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Exploring the web visibility of world-class universities

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Abstract With the rapid development of the Internet, there is a need for evaluating the public visibility of universities on the Internet (i.e., web visibility) in terms of its implications for university management, planning, and governance. The data were collected in December 2010 by using Yahoo, one of the most widely used search engines. Specifically, we gathered "Single Mention" data to measure the number of times that each university was mentioned on websites. In addition, we collected network-based data on Single Mentions. We obtained another data set based on the 2010 world university rankings by Shanghai Jiao Tong University (SJTU). We employed several analytical methods for the analysis, including correlations, nonparametric tests (e.g., the Mann–Whitney test), and multidimensional scaling (MDS). The significant positive correlation between university rankings and web visibility suggests that indicators of web visibility can function as a proxy measure of conventional university rankings. Another distinctive implication can be drawn from the pattern of a disparity in web visibility stemming from the linguistic divide, that is, universities in English-speaking countries dominated the central positions in various network structures of web visibility, whereas those in non-English-speaking countries were located in the periphery of these structures. In this regard, further research linking web visibility to university management, planning, and governance is needed.

Keywords Web visibility · Webometrics · World university rankings

The "education gospel" glorifying the key role of education in national economic competitiveness (Grubb and Lazerson 2004) has driven a new international race of higher education over the last decades. A majority of global universities have made considerable

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efforts to attain the title of "world-class university" through various strategic approaches, such as recruiting global talents (Brown et al. 2011), highlighting outcome-based research performance (e.g., research published in certain academic indices), securing huge funding, encouraging academic exchanges and collaborations, launching offshore universities (Marginson 2007), etc. Amid various efforts made to achieve the status of world-class university (and thereby improve their university rankings), there has been a growing recognition of the importance of web visibility (i.e., structure of web links) of universities that may critically shape people's perceptions of university reputations and images.

In particular, with the rapid development of the Internet, web visibility of universities has been critically appreciated in that the Internet has played a key role in forging the academic and educational competences of universities across countries through various e-learning programs and open sources for cutting-edge knowledge produced by higher education institutions (Ortega and Aguillo 2009). Indeed, reflecting the importance of web visibility of universities, a handful of online rankings on web performance of universities have been introduced. These online rankings are based on measuring the extent to which particular universities receive attention on the Internet in general (e.g., Ranking Web of World Universities) and from social networking sites in particular (e.g., Klout). University administrators have also started to recognize the university website as an important channel to increase institutional reputation and organizational image and spread knowledge produced by universities to global communities (Masterson 2011).

Despite this growing interest in web visibility of universities, empirical research on this topic is extremely thin in the field of educational research. To fill this research gap, this study explores web visibility of universities. This study focuses particularly on world-class universities, recognized by a conventional university ranking table—i.e., the Shanghai Jiao Tong University (SJTU) system. In doing so, the study attempts to discover a possible linkage between conventional university ranking and web links, one of the major web performance measures. Additionally, the study aims to identify certain factors that influence particular structures of web links among world-class universities.

Review of relevant literature

Research on global web visibility[1]

Due to the dearth of literature on web visibility of universities, we begin with research on general web visibility at a global scale in order to identify a conceptual framework to guide our study. Research on global web visibility has illustrated the structure of international web links, such as the increased centralization or increased diversification of web visibility (Park et al. 2011). The former perspective highlights the structure of global web links as reflecting a broader spectrum of global economics. Thus, this perspective places an emphasis on the asymmetry of global web visibility between North and South (Barnett and Park 2005; Chase-Dunn and Grimes 1995; Lee et al. 2007), which resonates with Wallerstein's world-system theory (Wallerstein 1974). The world-system theory posits that nations' economic development can be best understood by considering the systematic ways in which societies are connected to one another within the context of a global network of finance and trade (Barnett et al. 1996; Barnett and Park 2005). In a similar vein, research

[1] This section is mostly reconstructed and rephrased in accordance with the purpose of current paper, based on Park et al. (2011).

on global web visibility has documented that information exchanges or connections can be described using three structurally equivalent categories—the core, the periphery, and the semi-periphery—which are determined by the level of economic development (Barabasi 2002; Barnett and Choi 1995; Barnett and Park 2005). For example, Barnett and Park (2005) identified that the infrastructure of the Internet at a global scale could be illustrated as a wheel with the US at the hub, Western European countries at a semi-peripheral position, and the rest of the countries (e.g., Asia, Latin America, and Eastern Europe) at the periphery.

This line of research based on the world-system theory provides an important implication for the examination of global links of universities on the web—i.e., the structural position of a country determined by economic development status may shape its universities' potential and interaction patterns on the web (Park et al. 2011). For example, it can be assumed that universities from the core (e.g., U.S. universities) may be located in the central part of the web links and would be proximate to each other in the structure of web links, whereas universities from the semi-peripheral countries (i.e., Western Europe) may be relatively closer to the center than to each other (Lee et al. 2007; Monge and Contractor 2003).

Another perspective on global web visibility focuses more on the increasing trends of decentralization in terms of geography and culture, and the emergence of clusters in peripheral areas (Barnett 2001; Danowski 2000; Lee et al. 2007; Matei 2006; Monge and Matei 2004; Robertson 1992). While this decentralization perspective acknowledges the tremendous interconnections on the web across many countries, it questions the adequacy of the world-system theory in capturing the complexities of global web links (Barnett and Choi 1995; Barnett et al. 1999). A distinctive feature of this perspective is that, beyond economic relations, it highlights other factors such as geographical proximity (Barnett and Choi 1995), linguistic clusters (Barnett and Choi 1995), religious homogeneity (Barnett et al. 1999), and cultural similarity (Barnett and Sung 2006) in explaining the formation of the structure of global web links.

Research using this decentralization framework also provides a meaningful implication for understanding global web visibility among universities—i.e., there may be sub-systems of global web visibility among universities that are formed by socio-cultural homophily and geographical proximity. Such sub-systems may bring a multilayered structure of global web links into the traditional core-periphery model (Lee et al. 2007).

Research on university web links

Based on these two theoretical perspectives, we aim to examine global links among world-class universities on the web. While there exists considerable research exploring global web visibility, mostly conducted in the communication studies noted above (e.g., Barnett 2001; Choi and Ahn 1996; Lee et al. 2007), only a few empirical studies have examined the structure of university web links. Most of these studies have been conducted by capturing web links within a particular disciplinary area or country. Specifically, Thelwall and co-workers have significantly contributed to this line of research by exploring web interconnectedness of academic and scientific activities among universities (Li et al. 2003; Payne and Thelwall 2004; Tang and Thelwall 2004; Thelwall 2002a; Thelwall and Harries 2003, 2004; Vaughan and Thelwall 2005). As mentioned previously, these studies have examined interconnections of academic outputs in certain disciplines or hyperlinks of academic departments within a particular country, such as Canada, Spain, the UK, and the US. Recently, a handful of studies have attempted to expand the scope of geographical coverage (Ortega and Aguillo 2009; Ortega et al. 2008; Park and Thelwall 2006). For

example, Ortega et al. (2008) examined various internal clusters of European universities based on linguistic or geographical factors. Park and Thelwall (2006) further explored the connectivity structure of links between two different continents. University websites in 25 Asian and European countries were investigated in order to identify an inter- and intra-regional web structure.

Probably the largest scale study would be Ortega and Aguillo's (2009) recent work targeting these web connections at a global level. Using the first 1,000 universities from the Ranking Web of World Universities, they explored web links of the 1,000 universities covering virtually all continents. Their findings support both of the theoretical perspectives noted above. Consistent with the world-system theory, U.S. universities dominated the global web links. For example, the top 10 universities that are connected with the most other universities on the web were U.S. universities. However, the study also found regional clusters [e.g., European Union (EU) universities] and sub-networks by linguistic similarities, which support the decentralization perspective. Ortega and Aguillo's study has contributed to research on university web visibility at a global scale. At the same time, however, those universities selected for analysis were high performing universities on the webometric ranking, which measures particular characteristics of university websites, such as the volume of content and incoming web links. As such, the remaining question is whether world-class universities recognized by conventional ranking tables (e.g., rankings by QS or SJTU) would perform well in terms of global web visibility. Rather than targeting top ranked universities in certain web performance measures, this study focuses on top ranked universities in conventional ranking tables in order to delve into the linkage between web visibility and world-class universities.

Research questions

Based on the conceptual framework previously discussed, we center our research on the following two research questions:

- What is the structure of web visibility of world-class universities?
- What are the factors that influence web visibility of world-class universities?

Method

Data collection

Data have been gathered through Yahoo, one of the most widely used search engines in webometrics (Park 2010). Another dataset was drawn from the 2010 world university ranking of SJTU. Two established international university ranking systems, published by SJU and the Times Higher Education Supplement (THES), respectively, are widely used and discussed in previous research (Lee 2007; Levin et al. 2006; Usher and Savino 2006; Marginson 2007). In line with this, we chose the SJU's ranking table. It should be noted that the purpose of using the university ranking table is to draw sample universities for the current study, not to imply that the rankings reflect the quality of the universities, because various ranking tables have limitations in measurement.[2]

[2] Research exploring the key features of world-class universities has identified several common criteria across different ranking tables, including academic reputation, faculty-student ratio, percentage of foreign students, entrance exam scores of accepted graduate students, and financial resources (e.g., Niland 2000;

Measures

- University ranking: We reverse-coded the ranking in the SJU's table. For example, Harvard University was ranked as 1, which was re-coded as 100 for easy interpretation. In addition, we re-ranked some universities with tied ranks for non-parametric analysis.
- Web visibility was operationally defined as various types of web mentions for each university and hyperlink counts directed to its website (Khan and Park 2011; Lim and Park 2011; Park 2011). First, "Single Mention" measured how many times each university name was mentioned in cyberspace. This is a simple and straightforward technique to identify online presence of a specific issue, person, and organization. Web mention analysis was also conducted in a relational context. A pair of university names—in this case 9,900 pairs (100*99)—was searched. Based on a co-mention matrix of the 100 universities, we calculated several network-based indicators of web visibility: in-degree, out-degree, flow betweenness, eigenvector, and pagerank. Each of the network indicators will be explained in the section below. Second, the number of external hyperlinks pointing to each university site was retrieved. In other words, "Single In-link" counts incoming links to each university site. We also measured web visibility of each university in the structure of inter-linking associations among 100 university sites. The existence of hyperlinks between a pair of websites was tracked. This provides online presence of some university sites relative to others. Third, co-link frequency was collected. Co-link refers to external links pointing to a pair of university sites at the same time. While inter-link reveals direct associations between universities, co-link is regarded as indirect relations from the third perspective.
- The indicator applied here is rooted in social network analysis using the following five measures (Park 2011; Yang et al. 2010): in-degree, out-degree, flow betweenness, eigenvector, and pagerank. In-degree refers to the total number of hyperlinks received by others for a single set of components, in this case, 100 university sites. On the other hand, out-degree is the sum of the links a university sent to other universities. While degree indicators measure the relations initiated by a university, betweenness measure is a useful index to measure the potential influence of some websites in controlling the amount of hyperlink-mediated information flow. Eigenvector index, suggested by Bonacich (1972), assesses the overall importance of some sites based on the links exchanged between sites. Compared to degree-based indicators, eigenvector does not consider the direction of hyperlinks. Pagerank was originated by the search engine Google to find out the most visible websites in a short time. Pagerank was used in this paper to identify online visibility of some websites from a search engine perspective.

Analytical strategies

Several analytical methods were employed for this analysis. We first used descriptive statistics, including correlations. To this end, the raw scores of web-visibility indicators were converted into scores based on natural logarithm because all of them are highly skewed. Second, we used non-parametric tests, including Mann–Whitney and Kruskal–

Footnote 2 continued
Clarke 2002; Rosso and Velasco 2006). Other ranking criteria point to faculty accomplishments, including faculty awards, honors and prizes, faculty citations in major citation indices (e.g., The Shanghai Jiao Tong University Global Ranking; Time Higher World University Ranking), and the alumni-giving rate (e.g., U.S. News & World Report Ranking).

Table 1 Descriptive statistics

	Mean	SD	Mean[a]	SD[a]	*N*
Single Mention	71,739,380	98,000,784	17.3497	1.31681	100
Mention In-degree	5,218,073	5,996,934	14.7588	1.36486	100
Mention Out-degree	5,218,073	5,996,934	14.7588	1.36486	100
Mention Flow Betweenness	1.1036	1.12376	22.5610	1.20382	100
Mention Eigenvector	.06368536	.07748680	−3.5712	1.48589	100
Mention Pagerank	.00821495	.00663287	−5.2058	.96972	100
Single In-Link	834,016	854,592	13.1538	1.04936	100
Interlink In-degree	388	446	5.3207	1.26694	100
Interlink Out-degree	388	435	5.3560	1.26132	100
Interlink Flow Betweenness	912,046	838,223	13.3064	1.01848	100
Interlink Eigenvector	.02993364	.09589547	−4.8163	1.51524	100
Interlink Pagerank	.00938836	.00809125	−5.0551	.91616	100
Co-inlink Degree	23,177	20,647	9.5419	1.15017	100
Co-inlink Flow Betweenness	57,750,672	46,028,771	17.4841	.99287	100
Co-inlink Eigenvector	.07308005	.06860295	−3.2113	1.26185	100
Co-inlink Pagerank	.00864001	.00553603	−5.0576	.88195	100

[a] The mean and standard deviation were transformed into natural logarithm

Wallis, since the measures were not normally distributed. Third, we utilized multidimensional scaling (MDS) in order to visualize web visibility among world-class universities.

Results

Descriptive statistics

Table 1 presents two types of mean and standard deviations from the raw data and the data transformed by natural logarithm. The average Single Mention generated from the 100 university through Yahoo was 71,739,380, indicating that there are a tremendous number of web mentions of the top 100 universities.[3]

We transformed the raw data using natural logarithm in order to compute correlations between university rankings and web-visibility indicators.[4] Table 2 shows that there were

[3] Specifically, single mentions for the top five universities were as follows: Harvard (140,000,000), U.C. Berkeley (63,600,000), Stanford (95,300,000), MIT (57,400,000), and Cambridge (161,000,000). Single mentions for the top five universities in non-English-speaking countries were as follows: Tokyo (77,200,000), Kyoto (26,900,000), Pierre and Marie Curie University-Paris 6 (678,000), Copenhagen (28,500,000), and Karolinska Institute (2,860,000).

[4] It should be noted that for some web-visibility indicators, standard deviations are higher than their means because they are extremely skewed. For this reason, we also provide means and deviations based on natural logarithm.

Table 2 Correlation matrix

	1	2	3	4	5	6	7	8	9
1	1	.331**	.334**	.334**	.324**	.337**	.393**	.521**	.558**
2	.331**	1	.964**	.964**	.967**	.958**	.921**	.559**	.487**
3	.334**	.964**	1	1.000**	.995**	.998**	.942**	.579**	.499**
4	.334**	.964**	1.000**	1	.995**	.998**	.942**	.579**	.499**
5	.324**	.967**	.995**	.995**	1	.989**	.937**	.551**	.469**
6	.337**	.958**	.998**	.998**	.989**	1	.939**	.590**	.513**
7	.393**	.921**	.942**	.942**	.937**	.939**	1	.578**	.510**
8	.521**	.559**	.579**	.579**	.551**	.590**	.578**	1	.873**
9	.558**	.487**	.499**	.499**	.469**	.513**	.510**	.873**	1
10	.403**	.452**	.468**	.468**	.443**	.480**	.469**	.867**	.800**
11	.481**	.449**	.453**	.453**	.433**	.461**	.465**	.887**	.889**
12	.479**	.439**	.445**	.445**	.425**	.454**	.438**	.829**	.836**
13	.595**	.471**	.474**	.474**	.437**	.490**	.494**	.881**	.893**
14	.457**	.609**	.631**	.631**	.599**	.645**	.609**	.947**	.880**
15	.454**	.595**	.610**	.610**	.584**	.621**	.591**	.949**	.885**
16	.461**	.614**	.640**	.640**	.605**	.656**	.614**	.936**	.869**
17	.461**	.545**	.581**	.581**	.550**	.596**	.565**	.865**	.856**

	10	11	12	13	14	15	16	17
1	.403**	.481**	.479**	.595**	.457**	.454**	.461**	.461**
2	.452**	.449**	.439**	.471**	.609**	.595**	.614**	.545**
3	.468**	.453**	.445**	.474**	.631**	.610**	.640**	.581**
4	.468**	.453**	.445**	.474**	.631**	.610**	.640**	.581**
5	.443**	.433**	.425**	.437**	.599**	.584**	.605**	.550**
6	.480**	.461**	.454**	.490**	.645**	.621**	.656**	.596**
7	.469**	.465**	.438**	.494**	.609**	.591**	.614**	.565**
8	.867**	.887**	.829**	.881**	.947**	.949**	.936**	.865**
9	.800**	.889**	.836**	.893**	.880**	.885**	.869**	.856**
10	1	.947**	.899**	.773**	.849**	.860**	.836**	.787**
11	.947**	1	.859**	.836**	.871**	.887**	.854**	.809**
12	.899**	.859**	1	.756**	.802**	.824**	.781**	.766**
13	.773**	.836**	.756**	1	.880**	.870**	.875**	.846**
14	.849**	.871**	.802**	.880**	1	.990**	.995**	.894**
15	.860**	.887**	.824**	.870**	.990**	1	.972**	.899**
16	.836**	.854**	.781**	.875**	.995**	.972**	1	.878**
17	.787**	.809**	.766**	.846**	.894**	.899**	.878**	1

1 University ranking, *2* Single Mention, *3* Mention In-degree, *4* Mention Out-degree, *5* Mention Flow Betweenness, *6* Mention Eigenvector, *7* Mention Pagerank, *8* Single In-Link, *9* Interlink In-degree, *10* Interlink Out-degree, *11* Interlink Flow Betweenness, *12* Interlink Eigenvector, *13* Interlink Pagerank, *14* Co-inlink Degree, *15* Co-inlink Flow Betweenness, *16* Co-inlink Eigenvector, *17* Co-inlink Pagerank

** Correlation is significant at the .01 level (2-tailed)

significantly positive correlations between the university rankings and various indicators of web visibility. This suggests that high ranked universities perform well in web visibility. Specifically, 13 out the 16 web-visibility indicators had modestly strong correlations with the university rankings (between .3 and .5). With respect to the other three indicators (i.e., Single Link, Interlink In-degree, and Interlink Pagerank), they had stronger correlations with the university rankings (between .5 and .6). Interlink Pagerank showed the highest correlation with the university rankings. The significantly positive correlations between the university rankings and various indicators of web visibility suggest that high ranked universities perform well in web visibility.

We explored whether there are differences in web-visibility indicators in terms of regions in which universities are located. We categorized the 100 universities into four groups: Asia (6), Australia (3), Europe (33), and North America (58); Canadian universities were grouped together with U.S. universities. One Russian university, the only university from Eastern Europe, was grouped with other Western European universities for simplified comparisons. The reason for this comparison was to explore whether the regional location of a university is associated with web visibility of that university. The Kruskal–Wallis test was employed.

Findings indicate that there were significant group differences in web visibility by region (see Table 3). Overall, North American universities and Australian universities performed better in a majority of web-visibility indicators than their counterparts in Asia and Europe. Specifically, North American universities showed the highest web visibility in all the indicators, except Single Mention and Mention Flow Betweenness; Australian universities demonstrated the highest scores in those measures. While Asian universities lagged behind other universities, they were the second best group in the following web-visibility areas: Interlink Out-degree, Interlink Eigenvector, Interlink Pagerank, and Co-inlink Flow Betweenness.

We investigated another distinctive feature of web visibility by comparing universities from English speaking countries with their counterparts from non-English speaking countries. The distinction of the two groups of universities reflects the language of instruction those universities adopt, even though some universities in non-English speaking countries adopt English either fully or partially as the language of instruction (e.g., universities in the Netherlands, Sweden, etc.). We were suspicious that there might be associations between language and web visibility because Yahoo is an English language website. To this end, we used another non-parametric group comparison, the Mann–Whitney test.

As illustrated in Table 4, there were significant differences in web visibility between the two groups. Universities from English speaking countries showed higher web visibility scores in all indicators than their non-English speaking counterparts.

To confirm the findings describe above, we further tested whether web visibility is associated with geographical proximity and English language. To this end, we used MDS. Figure 1 shows the MDS of Yahoo Mentions among the 100 universities. This was generated using the similarity matrix of PROXCAL; that is, the asymmetric network data (i.e., Mention In-degree and out-degree between two universities) were converted into a correlation matrix, which was used for the MDS.

One noticeable pattern emerging from the figure is that the pattern of web mentions mirrors the geographical proximity among universities. Obviously, a majority of U.S. universities were dominant in the center left side where they tended to gather together, whereas a majority of non-U.S. universities were located in the center right side where non-U.S. universities tended to be relatively scattered. Specifically, U.K. universities were

Table 3 Web visibility by four regions

	1 = Asia 2 = Australia 3 = Europe 4 = North America	*N*	Mean rank	χ^2	*P* value
Single Mention	1	6	36.75	15.69	.001
	2	3	63.33		
	3	33	36.05		
	4	58	59.48		
Mention In-degree	1	6	25	21.10	.00
	2	3	58		
	3	33	35.79		
	4	58	61.12		
Mention Out-degree	1	6	25	21.1	.00
	2	3	58		
	3	33	35.79		
	4	58	61.12		
Mention Flow Betweenness	1	6	27.17	15.81	.001
	2	3	61.33		
	3	33	38.09		
	4	58	59.41		
Mention Eigenvector	1	6	23.67	24.54	.00
	2	3	57		
	3	33	34.48		
	4	58	62.05		
Mention Pagerank	1	6	28.67	17.88	.00
	2	3	57		
	3	33	36.64		
	4	58	60.31		
Single Link	1	6	38	37.11	.00
	2	3	43.67		
	3	33	27.45		
	4	58	65.26		
Interlink In-degree	1	6	28.17	35.31	.00
	2	3	48.33		
	3	33	29.42		
	4	58	64.91		
Interlink Out-degree	1	6	39.83	27.11	.00
	2	3	32		
	3	33	31.7		
	4	58	63.26		
Interlink Flow Betweenness	1	6	33.83	26.81	.00
	2	3	37.67		
	3	33	32.27		
	4	58	63.26		

Table 3 continued

	1 = Asia 2 = Australia 3 = Europe 4 = North America	*N*	Mean rank	χ^2	*P* value
Interlink Eigenvector	1	6	51.5	33.88	.00
	2	3	27.67		
	3	33	28.39		
	4	58	64.16		
Interlink Pagerank	1	6	36.83	39.04	.00
	2	3	30		
	3	33	27.91		
	4	58	65.83		
Co-inlink Degree	1	6	30.17	46.78	.00
	2	3	38.67		
	3	33	25.79		
	4	58	67.28		
Co-inlink Flow Betweenness	1	6	37.17	41.86	.00
	2	3	36.67		
	3	33	26.42		
	4	58	66.29		
Co-inlink Eigenvector	1	6	26.67	48.03	.00
	2	3	39.67		
	3	33	25.94		
	4	58	67.5		
Co-inlink Pagerank	1	6	34.67	38.07	.00
	2	3	35.67		
	3	33	28.15		
	4	58	65.62		

located in the upper right area, European universities (except the UK) were positioned in the center right area, and Japanese universities were placed in the bottom right area, next to Australian universities.

Interestingly, European universities from non-English speaking countries were more closely placed with other European universities from non-English speaking countries. In other words, within European universities, U.K. universities were positioned slightly away from universities from the European Continent, although Oxford and Cambridge seemed to be slightly closer to those European universities than their U.K. peer universities.

Finally, the three Australian universities (Sydney, Melbourne, and Australian National) were located among universities from different continents, whereas Japanese universities were relatively isolated in the periphery.

Figure 2 illustrates another distinctive MDS—i.e., web co-inlinks among the 100 universities. This was generated using the similarity matrix of PROXCAL. Unlike the MDS of web mentions, web co-inlinks are based on symmetric networks. Therefore, the data were not converted into a correlation matrix. Instead, the raw scores of co-inlinks (not transformed into natural logarithm data) were used.

Table 4 Web visibility by universities in English speaking countries versus universities in non-English speaking countries

	1 = yes, 0 = no	*N*	Mean rank	Sum of ranks	*Z*	*P* value
Single Mention	0	28	28.71	804.00	−4.68	.00
	1	72	58.97	4246.00		
Mention In-degree	0	28	26.96	755.00	−5.06	.00
	1	72	59.65	4295.00		
Mention Out-degree	0	28	26.96	755.00	−5.06	.00
	1	72	59.65	4295.00		
Mention Flow Betweenness	0	28	28.79	806	−4.67	.00
	1	72	58.94	4,244		
Mention Eigenvector	0	28	26	728	−5.27	.00
	1	72	60.03	4,322		
Mention Pagerank	0	28	28	784	−4.86	.00
	1	72	59.25	4,266		
Single Link	0	28	25.52	714.5	−5.37	.00
	1	72	60.22	4,335.5		
Interlink In-degree	0	28	25.32	709	−5.41	.00
	1	72	60.29	4,341		
Interlink Out-degree	0	28	31.14	872	−4.16	.00
	1	72	58.03	4,178		
Interlink Flow Betweenness	0	28	28.43	796	−4.74	.00
	1	72	59.08	4,254		
Interlink Eigenvector	0	28	31.68	887	−4.05	.00
	1	72	57.82	4,163		
Interlink Pagerank	0	28	24.91	697.5	−5.50	.00
	1	72	60.45	4352.5		
Co-inlink Degree	0	28	21.64	606	−6.20	.00
	1	72	61.72	4,444		
Co-inlink Flow Betweenness	0	28	23.29	652	−5.85	.00
	1	72	61.08	4,398		
Co-inlink Eigenvector	0	28	21.14	592	−6.31	.00
	1	72	61.92	4,458		
Co-inlink Pagerank	0	28	25.27	707.5	−5.44	.00
	1	72	60.31	4342.5		

Similar to the MDS of web mentions, the pattern of web co-inlinks reflected the geographical proximity among universities. Again, a majority of U.S. universities were dominant in the center. Four U.K. universities (Oxford, Cambridge, University College London, and Edinburgh) were located right next to the U.S. universities. However, other U.K. universities (e.g., Imperial College, Manchester, Nottingham, Birmingham, Bristol, King's College London, and Manchester) were placed in the periphery of the MDS. Japanese universities, except Tokyo University, were again isolated in the periphery, so were French universities in the center right area.

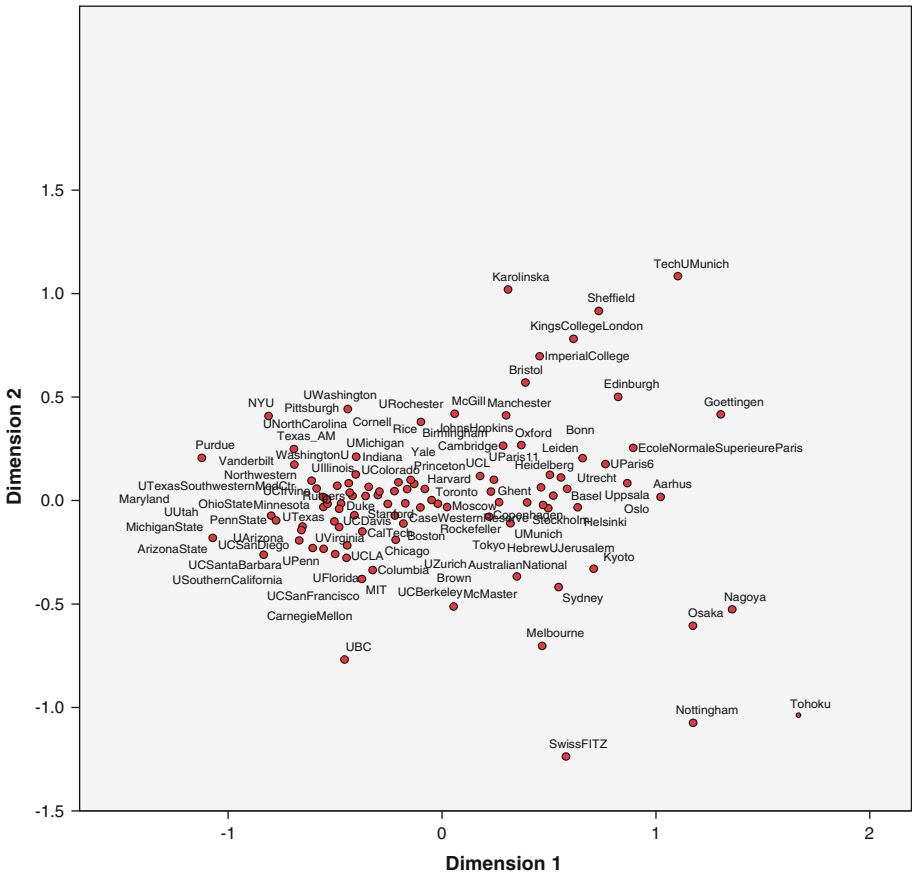

Fig. 1 MDS of world class universities by web mentions. *Note*: Normalized Raw Stress was .0254

A distinctive pattern from the MDS of web co-inlinks is that many universities from the European Continent were placed in the periphery. We can identify this by drawing a line counterclockwise, which is shaped like a semi-circle rim, beginning from "Technical University of Munich" at the bottom to "Ghent University" at the top in the MDS. Australian and Canadian universities were relatively closely located in the center in the MDS.

Finally, we explored interlinks among the 100 universities using MDS. This was generated using the similarity matrix of PROXCAL; that is, the asymmetric network data were converted into a correlation matrix, which was used for the MDS. Similar to the MDS of web co-inlinks, the pattern of web interlinks resonated with the geographical proximity among universities. Again, a majority of U.S. universities were dominant in the center left in a more dense way. Similar to the MDS of web co-inlinks, many European universities, including most U.K. universities, were placed in a scattered pattern and located in the periphery. Australian and Canadian universities were relatively closely located in the center, close to many U.S. universities, although Melbourne and University of British Columbia were somewhat exceptional. All Japanese universities were again isolated in the lower right side (Fig. 3).

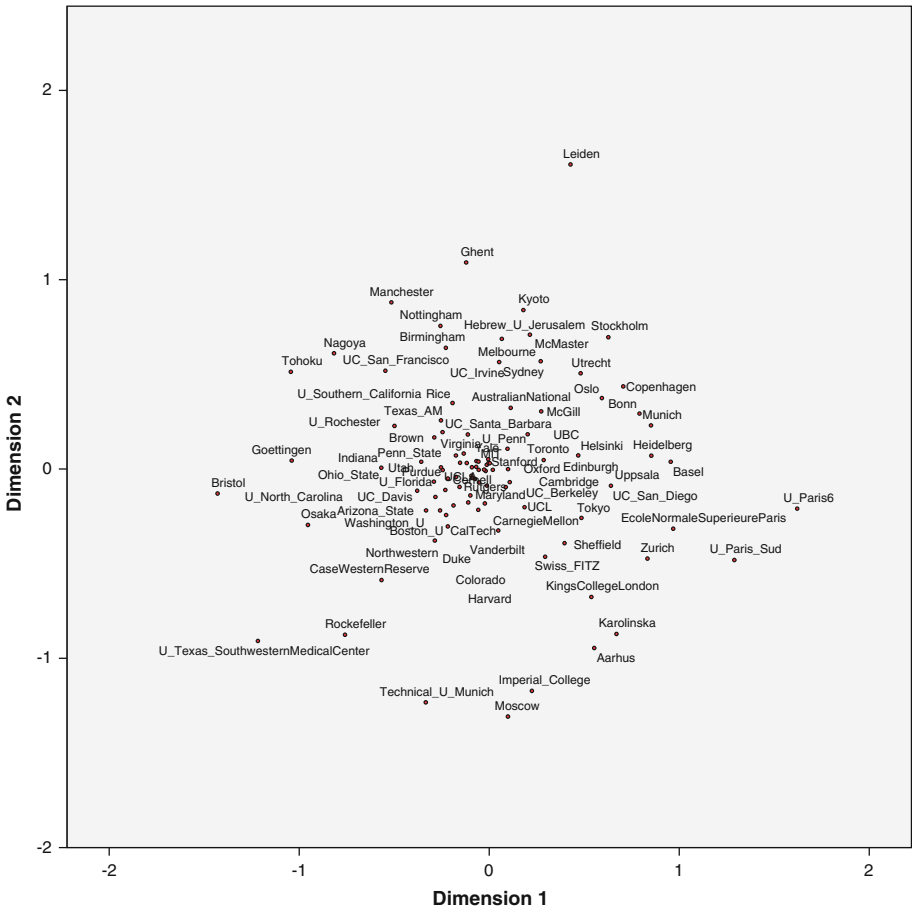

Fig. 2 MDS of world class universities by web co-inlinks. *Note*: Normalized Raw Stress was .080

Discussion

An overall patten: the higher ranking, the better web links

The findings indicate that there are a tremendous number of web mentions generated from the top 100 universities. The average Single Mention of the 100 universities through Yahoo was 71,739,380, indicating that there are a sizeable number of web mentions of the top 100 universities. High ranked universities seemed to perform well in web links because there were significantly positive correlations between the university rankings and various indicators of web links. This suggests that the indicators of web links function as a proxy measure of university rankings.

Regional disparity

There were, however, disparities in web visibility among the 100 universities in terms of geographical locations. Overall, North American universities and Australian universities

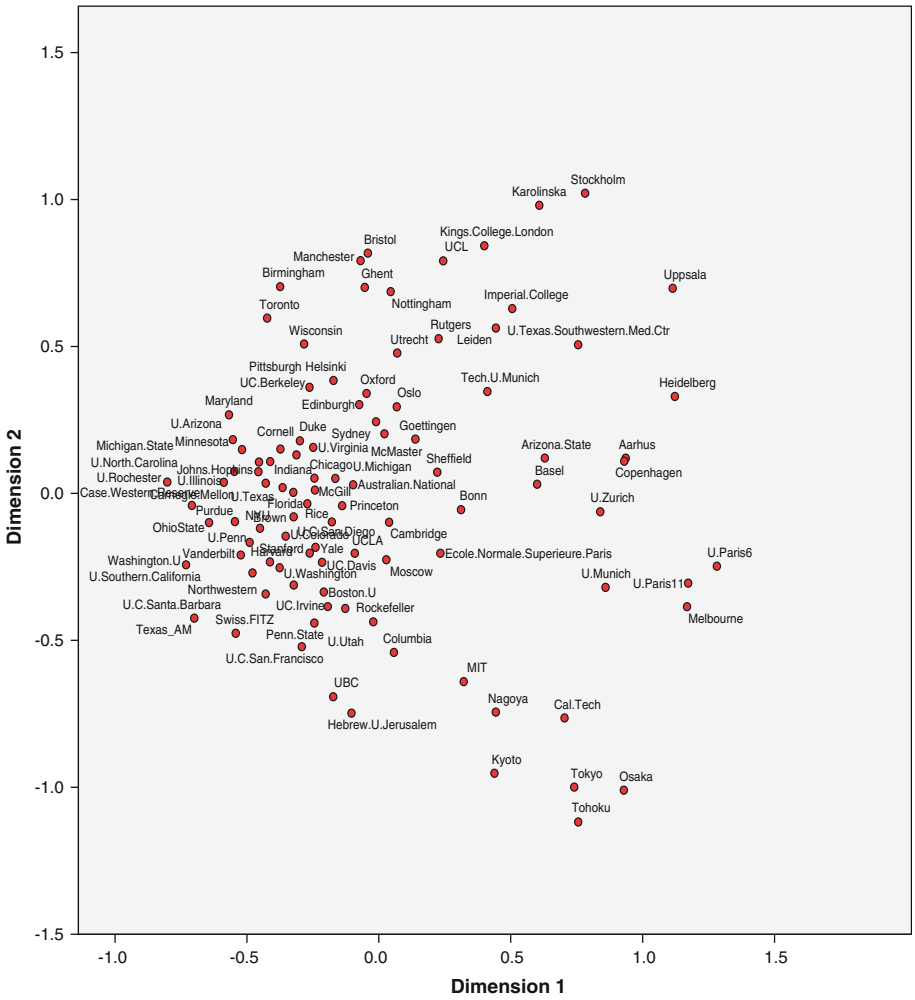

Fig. 3 MDS of world class universities by web interlinks. *Note*: Normalized Raw Stress was .083

performed better in a majority of web-visibility indicators than their counterparts in Asia and Europe. However, while Asian universities lagged behind their counterparts in North America and Australia, they were the second best group in the following web-visibility areas: Interlink Out-degree, Interlink Eigenvector, Interlink Pagerank, and Co-inlink Flow Betweenness.

A linguistic divide: the use of English

Another disparity in web visibility is associated with language. Universities from English speaking countries had higher web-visibility scores in all the indicators than their non-English speaking counterparts. We propose two reasons for this. First, Yahoo, our data source, is basically an English language website, which might cover more English mediated websites, even though this claim should be scrutinized in future studies (Vaughan and

Thelwall 2004). As such, universities in English speaking countries might benefit from their language in web-visibility performance. Another reason might be the fact that English is used as the *lingua franca* for a majority of websites. As Park and Thelwall (2006) pointed out, English as the international language of websites is a primary advantage in the high performance of universities from English speaking countries in terms of web visibility.

Intersection between geographical clustering and linguistic convergence

We note two emerging patterns from the disparity. First, the web-visibility disparity is formed by geographical clustering. For example, universities' web mentions were associated with their geographical clustering based on proximity. This was evident in a majority of U.S. and European universities. This suggests that geographic proximity is an important factor shaping the university clustering of web mentions. The higher number of web mentions among U.S. universities is not surprising because they are located in one country. However, the higher number of web mentions among European universities is an interesting phenomenon, given that they are linguistically and culturally more diverse than U.S. universities.

Despite their relatively heterogeneous status, the clustering of universities from the European Continent in web mentions may be explained from the "European Dimension of Education" framework that aims to facilitate academic exchanges, student mobility, and academic collaborations through EU policies such as the Socrates program. Indeed, since the 1992 European Treaty, the EU has been a key actor of European integration in the area of education and training, based on its relatively expanded power (Lee et al. 2008). As such, the European Commission has actively played a role in pursuing the European dimension of education and training by facilitating co-operation and mobility in education and training among EU countries (Lee et al. 2008). This suggests that the clustering of web mentions among European universities might be associated not just with their geographical proximity but also with certain macro-policy contexts shaped by the EU (i.e., European universities have active inter-university program/faculty), although European universities are relatively marginalized in web-visibility indicators among the top 100 universities.

Notably, the language of instruction in universities also seems to be associated with web mentions. We wish to note that U.K. universities tended to cluster away from European universities in non-English speaking countries. Such polarization simultaneously resonated with (1) English as a dominant language that links European websites and (2) the multilingual character of websites within European countries (Thelwall et al. 2003).

This linguistic divide (English vs. non-English) might be applied to both Australian and Japanese universities in an opposite way. While Australian universities are well positioned between universities from different continents, probably because English is their language of instruction, Japanese universities are relatively isolated in terms of web mentions. This finding is in line with Park and Thelwall's (2006) study reporting that Japanese universities form a relatively isolated cluster in interlinks among Asian and European universities.

Findings from both web co-inlinks and interlinks echo geographical and linguistic factors. Web co-inlinks also seem to be influenced by geographical proximity and language. However, language seems to play a more important role in shaping web co-inlinks than web mentions, considering that (1) a majority of European universities from non-English speaking countries are more marginalized in co-inlinks than web mentions and (2) Australian and Canadian universities are more closely located in the center in terms of web co-inlinks than web mentions. Web interlinks show a similar pattern as web co-inlinks.

Based on the patterns from co-links and interlinks, the divided locations between U.S. (center) and other universities (periphery) seem to be a result of the interplay among geographical proximity, use of English language, and regional academic collaborations (i.e., European Dimension of Education).

Concluding remarks

Key findings from this study can be summarized as follows:

- Web-visibility indicators could function as proxy measures of university rankings.
- The formation of university web visibility seems to be influenced by geographical proximity and the use of English. In other words, their web visibility tends to be clustered by geographical proximity (e.g., U.S. universities vs. European universities), and it is linguistically divided (e.g., English versus non-English).
- While geographical and language-based clusters are evident, universities from English speaking countries in general, and U.S. universities in particular, are dominant in various web-visibility indicators.
- This finding is in line with the findings from previous research mostly focusing on academic (or university) web links (Park and Thelwall 2006; Thelwall 2002b; Thelwall et al. 2003).
- The divide among European universities seems to be influenced by the use of English and geographical locations (U.K. vs. European Continent universities); at the same time, their overall clustering seems to be explained by the EU's macro-policy factors.

In terms of research, these findings support both the world-system theory and the decentralization perspective. On the one hand, this study shows that the structure of web links among the world-class universities can be classified into the core (U.S. universities), the periphery (Asian universities and Western European universities on the European Continent), and the semi-periphery (U.K. and Australian universities). This asymmetry of global web links among the top 100 universities reflects the perspective of the world-system theory to some extent. On the other hand, it should be noted that the structural position of world-class universities was not entirely determined by the economic development status or economic relations of countries in which they were located. Rather, there was a pattern of decentralization that seemed to stem from geographical proximity, linguistic divide, and macro-policy contexts (i.e., European Dimension of Education), which resonated with the decentralization perspective. In summary, the structure of web visibility among world-class universities has a clear hierarchy that seems to be shaped by factors such as geographical, linguistic, and macro-policy contexts.

In terms of practice, the finding that the indicators of web visibility could serve as proxy measures of university rankings suggests the importance of web visibility in relation to university governance. In other words, the findings may contribute to research on higher education by linking the importance of web visibility of universities to various issues surrounding university management and strategic planning, given that higher education institutions spend substantial budgets for institutional research on branding, marketing, and institutional initiatives. These initiatives are designed to enhance the universities' public visibility and reputation among key stakeholders, such as prospective students and faculty, peer institutions, funding bodies, etc. (Masterson 2011). For example, university administrators in non-English speaking countries will need to think about how they could enhance their universities' web visibility to both the public and academia by scrutinizing

the strengths and weaknesses of particular web-visibility indicators of their universities. It should be noted that each of the indicators of web visibility in this study represents various, unique features of semantic interactions among universities on the Internet and the structure of such semantic interactions.

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