Visualizing the intellectual structure in urban studies:
A journal co-citation analysis (1992–2002)

ZAO LIU

Sterling Evans Library, Texas A&M University, College Station, TX (USA)

This paper studied the intellectual structure of urban studies through a co-citation analysis of its thirty-eight representative journals from 1992 to 2002. Relevant journal co-citation data were retrieved from *Social SciSearch*, and were subjected to cluster analysis, multidimensional scaling, and factor analysis. A cluster-enhanced two-dimensional map was created, showing a noticeable subject variation along the horizontal axis depicting four clusters of journals differentiated into mainstream urban studies, regional science and urban economics, transportation, and real estate finance. The cluster of the mainstream urban studies journals revealed a higher degree of interdisciplinarity than other clusters. The four-factor solution, though not a perfect match for the cluster solution, demonstrated the interrelationships among the overlapping journals loaded high on different factors. The results also showed a strong negative correlation between the coordinates of the horizontal axis and the mean journal correlation coefficients reflecting the subject variation, and a less revealing positive correlation between the coordinates of the vertical axis and the mean journal correlation coefficients.

Introduction

Urban studies has long been recognized as an interdisciplinary field by its scholars.[1–3] As a field of academic inquiry, it typically involves disciplines of urban planning, economics, history, architecture, sociology, anthropology, geography, environmental science, psychology, and political science. Historically, urban studies developed as a field from urban planning, sociology, and other social sciences in response to the need of a broader perspective of studying cities.[1,2] It grew slowly in the 1950s and developed rapidly in the 1960s. Today, urban studies is pursued among institutions of higher learning either as an interdisciplinary program or as part of curricula taught in the related social sciences.[2] An interdisciplinary field, urban studies overlaps a great deal with urban/regional planning and regional science in subject matter. To help better understand the relationships among the three, a definition of each of them seems necessary.

Although scholars have recognized the difficulty in delimiting the boundaries of the field due to the multi-faceted nature of cities and broad scope of subject matter covered,[1,3] they have managed to define the field in terms of its primary concerns. A simple definition given so far is that urban studies is a field concerned with understanding cities.[2,3] Paddison identified the core of the field in its physical, economic, historical, social, cultural, and political terms.[3] Likewise, LeGates described the subject matter of the field by listing its twelve major concerns: the evolution of cities; urban culture; urban society; urban politics and governance; urban economics, urban public finance, and regional science; urban and metropolitan space and city systems; mega cities and global city systems; technology and cities; urban planning, urban design, landscape architecture, and architecture; race, ethnic, and gender relations in cities; urban issues and policy; and urban futurism.[2]

Somewhat narrower in scope than urban studies, urban and regional planning is a discipline that focuses on planning, an activity that has a desired objective to be achieved. The definition of urban planning given in *Encyclopedia Britannica* reads: "Urban planning and redevelopment is aimed at fulfilling social and economic objectives that go beyond the physical form and arrangement of buildings, streets, parks, utilities, and other parts of the urban environment."[4] A similar definition was given by Witzling in *Encyclopedia Americana*: "A social and governmental process whereby the spatial organization and content of cities are evaluated, designed, and regulated. Urban planning is more than the design of streets, residential areas, parks, utilities, and public buildings. It also involves less obvious but critical decisions related to the underlying social and economic well-being of cities."[5] Urban and regional planning actually involves two levels of planning – urban or city planning and regional planning. When planning is for a metropolitan area instead of a city only, it is regional planning.

Isard and Reiner defined regional science as a discipline that "focuses on the locational dimension of human activities in the context of their institutional structure and function and on the significance of this dimension in the understanding of social behavior and forms."[6] It "relies heavily on mathematical models to frame its theories and draws on the theories and findings of other social sciences, particularly location theory."[6]

Given the interdisciplinary nature of urban studies, how can we understand the interconnection of its subfields? One way of understanding interdisciplinarity in a field is to examine its literature by utilizing information visualization techniques. As White and McCain pointed out, "Visualization can provide evidence for the existence of interdisciplinary ties, highlight relationships between emerging and established specialties, suggest directions of information transfer between old fields and new, and demonstrate developmental trends."[7] Co-citation analysis, a bibliometric method that produces cluster-enhanced multidimensional scaling maps, has been used as an effective method of visualizing the subject relatedness in an interdisciplinary field. The

basic assumption of co-citation analysis is that the more frequently two documents, authors, journals, or terms are co-cited, the more closely they are linked together in subject matter. Co-citation analysis can help us understand the intellectual structure of a particular field through its published literature.

The utilization of co-citation techniques to create the intellectual structure of an academic field dated back to the 1970s. Small first discussed the possibility of mapping the intellectual structure of an academic field through co-citation analysis, which is "the frequency with which two items of earlier literature are cited together by the later literature."[8] He introduced the concept of document co-citation using an example from the literature of particle physics. Subsequently, more document co-citation studies were conducted by Small, Griffith, and their co-workers at the Institute for Scientific Information (ISI) which mapped connections among documents based on their joint citation by later writers.[9–11] Author co-citation analysis, using co-cited oeuvres (sets of documents by authors) instead of co-cited individual documents as the unit of analysis, was innovated by White and Griffith.[12–14] The technique led to a number of author co-citation analyses in science and engineering, social sciences, and more recently, in humanities. Journal co-citation analysis was first experimented by McCain who used journals as the unit of analysis.[15] As McCain stated, "two journals would be cocited when at least one article from each journal is listed in a citing article's reference list."[15]

Although there have been co-citation studies on various academic fields, the field of urban studies remains unexplored. The purpose of this paper is to map the intellectual structure of urban studies by investigating the co-citation patterns among its representative journals during the time period of 1992–2002. The study addresses the following research questions: What is the overall structure of the published literature in urban studies journals? How are these journals interrelated to one another? The results of the research project will contribute to the understanding of scholarly communication in the field. They will benefit urban studies scholars and researchers in terms of grasping the field's cognitive and intellectual structure as reflected in its published journals. Additionally, the research results may serve as a reference guide for information providers in collecting and managing the related academic journals.

Methods

Thirty-eight journals in urban studies representing its major publications and scholarly communication were selected. The journals were selected based on the information in *Journal Citation Reports* on the *ISI Web of Science* and *Urban and Regional Planning Periodicals with Book Reviews*,[16] a city and regional planning bibliography. Most of the journals listed under the subject category "Urban Studies" in the 2002 social sciences edition of *Journal Citation Reports* were included. Additional titles central to urban studies were chosen from the related categories of the reports and

Clarke and Thompson-Wise's bibliography. A stringent threshold of mean co-citation rate of 11 was set for including journals for the time period of 11 years (1992–2002). Based on the suggestion in a recent study on author co-citation analysis,[17] journals that produced many co-citation zero blocks or counts were excluded from the list. The above criteria eliminated from the list some journals in the "Urban Studies" category of *Journal Citation Reports* which had excessive zero counts. These included *Education and Urban Society*, *EURE-Revista LatinoAmericana de Estudios Urbano Regionales*, *Journal of Contemporary Ethnography*, *Journal of Urban Planning and Development – ASCE*, *Urban Education*, *Urban Lawyer*, and *Urban Technology*. All selected journals were checked for title change from *Ulrich's Periodicals Directory* online. To get a sense of the communication status of the selected journals, their general publication and citation information was sought from *ISI Essential Science Indicators* on *ISI Web of Knowledge*. The list of the selected journals and their general citation information (from January 1, 1993 to December 31, 2003) available from *ISI Essential Science Indicators* are presented in Table 1.

Although representative journals in urban studies were selected for this study, it does not mean that the selection was exhaustive. For example, Clarke and Thompson-Wise's bibliography contains a more comprehensive list of journals than what were selected in this study. This study did not include all of them for two reasons. First, some of the journals in the bibliography have not been indexed by *Social Sciences Citation Index*. Hence, their citation information was unavailable when the data were collected. Second, although there are more journals in the bibliography that are indexed by *Social Sciences Citation Index* than those selected for this study, those additional indexed journals were excluded because they tilt more toward other fields instead of urban studies in coverage, such as economics, geography, public administration, business management, and sociology. Besides the urban studies journals included in Clarke and Thompson-Wise's bibliography, other journals, which would have added to the composition of the structure, including *Ekistics*, *Journal of Environmental Planning and Management*, *Journal of Urban Design*, *Urban Anthropology*, and *Urban History*, were not included either because they have not been indexed by *Social Sciences Citation Index*, or the coverage has been dropped.

The study followed the basic steps in author co-citation analysis outlined by McCain,[18] which were extended and developed into journal co-citation analysis.[15] Each selected journal was paired with other journals in the journal set. A journal co-citation matrix was established according to the pairs which were determined by the formula N (N−1)/2 where N is the total number of journals in the set. Consequently, a total of 703 pairs were created and used. Frequencies of co-cited journals were obtained from the *Social SciSearch* database on Dialog. In collecting the raw data from Dialog, a journal's cited work field was expanded to check its abbreviation variants.

Table 1. Thirty-eight journals in urban studies and their citation information (1993–2003)

Abbrev.	Journal title	No. of papers	Total citations	Citations per paper
EPA	*Environment and Planning A*	1,186	6,075	5.12
US	*Urban Studies*	1,166	5,489	4.71
RS	*Regional Studies*	753	3,450	4.58
EPD	*Environment and Planning D: Society and Space*	378	3,412	9.03
IJURR	*International Journal of Urban and Regional Research*	529	3,019	5.71
LE	*Land Economics*	450	2,512	5.58
JUC	*Journal of Urban Economics*	499	2,353	4.72
LUPL	*Landscape and Urban Planning*	830	2,163	2.61
JAPA	*Journal of the American Planning Association*	293	1,908	6.51
UG	*Urban Geography*	405	1,551	3.83
UAQ	*Urban Affairs Review/Urban Affairs Quarterly*	382	1,493	3.91
EPB	*Environment and Planning B: Planning and Design*	511	1,437	2.81
RSUE	*Regional Science and Urban Economics*	376	1,345	3.58
HPD	*Housing Policy Debate*	212	1,342	6.33
JREFE	*Journal of Real Estate Finance and Economics*	390	1,097	2.81
TRPA	*Transportation Research Part A: Policy and Practice*	403	1,062	2.64
EPC	*Environment and Planning C: Government and Policy*	410	1,024	2.50
JRS	*Journal of Regional Science*	330	1,002	3.04
HS	*Housing Studies*	340	968	2.85
JUA	*Journal of Urban Affairs*	282	959	3.40
T	*Transportation*	229	736	3.21
JPER	*Journal of Planning Education and Research*	268	696	2.60
IRSR	*International Regional Science Review*	205	677	3.30
EU	*Environment and Urbanization*	318	676	2.13
GC	*Growth and Change*	250	599	2.40
REE	*Real Estate Economics*	237	571	2.41
EDQ	*Economic Development Quarterly*	252	560	2.22
C	*Cities*	375	549	1.46
ARS	*Annals of Regional Science*	317	501	1.58
EURS	*European Urban and Regional Studies*	123	455	3.70
LUPO	*Land Use Policy*	266	442	1.66
PRS	*Papers in Regional Science*	211	427	2.02
HI	*Habitat International*	--	--	--
JAPR	*Journal of Architectural and Planning Research*	--	--	--
JHE	*Journal of Housing Economics*	--	--	--
JUH	*Journal of Urban History*	--	--	--
TR	*Transport Reviews*	--	--	--
TQ	*Transportation Quarterly*	--	--	--

Note: The sign, --, indicates absence of data from *ISI Essential Science Indicators*.

If abbreviation variants did exist, reasonably productive abbreviations of the journal were included in the search command. The obtained raw data were put into the square symmetric journal co-citation matrix with the data in the diagonal cells treated as missing values. Then the raw data matrix was converted into a matrix of correlation coefficients, which served as the measure of similarity. Using correlation coefficients as

similarity measure in co-citation analysis reflects the similarity of entities' "co-citation profiles,"[18] in this case, the journals' co-citation records across the entire set of selected journals.

The correlation coefficients were analyzed using the statistical procedures of cluster analysis, multidimensional scaling (MDS), and factor analysis. The complete linkage method was employed in conducting the hierarchical agglomerative cluster analysis on the correlation data of this study. As one of the two most frequently used methods in co-citation analysis,[18] complete linkage is a clustering procedure in which the distance (similarity) between clusters is determined by the maximum distance (similarity) between the two elements, one from each cluster.[19] The correlation data were also analyzed using multidimensional scaling procedure, a dimension reduction technique that aims at fitting the original data into a low-dimensional space such that the distortion of the similarities and dissimilarities among the original data caused by reduction in dimensionality is minimized.[19] Two- and three-dimensional solutions were explored in the multidimensional scaling with the procedure of ALSCAL. Furthermore, an exploratory factor analysis was conducted to assess the underlying dimensions among the journals. The principal components analysis was used to extract factors. Kaiser's criterion (eigenvalue > 1) and the scree test were compared to determine the extracted number of factors. After the extraction, factors were rotated using the procedure of Varimax rotation. Factor analysis can be used to complement multidimensional scaling and clustering displays in a co-citation study and show an entity's contribution to more than one specialty.[18,20] Unlike cluster analysis, which only assigns an entity to one cluster, the entity can load on more than one factor in a factor analysis. Therefore, the interrelationships between specialties can be easily revealed from a different perspective.

Results and discussion

The journals' mean co-citation counts, mean correlation coefficients, and their grand means were calculated for comparative purposes. In spite of the slight difference in time frames, the rank order of the mean co-citation counts corresponded, in a great measure, to that of the journals' total citations obtained from *ISI Essential Science Indicators* (Table 1). Among journals having high mean co-citation counts were *Environment and Planning A* (338), *Urban Studies* (328), *Regional Studies* (212), and *Journal of Urban Economics* (195). *Journal of Urban History* had the lowest mean co-citation rate (11). The grand mean co-citation rate for all the journals in the set was 86.7. Of all the correlation coefficients in the set, the highest was 0.925 (*Environment and Planning C: Government and Policy* and *European Urban and Regional Studies*) and the lowest was −0.058 (*European Urban and Regional Studies* and *Real Estate Economics*). The grand mean of the correlation coefficients was 0.423, indicating a fair association among

journals across the set. Table 2 shows the mean journal co-citation counts and mean correlation coefficient rates of the thirty-eight journals.

The complete linkage clustering method yielded a number of identifiable clusters. A four-cluster solution was chosen because it was considered the best fit for interpretation.

Table 2. Mean journal co-citation rates and mean correlation coefficients of thirty-eight journals in urban studies (1992–2002)

Journal title	Mean co-citation rate	Mean correlation
Environment and Planning A	338	0.403
Urban Studies	328	0.456
Regional Studies	212	0.518
Journal of Urban Economics	195	0.360
International Journal of Urban and Regional Research	188	0.501
Journal of Regional Science	156	0.442
Journal of the American Planning Association	147	0.509
Environment and Planning D: Society and Space	145	0.494
Urban Geography	143	0.567
Papers in Regional Science	125	0.505
Regional Science and Urban Economics	118	0.381
Urban Affairs Review/Urban Affairs Quarterly	115	0.467
Land Economics	106	0.466
International Regional Science Review	83	0.491
Environment and Planning C: Government and Policy	81	0.545
Growth and Change	79	0.527
Journal of Urban Affairs	70	0.397
Annals of Regional Science	59	0.439
Housing Policy Debate	57	0.455
Environment and Planning B: Planning and Design	54	0.530
Housing Studies	53	0.537
Journal of Real Estate Finance and Economics	48	0.201
Cities	41	0.489
Economic Development Quarterly	40	0.491
Transportation	38	0.425
Journal of Planning Education and Research	36	0.392
Real Estate Economics	35	0.160
Journal of Housing Economics	32	0.227
Habitat International	30	0.375
European Urban and Regional Studies	21	0.451
Landscape and Urban Planning	17	0.395
Environment and Urbanization	17	0.317
Transportation Quarterly	17	0.305
Land Use Policy	16	0.498
Transport Reviews	15	0.224
Transportation Research Part A: Policy and Practice	14	0.355
Journal of Architectural and Planning Research	13	0.394
Journal of Urban History	11	0.386

Aldenderfer and Blashfield observed the difficulty in determining the number of clusters in cluster analysis and the major reasons –"the lack of a suitable null hypothesis and the complex nature of multivariate sampling distributions."[21] They also noted the two basic approaches to this issue in social sciences: the heuristic methods and formal tests.[21] The stopping rule used in this study was heuristic, therefore subjective, not for the purpose of determining the true number of clusters but largely "to inform a more general discussion."[18] The clusters were named cluster 1, cluster 2, cluster 3, and cluster 4, respectively. Cluster 1 was further divided into sub-clusters 1-a and 1-b. The dendrogram of the cluster analysis is shown in Figure 1.

To visualize the subject relatedness among the journals in the multivariate space, two- and three-dimensional solutions were considered for the multidimensional scaling. Kruskal's stress values for these two solutions were 0.12676 and 0.062, respectively. Both values met the stress criterion (< 0.2) suggested by McCain for author co-citation analysis.[18] The corresponding R^2 goodness-of-fit values for the two solutions were 0.93484 and 0.97916. The coordinates of dimension 1 and dimension 2 in the three-dimensional solution were very similar to those in the two-dimensional solution if rank-ordered in their magnitude. The third dimension in the three-dimensional solution, however, did not add much explanatory power. Therefore, the two-dimensional solution was selected for being optimal in terms of interpretability, which was deemed important in determining dimensionality.[22] Table 3 shows the axis coordinates of the two-dimensional solution and their cluster memberships.

The four clusters were embedded into the two-dimensional map to facilitate the interpretation. The cluster-enhanced map is shown in Figure 2.

When the coordinates of these two dimensions are viewed in magnitude, journals having greater coordinate values are associated with one of these dimensions, which correspond to the four clusters in a meaningful manner (Table 3). Thus, journals in clusters 3 and 4 and those in sub-cluster l-b all share higher coordinate values with dimension 1. Journals in sub-cluster 1-a have higher coordinate values with dimension 2. Journals in cluster 2 are divided in sharing higher coordinate values with the dimensions, with five journals near the top of the map affiliated with dimension 2 and the other four with dimension 1.

The subject variation is noticeable along the horizontal axis (dimension 1). Viewed from left to right, with few exceptions, the multidimensional scaling map shows the mainstream journals on the left, and regional science, economics, and transportation journals on the right. A strong negative association ($r = -0.813$, $p < 0.001$) was found between the journals' mean correlation coefficients and the coordinates of dimension 1, suggesting an approximate correspondence among the mean correlation coefficients, the coordinates of dimension 1, and the subject relatedness.
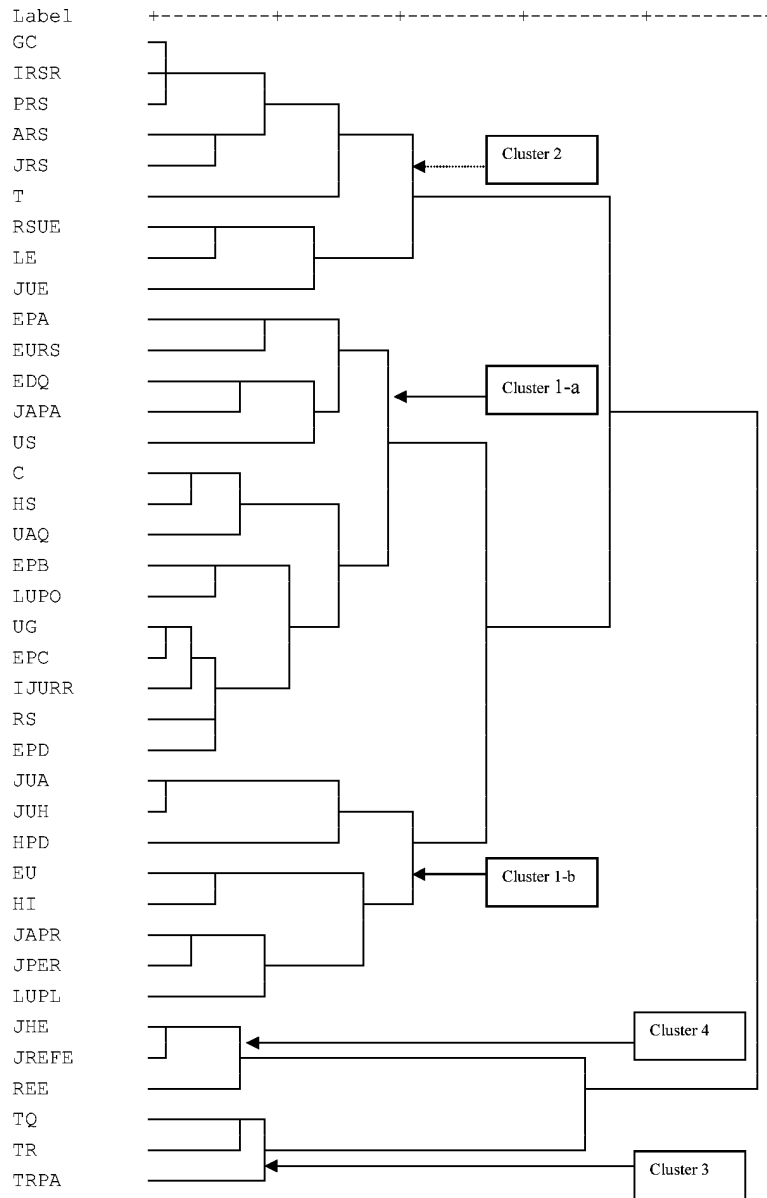
Figure 1. Dendrogram of complete linkage cluster analysis of thirty-eight journals in urban studies
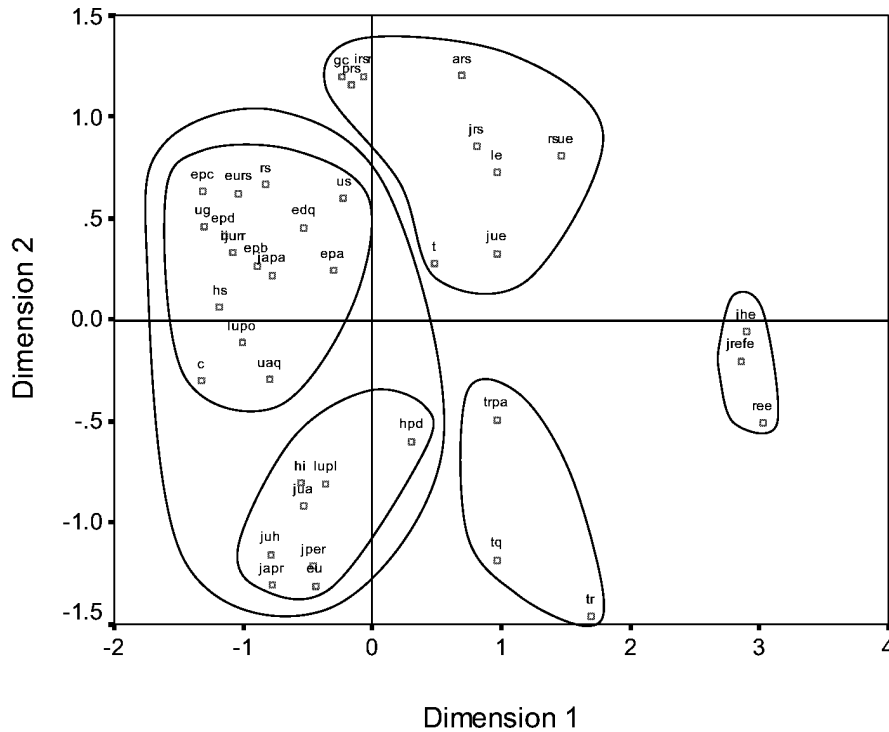(1992–2002)

Figure 2. Multidimensional scaling plot of thirty-eight journals in urban studies (1992–2002)

It should be noted that the highly interdisciplinary nature of the journals in cluster 1 makes it hard to label the subdivisions in absolute terms. Therefore, the term "mainstream" is used to refer to journals in this cluster. Sub-cluster 1-a has the largest membership representing the mainstream urban studies journals. Three sub-groups are identified within the sub-cluster. One of them includes some most reputable, wide-ranging, urban and regional studies and planning journals that span the field in subject coverage (*Environment and Planning A*, *Urban Studies*, *Journal of the American Planning Association*). Accordingly, these journals are among the most highly cited and co-cited ones (see Tables 1 and 2). *Environment and Planning A* has a wide scope of coverage while maintaining its core interests in urban and regional research. *Urban Studies*, another major interdisciplinary journal, publishes quality articles from a variety of disciplines relating to social, economic, environmental, political, and planning aspects of urban studies. Diverse perspectives are reflected in *Journal of the American Planning Association*, the flagship planning journal, which covers various components in planning such as land use, spatial science, community development, housing,

transportation, economic development, environment and natural resources, architectural and urban design, public administration and so on. *European Urban and Regional Studies* and *Economic Development Quarterly* are associated with the sub-group due to their similarity to the above journals. *European Urban and Regional Studies* is adjacent to *Regional Studies* on the map because of its co-citation profile.

Table 3. Dimension coordinates and cluster membership of two-dimensional solution

Journal abbrev.	Dimension 1	Dimension 2	Cluster Membership
REE	3.0308	−0.5075	4
JHE	2.9036	−0.0598	4
JREFE	2.8634	−0.2023	4
TR	1.6931	−1.4618	3
RSUE	1.4700	0.8063	2
TQ	0.9734	−1.1824	3
LE	0.9714	0.7252	2
JUE	0.9677	0.3261	2
TRPA	0.9641	−0.4904	3
T	0.4829	0.2785	2
HPD	0.3034	−0.5994	1-b
LUPL	−0.3612	−0.8062	1-b
EU	−0.4384	−1.3097	1-b
JPER	−0.4576	−1.2127	1-b
JUA	−0.5329	−0.9170	1-b
HI	−0.5557	−0.8037	1-b
JAPR	−0.7773	−1.3065	1-b
JUH	−0.7850	−1.1544	1-b
ARS	0.6904	1.2038	2
IRSR	−0.0648	1.1999	2
GC	−0.2337	1.1980	2
PRS	−0.1651	1.1553	2
JRS	0.8086	0.8537	2
RS	−0.8321	0.6647	1-a
EPC	−1.3115	0.6329	1-a
EURS	−1.0416	0.6222	1-a
US	−0.2227	0.5984	1-a
UG	−1.3046	0.4596	1-a
EDQ	−0.5312	0.4548	1-a
EPD	−1.1471	0.4157	1-a
IJURR	−1.0803	0.3321	1-a
EPB	−0.8950	0.2654	1-a
EPA	−0.3017	0.2418	1-a
JAPA	−0.7751	0.2202	1-a
HS	−1.1818	0.0635	1-a
LUPO	−1.0060	−0.1117	1-a
UAQ	−0.7924	−0.2930	1-a
C	−1.3281	−0.2993	1-a

Another sub-group encompasses a number of major urban studies journals that are also interdisciplinary in scope (Regional Studies, International Journal of Urban and Regional Research, Urban Geography, Environment and Planning B: Planning and Design, Environment and Planning C: Government and Policy, Environment and Planning D: Society and Space, Land Use Policy). Regional Studies and International Journal of Urban and Regional Research are leading urban studies journals, both highly cited and co-cited (Tables 1 and 2). Equally broad in coverage, these two journals discuss issues relative to urban and regional studies, the latter often bringing the discussion into an international context. Environment and Planning C: Government and Policy, Environment and Planning D: Society and Space, and Urban Geography focus on urban and administrative policy and social and cultural aspects of urban studies. Environment and Planning B: Planning and Design, oriented to planning and designing the environment and the spatial structures of cities and regions, is strongly associated with Land Use Policy, a journal concerned with various aspects of urban and rural land use. The last sub-group in l-a comprises three journals (Cities, Housing Studies, Urban Affairs Review). Urban Affairs Review and Cities publish papers on urban policy, housing, community development, economic development, urban transportation, urban sociology and cultural studies, and urban environment. Housing Studies is a forum for exploring the relationship between housing and various other aspects of urban studies. These journals are placed near the bottom of the sub-cluster because of their connections to some related journals in sub-cluster 1-b.

Three sub-groups of journals are formed in sub-cluster 1-b: journals concerned with architectural, landscape, and urban design (*Journal of Architectural and Planning Research*, *Journal of Planning Education and Research*, *Landscape and Urban Planning*), journals about housing, urban affairs, and urban history (*Housing Policy Debate*, *Journal of Urban Affairs*, *Journal of Urban History*), and journals with a focus on environment and cities (*Environment and Urbanization* and *Habitat International*). Most of the journals in this sub-cluster have lower mean journal co-citation rates than those in sub-cluster 1-a. Note that the distinction between these two sub-clusters is only relative because some journals of similar specialties are found in either of them. For example, urban planning journals are distributed in sub-clusters 1-a and 1-b, so are the urban affairs and housing journals.

Cluster 2 is primarily composed of journals related to regional science, urban economics, and land economics. *Growth and Change* and *Transportation* are included in this cluster because of their strong connections to these journals. While broad-based, most journals here are economics- orientated. Two sub-groups of journals are identified in this cluster. One embraces *Annals of Regional Science*, *Journal of Regional Science*, *International Regional Science Review*, *Papers in Regional Science*, and *Growth and Change*; the other includes *Journal of Urban Economics*, *Land Economic,* and *Regional Science and Urban Economics*. Journals in the first sub-group are predominantly

regional science journals that focus on economics and spatial phenomena in urban studies. Most of these journals are situated near the top of the map, with three of them (*Growth and Change*, *International Regional Science Review*, *Papers in Regional Science*) located on its left side, indicating their relatively close associations with journals in sub-cluster 1-a. Journals in the second sub-group cover topics on urban and land economics. *Land Economics* has a high correlation with *Regional Science and Urban Economics*, and a high frequency count with *Journal of Urban Economics*.

Journals in clusters 3 have relatively low mean correlation coefficients, and are peripheral to the main agglomerations of journals on the map. Located in the lower right part of the map, the cluster consists of three transportation journals (*Transport Reviews*, *Transportation Quarterly*, *Transportation Research Part A: Policy and Practice*). The majority of the existing transportation journals tend to be quantitative in style, with primary focuses on transportation system design, formal methods, model building, and operation research, topics that are finding their way into the current arena of urban studies. The selected transportation journals in this study, however, have certain planning and policy-making orientations. It appears that *Transportation* in cluster 2 has the highest correlation with the mainstream urban studies journals.

Located on the far right side of the map is cluster 4 that contains three real estate economics journals (*Journal of Housing Economics*, *Journal of Real Estate Finance and Economics*, *Real Estate Economics*). Obviously, the journals are grouped together because of their shared subject matter in real estate finance and economics. The data in this study also indicate their relatively strong ties to *Journal of Urban Economics*, *Regional Science and Urban Economics*, and *Land Economics* that are outside their own cluster.

Although a good positive relationship ($r = 0.555$, $p < 0.001$) was observed between the journal mean correlation coefficients and the coordinates of dimension 2, the correlation does not contribute to the general interpretation as much as that between the same mean correlation coefficients and the coordinates of dimension 1. The vertical axis does not present a quantitative vs. qualitative continuum in this study as it has been observed in some co-citation studies of other fields, such as in McCain's study of economics journals[15] and Kreuzman's study of representative authors in epistemology and philosophy of science.[23] Generally speaking, journals located up on the vertical axis are quantitative in style – journals about regional science, urban economics, and urban and regional studies. But a number of journals situated down the axis are quantitative too, such as *Journal of Real Estate Finance and Economics*, *Real Estate Economics*, *Transportation Research Part A: Policy and Practice*, *Transportation Quarterly*, *Journal of Planning Education and Research*, and *Journal of Architectural and Planning Research*. Conversely, some journals (for example, *Environment and Planning D: Society and Space, Cities*) occupying relatively higher positions on the

vertical axis publish articles that are mostly qualitative in style. So the contrast is not striking enough to justify the distinction. Nor does the axis reflect an obvious subject variation or temporal orientation.

As mentioned previously, an exploratory factor analysis was conducted to determine the underlying dimensions among these journals. In extracting the factors, both Kaiser's criterion (eigenvalue > 1) and the scree test were explored to find the best fit. The former yielded a five-factor solution whereas the latter a four-factor solution. The results obtained from both criteria were compared. An examination of the plot of the scree test showed that the "elbow" occurred at the fourth factor, indicating a more accurate result. Thus, the four-factor solution was chosen for interpretation. As shown in Table 4, the four factors explained 89.16% of the total variance.

Table 5 shows the results of the rotated factor analysis of the journals. Although there is no perfect match between the factor assignment and the cluster assignment, there are ample similarities between the two. Factor 1 includes all the journals in sub-cluster 1-a along with *Environment and Urbanization* and *Habitat International* from sub-cluster 1-b. Regional science and economics-oriented journals all load high on factor 2, which encompasses journals from clusters 2 and 4. Note that three journals (*Growth and Change*, *International Regional Science Review*, *Papers in Regional Science*) in cluster 2 located close to sub-cluster 1-a also load high on factor 1. Factor 3 has high loadings from all transportation journals, along with *Landscape and Urban Planning*, which overlaps several factors. *Transportation,* loaded high on factor 3, overlaps factor 2, which holds most journals from cluster 2 to which it belongs. The majority of journals in sub-cluster 1-b join factor 4. It is interesting to note the overlapping high loadings of a number of journals from sub-clusters 1-a and 1-b on both factors 1 and 4, suggesting the close connections between these two sub-clusters of mainstream urban studies journals. The overlaps here are generally consistent with the data in the correlation coefficient matrix. When comparing several methods for co-citation analysis, Gmür noted the insufficient differentiating power of factor analysis in forming clusters.[24] Gmür's cluster formation method based on factor loadings resulted in a significant amount of overlaps between factors as visualized in the network diagram. Overlapping factor loadings among different clusters, though expressed differently, were also observed in other co-citation studies.[20,25] Presumably, using factor analysis in a journal co-citation analysis can provide supplementary information that explains the interconnections among journals of a highly interdisciplinary field.

Table 4. Total variance explained by factor analysis

Factor	% of variance explained	Cumulative %
1	39.13	39.13
2	23.56	62.69
3	13.78	76.47
4	12.69	89.16

Table 5. Rotated component matrix from factor analysis of thirty-eight journals in urban studies (1992–2002)

Journal Abbrev.	1	2	3	4
EPC	0.974			
EURS	0.960			
EPD	0.957			
IJURR	0.952			
UG	0.945			
RS	0.894	0.328		
C	0.835			0.330
LUPO	0.824		0.314	
EPA	0.781			
JAPA	0.779			0.474
HS	0.764			0.455
HI	0.699			0.302
EPB	0.690		0.662	
US	0.686	0.490		
UAQ	0.675			0.621
EU	0.651			0.250
JRS		0.951		
ARS		0.912		
RSUE		0.869		
LE		0.852		
IRSR	0.481	0.830		
GC	0.520	0.828		
PRS	0.554	0.767		
JUE		0.732		
JREFE		0.517		
JHE		0.481		
REE		0.422		
PTPA			0.882	
TQ			0.874	
TR			0.866	
T		0.516	0.728	
LUPL	0.421		0.653	0.338
HPD				0.940
JUA	0.449			0.753
JUH	0.504			0.689
JAPR	0.399			0.627
EDQ	0.580	0.388		0.585
JPER			0.542	0.560

The different computational results of cluster analysis and factor analysis are largely due to their different statistical procedures although both methods are data reduction techniques. Cluster analysis is a multivariate statistical procedure for grouping individual cases on the basis of similarity or dissimilarity.[19] The agglomerative hierarchical clustering starts with N clusters in a distance matrix. It searches the distance matrix for the most similar pair of clusters and merges these two clusters into one. The process is repeated a total of N–1 times until all objects are grouped into a large cluster.[19] By definition, principle components analysis (the factor analysis used in this study) is a data reduction method for explaining the variance-covariance structure of a set of variables through a few linear combination of these variables.[19] The original correlated variables are decomposed into uncorrelated variables or components which explain as much variance in the data as possible. The importance of this method lies in how much variance can be explained by components to which factor loadings of each case or variable are assigned.

Conclusions

Cluster analysis, multidimensional scaling, and factor analysis have been employed in this journal co-citation analysis of the intellectual space in urban studies for the time period of 1992–2002. The obtained results show a structure with four identifiable clusters of journals focusing on different aspects of urban studies. The clusters fit the two dimensions well if the magnitude of the dimension coordinates is taken into consideration. The two-dimensional map generated by the multidimensional scaling reaffirms the clustering of journals with related subjects. In sum, the study supports the following findings:

The horizontal axis of the multidimensional map has more interpretative power than the vertical one. There is a strong negative correlation between the horizontal axis coordinates and the mean journal correlation coefficients and a good positive relationship between the vertical axis coordinates and the mean journal correlations. To describe it roughly, the horizontal axis demonstrates the subject variation, with the mainstream urban studies journals flanked to the left side of the map and the regional science, transportation, and economics journals to the right. Overall, the vertical axis does not reflect a quantitative vs. qualitative continuum, nor does it reveal obvious subject and temporal orientations. Journals positioned close to the upper pole of the axis are quantitative in style, so are some journals located down the opposite pole.

The positions of the journals on the map are largely determined by their correlation coefficients, which represent the relative similarity of their co-citation profiles, hence their subject relatedness. The fact that no major journals occupy the central positions on the map suggests their limited connections to the rest of the journals across the set.

Taken as a whole, the mainstream urban studies journals in cluster 1 are highly interdisciplinary in scope. Practically all journals in cluster 1 are agglomerated on the left side of the map. The clustering implies the relatively close interconnections among these journals, covering urban planning, regional studies, economics, geography, political science, sociology, anthropology, environmental science, and other related disciplines. As has been stated, the journals' high degree of interdisciplinarity baffles the naming of their sub-groups. A clearer picture about the interdisciplinarity is presented by the factor analysis showing relative interrelationships among these journals through factor loadings.

To conclude, as an interdisciplinary field urban studies is changing and being changed as its subfields develop and new related fields arise. This study is limited to the analysis of urban study journals that exhibit certain salient features related to urban planning and regional studies. Future studies may explore the scholarly communication of the field by putting it in a broader context, which incorporates more general and broad-based journals from other fields – economics, geography, public administration, and sociology, to name only a few. Thus, a more comprehensive picture of its intellectual structure may be obtained. Studies using alternative approaches and techniques, such as qualitative methods, surveys of urban studies experts, journal-to-journal analysis, and content analysis, can help validate the results of this study.

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