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Effect of gender on collaborative associations of researchers in Malaysia

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Abstract

Purpose – This study aims to find the level of gender-based assortativity in the association of researchers and investigate if gender has influence over social capital of researchers and their research performance in the context of a multi-ethnic nation, such as Malaysia.

Design/methodology/approach – Social network analysis is used as a primary research method to analyse the associations between the authors. Mann-Whitney test is used for testing the significant differences in research performance and social capital based on gender.

Findings – The assortative mixing patterns of 187 researchers revealed positive assortativity, meaning that more authors preferred to co-author with authors of their gender. No influence of gender was seen on the social capital of authors. However, gender did significantly influence the research productivity of authors.

Originality/value – This is one of the first studies that attempts to find the influence of gender on collaborative associations of researchers in Malaysia.

Keywords Gender, Malaysia, Social network analysis, Social capital, Assortativity, Research productivity

Paper type Research paper

Introduction

The influence of gender in higher education has been widely studied (Machado-Taylor and Ozkanli, 2013; Renzulli *et al.*, 2013; Teelken and Deem, 2013). However, few studies have quantitatively analysed the influence of gender over social capital, assortativity or research performance of researchers. Coleman (1988) referred to social capital as the resources available through social relationships. Social capital could be quantitatively measured through the cohesion or the diversity of ties that exist among the actors and their alter egos. Burt (1997) presented a theory of *structural holes* which suggested that the diversity of connections presents more brokerage positions that may be crucial to individual outcomes. In contrast, Coleman (1988) suggested that social capital arises from cohesion or connectedness that aids in trust and cooperation among the actors. Yet another concept of association is that of assortativity. Assortativity or homophily is the tendency of entities to connect to others who are similar. This similarity could be due to race, language, nationality or professional position, among others.

Renzulli *et al.* (2013) examined institution type, academic division and rank to show that women were disproportionately located in academic places that pay less than places where men are found more. In another study, Eloy *et al.* (2013b) evaluated gender

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differences in National Institutes of Health funding among faculty in a medical department and found that, looking at both academic rank and years of active service, men had significantly higher levels of funding. This inequality of funding existed despite the increasing percentages of female academicians in higher ranks. However, if academic rank is controlled, women and men were equally successful in acquiring grants. Waisbren *et al.* (2008) evaluated data on 6,319 grant applications submitted by 2,480 faculty applicants (with women submitting 26 per cent of all grant requests) and found that, controlling for academic rank, grant success rates were not significantly different between women and men.

Gender disparities are evident in the academic performance of researchers. Eloy *et al.* (2013a) found that, among academic otolaryngologists, men had significantly higher *h* indices than women. In addition, men had higher research productivity rates than women at points early in their career. Nonetheless, the productivity of women equalled or even surpassed those of men as they moved up the career ladder. Although gender disparities seem to be diminishing in academia during the past 30 years or so, female attrition rates remain high. Hopkins *et al.* (2013) showed that women remain underrepresented in academic positions and that a lower percentage of women are published at each academic level. However, it is not always gender disparity that negatively impacts research productivity of researchers. A recent study by Sotudeh and Khoshian (2014) found that though female nanoresearchers were small in number, they have similar performance with that of male researchers in the field. Another study by Iwe (2005) found that, despite traditional prejudices against women, the productivity of women researchers in the library and information sector in Nigeria had remained high.

The effect of social capital, as evidenced through structural holes and cohesion values, on research performance has been investigated and positive association has been seen between the two (Abbasi *et al.*, 2011; Kumar and Jan, 2013). Pepe and Rodriguez (2010) investigated the assortative mixing patterns of researchers at a research collaboratory and found that researchers did show a degree of preference in associating based on certain socio-academic parameters. Recently, Kumar and Jan (2014) investigated assortativity of researchers based on socio-academic parameters, such as race, gender and professional position, at a research-intensive university on Malaysia.

As can be seen, while most studies have focussed on gender disparities in academia, some newer studies have investigated the role of gender in academic performance of researchers. Rarely, however, has the influence of gender on social capital of researchers and the gender-based assortative patterns been studied. This study attempts to find the level of gender-based assortativity in the association of researchers and investigate if gender has an influence over social capital of researchers and their research performance in the context of a multi-ethnic nation, such as Malaysia.

Research questions

The study aims to answer the following research questions in the context of business and management researchers with a Malaysia-specific dataset:

RQ1. Based on gender, are researchers assortative?

RQ2. Does gender influence social capital and/or the research performance of researchers?

In the next section, the research methods used for the study are delineated. Results are presented and discussed, with some concluding thoughts presented at the end.

Materials and methods

Data were harvested from the Web of Science SSCI database with a search limit from 2006 to 2010 with "Business" and "Management' as the subject categories, "Article" as the document type and "Malaysia" as the country. Articles that were published in "*African Journal of Business Management*" were truncated, as this journal has been dropped from the Web of Science. Further, two articles with hyper authorships (paper ids A102 and A103) were removed. Hyper-authored papers (Cronin, 2001) in a small dataset, such as this set, tend to completely skew results in their favour. Lastly, all solo authors who did not have any ties in the network were removed. The set was reduced to 75 papers comprising 187 authors. The dataset, understandably small, aided in the micro-analysis of the author associations.

Social network analysis (Knoke and Kuklinski, 1982; Wasserman and Faust, 1994; Wellman and Berkowitz, 1988) is used to analyse the associations between the authors. Two authors (or nodes) form a connection (or *edge*) if they have co-authored a research article together. On a graph, nodes are depicted with a dot and an edge by a line passing between those dots. Multiple associations of co-authorship are depicted in co-authorship networks with a thicker line between the nodes. Figure 1 shows a typical co-authorship network. Patterns of these connections could reveal the structure of a network at both local and global levels.

Gender of the author is discerned using their first names and comparing them with name nomenclature of the country. For example, a "binti" in a Malaysian name indicates a female and names starting with "Mohd" generally refer to a male. CVs of the researchers, of which many had pictures, were also checked for further confirmation.

Assortativity is calculated by giving a 1 to a same gender or assortative connection and -1 to a mixed disassortative connection. Hence, a male-male or female-female connection would get a score of 1, and a male–female connection would get a score of -1. The mean of the scores of all pairs would effectively give a gender-based assortativity coefficient. A mean of -1 would indicate a complete disassortative association in the community and a mean of 1 would indicate a complete assortative association.

In this study, the second effort is to find out if there are gender-based differences in the social capital of authors. Here, social capital of an author is calculated using four distinct parameters:

(1) A *degree* of a node is the number of direct associations a node or vertex has (Wasserman and Faust, 1994). It is assumed that the greater the degree of a node, the more connected the person is with other scholars in the community. However, degree does not take into account the strength of association, which is measured through vertex tie strength.

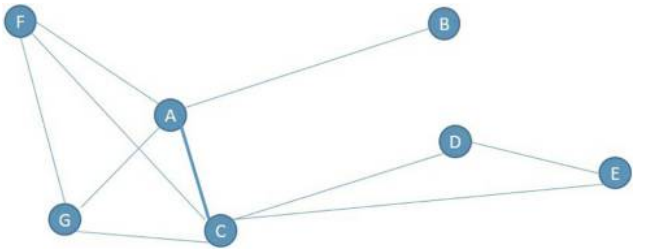


Figure 1.
A typical co-authorship network

(2) *Efficiency* scores are measured through calculating structural holes or the absence of ties in an ego network. Burt (1997) asserts that structural holes provide bridging opportunities to the ego, thus making him or her more important or efficient in the ego network.

(3) *Constraint* scores are calculated based on the idea of cohesion or extent to which an ego is invested in another ego's alters. Burt (1997) claims that those with higher constraint (or more cohesion), in addition to losing the bridging power, may also run the risk of expending more resources than what is necessary in maintaining the association in the ego network.

(4) *Vertex tie strength* is calculated by dividing the total number of ties a vertex has by its degree (Abbasi *et al.*, 2011). It is generally understood that those with higher tie strength have stronger relationships among connected authors which may, in turn, signify that these actors are among those who are more trusted. Code sheets for edge-list (Table I) and vertices were then prepared.

Constraint and efficiency scores are calculated using UCINET (Borgatti *et al.*, 2002) software. Visualizations and calculation of other graph metrics are done using NodeXL (Smith *et al.*, 2009).

Results

There are 187 authors with 183 associations made through 75 papers or association opportunities. Because this is a Malaysia-centric dataset, about 75 per cent of all authors (142 of 187) belong to Malaysia. Malaysian authors have also co-authored papers with authors from 14 countries other than Malaysia: UK 7.9 per cent, USA 5.5 per cent, Australia 3.21 per cent and other countries 8 per cent. The dataset has 130 male researchers and 57 female researchers. Eleven of the female researchers and 34 of the male researchers belong to countries other than Malaysia. Table II shows the top institutions hosting the researchers and their gender make-up.

Gender and journal ranking (JCR tier)

It was checked if gender influenced the appearance of paper in a higher ranked or higher tiered journals. JCR 2010 was used to check each journal's tier. A journal is placed in a tier based on the impact factor rankings. Suppose a subject category has 100 journals, 25 of those (the top 25 per cent) would be ranked as Tier 1, next 25 (26-50 per cent) as Tier 2

Paper ID	Vertex 1	Vertex 2	Year	Journal	Vertex 1 gender	Vertex 2 gender	Assortativity
n1	Ali, NA	Mahat, F	2010	TQMBE	M	F	−1
n1	Ali, NA	Zairi, M	2010	TQMBE	M	M	1
n1	Mahat, F	Zairi, M	2010	TQMBE	F	M	−1
n5	Cheng, JK	Tahar, RM	2010	IJSTL	M	M	1
n5	Cheng, JK	Ang, CL	2010	IJSTL	M	F	−1
n5	Tahar, RM	Ang, CL	2010	IJSTL	M	F	−1
n6	Shumate, M	Ibrahim, R	2010	EJIMGMT	F	F	1
n6	Shumate, M	Levitt, R	2010	EJIMGMT	F	M	−1
n6	Ibrahim, R	Levitt, R	2010	EJIMGMT	F	M	−1

Table I.
A portion of the *edge list* of the network

Institutions (Malaysia)	Female	Male	Grand total	Institutions (foreign)	Female	Male	Grand total
Putra Univ Malaysia	8	17	25	Univ S Australia	1	2	3
Univ Malaya	5	14	19	Wolverhampton Univ	1	1	2
Univ Kebangsaan Malaysia	8	6	14	Univ Aberdeen	2		2
UUM	5	9	14	Cardiff Univ	1	1	2
Univ Sains Malaysia	2	10	12	Univ Western Ontario		2	2
Univ Teknologi Malaysia	2	9	11	Thammasat Univ		1	1
Univ Tunku Abdul Rahman	2	3	5	Univ Leeds		1	1
Univ Teknologi Mara	2	2	4	Univ Bath		1	1
Univ of Nottingham, Malaysia Campus	2	2	4	Kianan Univ		1	1
Management and Science Univ		3	3	Da Yeh Univ		1	1
Malaysia total	46	96	142	Foreign Total	11	34	45

Table II.
Top ten institutions in and gender make-up of researchers

and so on until Tier 4. Out of 41 journals, 14 did not have an impact factor and, hence, did not appear in the JCR listing. Tiers of 27 journals that were extracted from JCR 2010 were then matched with the author of each paper. On papers where there were at least one male on a paper, the average tier was 3.26. This figure was 3.32 for females. It was investigated if papers first-authored by a particular gender had significant difference in the journal tier where it appeared. No significant difference was found. For male first-authored papers, the average tier was 3.22 to females at 3.28. Overall, the papers appeared mostly in Tier 3 or Tier 4 ISI indexed journals; hence, these low average figures were anticipated.

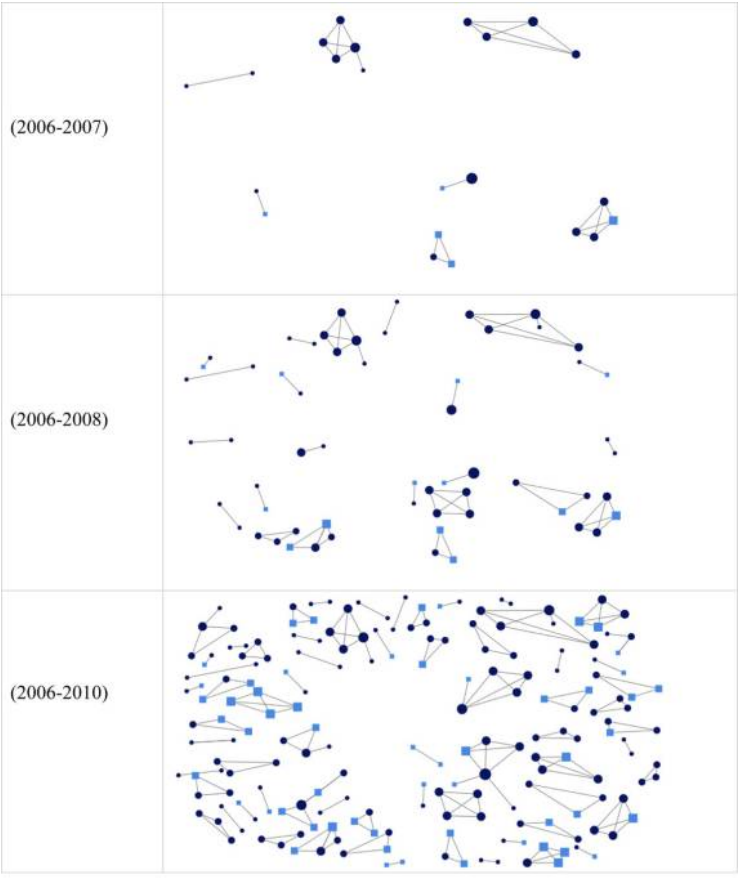
Assortativity

An assortativity coefficient of 0.245 indicates a same-gender (male-male and female-female) or homophilic preference of associations or assortativity to a fair degree. However, on papers, where there are both males and females, there is almost no dominance of a gender. In the 38 paper instances, male population percentage per paper is 52.19 per cent to female population percentage of 47.80 per cent. However, all-male papers are much higher in proportion than all-female papers. Whereas the all-male papers account for 45.33 per cent of all papers, just 4 per cent accounted for all female papers. Females had 41 opportunities to work on a paper out of which, on 92.68 per cent they worked with another gender. In contrast, males had 72 opportunities to work on a paper, out of which in just 52.78 per cent they have worked with the other gender. This may provide a hint that males may in fact be more assortative in this community.

The first author of a paper in often considered the most significant contributor to the paper (Bhandari *et al.*, 2003). When checked for the gender-based first authorship ratio, it was found that out of 38 papers in which both males and females worked together, females have first authored a slightly larger percentage of papers (52 per cent) than males (48 per cent). The results show that females have been equally assertive in terms of significance of contribution on multi-gendered (disassortative) papers.

Collaboration dynamics

Just two male and two female associations were seen in 2006. Five female author associations were visible in 2007 when compared to 19 associations among male authors. This level rose to 14 female and 51 male author associations in 2008 and further to 59 female and 147 male associations in 2010 (Figure 2). The percentage of female population went up from just 15 per cent in 2007 to 36.78 per cent in 2010, indicating that,



Notes: Size of the nodes depicts degree; a disk represents a male node; and a solid square a female node

Figure 2.
Graphical depiction of the association between male and female researchers, based on three time slices

in comparison with male authors, there has been an incremental increase in the ratio of female authors.

The network, as such, is highly fragmented, consisting of 65 components, with the maximum geodesic distance of 2. Further, 187 vertices form 183 edges (six duplicates) in the network.

Influence of gender on social capital and research performance of authors

Inferential statistical tests to examine if gender had influence on social capital and research performance of researchers were carried out next. Social capital is quantitatively examined through degree, vertex tie and social capital measures of efficiency and constraint. Table III shows the top ten authors with their social capital values and research performance.

The Mann-Whitney U test found that gender had a significant influence only in the number of publications ($p < 0.05$) (Table III). Degree, vertex tie, efficiency, constraint and citations did not show significant gender-based differences (Table IV).

In light of past studies on gender inequality, it was surmised that female researchers, in comparison with their male counterparts, may have restricted social capital. Malaysia is a Muslim country where three distinct ethnic communities live together. It is interesting to see that despite its multi-ethnic nature with a Muslim majority country structure, there is no specific influence of gender on social capital. Nonetheless, we do see significant gender-based differences in research productivity.

Table III.
Top authors based on degree

Vertex	Sex	Country	Degree	Total tie	Vertex tie strength	Constraint	Efficiency	No. of works	Citations
Yusof, SM	M	Malaysia	5	5	1	0.24	0.893	1	0
Musa, G	M	Malaysia	4	4	1	0.583	0.625	1	0
Abu Bakar, N	M	Malaysia	4	4	1	0.583	0.625	2	0
Ali, KAM	M	Malaysia	4	4	1	0.583	0.625	2	0
Sambasivan, M	M	Malaysia	4	4	1	0.563	0.75	2	0
Zakuan, NM	F	Malaysia	3	3	1	0.926	0.333	1	4
Laosirihongthong, T	M	Malaysia	3	3	1	0.926	0.333	1	4
Shaharoun, AM	M	Malaysia	3	3	1	0.926	0.333	1	4
Safa, MS	M	Malaysia	3	3	1	0.926	0.333	1	4
Boon, OK	M	Malaysia	3	3	1	0.926	0.333	1	4

Table IV.
Mann-Whitney U test for testing the significant difference in research performance and social capital based on gender

Graph metrics	Asymp. significance (two-tailed)
Degree	0.869
Num_pub	0.039*
Citations_cnt	0.056
Vertex_tie	0.882
Efficiency	0.336
Constraint	0.365

Notes: Grouping variable: gender; *significant $p < 0.05$

Conclusions

The study attempted to investigate the assortative mixing patterns and influence of gender on social capital and academic performance of researchers in the business and management field in Malaysia. The study found that there indeed was positive assortativity, meaning that more authors preferred to co-author with authors of similar gender. No influence of gender was seen on the social capital of authors. However, gender did significantly influence the number of publications of authors. The number of female authors was much lower than men which may also indicate the fact that females are generally underrepresented in academia. Based on first-authorship, the results indicate that females have been equally assertive in terms of significance of contribution on multi-gendered (disassortative) papers. A temporal visualization shows that, in comparison with male authors, there has been incremental growth in the number of female authors. This may indicate that more female authors may be coming to the research landscape in their later years.

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