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SPECIAL THEME - INVITED PAPER

Co-authorship networks in electronic markets research

Kai Fischbach · Johannes Putzke · Detlef Schoder

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Abstract This article examines co-authorship networks of researchers publishing in Electronic Markets—The International Journal of Networked Business (EM). The authors visualize the co-authorship network and provide descriptive statistics regarding the degree to which researchers are embedded in the co-authorship network. They develop and test seven hypotheses associating the researchers' embeddedness in the co-authorship network with the number of the researchers' citations. Results indicate that author who publish co-authored articles in EM have their EM articles (whether co-authored or not) cited more frequently than those who publish EM articles only in their own names, and that the more they co-author the more they are cited because they are located in the center of a co-authorship network.

Keywords Bibliometrics · Centrality · Citation analysis · Scientometrics · Social network · Structural holes

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K. Fischbach · J. Putzke (✉) · D. Schoder
Department of Information Systems and Information Management, University of Cologne,
Pohligstr. 1,
Köln D-50969, Germany
e-mail: putzke@wim.uni-koeln.de

K. Fischbach
e-mail: fischbach@wim.uni-koeln.de

D. Schoder
e-mail: schoder@wim.uni-koeln.de

Introduction

With this issue, we celebrate the 20th anniversary of *"Electronic Markets—The International Journal of Networked Business"*. To mark the jubilee, we analyze the social network of scholars who have co-authored articles in Electronic Markets since its first publication in 1991. Our study reads like a "Who's Who?" of Electronic Markets and credits those who developed the journal to become an internationally recognized outlet for high-quality research.

While the principal aim of this study is a (descriptive) documentation of co-authorship networks in Electronic Markets (EM), we also examine a research question: is there a correlation between an author's embeddedness in the co-authorship network of Electronic Markets and the number of citations by other researchers of all his or her EM articles?

After the obligatory literature review, we have a "Data preparation" section that first provides a short review of the history of EM. The review reveals that it is not necessary to treat all papers published in Electronic Markets equally in the analyses that follow. Rather, we classify articles into one of seven categories. We then describe several subsamples, based on this classification, that will be used for further analyses. In the same section, we describe the data collection. The next section, "Visualization," illustrates the co-authorship network graphically. It is followed by a "Descriptive statistics" section that sets out the co-authorship network quantitatively. Since many quantitatively oriented researchers publishing in EM follow the paradigm of critical rationalism, the next section, "Hypotheses development and inferences," outlines and tests hypotheses to answer the research question. Finally, "Summary and discussion" addresses the theoretical and managerial implications of the study, notes the limitations, and provides some suggestions for further research.

Literature review

The analysis of co-authorship networks in electronic markets research draws on two closely related streams of research. The first is the literature on scientometrics, a discipline that aims to analyse and measure systematic knowledge creation. The roots of scientometrics can be traced back to the 12th century (Weinberg 1997), making it impossible to review the entire scientometric literature in this paper. For an introduction, we refer the interested reader to literature reviews by Shapiro (1992), Sellen (1993), and Hood and Wilson (2001), as well as to specialized scientometric journals such as, for example, *Scientometrics* and the *Journal of the American Society for Information Science and Technology.*[1]

In this review, we focus on the scientometric literature that examines (co)authorship patterns in information systems (IS) research (e.g. Cunningham and Dillon 1997; Duan et al. 2010; Eto 2002; Fiala et al. 2008; Marion et al. 2005; Culnan 1986), especially those articles that analyze a particular IS journal or conference (e.g. Cheong and Corbitt 2009; LaRowe et al. 2007; Vidgen et al. 2007; J. Xu and Chau 2006).

When analyzing co-authorship patterns in a particular journal or conference, many authors employ methods from social network analysis (SNA), the second stream of research relevant here (see, for example, Otte and Rousseau 2002, for a discussion on how to employ methods and measures from social network analysis in scientometrics).

Readers of Electronic Markets are not new to (social) network analysis (e.g. Peng and Woodlock 2009). Social network analysis (for an introduction, see Wasserman and Faust 1994) incorporates several methods and techniques to analyze social structures that emerge from the interaction among and between human actors. It is an interdisciplinary research paradigm that combines, among others, information systems, sociology, physics, biology, computer science, and management science (Putzke et al. 2010a). Recent special issues of leading IS journals (e.g. Agarwal et al. 2008; Oinas-Kukkonen et al. 2010) provide further evidence for the high relevance of social network analysis in IS research. In these special issues, some authors also focus on combining social network analysis with electronic markets research (e.g. Hinz and Spann 2008).

In these types of analyses, social networks and their graphs are usually represented algebraically by adjacency matrices $\boldsymbol{X}$. The graph G depicted in Fig. 1, for example, consists of so-called nodes (here: authors, $\boldsymbol{A}$) and edges (here: papers written jointly by authors, $\boldsymbol{P}$). An adjacency matrix is a $n \times n$ matrix on the set of n authors. In the adjacency matrix, a cell entry x_{ij} reflects whether author n_i and author n_j published a paper jointly in EM. In the following analyses, the authors employed two different ways for computing x_{ij}. Whereas in some analyses x_{ij} expresses the number of papers published jointly by a pair of two authors, in other analyses x_{ij} is assumed to be 1 if two authors published at least one paper jointly in EM and 0 otherwise. Further, the value of the main diagonal of $\boldsymbol{X}$ has been computed differently in different analyses. In some, it expresses the number of papers written by an author alone, while in others it expresses the total number of papers written by an author, whether alone or as co-author.[2]

Data preparation

Before x_{ij} can be computed, the researcher must decide on the papers to include in the analysis. To do so for the present study, we next review the history of Electronic Markets, propose a classification of papers published in EM, and highlight the sample selection and data collection based on this classification.

History of Electronic Markets

Electronic Markets—The International Journal of Networked Business (ISSNs: 1019–6781 [print version] and 1422–8890 [electronic version]) is a quarterly, fully double-blind peer-reviewed journal, currently published by Springer. It first appeared in September 1991 as a kind of "newsletter" issued by the Competence Center for Electronic Markets, a research group at the University of St. Gallen, Switzerland (as "Elektronische Märkte" 1991). During that time, Electronic Markets (EM) appeared sporadically. Many articles were written in German and would probably not be termed scholarly research articles by most faculty today. Nevertheless, EM can be regarded the first academic journal of electronic commerce research.

From 1997 on, EM changed its appearance in several aspects. First, it changed its layout and introduced professional production management to the newsletter. It then began to appear on a regular, quarterly basis. Guest editors where put in charge for sections with a

[1] In this paper, we regard scientometrics, bibliometrics, and informetrics as the same discipline. We refer the interested reader to a literature review by Hood and Wilson (2001) for a distinction between these three streams of thoughts. However, as Hood and Wilson (2001, p. 293) acknowledge, "much of scientometrics is indistinguishable from bibliometrics, and much bibliometric research is published in the journal, Scientometrics".

[2] We refer the interested reader to Peters and Van Raan (1991) and Newman (2004) for a further discussion of the computation of x_{ij} in scientometric analyses.

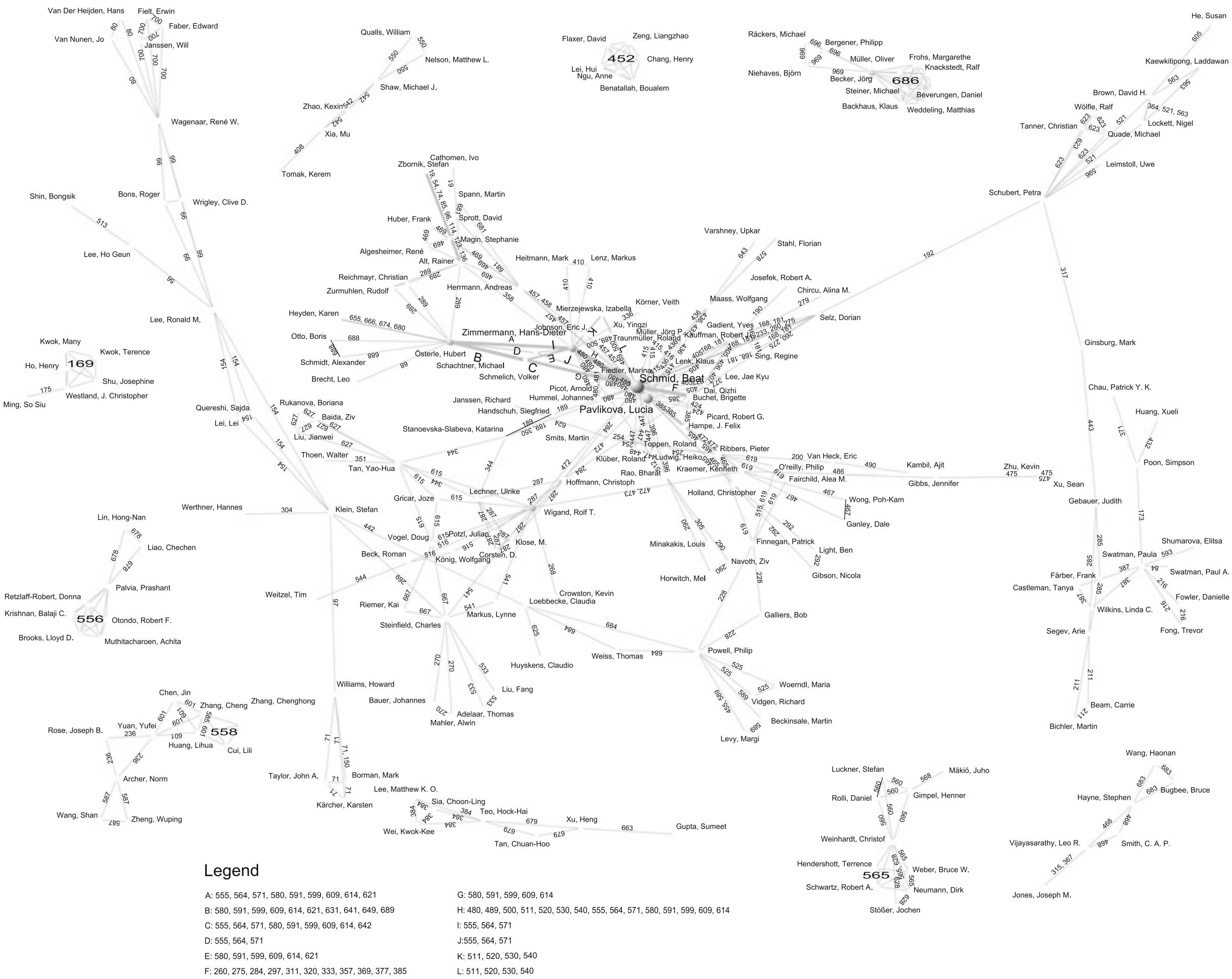

Fig. 1 Co-authorship network (10 largest components)

focused theme (and/or complete special issues) of EM (Schmid 1996). These changes further fostered EM's shift to become an internationally recognized outlet for high-quality research.

With the double issue 9(1/2) in 1999, these changes became further institutionalized. Routledge (Taylor & Francis) took over publishing EM, which moved to a subscription-based model and a full, double-blind peer review process (Schmid et al. 1999).

Ultimately, beginning with Volume 19 in 2009, EM changed its full name to "Electronic Markets—The International Journal on Networked Business" and Springer became the publisher. Other changes included the shift to an online submission system and the shift to publishing articles online before the print edition comes out. Authors can now retain the copyright of their articles for a fixed fee, and grant open access to their articles (Österle and Schmelich 2009).

Classification of papers and sample selection

EM's rich history suggests that it might not be meaningful to treat every paper published in EM equally during the following analyses. Therefore, we classified each paper into one of following seven categories: (1) editorials, (2) prefaces, (3) research articles, (4) issues and opinions, (5) feature articles, (6) articles from the period when EM was still a newsletter, and (7) others. In most cases, this classification followed the label that had been assigned to the papers in EM.

Editorials are short introductory pieces that highlight the contents of a particular issue of EM and/or reflect on current topics related to EM's editorial policies. Generally, these pieces are written by the regular editors of EM (e.g. Österle and Heyden 2010).

Prefaces are introductory pieces that highlight the contents of a focus section of a particular issue (e.g. Brown et al. 2005). A focus section usually comprises three to five articles around a common theme. Generally, prefaces are written by guest editors and are slightly lengthier than editorials. Often, they also highlight the focus theme in more detail. Alternative labels in EM are, for example, “introduction to the focus issue”.[3]

The *Research Articles* category includes most papers that contain original research and that were published after issue 9(1/2) in 1999. Generally, these papers are double-blind peer-reviewed. Exceptions are, for example, invited papers by Kock (2009) and by Pinkwart and Olivier (2009). We do not distinguish between research articles belonging to a focus theme section and general research articles. Furthermore, the analysis does not distinguish between quantitative, qualitative, theoretical, or other forms of research.

The category *Issues and Opinions* comprises papers that would be classified as research articles but that were either published before the introduction of the double-blind peer-review process, but after the introduction of the professional production management system, or were substantially shorter than the average original research paper (e.g. Antaki 2000; Bekele 2000; Tassabehji 2000). The preferred research article length for EM is between 3,500 and 6,500 words.

All original research papers published before the introduction of a professional production management system were classified as *Newsletters*.

Some articles in EM were labeled as Leading Articles (German: “Leitartikel”). However, the direct translation from German “Leitartikel” to “Leading Article” is problematic. Sometimes, these leading articles have the character of an editorial or preface (e.g. Ismail and El-Nawawy 2000), but most can be regarded as regular research articles that open an issue or section of EM and are related to the main theme of the particular issue (e.g. Segev et al. 1999). Hence, we classified all these “Leitartikel” as *Feature Articles*.

Finally, papers classified as belonging to one of the remaining categories (“*Others*”) were excluded from further analyses because including them would not be meaningful. These are the categories *Calendar of Events* (announcements of conference dates, workshop schedules and similar information), *Book Reviews* (critical evaluations of a single piece of literature published in outlets than EM other), *CC EM* (news related to the Competence Center for Electronic Markets), and miscellaneous “*Project Descriptions*” (from EM’s early days as a newsletter that were often also related to the CC EM but not explicitly labeled).

Papers that could not be attributed to a particular author were excluded from the analyses. In total, 646 papers published by 943 authors were classified and used for further analyses. These papers and the aforementioned classification were then used to formulate the five subsamples illustrated in Table 1. For example, the first subsample, ALL, comprises all papers classified as belonging to the categories (1) Editorials, (2) Prefaces, (3) Research Articles, (4) Issues and Opinions, (5) Featured Articles, and (6) Newsletters.

Data collection

Bibliographic information about the selected papers was downloaded from several online databases (e.g. ABI/INFORM) as well as from the EM webpages maintained by Springer, Taylor & Francis, and the University of Leipzig (the latter has become involved in the editing process). We then assigned unique character IDs to each author and article. This was an indispensible but painstaking step; we had to review each article because many names that belonged to the same individual were spelled differently (either in the same database or on the printed articles themselves).[4] Furthermore, none of the databases were exhaustive. Several names gave the impression of belonging to the same individual but were identified as belonging to different authors: for example, “Zhang, Cheng” and “Zhang, Chenghong”, as well as “Swatman, Paul A.” and “Swatman Paula”. These names were assigned different author IDs. To our knowledge, we did not face the problem that two different authors had the same name during our analyses.[5]

We had to correct other inconsistencies in the data prior to the analyses: for example, a research article published in issue 8(3) that was supposed to be published in issue 8(1) according to some databases (Mulvenna et al. 1998), and an editorial that was supposed to be written jointly by Strader, Buchet, Walstrom, & Schmid (Strader et al. 1999), but that was in fact created by the editors from two distinct papers, namely an Editorial (Schmid et al. 1999) and a Preface (Strader and Walstrom 1999).

Table A on the supporting webpage (ESM 1) provides an overview of which article ID was assigned to which article.

[3] In most cases, the distinction / classification of editorials and prefaces is unequivocal, because both type of papers appear only once in a particular issue of EM. However, some papers were labelled as “editorials” in EM (and also classified as such by the authors) although they had the characteristics of a preface, which serves as an opening piece to highlight the content of a special topic and is written by a guest editor or editors (e.g. Lechner et al. 2000). We also identified two interviews that had the characteristics of a preface and, hence, classified them as such (Dai and Kauffman 2002; Österle and Schmid 2008).

[4] For example, the same character ID was assigned to “Archer, Norm” and “Archer, Norman P.”.

[5] This is a problem we have faced frequently in other studies that examine large social networks without unique actors’ IDs. We suggest researchers support initiatives that foster unique universal author IDs (that would also remain the same, for example, after changing names after marriage).

Table 1 Sample selection

Sub-Sample	Categories	Number of papers
1) All Papers (ALL)	(1), (2), (3), (4), (5), (6)	646
2) Editorials (EDS)	(1)	60
4) Editorials + Prefaces (E&P)	(1), (2)	99
5) Research Papers (RP)	(3), (4), (5), (6)	547
6) Strictly Research Papers (SRP)	(3)	330

Visualization

To illustrate the co-authorship network graphically, as in Fig. 1, each author is represented by a circle. A line ("edge") between two authors indicates they published a paper together in EM. The small numbers next to the lines are the article IDs for the articles that were written jointly by each pair of two authors (called "dyads"). The thickness of the lines varies with the number of publications two authors have written jointly. The thicker the line, the more papers the dyad wrote together. In Fig. 1, we show only the ten largest components[6] of the co-authorship network, because depicting all 943 authors would hamper the clarity of the figure in print.[7]

Since the force directed algorithm placed some of the components farther away, we manually shifted these components closer to the main component (i.e. the component with the largest number of co-authors) to increase the figure's readability on a single page in EM. However, each actor's relative position within his or her component remained unchanged.

Since the center of Fig. 1 remains difficult to read, Fig. 2 shows the largest component of the network of authors who jointly published an editorial and/or preface in EM.

Descriptive statistics

This section describes the (co-)authorship network quantitatively, at three sub-levels. The Individual Level provides descriptive statistics for each focal author. The Group Level provides statistics that identify and/or describe sub-groups of authors in the network. The Network Level provides descriptive statistics for the network as a whole. Statistics were calculated using various software programs: Condor (v. 2.0), Gephi (v. 0.7 alpha4), Microsoft Excel (v. 2007, 12.0.6535.5002), NetDraw (v. 2.086), and UCInet (v. 6.221).

Individual level

Number of papers

The first basic statistic at the individual author level is the number of papers published by an author in EM. As we stated in the "Data preparation" section, it would not be meaningful to treat all papers equally. Rather, we present the results for the subsample of (1) all papers (ALL), (2) editorials and prefaces (E&P), (3) strictly research papers (SRP), and (4) research papers (RP).

Table 2 lists the 20 authors with the most papers published in EM in the respective sub-samples (blank ranks indicate that more authors occupy the same rank than can be listed).

Degree-centrality

The second statistic at the individual level is an author's degree centrality. In social network analysis, degree centrality of author i is defined as $C_D(n_i) = \sum_j x_{ij}$ (Freeman 1979).

If the x_{ij} are assumed to be dichotomous, $C_D^{unweighted}(n_i)$ can be understood as the number of different co-authors that published a paper jointly together with author i. Table 3 lists the ten authors with the highest $C_D^{unweighted}(n_i)$ values.

If the x_{ij} indicate the number of publications co-authored jointly by author i and author j, $C_D^{weighted}(n_i)$ accounts for the fact that several publications with the same co-authors should also increase the numerical value of $C_D^{weighted}(n_i)$. Table 4 shows these results.

As evident from both tables, the top authors per degree centrality often belong to EM's editorial team. Therefore, it would also be meaningful to present the results for sub-samples other than the ALL sample.

In the remainder of the paper, we also present all statistics for the Research Papers (RP) sub-sample. We do not present the results for the other sub-samples due to space restrictions. However, those results often do not differ substantially for RP, because most papers that were, for example, classified as "newsletters" were written by a single author and therefore are not relevant when calculating co-authorship statistics. Table 5

[6] A component is defined as a maximal sub-graph in which any two co-authors are connected by a sequence of dyads that have published a paper together (called "path").

[7] We visualized this network using a force directed algorithm that is, in its full extent, beyond the scope of this paper. The interested reader is referred to a book edited by Kaufmann and Wagner (2001) for an introduction to graph drawing algorithms.

Table 2 Top 20 authors by number of publications in EM

ALL		E&P		SRP		RP	
Name	#	Name	#	Name	#	Name	#
Schmid, Beat	49	Schmid, Beat	43	Schubert, Petra	5	Klein, Stefan	8
Zimmermann, H.-D.	23	Zimmermann, H.-D.	18	Powell, Philip	4	Schmid, Beat	6
Österle, Hubert	22	Österle, Hubert	18	Kshetri, Nir	4	Schubert, Petra	6
Alt, Rainer	11	Buchet, Brigette	11	Loebbecke, Claudia	4	Zimmermann, H.-D.	5
Buchet, Brigette	11	Pavlikova, Lucia	11	Vijayasarathy, Leo R.	4	Palmer, Jonathan W.	5
Pavlikova, Lucia	11	Schmelich, Volker	10	Reimers, Kai	3	Kärcher, Karsten	5
Klein, Stefan	10	Alt, Rainer	8	Rao, Bharat	3	Powell, Philip	5
Schmelich, Volker	10	Zbornik, Stefan	7	Brown, David H.	3	Swatman, Paula	5
Zbornik, Stefan	8	Selz, Dorian	5	Bouwman, Harry	3	Österle, Hubert	4
Schubert, Petra	7	Wigand, Rolf T.	4	Bughin, Jacques	3	Kshetri, Nir	4
Wigand, Rolf T.	7	Heyden, Karen	4	Gomber, Peter	3	Lee, Ronald M.	4
Palmer, Jonathan W.	6	Mierzejewska, Izabella	4	Zhu, Kevin	3	Loebbecke, Claudia	4
Rao, Bharat	6	Rao, Bharat	3			Reimers, Kai	4
Selz, Dorian	6	Kauffman, Robert J.	3			Vijayasarathy, Leo R.	4
Kärcher, Karsten	5	Steinfield, Charles	3				
Kauffman, Robert J.	5	Herrmann, Andreas	3				
Powell, Philip	5	Holland, Christopher	3				
Steinfield, Charles	5	Maass, Wolfgang	3				
Swatman, Paula	5	Dai, Qizhi	3				
		Schachtner, Michael	3				

Fig. 2 Co-authorship network (Editorials and Prefaces, main component)

Table 3 Top authors by unweighted degree centrality

Rank	Name	$C_D^{unweighted}(n_i)$
1.	Schmid, Beat	35
2.	Pavlikova, Lucia	23
3.	Zimmermann, Hans-Dieter	15
4.	Wigand, Rolf T.	11
5.	Österle, Hubert	11
6.	Becker, Jörg	10
7.	Steinfield, Charles	9
7.	Ribbers, Pieter	9
7.	Tan, Yao-Hua	9
10.	Several	

lists the number of papers in each category written by a single author and hence not considered when analyzing co-authorship patterns.

Finally, Table 6 lists the $C_D^{unweighted}(n_i)$ and $C_D^{weighted}(n_i)$ values for the authors who score the highest on both statistics in the RP sample. As the results do not differ for both statistics, they are displayed in the same table.

Bonacich's power index

An author's degree centrality simply reflects how many other authors have written a paper together with him or her. Bonacich's Power Index (Bonacich 1972, 1987) is another statistic that can describe an author's embeddedness in the co-authorship network of EM. It is defined as $C_P(n_i) = \sum_j x_{ij}(\alpha + \beta C_p(n_j))$, in which the parameter α is a scaling parameter and is usually chosen in such a way that the sum of squares of the authors' power indices equals the total number of authors in the network, the choice of the parameter β depends on the research context. It attributes a weight to the centralities of all alters the focal ego author co-authored a paper with. In this study, we chose a (small) positive value. With this parametrization, $C_P(n_i)$ is increasing with increasing adjacency to "powerful" alters. Since $C_P(n_i)$ is defined recursively, the weight of alters becomes lower the more steps away from the focal author they are situated. Hence, Bonacich's Power Index identifies authors who co-authored with alters who also have co-authored together with many other authors. Since the measure is defined recursively, it is meaningful to restrict the analyses to the main component. (Again, the main component is the component with the largest number of co-authors.)

Table 4 Top-authors by weighted degree centrality

Rank	Name	$C_D^{weighted}(n_i)$
1.	Schmid, Beat	94
2.	Zimmermann, Hans-Dieter	48
3.	Österle, Hubert	41
4.	Pavlikova, Lucia	33
5.	Schmelich, Volker	21
6.	Buchet, Brigette	17
7.	Alt, Rainer	13
8.	Selz, Dorian	12
8.	Wigand, Rolf T.	12
10.	Becker, Jörg	10

Table 5 Number and percentage of papers written by a single author, by category

Category	Number of Papers	Percentage
(1) Editorials	6	10%
(2) Prefaces	8	20.5%
(3) Research Articles	80	24.2%
(4) Issues and Opinions	56	53.8%
(5) Newsletter	88	79.2%

Table 7 lists the top authors in the main component per Bonacich's Power Index at the total sample level (β=.02). The parameter β was chosen at its upper bound in order for the computational methods to match. Again, the table is led by members of EM's editorial team.

Table 8 lists the top authors in the main component per Bonacich's Power Index at the RP sub-sample (β=.02).

Betweenness centrality

The fourth statistic at the individual level is an actor's betweenness centrality $C_B(n_i) = \sum_{i \neq j \neq k} \frac{g_{jk}(n_i)}{g_{jk}}$ (Freeman 1979), defined either as the sum of the proportion of all geodesic paths linking author j and author k that pass through author *i* over all pairs of authors (*j, k*), or as just the number of all these geodesic paths.

Since betweenness centrality can be calculated only in connected graphs, it is meaningful to restrict the computation of $C_B(n_i)$ to the main component. In this context, an actor scoring high in betweenness centrality can be regarded as an actor that bridges distinct research streams and publishes papers together with other authors whose alters (with several degrees of separation) would not be linked to one other without the focal author.

Table 6 Top authors by degree centrality (RP sub-sample)

Rank	Name	$C_D(n_i)$
1.	Becker, Jörg	10
2.	Powell, Philip	9
3.	Wagenaar, René W.	8

Table 7 Top authors per Bonacich's power index (ALL)

Rank	Name	$C_P(n_i)$
1.	Schmid, Beat	230.97
2.	Zimmermann, Hans-Dieter	162.78
3.	Österle, Hubert	134.54
4.	Pavlikova, Lucia	93.992
5.	Schmelich, Volker	90.539
6.	Buchet, Brigette	71.906
7.	Schachtner, Michael	40.697
8.	Selz, Dorian	39.561
9.	Mierzejewska, Izabella	39.5
10.	Alt, Rainer	21.043

Table 8 Top authors per Bonacich's power index (RP)

Rank	Name	$C_P(n_i)$
1.	Powell, Philip	9.584
2.	Wagenaar, René W.	8.575
3.	Lee, Ronald M.	7.615
4.	Finnegan, Patrick	6.612
5.	Klein, Stefan	6.505
6.	Ribbers, Pieter	6.419
7.	Williams, Howard	5.434
8.	O'reilly, Philip	4.46
9.	Loebbecke, Claudia	4.389
10.	Borman, Mark	4.348

Tables 9 and 10 list the top authors by betweenness centrality at the total sample level (ALL) and at the RP sub-sample level. The table at the total sample level is again led by the editors of EM.

Closeness centrality

The fifth statistic at the individual level is an actor's closeness centrality $C_C(n_i) = \frac{1}{\sum_j d(n_i, n_j)}$ (Freeman 1979), defined as the reciprocal of the sum of the length of the geodesic from one author to all other authors in the network. It is meaningful to calculate this measure for the authors in the main component only. Tables 11 and 12 list these results for the sub-samples ALL and RP.

Authors scoring high on $C_C(n_i)$ can reach all other authors in the network via a shorter chain of co-authors than authors scoring low on $C_C(n_i)$. Hence, Beat Schmid and Stefan Klein might be regarded the analogs to Erdös and Ramsey in EM research (compare, for example, Goffman 1969; Odda 1979; Balaban and Klein 2002).[8]

Eigenvector centrality

The sixth statistic at the individual authors' level is an author's Eigenvector centrality $C_E(n_i)$ (Bonacich 1972, 1987; Bonacich and Lloyd 2001), defined as $C_E(n_i) = \alpha X_{ij} C_E(n_j)$, where α is a scaling parameter. Hence, the measure and its interpretation are similar to Bonacich's Power Index as $C_E(n_i)$ attributes higher scores to authors that have co-authored papers jointly with authors that score high on $C_E(n_i)$ for themselves. Tables 13 and 14 show the results at the ALL and RP sub-sample level.

[8] Paul Erdös was a famous Hungarian mathematician who published more than 1,000 papers. His productivity was paid tribute to by the so called "Erdös number" that indicates the distance of an author to Erdös via a chain of co-authors. Authors who published a paper jointly with Erdös were assigned the Erdös number of 1, their collaborators was assigned the Erdös number of 2, and so on.

Structural holes

The previous statistics examined in a social network. When examining individual characteristics with social network analysis, using measures of centrality is almost obligatory and often required by reviewers. However, interpreting centrality can be difficult in some cases (see Borgatti 2005), and so it may be more appropriate to consider one of the following five "structural holes" statistics (see Burt 1995, for an extensive definition and discussion of structural holes).

Effective size

Effective Size $ES(n_i) = \sum_{j \neq i} x_{ij} - \frac{1}{\sum_{j \neq i} x_{ij}} \sum_{k \neq i, k \neq j} x_{jk}$ is defined in unweighted graphs as the number of co-authors with whom a focal author has written a paper minus the average number of co-authors with whom each of the focal-coauthors has written a paper, excluding author n_i. Tables 15 and 16 list the top authors per effective size of their ego networks at both sub-sample levels. Authors scoring high

Table 9 Top authors by betweenness centrality (ALL)

Rank	Author	$C_B(n_i)$
1.	Schmid, Beat	5,609.651
2.	Wigand, Rolf T.	3,462.551
3.	Steinfield, Charles	2,701.766
4.	Klein, Stefan	2,465.866
5.	Selz, Dorian	1,861
6.	Schubert, Petra	1,817
7.	Ribbers, Pieter	1,693.133
8.	Pavlikova, Lucia	1,597.567
9.	Lee, Ronald M.	1,306
10.	Österle, Hubert	926.167

Table 10 Top authors by betweenness centrality (RP)

Rank	Author	$C_B(n_i)$
1.	Klein, Stefan	375
2.	Powell, Philip	326
3.	Loebbecke, Claudia	319
4.	Lee, Ronald M.	266
5.	Finnegan, Patrick	196
6.	Wagenaar, René W.	156
7.	Ribbers, Pieter	127
8.	Williams, Howard	96

on this statistics are those who connect alters that belong to different research communities.

Efficiency

Efficiency is defined as $Eff(n_i) = \frac{\sum_{j \neq i} x_{ij} - \frac{1}{\sum_{j \neq i} x_{ij}} \sum_{k \neq i, k \neq j} x_{jk}}{\sum_{j} x_{ij}}$, i.e. $Eff(n_i)$ standardizes an author's $ES(n_i)$ score by the size of the author's ego network. Since in this study this measure would be biased for small components ($Eff(n_i)$=1), we present three tables for the subsamples. Table 17 lists authors with $Eff(n_i)$=1. Tables 18 and 19 are restricted to authors with $Eff(n_i)$<1.

Constraint

An authors' constraint is defined as $Con(n_i) = \sum_{j \neq i} \left(\frac{1}{\sum_{i \neq j} x_{ij}} + \sum_{k \neq i, k \neq j} \frac{1}{x_{ik}} \frac{1}{x_{kj}} \right)^2$. When analyzing co-authorship networks, authors who score high on $Con(n_i)$can be understood as authors embedded in a network of co-authors directly adjacent to each other (i.e. are also co-authors among themselves). Hence, authors scoring high on this dimension generally are authors who published a particular article with a great number of co-authors. In contrast, authors scoring low on this dimension are authors who published together with many co-authors who are not connected to one another. Hence, these authors might be understood as bridging otherwise distinct research groups. Tables 20 and 21 list the top authors per $Con(n_i)$ score for the sub-samples ALL and RP.

Table 11 Top authors by closeness centrality (ALL)

Rank	Author	$C_C(n_i)$
1.	Schmid, Beat	.0027855
2.	Pavlikova, Lucia	.0025253
3.	Wigand, Rolf T.	.002439
4.	Kraemer, Kenneth	.0022422
5.	Ribbers, Pieter	.0021786
6.	Selz, Dorian	.0021552
7.	Zimmermann, Hans-Dieter	.0021459
8.	Österle, Hubert	.0021142
9.	Buchet, Brigette	.0027855
10.	Several	

Table 12 Top authors by closeness centrality (RP)

Rank	Author	$C_C(n_i)$
1.	Klein, Stefan	.010526316
2.	Loebbecke, Claudia	.010309278
3.	Powell, Philip	.009615385
4.	Lee, Ronald M.	.009345794
5.	Lei, Lei	.008547009
6.	Quereshi, Sajda	.008547009
6.	Weiss, Thomas	.008547009
8.	Finnegan, Patrick	.008130081
8.	Williams, Howard	.008130081
10.	Several	

Hierarchy

An author's Hierarchy is defined with the Coleman-Theil inequality index as

$$Hier(n_i) = \frac{\sum_{j} \left(\frac{\left(\frac{1}{\sum_{i \neq j} x_{ij}} + \sum_{k \neq i, k \neq j} \frac{1}{x_{ik}} \frac{1}{x_{kj}} \right)^2}{\frac{Con}{N}} \right) \ln \left(\frac{\left(\frac{1}{\sum_{i \neq j} x_{ij}} + \sum_{k \neq i, k \neq j} \frac{1}{x_{ik}} \frac{1}{x_{kj}} \right)^2}{\frac{Con}{N}} \right)}{N \ln N}$$

where N is the number of co-authors and Con/N is the average constraint. An author's hierarchy reflects how far an author's constraint can be attributed to one or many of his co-authors. If the constraint results equally from many co-authors, the $Hier(n_i)$ value will be low. Tables 22 and 23 present the top authors by Hierarchy for the ALL and RP

Table 13 Top authors per eigenvector centrality (ALL)

Rank	Author	$C_E(n_i)$
1.	Schmid, Beat	.518
2.	Pavlikova, Lucia	.408
3.	Zimmermann, Hans-Dieter	.258
4.	Fiedler, Marina	.176
4.	Hummel, Johannes	.176
4.	Picot, Arnold	.176
7.	Buchet, Brigette	.149
8.	Wigand, Rolf T.	.141
9.	Rao, Bharat	.141
10.	Ribbers, Pieter	.133

Table 14 Top authors per eigenvector centrality (RP)

Rank	Author	C_E (n_i)
1.	Wagenaar, René W.	.466
2.	Lee, Ronald M.	.451
3.	Bons, Roger	.287
3.	Wrigley, Clive D.	.287
5.	Klein, Stefan	.279
6.	Lei, Lei	.229
7.	Quereshi, Sajda	.229
8.	Faber, Edward	.212
8.	Fielt, Erwin	.212
8.	Janssen, Will	.212

Table 16 Top authors by effective size (RP)

Rank	Name	$C_D(n_i)$	$ES(n_i)$
1.	Powell, Philip	8	7
2.	Swatman, Paula	7	6.429
3.	Wagenaar, René W.	8	6.25
4.	Lee, Ronald M.	7	5.286
5.	Becker, Jörg	10	5.2
6.	Schubert, Petra	6	5
6.	Klein, Stefan	6	5
8.	Österle, Hubert	6	4.667
8.	Ribbers, Pieter	6	4.667
10.	Palvia, Prashant	7	3.857

sub-samples. Since in this study the $Hier(n_i)$ measure would be biased for small components (for example, $Hier(n_i)=1$, for authors of articles that are written jointly by two authors who are not connected to the other authors), we present the only top authors with $Hier(n_i)<1$.

Authors scoring low in $Hier(n_i)$ can be understood as having written a particular article with a large group of co-authors. Authors scoring high in $Hier(n_i)$ can be understood as authors bridging groups of researchers that are otherwise not densely connected.

Ego network density

Ego network density $\Delta(n_i)$ is defined as the percentage of all possible ties between all co-authors directly adjacent to the focal author n_i. The lower the density and the higher the degree of author n_i, the more the focal author bridges between distinct groups of researchers. Tables 24, 25 and 26 list the top authors by ego network density. Since in this study this measure would be biased for small components, we present the results separately for $\Delta(n_i)=0$, and $\Delta(n_i)>0$.

Table 15 Top authors by effective size (ALL)

Rank	Name	$C_D(n_i)$	$ES(n_i)$
1.	Schmid, Beat	35	32.086
2.	Pavlikova, Lucia	23	19.783
3.	Zimmermann, Hans-Dieter	15	12.2
4.	Wigand, Rolf T.	11	9.364
5.	Österle, Hubert	11	9.182
6.	Steinfield, Charles	9	7.889
7.	Ribbers, Pieter	9	7.444
7.	Tan, Yao-Hua	9	7.444
9.	Schubert, Petra	8	7
9.	Powell, Philip	8	7

Cutpoints

The last statistic we present at the individual level is the set of cutpoints. A cutpoint is an author n_i without which the number of components in the graph that contains n_i is fewer than the number of components in the subgraph that results from removing n_i from the graph (Wasserman and Faust 1994). Since the co-authorship network comprises many components, it is reasonable to present the cutpoints for the main component only (see Table 27).

One might argue whether the set of cutpoints is a statistic that should be presented at the individual level or at the group level. The next subsection, Group Level, presents statistics that explicitly characterize and identify groups of authors in the network.

Group level

Cliques

Cliques are defined as a maximal set of nodes in which all nodes are directly adjacent to each other (Luce and Perry 1949; Bron and Kerbosch 1973). For our purposes, then, a clique is a group of authors in which all authors have co-authored a paper with all other authors in the clique.[9] Hence, the largest cliques in this study will either identify groups of authors who collaborate closely on related topics or who wrote a particular article together with many co-authors. The largest cliques at the ALL sample level are presented in Table 28.

At the RP subs-sample level, the largest cliques are the same as at the ALL sub-sample level, with exception of the second clique.

[9] The formulas for identifying cliques are beyond the scope of this paper due to place constraints. The interested reader is referred to the referenced literature.

Table 17 Top authors by efficiency with $Eff(n_i)$=1 (RP and ALL since same results)

Rank	Name	$C_D(n_i)$	$ES(n_i)$	$Eff(n_i)$
1.	Poon, Simpson	3	3	1
1.	Palmer, Jonathan W.	3	3	1
3.	Several	2	2	1

2-cliques and 3-cliques

Since the largest cliques in this study identify groups of authors who published single papers in EM with the most co-authors, it might be reasonable to relax the strong assumption that each author in the clique must have published a paper together with all other authors in the clique. A 2-clique or 3-clique is defined as a maximal set of authors in which the largest geodesic distance between any two authors is of path length 2 or 3, respectively (Alba 1973; Bron and Kerbosch 1973; Luce and Perry 1949).

The largest 2-clique at the ALL sample level (n=36), hence, identifies a group of authors who closely collaborate and choose Electronic Markets as a main outlet for their research. These authors are listed in Table 29.

The largest 3-clique consists of the same 36 authors plus additional 11 authors (n=47). They are listed in Table 30.

When neglecting the editorials and analyzing the RP subsample, the largest 3-cliques (and 2-cliques) are

- First, Edward Faber, Erwin Fielt, Will Janssen, René W. Wagenaar, Ronald M. Lee, Roger Bons, Clive D. Wrigley, Hans Van Der Heijden, and Ju van Nunen as 2-clique (n=9), extended by Stefan Klein, Ho Geun Lee, Lei Lei, and Sajda Quereshi as 3-clique (n=13); and
- Second, Marin Becksindale, Margi Levy, Philip Powell, Patrick Finnegan, Claudia Loebbecke, Thomas Weiss, Richard Vidgen, Maria Woerndl, Bob Galliers as 2-clique (n=9) , extended by Alea M. Fairchield, Philip O'Reilly, Pieter Ribbers as 3-clique (n=12); and
- Third, the largest 2-clique (n=11) still comprises a network of 8 authors who published a particular article jointly (Backhaus et al. 2010) extended by Börn Niehaves, Michael Räckers and Philipp Bergener.

Table 19 Top authors by efficiency with $Eff(n_i)$<1 (RP)

Rank	Name	$C_D(n_i)$	$ES(n_i)$	$Eff(n_i)$
1.	Swatman, Paula	7	6.429	.918
2.	Powell, Philip	8	7	.875
3.	Gomber, Peter	4	3.5	.875
3.	Loebbecke, Claudia	4	3.5	.875
5.	Schubert, Petra	6	5	.833
5.	Klein, Stefan	6	5	.833
7.	Wagenaar, René W.	8	6.25	.781
8.	Österle, Hubert	6	4.667	.778
8.	Ribbers, Pieter	6	4.667	.778
10.	Several	3	2.333	.778

Whereas the first clique is a clique whose authors published mainly in the early period of EM, the authors of the second clique published in EM's later period. Although higher-order n-cliques are beyond the scope of this paper, further analyses revealed that both cliques are connected by the author Stefan Klein.

2-clans and 3-clans

The definition of 2-cliques and 3-cliques allows co-authorship ties that determine whether the members of n-cliques that are more than n steps away from each other must not lie in the clique itself. Hence, n-clans are defined as n-cliques with diameter smaller than n (Mokken 1979). Nevertheless, the largest 2-clans (3-clans) and 2-cliques (3-

Table 18 Top authors by efficiency with $Eff(n_i)$<1 (ALL)

Rank	Name	$C_D(n_i)$	$ES(n_i)$	$Eff(n_i)$
1.	Swatman, Paula	7	6.429	.918
2.	Schmid, Beat	35	32.086	.917
3.	Klein, Stefan	7	6.143	.878
4.	Steinfield, Charles	9	7.889	.877
5.	Schubert, Petra	8	7	.875
5.	Powell, Philip	8	7	.875
7.	Loebbecke, Claudia	4	3.5	.875
7.	Gomber, Peter	4	3.5	.875
7.	Strader, Troy J.	4	3.5	.875
10.	Pavlikova, Lucia	23	19.783	.86

Table 20 Top authors by constraint (ALL)

Rank	Name	$C_D(n_i)$	$Con(n_i)$
1.	Schmid, Beat	35	.117
2.	Pavlikova, Lucia	23	.203
3.	Zimmermann, Hans-Dieter	15	.211
4.	Österle, Hubert	11	.226
5.	Wigand, Rolf T.	11	.229
6.	Swatman, Paula	7	.245
7.	Schubert, Petra	8	.247
8.	Steinfield, Charles	9	.25
9.	Klein, Stefan	7	.252
10	Several	9	.274

Table 21 Top authors by constraint (RP)

Rank	Name	$C_D(n_i)$	$Con(n_i)$
1.	Swatman, Paula	7	.245
2.	Powell, Philip	8	.281
3.	Schubert, Petra	6	.315
4.	Klein, Stefan	6	.315
5.	Becker, Jörg	10	.325
6.	Wagenaar, René W.	8	.331
7.	Poon, Simpson	3	.333
8.	Palmer, Jonathan W.	3	.333
9.	Lee, Ronald M.	7	.361
10.	Several	6	.384

Table 23 Top authors by hierarchy (RP)

Rank	Name	$C_D(n_i)$	$Con(n_i)$	$Hier\ (n_i)$
1.	Bouwman, Harry	3	.84	.074
1.	Haaker, Timber	3	.84	.074
3.	Schubert, Petra	6	.315	.064
3.	Klein, Stefan	6	.315	.064
5.	Alt, Rainer	5	.413	.061
6.	Kwok, Sai Ho	4	.704	.057
6.	Tam, Kar Yan	4	.704	.057
8.	Gomber, Peter	4	.406	.055
8.	Loebbecke, Claudia	4	.406	.055
10.	Several	3	.611	.052

cliques) do not differ from the 2-cliques (3-cliques) and hence are not discussed in detail in this paper.

Dyads

Dyads are the smallest possible groups of people (i.e. $n=2$). In this study, the most interesting dyads might be the dyads that authored the most papers together. Table 31 lists the dyads that authored the most papers together in EM.

Another interesting statistic at the dyad level are dyads with the largest geodesic distance, i.e. two authors who are connected via the longest chain of co-authors between them. Table 32 lists the dyads with the largest geodesic distances in the main component. Theses dyads can reach each other via a chain of 11 co-authors.

Network level

The last set of statistics we present characterize the co-authorship network at the whole network level.

Density

The first statistic at the whole network level is network density Δ, defined as the proportion of possible lines that are actually present in a graph (Wasserman and Faust 1994). Thus, in the context of co-authorship networks, it reflects the percentage of the total network with which an average actor has co-authored a paper. The density is very low (Δ=.34%) and has a very high standard deviation ($s.d.$=8.03%), which is common for large co-authorship networks of international journals.

Clustering and transitivity

Whereas network density reflects the percentage of authors who have co-authored papers together, the next two statistics describe whether co-authors are clustered in local communities and connected by a few co-authors that belong to several local clusters.

Earlier, the authors presented ego network density $\Delta(n_i)$ as a statistic at the individual author level. It was defined as the percentage of all possible ties between all co-authors directly adjacent to the focal author n_i.The Clustering Coefficient $CC^{unweighted} = \frac{1}{N}\sum_i \Delta(n_i)$ is defined as the average value of $\Delta(n_i)$ overall authors (Watts and Strogatz 1998). Hence, it measures how strongly the network is clustered around local groups of authors publishing together. The high value of $CC^{unweighted}$=.875 indicates strong local clustering (particularly compared to the overall density (Δ=.0034).

One weakness of $CC^{unweighted}$ is that it does not attribute more weight to the $\Delta(n_i)$ of authors with larger network sizes. Hence, a weighted version of CC is defined as

Table 22 Top authors by hierarchy (ALL)

Rank	Name	$C_D(n_i)$	$Con(n_i)$	$Hier\ (n_i)$
1.	Pavlikova, Lucia	23	.203	.379
2.	Schmid, Beat	35	.117	.269
3.	Buchet, Brigette	6	.517	.209
4.	Zimmermann, Hans-Dieter	15	.211	.142
5.	Brown, David H.	4	.535	.092
6.	Alt, Rainer	6	.369	.085
7.	Selz, Dorian	5	.491	.078
8.	Several	3	.84	.074

Table 24 Top authors by ego network density with $\Delta(n_i)$=0 (RP and ALL since same results)

Rank	Name	$C_D(n_i)$	$\Delta(n_i)$
1.	Poon, Simpson	3	0
2.	Palmer, Jonathan W.	3	0
3.	Vemuri, Vijay K.	2	0

Table 25 Top authors by ego network density with $\Delta(n_i)$>0 (ALL)

Rank	Name	$C_D(n_i)$	$\Delta(n_i)$
1.	Schmid, Beat	35	.086
2.	Swatman, Paula	7	.095
3.	Steinfield, Charles	9	.139
4.	Klein, Stefan	7	.143
5.	Schubert, Petra	8	.143
5.	Powell, Philip	8	.143
7.	Pavlikova, Lucia	23	.146
8.	Wigand, Rolf T.	11	.164
9.	Loebbecke, Claudia	4	.167
9.	Gomber, Peter	4	.167

$CC^{weighted} = \frac{1}{\sum_j x_{ij}^{unweighted}} \sum_i \Delta(n_i) \sum_j x_{ij}^{unweighted}$. Although the value of $CC^{weighted}$ is substantially lower ($CC^{weighted}$=.497), it is indicative of strong local clustering.

Related to the concept of clustering is the concept of transitivity and transitive triads (e.g. Chase 1980; Holland and Leinhardt 1972; Rapoport 1953). A triad consists of three authors and the possible links among them. In undirected networks, a triad is transitive if $x_{ij}\ x_{ik}\ x_{jk} = 1$ (meaning that all possible ties between the three authors are present). The higher the proportion of transitive triplets in a network (i.e. transitivity), the higher the local clustering of this community (for an extensive reasoning, see, for example, Granovetter 1973; Heider 1946). The high number of transitive triads (n=2886) in comparison to the total number of incomplete triads indicates strong local clustering ($Tran$=.497), which corresponds to the results obtained with the clustering coefficient. In summary, the co-authorship network of EM can hence be described as a network with strong local clustering.

Table 26 Top authors by ego network density with $\Delta(n_i)$>0 (RP)

Rank	Name	$C_D(n_i)$	$\Delta(n_i)$
1.	Swatman, Paula	7	.095
2.	Powell, Philip	8	.143
3.	Gomber, Peter	4	.167
3.	Loebbecke, Claudia	4	.167
5.	Schubert, Petra	6	.2
5.	Klein, Stefan	6	.2
7.	Wagenaar, René W.	8	.25
8.	Österle, Hubert	6	.267
8.	Ribbers, Pieter	6	.267
10.	Lee, Ronald M.	7	.286

Hypotheses development and inferences

Since many researchers publishing in EM follow the hypothetico-deductive model promoted by critical rationalism (Popper 1959), some readers might perceive a study about co-authorship networks without testing formal hypotheses as incomplete. Hence, in this section we develop and test seven hypotheses to explain authors' embeddedness in the co-authorship network.

Theoretical reasoning

Many authors state that articles written by authors who publish together with many co-authors will be cited more often (e.g. Stewart 1983). There are at least three theoretical reasons for this effect (compare, for example, Van Dalen and Henkens 2001). First, articles published by many

Table 27 Cutpoints in main component

Cutpoints in main component
Andreas Herrmann
Arie Segev
Charles Steinfield
Christopher Holland
Claudia Loebbecke
David Brown
Dorian Selz
Eric Van Heck
Hans-Dieter Zimmermann
Ho Geun Lee
Howard Williams
Hubert Österle
Jennifer Gibbs
Judith Gebauer
Kenneth Kraemer
Mark Ginsburg
Martin Smits
Petra Schubert
Philip Power
Pieter Ribbers
Rainer Alt
Rao Bharat
René Wagenaar
Robert Kauffman
Rolf Wigand
Roman Beck
Ronald Lee
Stefan Klein
Wolfgang Maas
Yao-Hua Tan

Table 28 Largest cliques (ALL)

Clique 1	Clique 2	Clique 3	Clique 4
Klaus Backhaus	Hans-Dieter Zimmermann	Lloyd D. Brooks	Boualem Benatallah
Jörg Becker	Lucia Pavlikova	Balaji C. Krishnan	Henry Chang
Daniel Beverungen	Beat Schmid	Achita Muthitacharoen	David Flaxer
Margarethe Frohs	Marina Fiedler	Robert F. Otondo	Hui Lei
Ralf Knackstedt	Johannes Hummer	Prashant Palvia	Anne Ngu
Oliver Müller	Arnold Picot	Donna Retlaff-Robert	and Liangzhao Zeng
Michael Steiner			
Matthias Weddeling			

authors benefit from their authors' diverse expertise and complementary capabilities, and hence are cited more often due to their higher scientific quality. Second, each author brings his or her own network of scientific relations. Members of these networks are more likely to be knowledgeable about the authors' work and cite the article. Third, the more co-authors publish a paper, the more likely these authors will cite their own work and hence increase the number of citations.

However, some authors have found that the number of co-authors of an article is negatively correlated with the number of citation the article receives (e.g. Bergh et al. 2006). This finding, however, might be attributed to the high correlations between the independent variables in the particular study. Hence, the following hypothesis should be tested.

H1: Authors who publish together with many co-authors will be cited more often. Hence, the higher an author's degree centrality, the more that author is cited.

Authors do not only differ in their number of co-authors but also in their domains. For example, some researchers predominantly take a design science approach (e.g. Pries-Heje and Baskerville 2008). Others focus on quantitative, empirical studies (e.g. Floeck et al. 2011). Others predominantly conduct case studies with qualitative methods (e.g. Loebbecke 2007). Furthermore, some scholars mainly address managerial audiences. Others focus on academic audiences. Furthermore, there are different research topics that are of interest for our community.

We assume that authors who publish together with many co-authors from different domains might also produce research papers that are of high interest to scholars from different domains. Hence, these papers and authors should be cited more often (Stremersch et al. 2007). Furthermore, these authors have a higher visibility and status and hence should be cited more often (Merton 1968). Therefore, employing the measures discussed earlier,

Table 29 Largest 2-clique (ALL)

Author's name
Andreas Herrmann
Arnold Picot
Beat Schmid
Bharart Rao
Brigette Buchet
Chirstopher Holland
Christoph Hoffmann
Dorian Selz
Eric J. Johnson
Felix J. Hampe
Hans-Dieter Zimmermann
Heiko Ludwig
Hubert Österle
Izabella Mierzejewska
Johannes Hummel
Jörg P. Müller
Katarina Stanoevska-Slabeva
Kenneth Kraemer
Klaus Lenk
Kyu Jae Lee
Lucia Pavlikova
Marina Fiedler
Michael Schachtner
Pieter Ribbers
Qizhi Dai
Regine Sing
Robert G. Picard
Robert J. Kauffman
Roland Klüber
Roland Traunmüller
Rolf T. Wigand
Siegfried Handschuh
Volker Schmelich
Wolfgang Maass
Yingzi Xu
Yves Gadient

Table 30 Additional 11 authors in largest 3-clique (ALL)

Author's name
Charles Steinfield
Dale Ganleay
Doug Vogel
Jennifer Gibbs
Joze Gricar
Kevin Crowston
Lynne Markus
Poh-Kam Wong
Roman Beck
Wolfgang König
Yao-Hua Tan

H2: The greater the effective size of an author's ego network, the more that author will be cited.

H3: The greater an author's efficiency, the more that author will be cited.

H4: The higher an author's betweenness centrality, the more that author will be cited.

H5: The lower an author's constraint, the more that author will be cited.

H6: The lower an author's ego network density, the more that author will be cited.

Earlier, we presented an author's closeness centrality as a statistic that measures how far away an author is located from other authors in the EM network. Since many authors agree that they tend to cite papers by other researchers they perceive to be close to them, this truism has been subject to satirical scientific articles (e.g. Schulman 1996) that claim the hidden agenda behind an introduction was to cite work by advisors, family, colleagues, friends, and even someone you have never met as long as your name happens to be on the same paper. Hence,

H7: The higher an author's closeness centrality, the more that author will be cited.

Method

We tested the proposed hypotheses by regressing the number of citations per author on the corresponding network statistics, controlling for an author's number of publications, the average age of the author's publications (measured in volumes), the average number of pages per the author's publications, and the author's average position in the list of authors on the paper (first, second, third, and so on).

Although we presume that controlling for these variables is an indispensible step during the further analyses, we did not want to develop and test formal hypotheses for these effects, since the direction of these effects is less equivocal. For example, one might argue that an author's number of publications should increase the author's visibility. As a consequence, the author should be cited more often. However, one might also argue that the quality per publication decreases with an author's increasing number of publications. Hence, an author with many publications should be cited less often. One might also combine both arguments and claim a reversed U-shaped relationship. However, a reversed U-shaped relationship depends on the range of values of the control variable. Therefore, we included the effects in each model that affords the best model fit (according to the sum of squared errors).

Since the networked data prohibit using standard statistical methods (mainly due to violation of the i.i.d. assumption, e.g. Dekker et al. 2007), the inferences are drawn on the basis of empirical standard errors with 1,000 permutations. Before the analyses, we excluded an outlier with more than 1,200 citations (Paul Timmers) because it biased the results substantially. Table 33 lists the other top authors by their number of citations.

Results

Table 34 shows the results at the ALL sample level. Model 1 is the baseline model and includes all control variables. The control variables are associated with the number of citations in a reasonable direction. Authors who write longer articles are cited more often than authors who write shorter articles (β=.254). Authors with newer articles are cited less often then authors with older articles (β=−.237). Authors who have, on average, a later position in the list of authors are cited more often (β=.06). This is reasonable, since supervisors of PhD students often have a later position in the authors' list on the paper, a higher reputation and hence are cited more often. Finally, authors who write more articles are cited more often (β=.387). In total, the

Table 31 Top dyads by number of papers co-authored together (ALL)

Rank	Name 1	Name 2	Number of Papers
1.	Schmid, Beat	Zimmermann, Hans-Dieter	15
2.	Buchet, Brigette	Schmid, Beat	11
2.	Pavlikova, Lucia	Schmid, Beat	11
4.	Österle, Hubert	Schmelich, Volker	10
5.	Österle, Hubert	Schmid, Beat	9
5.	Österle, Hubert	Zimmermann, Hans-Dieter	9
7.	Alt, Rainer	Zbornik, Stefan	8
8.	Schmelich, Volker	Zimmermann, Hans-Dieter	6
9.	Schmelich, Volker	Schmid, Beat	5
9.	Schmid, Beat	Selz, Dorian	5

Table 32 Top dyads by geodesic distance (ALL)

Name 1	Name 2	Name 1	Name2
Beam, Carrie	Faber, Edward	Bichler, Martin	Faber, Edward
Beam, Carrie	Fielt, Erwin	Bichler, Martin	Fielt, Erwin
Beam, Carrie	Janssen, Will	Bichler, Martin	Janssen, Will
Beam, Carrie	Shin, Bongsik	Bichler, Martin	Shin, Bongsik
Beam, Carrie	Van Der Heijden, Hans	Bichler, Martin	Van Der Heijden, Hans
Beam, Carrie	Van Nunen, Jo	Bichler, Martin	Van Nunen, Jo

baseline model explains 16.1% of the variance in the dependent variable "number of citations".

Model 2 extends the baseline model by the authors' degree centrality. Results indicate a strong (β=.238) and statistically significant effect when using theoretical (p<.01) and empirical (p<.05) standard errors. R^2 rises from 16.1% to 18%. Hence, Hypothesis 1 is supported, that is, authors who publish together with many co-authors are cited more often.

Model 3 extends the baseline model by the author's effective size. Results indicate a strong (β=.247) effect. However, the effect is found to be statistically significant only when using theoretical standard errors (p<.01), but not when using empirical standard errors. Hence, there is limited support for Hypothesis 2.

Model 4 extends the baseline model by the authors' efficiency. Although the effect is rather weak (β=.051), it is found to be statistically significant based on theoretical (p<.1) as well as on empirical standard errors (p<.05). Hence, Hypothesis 3 is supported.

Since it is not meaningful to calculate some of the statistics in unconnected networks (e.g. betweenness centrality), we tested the corresponding hypotheses using the main component of the ALL sample.

Model 5 is the baseline model (compare Model 1) and explains about 25.6% of the variance in the dependent variable.

Model 6 extends the baseline model by the authors' effective size. As in Model 3, this effect (β=.249) is found to be statistically significant only when using theoretical standard errors (p<.1), but not when using empirical standard errors. The explained variance by the model is 27.1%. Hence, there is limited support for Hypothesis 2.

Model 7 extends the baseline model by the authors' efficiency. As in Model 4, the effect (β=.192) is found to be statistically significant based on theoretical (p<.05) as well as on empirical (p<.05) standard errors. R^2 is .286. Hence, Hypothesis 3 is supported.

Model 8 extends the baseline model by the authors' betweenness centrality. The strong (β=.523) and statistically significant effect based on theoretical (p<.01) and empirical standard errors (p<.05), as well as the large increase in explained variance (R^2=.378), provide strong support for Hypothesis 4. Hence, it can be concluded that the higher an author's betweenness centrality, the more often that author will be cited.

Model 9 extends the baseline model by the authors' constraint. As hypothesized in H5, the strong negative effect (β=−.413) that is found to be highly statistically significant (p<.01), as well as the high explained variance (R^2=.375) indicate that the lower an author's constraint, the more that author will be cited.

Model 10 extends the baseline model by the authors' ego density. Results indicate that the lower an author's ego density, the more that author will be cited (β=−.446; p<.01; R^2=.406). Hence, Hypothesis 6 is supported.

Finally, Model 11 extends the baseline model by the authors' closeness centrality. The weak (β=−.063); but statistically significant effect when using empirical standard errors (p<.01) provides some support for Hypothesis 7. Hence, it can be concluded that the higher an author's closeness centrality, the more that author will be cited. However, adding the effect does not increase explained variation (R^2=.259).

Summary and discussion

Summary

In this article, we have highlighted the history of Electronic Markets, and visualized the co-authorship network of

Table 33 Top authors by number of citations

Rank	Author	# Citations
1.	Timmers, Paul	1,241
2.	Schubert, Petra	345
3.	Klein, Stefan	298
4.	Zimmermann, Hans-Dieter	232
5.	Steinfield, Charles	194
6.	Alt, Rainer	188
7.	Zhu, Kevin	169
8.	Kauffman, Robert J.	157
9.	Several	156

Table 34 Model results

Parameters	Model 1 - Baseline		Model 2		Model 3		Model 4		Model 5 - Baseline		Model 6	
	Estimate	stand. Estimate	Estimate	β	Estimate	β	Estimate	β	Estimate	β	Estimate	β
Constant	11.216		15.208		13.236		9.449		55.057		53.684	
	3.093 ***		3.172 ***		3.100 ***		3.271 ***		17.363 ***		17.272 ***	
	4.619 **		4.907 ***		4.491 ***		3.897 **		18.612 ***		19.174 ***	
Pages per Article (mean)	1.798	.254	1.685	.238	1.696	.240	1.755	.248	4.035	.295	3.765	.275
	.314 ***		.311 ***		.312 ***		.315 ***		1.284 ***		1.286 ***	
	.274 ***		.288 ***		.272 ***		.284 ***		1.252 ***		1.320 ***	
Volume (mean)	−1.656	−.237	−1.779	−.255	−1.740	−.249	−1.705	−.244	−4.105	−.302	−3.988	−.293
	.310 ***		.307 ***		.307 ***		.311 ***		1.207 ***		1.201 ***	
	.232 ***		.243 ***		.238 ***		.252 ***		1.011 ***		1.086 ***	
Author's Position on Article (mean)	2.055	.060	−.774	−.023	1.343	.039	2.214	.064	−6.348	−.093	−6.450	−.094
	1.048 *		1.196		1.051		1.052 **		5.231		5.198	
	1.040 **		1.701		1.164		1.045 **		3.482 *		3.532 *	
Numbers of Publications	6.043	.387	3.372	.216	2.760	.177	5.950	.381	5.336	.462	2.778	.240
	.476 ***		.734 ***		.894 ***		.479 ***		.911 ***		1.790	
	3.263 *		3.400		3.655		2.921 **		3.545		4.635	
Degree Centrality			3.736	.239								
			.788 ***									
			1.677 **									
Effective Size					5.115	.247					4.082	.249
					1.183 ***						2.465 *	
					3.516						5.542	
Efficiency							4.612	.051				
							2.797 *					
							2.258 **					
Betweenness												
Constraint												
Ego-Network Density												

Parameters	Model 7		Model 8		Model 9		Model 10		Model 11	
	Estimate	β	Estimate	β	Estimate	β	Estimate	β	Estimate	β
Constant	18.873		56.285		13.803		115.729		12,942.725	
	22.903		15.934 ***		21.886 ***		18.759 ***		17,404.545	
	19.998		17.632 ***		31.457 ***		25.192 ***		581.692 ***	
Pages per Article (mean)	3.996	.292	3.033	.222	3.930	.288	3.675	.269	4.302	.315
	1.262 ***		1.194 **		1.181 ***		1.153 ***		1.335 ***	
	1.160 ***		1.118 ***		1.069 ***		.976 ***		1.259 ***	
Volume (mean)	−3.974	−.292	−3.323	−.245	−3.709	−.273	−3.562	−.262	−4.352	−.320
	1.188 ***		1.118 ***		1.113 ***		1.087 ***		1.254 ***	
	1.043 ***		.860 ***		.953 ***		.905 ***		.973 ***	
Author's Position on Article (mean)	−1.682	−.025	−6.941	−.102	−7.354	−.108	−4.078	−.060	−6.926	−.101
	5.507		4.801		4.815		4.709		5.297	
	3.750		3.491 **		3.523 **		3.019		3.729 *	
Numbers of Publications	4.856	.420	.676	.058	2.716	.235	2.792	.242	5.144	.445
	.918 ***		1.234		.985 ***		.927 ***		.949 ***	
	3.238		3.747		2.763		2.925		4.058	
Degree Centrality										
Effective Size										
Efficiency	44.927	.192								
	48.954 **									
	17.508 **									
Betweenness			.044	.523						
			.008 ***							
			.019 **							
Constraint					−83.358	−.413				
					16.472 ***					
					25.065 ***					
Ego-Network Density							−77.885	−.446		
							13.416 ***			
							19.198 ***			

Table 34 (continued)

Parameters	Model 1 - Baseline		Model 2		Model 3		Model 4		Model 5 - Baseline		Model 6		Model 7		Model 8		Model 9		Model 10		Model 11	
	Estimate	stand. Estimate	Estimate	β	Estimate	β	Estimate	β	Estimate	β	Estimate	β	Estimate	β	Estimate	β	Estimate	β	Estimate	β	Estimate	β
Closeness / Farness																					−.026 .035 .001 ***	−.063
R2	.161		.180		.177		.163		.256		.271		.286		.378		.375		.406		.259	
ANOVA (df regression; df residuals; F)	4; 937; 44.874		5; 936; 41.221		5; 936; 4.318		5; 936; 36.509		4; 135; 11.613		5; 134; 9.959		5; 134; 1.732		5; 134; 16.299		5; 134; 16.106		5; 134; 18.282		5; 134; 9.369	

$^{*}p<.1$; $^{**}p<.05$; $^{***}p<.01$

researchers publishing in EM. We have described the co-authorship network quantitatively, and have developed and tested seven hypotheses that examine the association between an author's embeddedness in the co-authorship network and that author's number of citations. Results indicate that researchers who publish together with many co-authors, who bridge between different groups of authors, and who are located in the center of the co-authorship network are cited more often.

Theoretical relevance

To our knowledge, this is the first study published in EM that examines co-authorship and the citation frequency of papers published in EM. Our results may be of considerable interest to the readers of EM. The theoretical relevance of our work falls into five general categories.

First, junior scholars often have some difficulties identifying research streams and the senior researchers who drive those research streams. This article provides an overview about the history of Electronic Markets. In doing so, it shows authors' embeddedness in a co-author network and identifies the most important researchers for EM by applying methods from social network analysis. A junior scholar new to EM who examines the figures and tables in this paper will understand which clusters of researchers determine the research tradition, editorial policies, and aims and scope of this journal.

Second, senior researchers and their descendants may benefit from this study's documention of their work. It is these senior researchers who made EM what it is today: a journal well recognized internationally for high-quality research that has been ranked in the "A journal" category.[10]

Third, this study shows that researchers who publish together with many co-authors are cited more often. Since it is likely that measures such as the h-index (Hirsch 2005) will increasingly be used for tenure decisions, junior researchers should consider the long-term citation effects of working in research groups and thus publishing with (additional) co-authors.

Fourth, although many researchers of electronic markets are familiar with social network analysis, surprisingly few SNA studies have been published in EM. Insomuch as our article is written in a tutorial-like way, the presentation of a variety measures commonly to SNA will facilitate their use by junior researchers conducting similar analyses.

[10] EM has been so ranked by the Australian Research Councils's (ARC) Excellence in Research for Australia Initiative (ERA) (http://www.arc.gov.au/era/), in the common journal ranking of the Center of Excellence for IS Research in the German Academic Association for Business Research (WKWI VHB), and by German Society for Computer Sciences (GI) ("WI-Orientierungslisten 2008").

Finally, the results of this study are also relevant from a methodological point of view. Many researchers employ network statistics (such as Eigenvector centrality) as independent variables in their regressions. However, standard statistical methods are not applicable to networked data due to violation of the i.i.d. assumption. Our results illustrate strikingly that inferences based on (erroneous) theoretical standard errors might lead to false conclusions. We therefore recommend that researchers employ empirical standard errors when testing hypotheses with network statistics violating the i.i.d. assumption.

Managerial relevance

In addition to the theoretical insights, this study also provides some insights for practitioners. Managers do not typically search the scientific literature, but they do sometimes work closely with academics. This article may help these practitioners identify other scholars with whom they might find it interesting to work. Figure 1 may show practitioner the other scholars with whom those they already know have worked and who may be interested in similar topics.

Limitations and future research

Of course, as with any empirical study, this study is subject to some limitation. We do not consider most of these limitations to void the results, so long as readers remain aware of them as they draw their conclusions. In fact, the limitations suggest some future research that examines the authors' embeddedness in co-authorship networks and citation frequency of their articles in a variety of different disciplines.

There are seven specific limitations to discuss.

First, we conducted a static analysis and supposed that an edge between two co-authors persists over time since their common article constitutes scientific knowledge and a legacy for all subsequent research projects. However, one might argue that nodes and edges disappear from a co-authorship network when they stop cooperation and / or existence.[11] Future research should, therefore, conduct dynamic analyses. An unresolved question in these kinds of analyses is, for example, how long nodes and edges are assumed to remain active in the network. The answer certainly depends on the research context.

Second, we did not examine which factors lead authors to seek publishing together with each other. Future research should examine co-authorship networks with a methodology that allows for drawing statistical inferences about the evolution of co-authorship networks (e.g. Putzke et al. 2010a).

Third, space limitations did not allow us to present many other statistics that are frequently used to characterize co-authorship networks or citation frequency. For example, future research should analyse k-cores (maximal subgraphs in which each author has co-authored papers with at least k other authors in the subgraph), and k-plexes (maximal subgraphs in which each author has co-authored papers together with all but k authors in the subgraph) of the co-authorship network in EM (Wasserman and Faust 1994). Furthermore, future studies should examine the author's h-index in more detail. The h-index is one of the most cited statistics in the context of citation analyses, as it is meant to combine the quality and quantity of an author's publication in one statistic.[12] Other interesting statistics might be, for example, half-life, immediacy, and impact factor (compare, for example, De Bellis 2009).

Fourth, we restricted our analyses to the co-authorship network within EM. It is certainly possible that some of the authors are connected via a path of co-authors that have published a paper elsewhere. For example, Michael Haenlein belongs to an isolated dyad in the co-author network of EM (i. e., Schoder and Haenlein 2004). However, Detlef Schoder published a paper together with Kai Fischbach in the Journal of Media Economics (Putzke et al. 2010b). In turn, Kai Fischbach worked together with Heng Xu (H. Xu and Fischbach 2006), who published two papers in EM (e.g. Tan et al. 2010; H. Xu and Gupta 2009). Hence, future research should analyze co-authorship networks that span the boundaries of EM. This fact would also address the problem that many authors had to be excluded when we calculated some of the network statistics (such as betweenness centrality), which might have led to a systematic error due to missing heterogeneity.

Fifth, the dataset used for this study cannot be considered to be complete. For example, the authors of some editorials in EM were not named, although it is obvious that a person had to have been the writer. These editorials were excluded from analyses. Furthermore, we had to rely on Google Scholar when examining the citation frequencies. Although these data may be a good indicator for the citation frequency of an article, we noticed some erroneous data sets during our analyses. Recently, Electronic Markets has been included in Thomson Reuters' Social Sciences Citation Index (SSCI), which is supposed to be a reliable citation database. However, at the time of this study, the data had not yet been updated. Hence, future research should analyse citation patterns using the SSCI. Finally, the data used for the analyses are necessarily right censored since it is possible that the articles will be cited in the future.

[11] For example, René Wagenaar passed away unexpectedly just after completing a research project published in EM (Fielt et al. 2008).

[12] "A scientist has index h if h of his or her N_p papers have at least h citations each and the other (N_p - h) papers have $\leq$ h citations each" (Hirsch 2005).

Table 35 Most cited articles in Electronic Markets

Rank	Article ID	Title	# Citations
1.	219	Business Models for Electronic Markets	1,241
2.	358	Preface: Introduction to Special Section—Business Models	178
3.	418	Encouraging Citizen Adoption of e-Government by Building Trust	156
4.	192	Web Assessment—A Model for the Evaluation And the Assessment of Successful Electronic Commerce Applications	143
5.	195	Introduction to Electronic Auctions	140
6.	498	Prediction Markets: Does Money Matter?	138
7.	438	The 2001 Trading Agent Competition	134
8.	317	Virtual Communities of Transaction: The Role of Personalization in Electronic Commerce	129
9.	455	Exploring SME Internet Adoption: Towards a Contingent Model	115
10.	210	Agents as Mediators in Electronic commerce	100
10.	279	Strategies for Internet Middlemen in the Intermediation/Disintermediation/Reintermediation Cycle	100
12.	196	Auctions and Bidding on the Internet: an Assessment	92
13.	269	Special Section: Local vs. Global Issues in Electronic Commerce	87
14.	270	Electronic Commerce and the Local Merchant: Opportunities for Synergy Between Physical and Web	86
14.	417	Integrated Service Modelling for Online One-stop Government	86
16.	402	Information Quality for Mobile Internet Services: A Theoretical Model with Empirical Validation	85
17.	441	Assessing Motivation of Contribution in Online Communities: An Empirical Investigation of an Online Travel Community	82
18.	285	Internet-based Electronic Markets	78
20.	475	Global Technology, Local Adoption: A Cross-Country Investigation of Internet Adoption by Companies in the United States and China	74

Table 36 Journals with the most citations of EM articles

Rank	Journal	Number of Citations
1.	Electronic Markets	269
2.	International Journal of Electronic Commerce	112
3.	Information Systems Frontiers	51
4.	Decision Support Systems	44
5.	International Journal of Electronic Business	35
5.	Journal of Electronic Commerce Research	35
7.	European Journal of Information Systems	34
8.	Electronic Commerce Research	31
8.	Journal of Organizational Computing and Electronic Commerce	31
10.	Wirtschaftsinformatik	31
11.	Journal of Computer-Mediated Communication	27
12.	Journal of Management Information Systems	26
13.	Group Decision and Negotiation	24
14.	Electronic Commerce Research and Applications	23
14.	Information & Management	23
14.	Information Systems and E-Business Management	23
14.	International Journal on Media Management	23
18.	Communications of the ACM	20
18.	International Journal of Mobile Communications	20
18.	The Information Society	20

Sixth, we neglected the authors' geographic proximities and institutional affiliations. However, these factors were shown to influence the number of citations (e.g. Stremersch and Verhoef 2005). Future research should control for these two variables.

Seventh, we could not include some variables in the same regression due to collinearity issues (e.g. degree centrality and betweenness centrality). Testing these effects at the same time would be interesting and should be done so with a dataset in which collinearity is not a problem.

It is our hope that our research will assist others in conducting these types of studies and form the basis for substantial future research into co-author networks and citation frequency in electronic markets research. In particular, we hope that future research will focus on different subjects for the analyses. For example, one might examine in more detail which articles are cited most (see Table 35; h-index=42) or in which other journals the papers published in Electronic Markets are cited (see Table 36).

References

Agarwal, R., Gupta, A. K., & Kraut, R. (2008). The interplay between digital and social networks. *Information Systems Research, 19*(3), 243–252.

Alba, R. D. (1973). A graph-theoretic definition of a sociometric clique. *Journal of Mathematical Sociology, 3*(1), 113–126.

Antaki, G. (2000). Internet development in Lebanon. *Electronic Markets, 10*(2), 147–147.

Backhaus, K., Becker, J. R., Beverungen, D., Frohs, M., Müller, O., Weddeling, M., et al. (2010). Enabling individualized recommendations and dynamic pricing of value-added services through willingness-to-pay data. *Electronic Markets, 20*(2), 131–146.

Balaban, A., & Klein, D. (2002). Co-authorship, rational Erdős numbers, and resistance distances in graphs. *Scientometrics, 55* (1), 59–70. doi:10.1023/a:1016098803527.

Bekele, D. (2000). EthioGift: a unique experience in electronic commerce in Ethiopia. *Electronic Markets, 10*(2), 146–146.

Bergh, D. D., Perry, J., & Hanke, R. (2006). Some predictors of SMJ article impact. *Strategic Management Journal, 27*(1), 81–100. doi:10.1002/smj.504.

Bonacich, P. (1972). Factoring and weighting approaches to status scores and clique identification. *Journal of Mathematical Sociology, 2*(1), 113–120.

Bonacich, P. (1987). Power and centrality: a family of measures.. *The American Journal of Sociology, 92*(5), 1170–1182.

Bonacich, P., & Lloyd, P. (2001). Eigenvector-like measures of centrality for asymmetric relations. *Social Networks, 23*(3), 191–201. doi:10.1016/S0378-8733(01)00038-7.

Borgatti, S. P. (2005). Centrality and network flow. *Social Networks, 27*(1), 55–71. doi:10.1016/j.socnet.2004.11.008.

Bron, C., & Kerbosch, J. (1973). Finding all cliques of an undirected graph. *Communications of the ACM, 16*(9), 575–577.

Brown, D. H., Lockett, N., & Schubert, P. (2005). Preface to the focus theme section 'SMEs and E-Business'. *Electronic Markets, 15* (2), 76–78.

Burt, R. (1995). *Structural holes: The social structure of competition*. Harvard University Press.

Chase, I. (1980). Social process and hierarchy formation in small groups: a comparative perspective. *American Sociological Review, 45*(6), 905–924.

Cheong, F., & Corbitt, B. (2009). A social network analysis of the co-authorship network of the pacific asia conference on information systems from 1993 to 2008. In *PACIS 2009 Proceedings* (pp. 23).

Culnan, M. J. (1986). The intellectual development of management information systems, 1972–1982: a co-citation analysis. *Management Science, 32*(2), 156–172.

Cunningham, S., & Dillon, S. (1997). Authorship patterns in information systems. *Scientometrics, 39*(1), 19–27.

Dai, Q., & Kauffman, R. J. (2002). B2B E-Commerce revisited: leading perspectives on the key issues and research directions. *Electronic Markets, 12*(2), 67–83.

De Bellis, N. (2009). *Bibliometrics and citation analysis: From the Science citation index to cybermetrics*. Scarecrow Press.

Dekker, D., Krackhardt, D., & Snijders, T. (2007). Sensitivity of MRQAP tests to collinearity and autocorrelation conditions. *Psychometrika, 72*(4), 563–581.

Duan, C., Kung, H., Tung, H., & Tseng, H. (2010). The intellectual structure of modern e-business research: an author co-citation analysis. *Research Journal of International Studies*, (13), 32–46.

Elektronische Märkte. (1991). *Electronic Markets, 1*(1), 1–2.

Eto, H. (2002). Authorship and citation patterns in Management Science in comparison with operational research. *Scientometrics, 53*(3), 337–349.

Fiala, D., Rousselot, F., & Ježek, K. (2008). PageRank for bibliographic networks. *Scientometrics, 76*(1), 135–158.

Fielt, E., Janssen, W., Faber, E., & Wagenaar, R. (2008). Design trade-offs for electronic intermediaries. *Electronic Markets, 18*(4), 362–374.

Floeck, F., Putzke, J., Steinfels, S., Fischbach, K., & Schoder, D. (2011). Imitation and quality of tags in social bookmarking systems—collective intelligence leading to folksonomies. In T. Bastiaens, U. Baumöl, & B. Krämer (Eds.), *On collective intelligence* (Vol. 76, pp. 75–91, Advances in Soft Computing). Springer Berlin / Heidelberg.

Freeman, L. (1979). Centrality in social networks conceptual clarification. *Social Networks, 1*(3), 215–239.

Goffman, C. (1969). And what is your Erdös number? *American Mathematical Monthly, 76*(7), 791.

Granovetter, M. S. (1973). The strength of weak ties. *The American Journal of Sociology, 78*(6), 1360–1380.

Heider, F. (1946). Attitudes and cognitive organization. *The Journal of Psychology, 21*(1), 107–112.

Hinz, O., & Spann, M. (2008). The impact of information diffusion on bidding behavior in secret reserve price auctions. *Information Systems Research, 19*(3), 351–368.

Hirsch, J. E. (2005). An index to quantify an individual's scientific research output. *Proceedings of the National Academy of Sciences of the United States of America, 102*(46), 16569–16572. doi:10.1073/pnas.0507655102.

Holland, P. W., & Leinhardt, S. (1972). Holland and leinhardt reply: some evidence on the transitivity of positive interpersonal sentiment. *The American Journal of Sociology, 77*(6), 1205–1209.

Hood, W., & Wilson, C. (2001). The literature of bibliometrics, scientometrics, and informetrics. *Scientometrics, 52*(2), 291–314. doi:10.1023/A:1017919924342.

Ismail, M. M., & El-Nawawy, M. A. (2000). The imminent challenge of click and mortar commerce in Egypt, Africa and the Middle East. *Electronic Markets, 10*(2), 73–79.

Kaufmann, M., & Wagner, D. (2001). *Drawing graphs: Methods and models*. Springer Verlag.

Kock, N. (2009). The evolution of costly traits through selection and the importance of oral speech in e-collaboration. *Electronic Markets, 19*(4), 221–232.

LaRowe, G., Ichise, R., & Borner, K. (2007). Analysis of Japanese information systems co-authorship data. In I. Ryutaro, & B. Katy (Eds.), *11th International Conference Information Visualization (IV '07)* (pp. 459–464).

Lechner, U., Stanoevska-Slabeva, K., & Tan, Y.-H. (2000). Editorial. *Electronic Markets, 10*(4), 213–213.

Loebbecke, C. (2007). Piloting RFID along the supply chain: a case analysis. *Electronic Markets, 17*(1), 29–38.

Luce, R. D., & Perry, A. D. (1949). A method of matrix analysis of group structure. *Psychometrika, 14*, 95–116. doi:10.1007/bf02289146.

Marion, L., Wilson, C., & Davis, M. (2005). Intellectual structure and subject themes in information systems research: a journal cocitation study. *Proceedings of the American Society for Information Science and Technology, 42*(1).

Merton, R. (1968). The Matthew effect in science: the reward and communication systems of science are considered. *Science, 159* (3810), 56.

Mokken, R. J. (1979). Cliques, clubs and clans. *Quality & Quantity, 13*(2), 161.

Mulvenna, M., Norwood, M., & Büchner, A. (1998). Data-driven marketing. *Electronic Markets, 8*(3), 32–35.

Newman, M. E. J. (2004). Coauthorship networks and patterns of scientific collaboration. *Proceedings of the National Academy of Sciences of the United States of America, 101*(Suppl 1), 5200–5205. doi:10.1073/pnas.0307545100.

Odda, T. (1979). On properties of a well-known graph or what is your Ramsey number? *Annals of the New York Academy of Sciences, 328*(Topics in Graph Theory), 166–172.

Oinas-Kukkonen, H., Lyytinen, K., & Yoo, Y. (2010). Social networks and information systems: ongoing and future research streams. *Journal of the Association for Information Systems, 11*(2), 3.

Österle, H., & Heyden, K. (2010). Editorial 20/1. *Electronic Markets, 20*(1), 1–1.

Österle, H., & Schmelich, V. (2009). Editorial 19/1. *Electronic Markets, 19*(1), 1–2.

Österle, H., & Schmid, B. F. (2008). Quo vadis electronic markets? *Electronic Markets, 18*(3), 206–210.

Otte, E., & Rousseau, R. (2002). Social network analysis: a powerful strategy, also for the information sciences. *Journal of Information Science, 28*(6), 441.

Peng, G., & Woodlock, P. (2009). The impact of network and recency effects on the adoption of e-collaboration technologies in online communities. *Electronic Markets, 19*(4), 201–210.

Peters, H., & Van Raan, A. (1991). Structuring scientific activities by co-author analysis. *Scientometrics, 20*(1), 235–255. doi:10.1007/bf02018157.

Pinkwart, N., & Olivier, H. (2009). Cooperative virtual worlds—a viable eCollaboration pathway or merely a gaming trend? *Electronic Markets, 19*(4), 233–236.

Popper, S. (1959). *The logic of scientific discovery*. Hutchinson.

Pries-Heje, J., & Baskerville, R. (2008). The design theory nexus. *MIS Quarterly, 32*(4), 731–755.

Putzke, J., Fischbach, K., Schoder, D., & Gloor, P. (2010a). The evolution of interaction networks in massively multiplayer online games. *Journal of the Association for Information Systems, 11*(2), 69–94.

Putzke, J., Schoder, D., & Fischbach, K. (2010b). Adoption of mass-customized newspapers: an augmented technology acceptance perspective. *Journal of Media Economics, 23*(3), 143–164.

Rapoport, A. (1953). Spread of information through a population with socio-structural bias: I. Assumption of transitivity. *Bulletin of Mathematical Biology, 15*(4), 523–533.

Schmid, B. F. (1996). Editor's note. *Electronic Markets, 6*(2), 2–2.

Schmid, B. F., Selz, D., & Buchet, B. (1999). Editorial. *Electronic Markets, 9*(1), 1–1.

Schoder, D., & Haenlein, M. (2004). The relative importance of different trust constructs for sellers in the online world. *Electronic Markets, 14*(1), 48–57.

Schulman, E. (1996). How to write a scientific paper. *Annals of Improbable Research, 2*(5), 8.

Segev, A., Gebauer, J., & Färber, F. (1999). Internet-based electronic markets. *Electronic Markets, 9*(3), 138–146.

Sellen, M. (1993). *Bibliometrics: An annotated bibliography, 1970–1990*. GK Hall Toronto: Maxwell Macmillan Canada, New York: Maxwell Macmillan International, New York.

Shapiro, F. R. (1992). Origins of bibliometrics, citation indexing, and citation analysis: the neglected legal literature. *Journal of the American Society for Information Science, 43*(5), 337–339. doi:10.1002/(sici)1097-4571(199206)43:5<337::aid-asi2>3.0.co;2-t.

Stewart, J. A. (1983). Achievement and ascriptive processes in the recognition of scientific articles. *Social Forces, 62*(1), 166–189.

Strader, T. J., & Walstrom, K. A. (1999). Special Section: 1998 AIS mini-track on electronic commerce. *Electronic Markets, 9*(1), 2–4.

Strader, T. J., Buchet, B., Walstrom, K. A., & Schmid, B. F. (1999). Editorial. *Electronic Markets, 9*(1), 1–1.

Stremersch, S., & Verhoef, P. C. (2005). Globalization of authorship in the marketing discipline: does it help or hinder the field? *Marketing Science, 24*(4), 585–594. doi:10.1287/mksc.1050.0152.

Stremersch, S., Verniers, I., & Verhoef, P. C. (2007). The quest for citations: drivers of article impact. *Journal of Marketing, 71*(3), 171–193.

Tan, C.-H., Teo, H.-H., & Xu, H. (2010). Online auction: the effects of transaction probability and listing price on a seller's decision-making behavior. *Electronic Markets, 20*(1), 67–79.

Tassabehji, R. (2000). E-Commerce in Dubai: realities and impediments. *Electronic Markets, 10*(2), 144–145.

Van Dalen, H. P., & Henkens, K. (2001). What makes a scientific article influential? The case of demographers. *Scientometrics, 50* (3), 455–482.

Vidgen, R., Henneberg, S., & Naudé, P. (2007). What sort of community is the European Conference on Information Systems? A social network analysis 1993–2005. *European Journal of Information Systems, 16*(1), 5–19. doi:10.1057/palgrave.ejis.3000661.

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. Cambridge University Press.

Watts, D., & Strogatz, S. (1998). Collective dynamics of 'small-world'networks. *Nature, 393*(6684), 440–442.

Weinberg, B. H. (1997). The earliest Hebrew citation indexes. *Journal of the American Society for Information Science, 48*(4), 318–330.

WI-Orientierungslisten. (2008). *WIRTSCHAFTSINFORMATIK, 50*(2), 155–163. doi:10.1365/s11576-008-0040-2.

Xu, J., & Chau, M. (2006). The social identity of IS: Analyzing the collaboration network of the ICIS conferences (1980–2005). In *27th ICIS Conference, Milwaukee, WI* (pp. 569–589).

Xu, H., & Fischbach, K. (2006). Trust formation in the usage of peer-to-peer (P2P) sharing software. In *INFORMS Annual Meeting, Pittsburgh, PA, November 5–8*

Xu, H., & Gupta, S. (2009). The effects of privacy concerns and personal innovativeness on potential and experienced customers' adoption of location-based services. *Electronic Markets, 19*(2), 137–149.