. The final selection of cities is based upon previous experiments and includes the capital cities of all but the smallest states plus numerous other cities of economic importance from all continents. The resulting set consists of 316 cities. This is, of course, a very large number of cities and we are satisfied that it is a large enough selection to ensure no major omissions. It is these cities that are used in recording information on the global service networks of firms.

Selecting firms and cities is relatively straightforward; problems arise when attempts are made to gather information on the importance of a given city to a firm's global service provision. There is no simple, consistent set of information available across firms. The prime sources of information are websites and everyone is different among the 100 firms. It is necessary to scavenge all possible relevant available information, firm by firm, from these sites supplemented by material from any other sources available such as annual reports. For each firm, two types of information have been gathered. First, information about the size of a firm's presence in a city is obtained. Ideally, information on the number of professional practitioners listed as working in the firm's office in a given city is needed. Such information is widely available for law firms, but is relatively uncommon in other sectors. Here other information has to be used, such as the number of offices the firm has in a city. Secondly, the extra-locational functions of a firm's office in a city are recorded. Headquarter functions are the obvious example, but other features like subsidiary HQs and regional offices are recorded. Any information that informs these two features of a firm's presence in a city is collected in this scavenger method of information gathering. The end-result is that, for each of the 100 firms, information is available to create service values in each of 316 cities.

Data Production

The problem with the scavenger method is that the type and amount of information vary immensely across the firms. For instance, some firms have geographical jurisdictions of offices that are 'regional' (transnational) in scope, others have 'national offices', or there may be 'area offices' or 'division offices' with wide variation in the geographical meaning of each category. In addition, many firms will have no specified geographical jurisdictions for any of their offices. Some information is quite straightforward—as when a hierarchical arrangement is shown through contact with an office being routed through an office in another city—but it is more common to find a confusing range of information indicating the special importance of an office. Here is a list of some such designations: 'key offices', 'main branches', 'global offices', 'international offices', 'hub offices', 'major operation offices', 'competence centres' (for a given function), 'asset management centres', 'global investment service centres', offices with 'international trade contacts' or simply with 'international contacts', offices for 'multinational corporate customers', offices housing 'senior managers' or 'senior partners', and offices of 'core firms' within alliances. This is a rich vein of information, but much work is required to convert it into usable data to compare firms across cities.

In conversion from information to data, there is always a tension between keeping as much of the original material as possible and creating a credible ordering that accommodates all degrees of information across cases. In this exercise, there is very detailed information for some firms and much less for others. This tension is resolved here by devising a relatively simple scoring system to accommodate the multifarious information gathered. A six-point scale is used where two levels are automatically given: obviously zero is scored where there is no presence of a firm in a city, and 5 is scored for the city that houses a firm's headquarters.[3] Hence decision-making on scoring focuses upon allocating the middle four scores (1, 2, 3 and 4) to describe the service value of a firm in a city. This means that, for each firm, three boundary lines have to be specified: between 1 and 2, 2 and 3, and 3 and 4.

The basic strategy of allocation is to begin with the assumption that all cities with a non-HQ presence of a firm score 2. This score represents the 'normal' or typical' service level of the given firm in a city. To determine such normality requires inspection of the distribution of information across all cities for that firm. To alter this score, there has to be a specific reason. For instance, a city where contact with its office is referred elsewhere will be scored 1 for that firm. In other firms where there is full information on numbers of practitioners, a city with an office showing very few (perhaps none) professional practitioners would also score 1. The point is that the boundary between 1 and 2 will differ across firms depending on information available. The same is true of the other boundaries. Generally, the boundary between 2 and 3 has been based upon size factors and that between 3 and 4 on extra-territorial factors. For instance, exceptionally large offices with many practitioners will lead to a city scoring 3, while location of regional headquarters will lead to a city scoring 4. In practice, size and extra-territorial information have been mixed where possible in deciding on the boundaries for each firm. The end result is the service value matrix **V**, a 316×100 data array with v_{ij} ranging from 0 to 5.

How credible are these data? They are far from perfect, largely dependent as they are on what information is available on websites. But the key issue is the subjectivity inherent in the process of this data creation: the resulting data do not have the key property of intersubjectivity: that is to say, two people using the same information will not always decide on the same boundaries. Given the nature of the information, this is inevitable. One fundamental question arises. Does this issue lead to so much uncertainty in the data that the exercise is irredeemably flawed? There are two answers to counter this concern. First, the method of scoring has been designed to be as simple as possible, pivoting on '2 as normal' and with decision-making limited to just three boundaries. Secondly, the exercise is carried out over a large number of firms so that particular differences are likely to be ironed out in the aggregate analyses for which the data are designed. Thus we are satisfied that we have produced credible data for describing the world city network in 2000.

Measuring Firms and Cities

Measurements of firms and cities in terms of their network locations can be easily derived from **V**. The sums for columns, rows and the total (specified as equations (1)–(3) in Taylor, 2001, p. 186) provide initial description of the universe of global services as defined by the GaWC 100. The total service sum is 16 901 and the top 10 firms and cities in terms of quantity of service values are given in Tables 1 and 2. There is nothing surprising in these rankings, with both tables, coincidently, showing a gap separating the top two from the rest. In Table 1, the dominance of the accountancy sector is expected given the large number of offices operated by the major firms in this sector. The cities listed in Table 2 are exactly the same as the 10 cities designated as alpha world cities in an earlier study based upon different data (Beaverstock *et al.*, 1999b). The obvious plausibility of these first simple measurements provides an initial credibility to the new data matrix.

Table 2. Top 10 cities ranked by total service value across 100 firms

Rank	City	Total
1	London	368
2	New York	357
3	Hong Kong	253
4	Tokyo	244
5	Paris	235
6	Singapore	229
7	Chicago	213
8	Los Angeles	201
9	Frankfurt	193
10	Milan	191

The total service values given in Table 2 measure the site service status of the cities (Taylor, 2001, pp. 184, 186). This is a measure of the size of cities as service nodes in the world city network. The situational status of a city within the network is a relational measure defined as

$$N_a = \sum_i \sum_j v_{aj} \cdot v_{ij}$$

where, $a \neq i$; and N_a is the nodal connection of city a into the network defined as n cities, i, and m firms, j, with v as the service values in **V**. (This equation is a combination of equations (4), (5) and (6) in Taylor, 2001, p. 187.) Given the range and scope of the data used here, this measure can be reasonably designated as the global connectivity of a city. The sum of all these city connectivities is 4 078 256 (equation (7) in Taylor, 2001, p. 187). Individual city values can be

Table 1. Top 10 firms ranked by total service value across 316 cities

Rank	Firm	Sector	Total
1	KPMG	Accountancy	618
2	PricewaterhouseCoopers	Accountancy	559
3	Arthur Andersen	Accountancy	392
4	CitiGroup	Banking/finance	377
5	Moores Rowland Int.	Accountancy	367
6	HLB International	Accountancy	357
7	BBDO Worldwide	Advertising	351
8	RSM International	Accountancy	346
9	HSBC	Banking/finance	345
10	PFK International	Accountancy	341

Table 3. Top 10 cities ranked by global connectivity

Rank	Cities	Gross connectivity	Proportional connectivity
1	London	63399	0.01556
2	New York	61895	0.01552
3	Hong Kong	44817	0.01100
4	Paris	44323	0.01087
5	Tokyo	43781	0.01076
6	Singapore	40909	0.01003
7	Chicago	39025	0.00957
8	Milan	38265	0.00938
9	Los Angeles	38009	0.00932
10	Madrid	37698	0.00924

expressed as a proportion of this grand total of interlocking connections (equation (8) in Taylor, 2001, p. 188).

The top 10 cities ranked in terms of global connectivity are shown as both gross and proportional measures in Table 3. Not surprisingly, this table is similar to Table 2 but is not exactly the same: Paris jumps ahead of Tokyo and Milan jumps ahead of Los Angeles, while Frankfurt drops out to be replaced by Madrid. What this is indicating is that the important firms in the cities that rise in the ranking are relatively more connected than the equivalent firms in cities falling in the rankings; hence the greater global connectivity of, say, Paris over Tokyo. In terms of comparing the relative utilities of the site and situational measures, global connectivity is an aggregate relational measure and therefore is the preferred means of assessing the importance of cities in a network context. In addition, the situational status of cities is the more analytically interesting since it leads on to the creation of connectivity matrices and more sophisticated data analyses (see Taylor, 2001).

The global connectivity of all 316 cities is shown in Figure 1. This graph is based on the conventional format for illustrating the structure of 'national urban systems' where the logarithm of city populations is arrayed against the logarithm of their ranks (see, for instance, Bourne, 1975, ch. 2). In national-scale studies, a linear plot represents the rank–size rule and an 'lazy L-shaped' distribution denotes a primate city pattern (see Berry and Horton, 1970, ch. 3 for a discussion). In effect, these two forms of curve denote different types of hierarchical urban system, the former is an orderly integrated hierarchy; the latter is a simple pattern of domination. In the one example of using this method to look at the global distribution of city populations (Ettlinger and Archer, 1987), the curve takes neither form, but is the inverse of the primate city pattern: this indicates a lack of hierarchy in the structure. It is significant that Figure 1 also shows such a curve. It should be noted that replacing simple city populations by measures of their network connectivity is a far better way of evaluating the nature of the urban pattern under scrutiny. Hence it is particularly significant that Figure 1 depicts a distinctively non-hierarchical urban structure. This is empirical support for the argument made in Taylor (2001, p. 192) that world cities constitute a complex network structure rather than a simple hierarchical one. Although the first two ranks stand out (London and New York), the rest of the curve shows that this is not a 'binary' (or 'double primate') city pattern. There may or may not be hierarchical patterns within the spatial organisation of individual firms at the global scale (it depends on their particular strategies), but when aggregated the result is a world city *network*. This network is illustrated as a pattern of nodes in Figure 2. The cartogram includes all cities that have at least one-fifth of the highest city connectivity (i.e London's) which creates a roster of 123 'world cities'.

Initial Analysis: Exemplars and Exceptions

With measurement of the world city network, broad empirical statements about relations between world cities become possible. The empirical support offered above for there actually being a network structure of cities is a simple illustration of this point. Finally, and in lieu of a conclusion that merely sum-

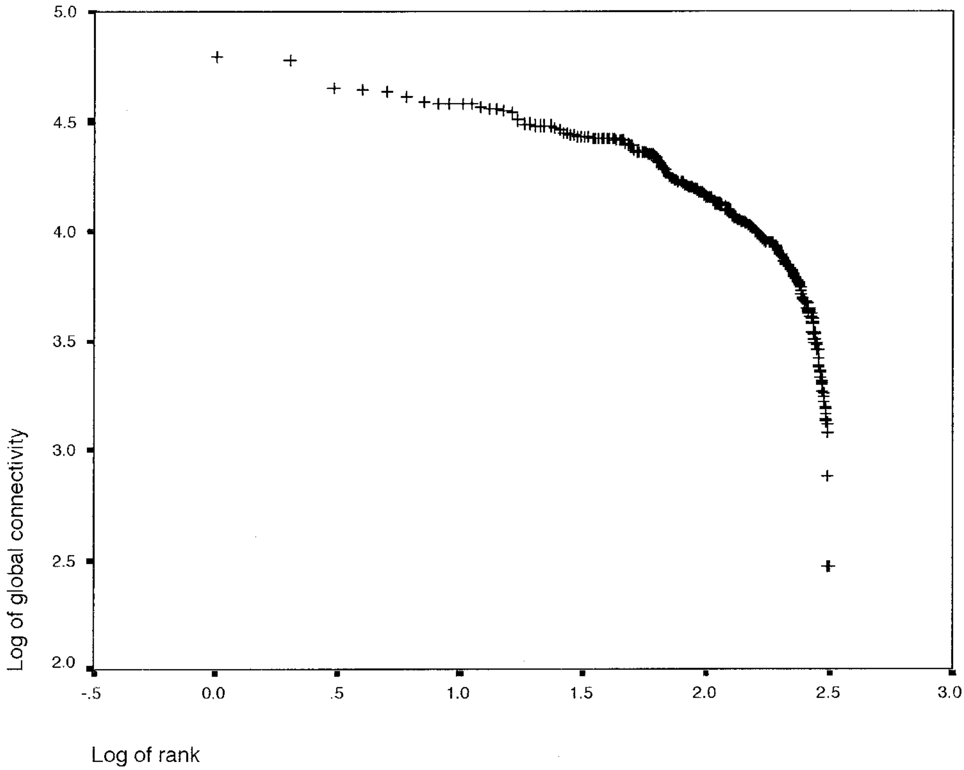

Figure 1. Distribution of cities by global connectivity.

marises, this basic argument will be exemplified through an initial analysis. It is not the purpose of this paper to present a full analysis, but it is instructive to use one particular set of findings to show how an important debate in world city studies can be informed as a result of the information gathering, data production and measurement described previously.

The development of the world city literature has been accompanied by a tendency to focus on the most important cities of the world system—notably London, New York and Tokyo, famously labelled 'global cities' by Sassen (1991). The processes of globalisation, and the geographical implications of contemporary communications in particular, are not, of course, limited to just very important cities. World cities, however defined, should be seen as part of a more general "problematic of cities in the process of globalisation" (Nijman, 2000, p. 1255). It is clear that focusing on a relatively small number of cities intersecting with globalisation processes can give a distorted view; it is certainly not a good basis for drawing generalisations about contemporary city development. This has even led to the verdict of "guilty of doing 'bad geography' " being proclaimed against some writings (Short *et al.*, 2000, p. 317; see also Massey *et al.*, 1999). With our large roster of cities, this question of "looking at cities below the top echelon" (Short *et al.*, 2000, p. 318) can be comprehensively tackled here.

Returning to the 123 cities in Figure 2, we can ask the question: which of these cities are typical as global service centres under conditions of contemporary globalisation and which are not? A precise answer can be derived from correlating the service values of each city against all other cities. A high correlation between two cities shows that they have very similar global service profiles

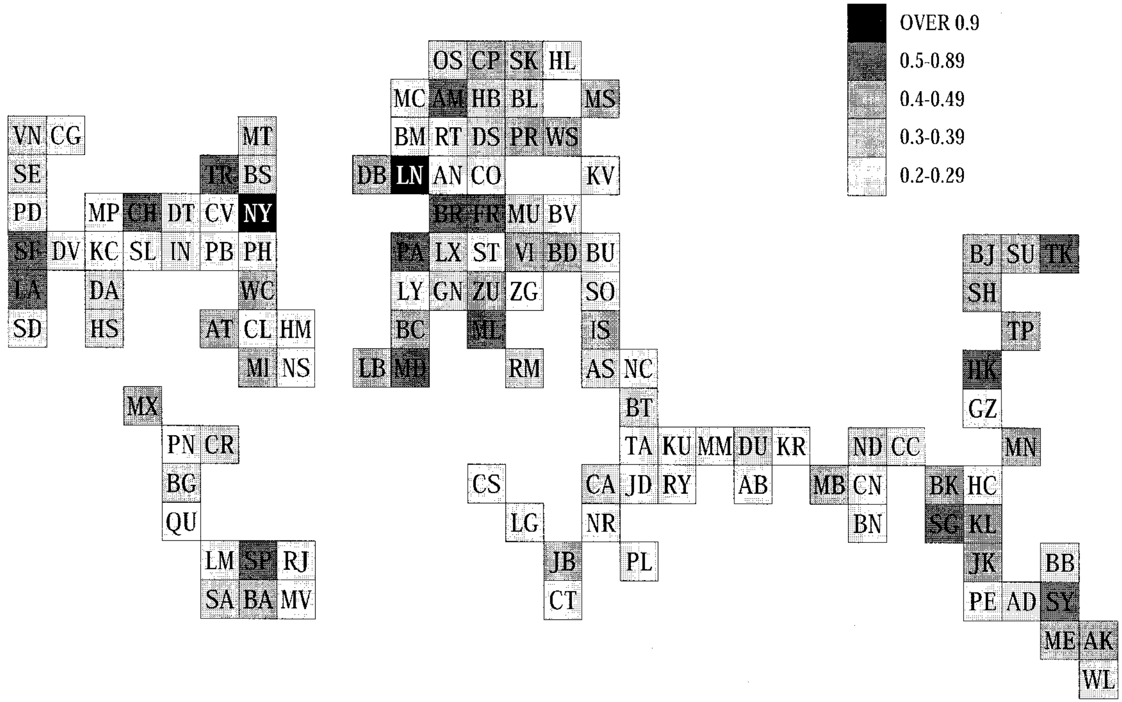

Figure 2. Global connectivity of the major nodes in the world city network. *Note:* This cartogram places cities in their approximate relative geographical positions. *Key:* AB Abu Dhabi; AD Adelaide; AK Auckland; AM Amsterdam; AS Athens; AT Atlanta; AN Antwerp; BA Buenos Aires; BB Brisbane; BC Barcelona; BD Budapest; BG Bogota; BJ Beijing; BK Bangkok; BL Berlin; BM Birmingham; BN Bangalore; BR Brussels; BS Boston; BT Beirut; BU Bucharest; BV Bratislava; CA Cairo; CC Calcutta; CG Calgary; CH Chicago; CL Charlotte; CN Chennai; CO Cologne; CP Copenhagen; CR Caracas; CS Casablanca; CT Cape Town; CV Cleveland; DA Dallas; DB Dublin; DS Dusseldorf; DT Detroit; DU Dubai; DV Denver; FR Frankfurt; GN Geneva; GZ Guangzhou; HB Hamburg; HC Ho Chi Minh City; HK Hong Kong; HL Helsinki; HM Hamilton (Bermuda); HS Houston; IN Indianapolis; IS Istanbul; JB Johannesburg; JD Jeddah; JK Jakarta; KC Kansas City; KL Kuala Lumpur; KR Karachi; KU Kuwait; KV Kiev; LA Los Angeles; LB Lisbon; LG Lagos; LM Lima; LN London; LX Luxembourg; LY Lyons; MB Mumbai; MC Manchester; MD Madrid; ME Melbourne; MI Miami; ML Milan; MM Manama; MN Manila; MP Minneapolis; MS Moscow; MT Montreal; MU Munich; MV Montevideo; MX Mexico City; NC Nicosia; ND New Delhi; NR Nairobi; NS Nassau; NY New York; OS Oslo; PA Paris; PB Pittsburg; PD Portland; PE Perth; PH Philadelphia; PL Port Louis; PN Panama City; PR Prague; QU Quito; RJ Rio de Janeiro; RM Rome; RT Rotterdam; RY Riyadh; SA Santiago; SD San Diego; SE Seattle; SF San Francisco; SG Singapore; SH Shanghai; SK Stockholm; SL St Louis; SO Sofia; SP São Paulo; ST Stuttgart; SU Seoul; SY Sydney; TA Tel Aviv; TK Tokyo; TP Taipei; TR Toronto; VI Vienna; VN Vancouver; WC Washington DC; WL Wellington; WS Warsaw; ZG Zagreb; ZU Zurich.

Table 4. Exceptions and exemplars among global service centres

Exceptions (lowest average correlation)		Exemplars (highest average correlation)	
Washington	0.001	Auckland	0.445
Boston	0.109	Dubai	0.434
New York	0.130	Cairo	0.433
Chicago	0.141	Beirut	0.428
London	0.142	Athens	0.423
Tokyo	0.146	Istanbul	0.421
Minneapolis	0.147	Montevideo	0.421
Munich	0.155	Karachi	0.412
Frankfurt	0.156	Mumbai	0.405
San Diego	0.164	Santiago	0.401
Hong Kong	0.170	Calcutta	0.387
Beijing	0.173	Manila	0.382
Los Angeles	0.175	Nairobi	0.381
Singapore	0.177	Perth	0.378
Guangzhou	0.179	Lima	0.378

(i.e. share many of the same firms and with similar service values). The average correlation of a given city with the other 122 cities, therefore, is a direct indication of how typical a city is as a global service centre among this roster of leading cities. Cities with high average correlations can be deemed 'exemplars', those with low average correlations are 'exceptions'.

In Table 4, the 15 cities with the highest and lowest average correlations are displayed. Taking the exceptions first, Washington is explicable in terms of its role as a 'law city' (lobbying the government) with relatively few other global services being provided. There are two features of this list of cities that are particularly noteworthy. First, the fact that nearly half (7) of the exceptional cities are from the US. This reflects the results as a whole, where US cities consistently have lower correlations than cities from other countries or regions. This suggests processes relating to the particularly large size of the US 'home market' for services. For instance, US firms may have less incentive to develop extra-territorial competences and non-US firms may find it more difficult to compete in this market, given the strength of home firms. Such processes will vary by sectors but there is no doubt that, overall, major US cities do not look very much like other world cities as global service centres. Secondly, the presence of London, New York and Tokyo in this list means that Sassen's 'global cities' are anything but typical. In contrast, the most typical service centres under globalisation are a quite motley crew of cities, a roll-call of places rarely mentioned in the globalisation and cities literature. Although world-wide in distribution, cities from the three prime globalisation arenas—northern America, Pacific Asia and western Europe—are conspicuous by their absence.

This relatively simple analysis can be said to have made a contribution to a current concern in the globalisation and cities literature. While not neglecting the unique but very important cities, it suggests that understanding globalisation through urban lenses requires that a broader range of cities be studied: the world is not evolving multiple 'little New Yorks' or 'mini-Londons'. But this is not the prime point being made as conclusion to this paper. A little thought might lead to the idea that these findings are not actually very surprising: what makes New York and London so important in the world economy is their distinctiveness as massive global service centres. But such reasoning remains conjecture; to be convincing, such a notion needs empirical verification in a broad comparative study. The value of the measurement exercise described here is that it can make such verification possible.

Notes

1. An earlier experiment creating such data covering 46 firms and 55 cities has been reported in Taylor and Walker (2001, pp. 25, 27). Those data had been derived from a project with a different purpose and which was part of a feasibility study for the research reported here.
2. The improvement on the experimental data (Taylor and Walker, 2001) is not just a matter of quantity, the latter included only four sectors (insurance and management consultancy were not included). In addition, subsequent experience has indicated that accountancy was underrepresented (with just 5 firms) and law was overrepresented (with 16 firms, it was the largest sector in the data).
3. In the experimental data-set (Taylor and Walker, 2001) a simpler four-point scale was used; here, we take advantage of more information specifically (and therefore more systematically) collected for this exercise to capture more detail in the service value scores.

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