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Proximity and Matthew Effect in co-authorship pattern of Iranian top universities

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ABSTRACT

Co-authorship is used to measure scholarly collaborations of countries, institutions, and individuals. It refers to the process in which two or more authors or researchers collaborate with each other to create a joint-work through collaboration methods and channels. Although many studies have been conducted to analyze the individual or field co-authorships in Iran, a little have concerned the organisational co-authorships in this country. This study aims to analyze organisational co-authorships among Iranian top universities based on proximity rule and Matthew effect. Data were limited to published articles affiliated to top universities in Iran and extracted from the Web of Science (WoS) database. The co-authorship matrix of these universities was shaped and their relationships were mapped. The "National Co-Authorship Index", which is the rate of scholarly co-authorships among universities of a country, was calculated. Results show that geographic proximity has important and strong role in co-authorships of Iranian top universities. Top universities tend to collaborate with universities of similar ranking and probably this result confirms the Matthew effect in the collaborations of Iranian top universities. Also, the role of collocation or proximity has been drawn on Iran map. Finally, some suggestions were made to improve the co-authorship system of Iranian universities.

Keywords: Collaboration pattern; Matthew effect; Proximity; Collocation, Co-authorship index.

INTRODUCTION

Scientific community is a combination of information resources, creators, and users of these resources. The community is the foundation of acquiring knowledge and scientific communication and its survival and continuity requires a stable relationship among the elements of a scientific community and these relationships are formed formally and informally in local, national and global levels (Hart 2000). Scholarly collaboration and particularly co-authorship that began with Price and Beaver's (1966) study, have been studied by many scientometricians (Merton 1973; Melin 2000; Zitt, Bassecoulard and Okubo 2000; Garg and Padhi 2001; Liang et al. 2001; Wagner-Dobler 2001; Glänzel and de Lange 2002; Meyer and Bhattacharya 2004; Bozeman and Corley 2004; Wagner and Leydesdorff 2005; Bookstein, Moed and Yitzahki 2006; Yamashita and Okubo 2006; Fry 2006; Persson, Glänzel and Danell 2004; He 2009; Zimmerman, Glänzel and Bar-Ilan 2009). Because of the participation of different people or organisations in a collaborative work

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and the number of references to the collaborative one, the impact a collaborative work may be higher (Department of Canadian Heritage 2006).

Merton (1968) analysed existing inequalities in the systems of allocation of scientific credits and introduced "Matthew effect". He explained this phenomenon by inspiration of verse 29 Meta testament which says: *"For to everyone who has, more shall be given, and he will have abundance; but from the one who does not have, even what he does have shall be taken away."* Based on this verse, it is clear that in the academia, there are some universities which are performing scientifically better than other universities and have more resources for conducting collaborative research activities. As a result, their scientific productivity and collaborative research works are increasing (Merton 1968). Merton (1998) also believes that inequality in communicative systems among the scientists (such as citation and keeping the writer's name in reader's mind) is due to higher visibility of the works of more famous scientists.

Scientometrics is one of the areas that have considered the role of Matthew effect (Bonitz, Bruckner and Scharnhorst 1997). Many studies have shown that top universities are super powers in scientific production. It should be said that although top universities rule the world of science, other universities try to decrease the existing gap through their active participation in scientific productions. Based on the Matthew's work, a scholarly collaboration is more efficient when it is introduced by a distinguished scientist in a scientific society (Merton 1968).

Proximity or collocation is another aspect which has been explored in scholarly communication studies. With the development of science and technology, new communication methods and channels such as electronic mail, Intranet, and Wikis have emerged to facilitate communication among researchers. Although these methods make scientific collaboration and communication easier than the past, physical distance (proximity and especially nearness) plays a key role in scholarly collaborations (Lee et al. 2010). Geographical proximity increases the scholarly collaboration in the tacit nature of knowledge (Ponds et al. 2006). A great deal of research collaborations, particularly in applied sciences, has been formed in heterogeneous networks such as universities, industries and governmental institutions (Etzkowitz and Leydesdorff 2000). In addition, geographical proximity plays a key but indirect role in scholarly collaboration and exchange of information (Howels 2002) and in the number and continuity of scholarly co-authorships (Katz 1994; Liang and Zhu 2002).

In recent years, there have been increasing interests in the study of scholarly collaboration among the researchers and public circles. The study of scholarly collaboration patterns has been explored by Talebi (1999), Rahimi and Fattahi (2007), Velayati (2008), Marshakova-Shaikevich (2006), Jan-Alizadeh Chub-Basti et al. (2008), Oliveira and Gracio (2008), Nouri and Danesh (2008); Osareh and Zare (2010) and Lee et al. (2010). These studies summarized in Table 1, show that a collaborative article written by two or more authors is an evidence to prove collaboration among them, and this collaboration creates a co-authorship network and by analysing these networks, the characteristics of the people or collaborative organisations in collaboration system and also the structure of collaborative networks can be realised. Scientists can share their knowledge, beliefs, hypotheses and equipments with scholarly collaboration and ask help from their counterparts to address the issues in the research. Newman (2001) points to some citation data, which generally shows the importance of collaborative works. He noted that the less developed countries are generally much more likely to collaborate than the developed countries, at least in

percentage terms. While the scholarly publication network may be larger, as a percentage of all research publications, the developed countries such as United States and Japan are among the least collaborating countries (Newman 2001).

Table 1: Selected Literature on Scholarly Collaboration and Brief Findings

Author(s)/ Year	Subject	Data Source(s)	Result(s)
Talebi (1999)	Scientific collaboration of research and educational centres of Iran	Science Citation Index (SCI)	☐ Non-academic centres have benefited from collaboration of experts in the internal universities more than foreign researchers. ☐ The highest rate of scholarly collaboration of research centres in Iran has been with USA and then England, Canada, Australia, Japan, India and Germany.
Etzkowitz, and Leydesdorff (2000)	Innovation Dynamics	Qualitative data	☐ A great deal of research collaborations, particularly in applied sciences, have formed in heterogeneous networks such as universities, firms and governmental institutions
Ponds et al. (2006)	Geographical and Institutional Proximity of Scientific Collaboration Networks	Web of Science (WoS)	☐ Geographical proximity increases the scholarly collaboration
Rahimi and Fattahi (2007)	Scholarly collaboration of faculty members in Ferdowsi University of Mashhad	Self-designed questionnaire	☐ Culture of participation in society, budget of collaborative activities, trust among researchers have more influence on the rate of scholarly collaboration ☐ Environmental barriers have negative influence on scholarly collaboration
Velayati (2008)	Scholarly collaborations of Iran and adjacent countries	Web of Science (WoS)	☐ The highest rate of scholarly collaboration of Iran among the adjacent countries is with Russia, Turkey and Pakistan ☐ The highest rate of collaboration is in the fields of physics, biology and chemistry. ☐ The collaborative articles have been published in the journals with the high impact factor. ☐ The industrial universities such as Sharif Univ Technol, Shahid Beheshti Univ and Univ Tehran have the highest rate of collaboration with the adjacent countries ☐ Political relationships among the countries are effective in forming collaboration.
Marshakova-Shaikevich (2006)	Scholarly collaboration of new ten members of European Union (EU)	NSI Standard version: 1998–2002	☐ Research activities in the area of social sciences are much lower than other areas in these countries ☐ The highest rate of collaboration of these countries has been with USA
Jan-Alizadeh Chub-Basti and Akmali (2008)	Effective factors on the rate of collaboration of the faculty members	Self-designed questionnaire	☐ Professors with more cultural capital and emotional energy have more scholarly collaboration. ☐ There is an inverse relationship between work experience of the faculty members and their scholarly collaboration ☐ Young scholars tend to collaborate more than the elders.

Author(s)/ Year	Subject	Data Source(s)	Result(s)
Oliveira and Gracio (2008)	Scholarly collaborative network in the field of metrical studies in Information Science	Online library "SciELO"	□ About 53% of noted articles were written by several writers. □ Among 17 organisations that had scholarly collaboration together, only 3 organisations were non- academic.
Nouri and Danesh (2008)	Scholarly productions of the faculty members of Isfahan University of Medical sciences	Web of Science (WoS)	□ Familiarity with English language, research method and institute for Scientific Information (ISI) have a direct relationship with the number of published articles of faculty members in covered journals of ISI.
Osareh and Zare (2010)	Scholarly productions of Tehran University	Web of Science (WoS)	□ Tehran University has the highest rate of scholarly productions compared with other universities in Iran □ Tehran University has collaborated with 81 countries that the highest rate of this collaboration has been done with USA.
Lee et al. (2010)	Proximity and scholarly collaboration in Harvard University	Harvard University	□ Big inter-disciplinary groups who act in a geographical region have more influence on each other and as the result, they collaborate more. □ Physical proximity of collaborative writers is an important factor in anticipating the scholarly effect of the research.

The exploration of individual and organisational scholarly collaboration patterns of Iranian researchers can show the strengths and weaknesses of scholarly communication systems in Iran. Also, awareness of scientific institutions about their collaboration system improves their strategies and, in directly helps the development of the collaborative network of Iranian researchers. This issue is very important in top universities of Iranian Ministry of Science, Research and Technology (MSRT), because these universities have always been regarded as a comprehensive sample of all research organisations and institutions in Iran, and they the main spotlights of Iranian universities in the international rankings. In this paper, we explore the Matthew effect and proximity rule in scholarly co-authorships of Iranian universities.

OBJECTIVES AND METHOD

This study aims to illustrate the patterns of scholarly collaboration of researchers in Iranian top universities, highlight the strength and weaknesses of this collaboration and analyse Matthew effect and proximity rule in the production of science within the sampled universities. The following research questions guided the investigation of the study:

a) What is the scholarly collaboration pattern of Iranian top universities with other universities of similar ranking or prestige in the country?
b) What is the scholarly collaboration pattern of smaller universities in Iran with top universities in the country in order to become more productive and to decrease their distance with top universities?
c) Has geographical proximity influenced the number of co-authorship of Iran universities?

In the 2010 ranking of Iran universities conducted by the Islamic Science Citation (ISC) Centre, a total of twenty (20) universities were recognized as the top universities of the Ministry of Science, Research and Technology (MSRT) and the Ministry of Health and Medical Education (MHME). Table 2 presents the list of the universities, with University of Tehran ranked top, followed by University of Tehran Medical Sciences and Sharif University of Technology. Only universities under the jurisdiction of MSRT were considered in this study. Therefore, a total of fourteen (14) universities constitute the sample and publications affiliated to these institutions were extracted from data source used i.e. Thomson-Reuters' Web of Science.

Table 2: Iranian Top 20 Universities (ISC 2010)

#	University Name	Abbreviated name	Affiliated organisation	Score (of 100)
1	University of Tehran	Univ Tehran	MSRT	100
2	University of Tehran Medical Sciences	Univ Tehran Med Sci	MHME	65.29
3	Sharif University of Technology	Sharif Univ Technol	MSRT	65.17
4	Amirkabir University of Technology	Amirkabir Univ Technol	MSRT	52.49
5	Iran University of Science and Technology	Iran Univ Sci and Technol	MSRT	44.78
6	Tarbiat Modarres University	Tarbiat Modarres Univ	MSRT	40.17
7	Shahid Beheshti University of Medical Sciences	Shahid Beheshti Univ Med Sci	MHME	36.9
8	Shiraz University	Shiraz Univ	MSRT	32.38
9	Shiraz University of Medical Sciences	Shiraz Univ Med Sci	MHME	24.58
10	Isfahan University of Technology	Isfahan Univ Technol	MSRT	23.69
11	Ferdowsi University of Mashhad	Ferdowsi Univ Mashhad	MSRT	23.56
12	Tabriz University	Tabriz Univ	MSRT	20.86
13	Khaje Nasir Toosi University	K N Toosi Univ	MSRT	20.11
14	Shahid Beheshti University	Shahid Beheshti Univ	MSRT	18.08
15	Tabriz University Medical Sciences	Tabriz Univ Med Sci	MHME	15.98
16	Isfahan University	Isfahan Univ	MSRT	14.93
17	Isfahan University of Medical Sciences	Isfahan Univ Med Sci	MHME	14.31
18	Mazandaran University	Mazandaran Univ	MSRT	12.31
19	Buali Sina University	Buali Sina Univ	MSRT	11.66
20	Mashhad University of Medical Sciences	Mashhad Univ Med Sci	MHME	10.9

Using the *Advanced Search* option, by limiting the years to 2006- 2010, the following query was sent to the database:

a) **OG= Tehran Univ OR Univ Tehran** (Query 1): Query 1 was used only for those universities whose names are not similar to universities under the jurisdiction of MHME. For example, there is no university in health and medical sciences in Iran which begins with the phrase "Tehran Univ". However, this query cannot be formulated for Iranian universities which have the phrase "medical science" attached to their names such as: "Shiraz Univ" and "Shiraz Univ Med Sci".

b) **OG= (Tehran Univ OR Univ Tehran) NOT OG= (Tehran Univ Med Sci OR Univ Tehran Med Sci)** (Query 2): It was found that the search phrase "Tehran Univ Med" is associated with "Tehran University of Medical Sciences" and has no relation with "Tehran University", therefore query 2 was sent to the database. Therefore, query 2 was used to refine the publication results of the universities.

c) **OG= (Tehran Univ Med Sci OR Univ Tehran Med Sci)** (Query 3): Records that are shown in this case, belong to "Tehran University of Medical Sciences" and co-authorship of other universities is evident in this case. So by selecting the "institution" option from left menu and selecting "Tehran University", the number of co-authorships of "Tehran University" and "Tehran Medical Sciences University"

is obtained and are added to the previously mentioned records (records obtained from query 2). This query was repeated for all universities whose names are similar with a university in medical sciences in Iran.

Scientometric approach was employed in this study. The scholarly collaboration was calculated and evaluated based on the 46639 articles affiliated to these universities extracted from the Web of Science database on 16 February 2010. The data were entered into a spreadsheet application and were analysed using the Statistical Products, Services and Solutions (SPSS) and NodeXL Software.

RESULTS

To answer the first and second research questions, the scholarly co-authorship index of the studied universities need to be identified. For this purpose, the number of publications from each university from 2006 to 2010 was calculated, and the number of collaborative articles of this university with other universities sampled in this study was obtained.

Table 3: Co-Authorship Matrix of Iranian Top Universities based on Data from the Web of Science (2006 to 2010)

	UT	SUT	AU	IUST	TMU	SU	IUT	FUM	TU	SBU	KNTU	IU	MU	BSU
Univ Tehran (UT)		216	152	129	452	133	52	79	141	163	80	32	23	25
Sharif Univ Technol (SUT)	216		140	113	85	40	67	29	27	59	57	33	14	32
Amirkabir Univ (AU)	152	140		88	76	17	29	15	46	60	57	18	7	21
Iran Univ Sci Technol (IUST)	129	113	88		71	19	20	19	32	14	20	-	10	17
Tarbiat Modarres Univ (TMU)	452	85	76	71		68	44	32	77	88	42	17	44	24
Shiraz Univ (SU)	133	40	17	19	68		38	21	16	14	11	36	6	8
Isfahan Univ Technol (IUT)	52	67	29	20	44	38		9	7	6	-	101	7	40
Ferdowsi Univ Mash (FUM)	79	29	15	19	32	21	9		8	18	4	5	10	-
Tabriz Univ (TU)	141	27	46	32	77	16	8	8		36	6	-	7	7
Shahid Beheshti Univ (SBU)	163	59	60	14	88	14	8	18	36		28	-	11	31
K N Toosi Univ (KNTU)	80	57	57	20	42	11	-	4	6	28		4	3	-
Isfahan Univ (IU)	32	33	18	-	17	36	101	5	-	-	4		9	46
Mazandaran Univ (MU)	23	14	7	10	44	6	7	10	7	11	3	9		18
Buali Sina Univ (BSU)	25	32	21	17	24	8	40	-	7	31	-	46	18	

Table 3 shows that the top universities in Iran such as “Univ Tehran (UT)”, “Tarbiat Modarres Univ (TMU)” and “Shiraz Univ SU)”, which are considered as premiere universities have the tendency to collaborate more with one another. The highest rate of collaborative scholarly productions is from UT and TMU (452 articles). Findings indicate that the universities which have higher number of scholarly publications tend to have more collaboration with top universities. Universities such as “Buali Sina Univ (BSU)”, “Mazandaran Univ (MU)” and “Isfahan Univ (IU)” that are not as prestigious as top universities tend to have scholarly collaboration with the top ones. This finding confirms the Matthew effect in scholarly co-authorship of Iranian universities. However, these

findings should be interpreted with caution as there may be other factors that may contribute to the collaborative pattern which can be ascertained in future studies. Plausible explanation may be due to the size of the research communities, limitations related to research funding or language, and political constraints that may inhibit contact with other institutions. The scholarship authorship pattern of these fourteen (14) universities is visualized in Figure 1.

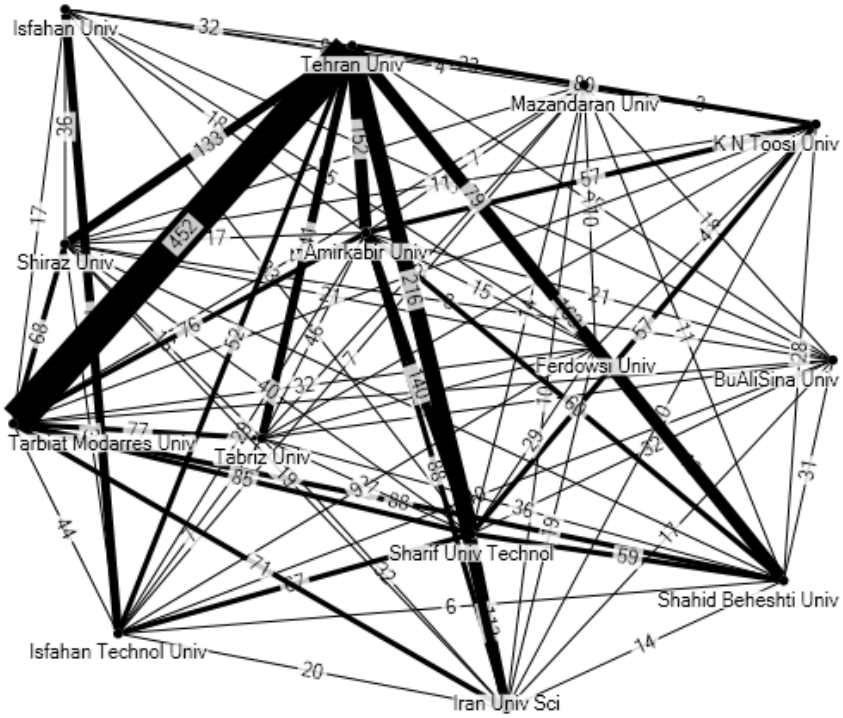


Figure 1: Scholarly Co-authorships of Iranian Top Universities

The ratio of collaborative articles of these universities to the total scholarly publications in Iran covered by the Web of Science for the period 2006 – 2010 was named and presented as the "National Co-Authorship Index"[2]. As can be seen from Table 4, "Shahid Beheshti University" has collaboratively published 38 percent of its articles with other top universities of MSRT and has the first place in "*National Co-Authorship Index"* in Iran, followed by "K N Toosi Univ" (23%) and "Tarbiat Modarres Univ" (21%). This finding is consistent with that of Velayati's (2008) who found that these universities have the highest rate of collaboration with adjacent countries (Velayati 2008) and echos the dynamics of a noted university in scholarly collaboration. In general, Table 4 indicates that the ratio of collaborative articles to all articles published is not that high which reflects the weakness of collaborative system or the lack of motivation of these universities in scholarly collaboration. Although "Univ Tehran" has the highest number of publications, the co-authorship index is not that impressive. One reason may be the existence of Matthew

[2] The authors searched in various search engines and scholarly databases for such indices; however an index with similar name or concept could not be located. There may exist an index with the same concept or purpose in this scientometrics discipline which the authors are not aware of.

effect in the scholarly collaborative works of this university. Osareh and Zare (2010) revealed that University of Tehran which always reported the highest rate of publications in the country has lesser tendency to collaborate with national universities and it has more scholarly collaboration with international universities, especially from the United States.

Table 4: Co-Authorship Measurement in Iranian Universities (Ranked based on National Co-Authorship Index)

Universities	Articles published between 2000 to 2010 in WoS	Co-authored articles with other 13 univs	National Co-Authorship Index*
Shahid Beheshti Univ	1373	528	38
K N Toosi Univ	1308	312	23
Tarbiat Modarres Univ	5204	1120	21
Iran Univ Sci and Technol	2819	552	19
Buali Sina Univ	1397	269	19
Amirkabir Univ Technol	3851	726	18
Univ Tehran	9633	1677	17
Tabriz Univ	2365	410	17
Isfahan Univ	1795	301	16
Sharif Univ Technol	5799	809	13
Isfahan Univ Technol	3114	423	13
Mazandaran Univ	1297	169	13
Ferdowsi Univ Mashhad	2124	249	11
Shiraz Univ	4560	427	9

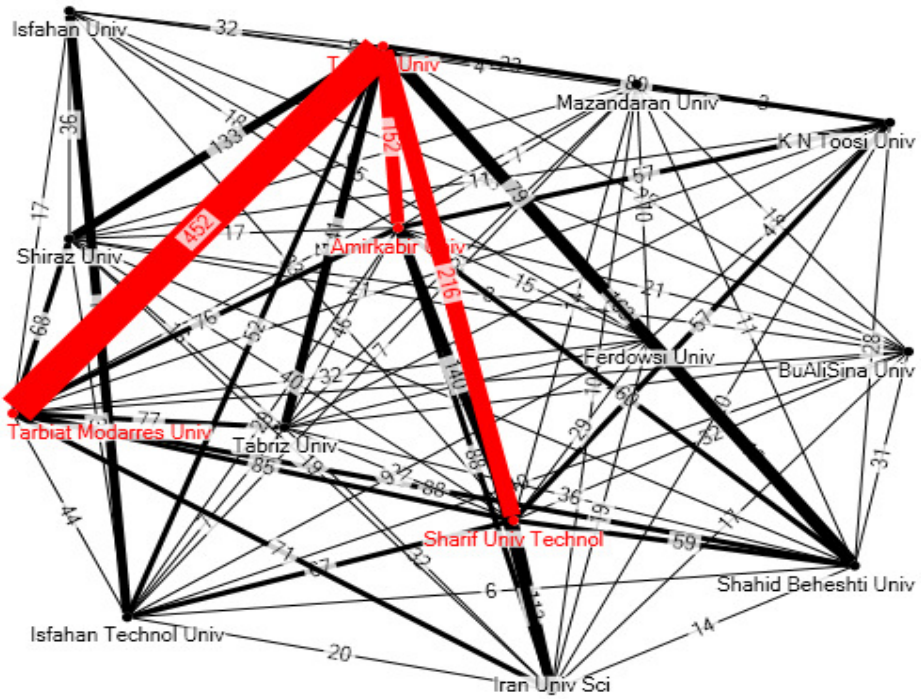
*Ratio of co-authored articles of a university with other universities of a country to all published articles of that university in a time period (denoted as %)

Collaboration of seven (7) universities located in Tehran city is another picture of scholarly co-authorship of adjacent universities. Table 5 shows that the universities located in Tehran collaborate more among themselves, and this draws attention to the importance of proximity in scholarly co-authorship of these universities. The four (4) top universities of Iran ("Univ Tehran", "Shahid Bheheshti Univ", "Iran Univ Sci and Technol" and "Tarbiat Modarres Univ") tend to collaborate more with one another and have less inclination to scholarly collaborate with undersized universities. This results in the empowerment of top universities with high number of publications and it keeps the smaller universities in the low layers of scholarly publication, and leads to Matthew effect for scholarly collaboration in Iranian universities.

In order to ascertain if geographical proximity affects the number of co-authorship of Iranian universities (Research Question 3), the network of scholarly co-authorship of the universities in this study is visualized in Figure 2. It is clear that that the less the geographical distance of the universities of a city to each other, the more their scholarly co-authorship rate is. The darker lines show the higher rate of scholarly co-authorship. "Univ Tehran" (UT), "Tarbiat Modarres Univ" (TMU), "Sharif Univ Technol" (SUT) and "Amir Kabir Univ" (AKU) which have the lower distance from other universities in Tehran, have more scholarly collaboration. This finding confirms the proximity rule in scholarly collaboration of Iranian universities.

Table 5: Co-Authorships of Universities Located in Tehran City (# co-authorships)

	UT	SUT	AKU	IUS	TMU	SBU	KNT	Sum of co-authorship with collocated universities	Sum of co-authorship with universities out of Tehran City
Univ Tehran (UT)		216	152	129	452	163	80	1192	485
Sharif Univ Technol (SUT)	216		140	113	85	59	57	670	139
Amirkabir Univ (AKU)	152	140		88	76	60	57	573	153
Iran Univ Sci Technol (IUS)	129	113	88		71	14	20	435	117
Tarbiat Modarres Univ (TMU)	452	85	76	71		88	42	743	377
Shahid Beheshti Univ (SBU)	163	59	60	14	88		28	412	116
K N Toosi Univ (KNT)	80	57	57	20	42	28		284	28



Note: Red lines are the collaboration of adjacent universities and black lines are the co-authorships of other universities located in Tehran City.

Figure 2: Co-Authorships of Adjacent Top Universities in Tehran City

CONCLUSION

In this paper, the scholarly co-authorship system of top universities of under the jurisdiction of MSRT Iran was depicted, highlighting Matthew effect regarding the scholarly collaboration pattern of the universities sampled. It means that scholarly publication in these universities is based on the strength of collaborative works in production of scientific knowledge. The collaborative system of the researches of the top universities is more inclined towards the proximity rule, which means that universities that have less geographical distance have more scholarly collaboration and their collaborative outputs are higher than the others.

It should be remarked that the study does not underline that proximity will be more determinant than the Matthew effect in scholarly collaboration. These two theories, proximity and preferential attachment, are two theories that have some overlap, but would not necessarily be tested with the same data. This study confirms the results of Howels (2002), Katz (1994), Liang and Zhu (2002), Lee et al. (2010) and Ponds, Oort and Frenken (2006) and confirms the influence of proximity factor in scholarly collaboration of institutions.

This study shows that although a university may have high publication, it does not necessarily mean that the strength of scholarly co-authorship system in that university is higher too. It also highlights that the scholarly co-authorship in the universities located in Tehran city is more than the scholarly co-authorship of other universities in other Iranian cities. Perhaps this is due to the fact that the universities in Tehran are more popular than the universities out of Tehran city and the former tend to have more scholarly collaboration in terms of research and publication together (confirmation of Matthew effect). The lower geographical distance of these universities is another reason for this kind of collaborations (confirmation of proximity rule). Findings of this study may have implication on how collaborative works should be weighted to measure scholars' publication productivity and impact.

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