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Factors Influencing the Extent of Co-Authorship in IS Research: An Empirical Investigation

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Abstract:

The extent of co-authorship in IS research is on the rise. Why has collaboration between IS academics increased? While prior research on the incidence of co-authorship provides several reasons for why academics collaborate, little is known about whether these rationales are equally adept at explaining the growing extent of co-authorship. To answer this question, we delve into extant research on collaboration and delineate four rationales for why papers have more co-authors. These include information processing, access to social resources, convenience, and the opportunity cost of time. We formulate several variables and propose several hypotheses based on these rationales. We collected data by coding 641 papers from six major U.S. and European journals. The results generally support the proposed hypotheses. We discuss the implications of the results in terms of how they inform the field and policy makers.

Keywords: IS Research, Collaboration, Publications, Co-Authorship, Extent of Co-authorship, Number of Co-authors, Rationale for Co-authorship, Reasons to Collaborate, Research Collaboration.

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1 The Golden Rule

In most scientific research, intellectual collaboration occurs through co-authorship where the participation of two or more authors in a study leads to "a scientific output of greater quality or quantity than could be achieved by an individual" (Acedo, Barroso, Casanueva, & Galan, 2006, p. 959). There is documented evidence that the incidence of co-authorship in business fields is on the rise. For instance, Hudson (1996), while writing about the incidence of co-authorship in economics, reports that in 1950 only eight percent of papers in the *Journal of Political Economy* (JPE) and the *American Economic Review* (AER) were co-authored, while, in 1993, the proportion of co-authored papers in *JPE* and *AER* was 39.6 percent and 54.9 percent, respectively. In IS, the corresponding numbers for *Management Information Systems Quarterly* (MISQ) unveiled by using Harzing's (2013) "Publish or Perish" software shows a similar trend: from 47 percent multi-authored papers in the early 1980s to 67 percent in the early 1990s and 85 percent in the late 2000s. Similarly, the extent of co-authorship has also increased over the years. For instance, Manton and English (2007) found that the extent of multiple authorship in six representative business journals increased from an average of 1.45 authors per paper in the early 1970s to an average of 2.19 authors per paper by the early 2000s. Representative numbers for top IS journals unveiled using Harzing's software show a similar trend in extent of co-authorship: from 1.63 authors per paper in the early 1980's to 2.61 authors per paper in the early 2010s in *MISQ*, from 1.86 authors per paper in the mid-1990s to 2.68 authors per paper today in *Information Systems Research*, and 1.78 authors per paper in the mid-1980s to 2.98 authors per paper today in the *Journal of MIS.* This trend of increasing incidence and extent of co-authorship is growing in most business fields (Cronin, Shaw, & La Barre, 2003a, 2003b; Moody, 2004).

Research on co-authorship in business fields most often examines the advantages of co-authoring (e.g., improved paper quality) (Urbancic, 1992; Brown & Gardner 1985), the experiences (positive and negative) in co-authoring (Nathan, Hermanson, & Hermanson, 1998), the credit granted for co-authored work (Nathan et al., 1998; Hollis 2001), and the ordering of authors (Fleischman & Schuele, 2009). These studies use the incidence of co-authorship as the variable of interest and focus on the phenomena in one of two ways (Laband & Tollison, 2000): 1) to study differences in co-authorship between broad fields (e.g., natural and social sciences) or fields in broader fields (e.g., between chemistry and physics in the natural sciences or between economics and marketing in the social sciences) and 2) to study the factors that drive a researcher's decision to collaborate rather than conduct research alone. Studies focusing on the extent of co-authorship view the number or average number of authors in co-authored papers as the variable of interest (Laband & Tollison, 2000). Such studies are rare in business. The lack of research on extent of co-authorship in business is perhaps attributable to the fact that the extent of co-authorship in social sciences is lower than that in the natural sciences. Acedo, Barroso, Casanueva, and Galan (2006) corroborate this observation when they write:

> *In the natural sciences, the shared use of laboratories and expensive equipment by research teams produces a greater extent of co-authorship (that is, the publication of papers with a greater number of authors). Within the social sciences, research teams are increasingly common. However, there is evidence of some reticence to publish papers in the social sciences with a large number of authors*. (Acedo et al. 2006, pg. 960)

However, the trend of three or more authors in business journals is now increasing, which suggests that the extent of co-authorship is indeed on the rise. As evidence, a search of papers with three or more authors in *MISQ* reveals that the percentage of such papers has gone up from 10 percent in the early 1980s to 27.5 percent in the 1990s. In the late 2000s, the percentage of papers in *MISQ* with three or more authors increased to 40 percent[1].Thus, in IS research, researchers are not only collaborating more instead of solo authoring research but also working with more co-authors rather than working with a single co-author. Despite this trend, the literature on the extent of co-authorship in IS is relatively sparse (i.e., we have little understanding of why researchers co-author with more researchers). In the absence of a methodological inquiry into the phenomena, we often run the danger of consigning it's occurrence to explanations such as "co-authorship is simply the norm" or "aren't more heads always better than one?". Such conjectures can be problematic for academic researchers as they pursue tenure and promotions in academic institutions, particularly when legitimate reasons exist for increasing the extent of co-authorship. For example, Sauer (1988) estimates using data on salaries and publications that public institutions apply a discount factor to co-authored papers such that an individual's return for a co-authored paper is approximately 1/nth (where n is the number of authors) than that for a solo-authored paper. Such

[1] Harzing's Publish or Perish software.

discounting is baffling to academic researchers given the evidence that co-authored papers are more likely to be accepted for publication (Laband & Tollison, 2000) and that papers with more authors are cited more often (Glänzel & Thijs, 2004; Wuchty, Jones, & Uzzi, 2007; Chung, Cox, & Kim, 2009). These findings suggest that increasing the extent of co-authorship affects both researchers' productivity and impact. On the other hand and contrary to the common understanding that more co-authors are always better, working with multiple co-authors may not necessarily be the preferred "natural state" for many academics. Prior research on academic collaboration lists several "co-authorship expenses". For example, Hudson (1996) suggests that collaborations involve compromises where individual authors working in groups must agree and compromise on ideas, approaches, or conclusions. He, Geng, and Campbell-Hunt (2009) describe collaboration costs associated with finding and evaluating co-authors and organizing and coordinating the collaborative activity. Similarly, Landry and Amara (1998) describe ex post collaboration transaction costs as those associated with monitoring and enforcing the promises of input that co-authors make. Corgnet (2010) describes the costs due to the inefficiency of collaborative arrangements, particularly as a result of having incomplete information about co-authors' abilities. The pitfalls of co-authorship are well known and have been written about in prior research. For example, a survey of finance faculty by Tompkins, Nathan, Hermanson, and Hermanson (1997) reveals that at least two-thirds of the surveyed academics had suffered through failed co-authorship endeavors. The leading explanations provided for this failure included "coordination difficulties" among participants (53%), disagreements over the directions taken in the project (35%), and personality clashes between co-authors (23%) (Tompkins et al., 1997).

So why should we care about studying co-authorship in our field? We can address this question at the individual level and the field level. At the individual level, given that working with many co-author might not be a "natural state", it is quite plausible to expect that academic researchers increase the extent of co-authorship for deliberate reasons. In this research paper, we unveil some of these reasons by investigating the factors that determine the extent of co-authorship in IS research. In other words, we address the following question: what factors lead to IS researchers working with more, rather than a lesser, number of co-authors? Our findings have implications for understanding collaborative research in IS by focusing on co-authorship as an *adaptive strategy* in response to stakeholders' needs. We maintain that environmental and institutional constraints—notwithstanding the factors that determine how many researchers an individual collaborates with—remains in individuals' control[2]. Furthermore, who individuals choose as a co-author depends on what the co-author brings to the table to address the stakeholders' specific needs and the research that is undertaken, which, in turn, determine the extent of co-authorship. Thus, the extent of co-authorship may be determined by the increasing complexity of IS phenomena, the increasing stock of knowledge in the field, the need for social and political resources for career advancement, or simply a sense of collegiality and convenience among collocated peers. At the field-based level, it is entirely plausible that the motivations for co-authorship differ significantly across fields based on different adaptations that these fields make. By analyzing a critical set of IS research papers, we not only provide an empirical test of rationales that drive co-authorship behavior but also reveal the kind of social interactions we value as a field[3].

This paper proceeds as follows. In Section 2, we review relevant literature to identify a set of arguments regarding factors that lead to greater extent of co-authorship among researchers. Concurrently, we enumerate a set of hypotheses based on the competing arguments. In Section 3, we describe the variables we used to test our hypotheses, the method we used to collect data, and how we analyzed the data. In Section 4, we present the results of the statistical analysis. In Section 5, we discuss the implications of our results. In Section 6, we discuss the study's limitations, and, in Section 7, we conclude the paper.

[2] Lee and Bozeman (2005) refer to this as endogenous co-authorship formation (i.e., authors choose whom to work with)

[3] We would like to clarify that this paper investigates the antecedents of co-authorship. However, we would also like to acknowledge that many other interesting phenomena associated with co-authorship might be worth investigating. As an anonymous reviewer points out, some might associate solo authorship with impactful or original contribution and co-authored work with a dilution of such contribution. Likewise, also worth investigating are several ethical questions such as those related to the practice of submitting co-authored work to multiple outlets, albeit with minor changes or rearrangement of the listed co-authors. While we cannot ascertain the veracity of these claims, if true, these phenomena require additional research. However, we view these questions as examples of the consequences of co-authorship and beyond the scope of the present research paper.

2 Theory and Hypothesis

Prior studies provide many justifications for scientific collaboration and co-authorship, which include enhanced productivity (Melin, 2000); increased specialization (Lee & Bozeman, 2005; Figlio, 1994; Moody, 2004); extension of problem-solving ability (Beaver, 2001); access to expertise (Laudel, 2001; Beaver, 2001; Hudson, 1996); access to equipment, resources, or data (Thorsteinsdottir, 2000); access to funds (Lundberg, Tomson, Lundkvist, Skar, & Brommels., 2006); acquisition of tacit knowledge (Nelson & Nelson, 2002; Balconi, 2002); student mentoring (Melin, 2000); cross-fertilization across fields (Lundberg et al., 2006); prestige and visibility (Bozeman & Corley, 2004); and pleasure or fun (Lee & Bozeman, 2005; Bozeman & Corley, 2004). We can categorize many of these justifications into one of the following co-authorship rationales: co-authorship for information processing, co-authorship for accessing social and technical resources, and convenient co-authorship due to spatial collocation. We can see co-authoring papers to enhance productivity, extend problem-solving ability, and gain access to expertise in response to the need for specialized knowledge as subscribing to the information-processing rationale. Access to equipment or resources, access to funds, prestige, and visibility intuitively map onto the social and technical resources rationale. Our third rationale, convenience due to spatial collocation, suggests that it is more convenient to acquire tacit knowledge and derive fun and pleasure from co-authorship when most of the participants are spatially collocated. To these, following Barnett, Ault, and Kaserman (1988), we add a fourth rationale: the opportunity cost of time. We view the opportunity cost of time argument as an opportunistic co-authorship rationale that has resulted from the pressure to publish in prestigious journals. In Sections 2.1 to 2.4, we explain the four rationales in detail.

2.1 Divide and Conquer: Using Co-authorship for Information Processing

A stream of research that is relevant to our study is the information processing view of organizations (Galbraith, 1974). In a nutshell, this theory identifies organizational information-processing needs, information-processing capability, and the fit between these two as the key determinants of organizational performance. As environmental uncertainty increases, Galbraith suggests two coping strategies. The first is reducing the need for additional informational processing by introducing slack and buffers into the organizational system. The second is to increase the organization's information-processing capability to match its information-processing needs, which is achieved by implementing structural mechanisms to enhance information flow and processing capacity in organizations.

While Galbraith (1974) views the environment as a major source of uncertainty, Perrow (1967) describes the source of uncertainty stemming from characteristics of the task itself. Perrow (1967) describes routine-non-routine work as the basis for information processing in organizations. Subsequently, Van de Ven and Delbecq (1974) expanded the continuum of routine-non-routine work into task variety as the frequency of novel events that occur in the information-conversion process and task analyzability, which concerns the manner in which individuals respond to novel problems. When a task's variety and unanalyzability are low, one can accomplish it in a mechanistic or clerical fashion without the intervention of specialists or experts. However, when variety and (un)analyzability is high such as it is in IS research or any other research and development (R&D), then the chasm between the information-processing need and information-processing capability widens, which necessitates the need for experts and specialists.

While the information-processing view highlights the need for specialists, the increasing specialization view that McDowell and Melvin (1983) explain describes the present state of the field and why it may be necessary for researchers to specialize in certain areas. The increasing specialization argument fundamentally says that, as the stock of knowledge in a field grows, researchers find it increasingly necessary to specialize in narrowly defined areas. With increasing specialization and when faced with high task variety and analyzability, conducting research projects requires the skills of two or more researchers. When researchers do not cope with increasing information-processing capability by including specialists, the only alternative is to reduce information-processing needs by introducing slack by way of stretching or missing submission deadlines. Hence, a researcher skilled in creating theories and hypotheses may find it attractive to collaborate with a researcher who is skilled in testing methods. Both researchers may, in turn, find it attractive to collaborate with a researcher adept at collecting and organizing data (Barnett et al., 1988). Since the skill sets or access needed for theorizing, creating data, and analyzing data are quite different, we propose that papers that require all three skills (i.e., empirical research in major IS journals) would also benefit more from co-authorship. Thus, the nature of the research that authors undertake (empirical or non-empirical) may determine the extent of co-authorship.

Hypothesis 1: Empirical research has more co-authors compared to non-empirical research.

Our first hypothesis extends rationales from prior literature in accounting and economics. For example, McDowell and Melville (1983) suggest that, under the assumption of specialization and division of labor, when there is rapid advance in methodologies and knowledge, collaboration is more likely as it ameliorates the costs of rapid obsolescence of researchers' knowledge and methodological skill. Hudson (1996) also argues that the incidence of co-authorship is related to the increase and proliferation of quantitative studies in a field (Also, c.f. Katz & Martin, 1997; Meadows & O'Connor, 1971).

Authors can also divide labor as a risk-diversification strategy. This rationale stems from the argument that the editorial review process might contain a random element where a paper may be accepted or rejected depending on the paper's topic, the reviewers' predisposition, or the editor's judgment concerning reader interest (Barnett et al., 1988). Furthermore, the length of time between submission, the subsequent review process, and decision might also have a random element. Faced with uncertainty, risk-averse researchers may respond by diversifying against the risk by increasing the number of papers produced by co-authoring papers and, as a result, achieve some expected rate of acceptance (Barnett et al., 1988). One way of increasing productivity is by dividing the task into manageable portions and assigning it to multiple researchers where someone collects data, sends them to the other who analyzes them, and perhaps writes a manuscript, which is then worked over a few times (Hollis, 2001).

So how does the presence of a prolific researcher affect the extent of co-authorship? To make the case for our hypothesis clearer, let us view a co-authoring endeavor from the perspective of a prolific researcher (PR) and the PR's co-author and articulate the chain of logic. First, as a risk-diversification strategy, a PR's objective is to publish a large number of journal papers (Barnett et al., 1988). This leaves the PR with a limited amount of time for any particular in-progress manuscript. Furthermore, as the number of manuscripts a PR gets involved in increase, the amount of time the PR can dedicate to each manuscript shrinks further. Thus, the more prolific and productive a PR is, the less time the PR can dedicate to each co-authorship endeavor, which can leave a disproportionately larger amount of labor for the co-author of each in-progress manuscript (assuming initially that each endeavor is dual authored). To balance the higher labor demands of such an arrangement, the co-author might respond by adding another co-author to divide the remaining labor more equitably. Since the PR has more experience and success in publishing, co-authors may often be willing to join the project to benefit from that experience. As a consequence, a PR's presence has increased the extent of co-authorship (i.e., a paper that might have been co-authored by two researchers is now co-authored by three or more researchers).

In conclusion, even though a PR's motivation in co-authorship endeavors might simply be to increase personal productivity and diversify risk, it may inadvertently trigger and necessitate working in larger co-authorship arrangements. Thus, highly productive researchers are more likely to work with more co-authors compared to less-productive researchers[4] .

Hypothesis 2: Papers authored by prolific researchers have more co-authors.

When researchers tackle research projects that are more substantive in nature, they may take on more co-authors simply to reduce individual work load. More substantive scientific contributions will plausibly require greater elucidation than less substantive contributions (LaBand & Piette, 1994), and, hence, more substantive papers may be longer than less substantive papers. Thus, a paper's length is commensurate with its assessed substantive contribution (Stremersch, Verniers, & Verhoef, 2007). Taken together, this means that the length of a research paper is indicative of its substantive contribution (Tams & Grover, 2010). Longer papers with greater substantive contribution have a greater need for information processing. Consequently, they require greater reliance on "more labor" that leads to a greater extent of co-authorship. Extending Laband and Tollison's (2000) arguments and Acedo et al.'s (2006) findings that suggest that the length of a paper is positively related to the incidence of co-authorship, we hypothesize that:

Hypothesis 3: Longer research papers have more co-authors.

[4] In contrast, Bayer and Smart (1991) describe '"low producers" in the academic field of chemistry as authors with less than ten publications during the first 25 years of their career. In their study, they found that a relatively high proportion of low producers' publications were single or dual-authored.

2.2 Co-authorship to Access Social Resources

Another rationale for co-authorship comes from the social resources theory (Lin, Ensel, & Vaughn, 1981). Lin et al. argue that, to fulfill their instrumental objectives, people (whom they refer to as ego) usually must cast a very wide social net. Thus, an ego's number and breadth of social contacts are important factors that determine whether the ego nets the metaphorical big fish (i.e., an ego comes in contact and maintains a tie with a social entity with access to instrumental resources). By using such a social strategy, the ego is more likely to form a tie with contacts in other functions (such as those in other academic fields or industry) and contacts at higher levels (such as high impact researchers or researchers with higher-ranking institutional positions) (Siebert, Kraimer, & Liden, 2001). Using the social resources theory as lens, we now present several hypotheses about co-authorship.

Forming ties with other functions, such as contacts in industry, is beneficial because heterogeneous functional groups can have different views, information, and unique resources. The information-processing view of organizations (Galbraith, 1974) implicitly acknowledges this fact when it proposes lateral or matrix designs and overlapping cross functional teams to aid information processing by using attributes such as differing perspectives, contrasting worldviews, and unique information inherent in these structures. In this vein, we can plausibly expect that a contact in industry who has access to unique information and resources (e.g., privileged access to meetings, strategy sessions, company data, or ability to assist or sanction field research) can become a very valuable social resource coveted by multiple egos. Thus, when at least one of a paper's co-authors is affiliated to a corporation or business firm, more individuals who covet access to unique resources and information will likely associate themselves with the research undertaking[5]. Hence, we hypothesize that:

Hypothesis 4: Papers that have at least one author from industry have more co-authors than papers in which all authors are from academia alone.

Forming ties at higher levels is also beneficial because it gives the ego access to information, material resources, and career sponsorship advantages. For example, researchers who have been active for a longer time or have produced more impactful work have more opportunities to build their networks, acquire greater knowledge and scientific and technical human capital, and have more experience with the collaboration process itself (Bozeman & Corley, 2004; Lee & Bozeman, 2005; Drenth, 1998). Additionally, they tend to be in higher positions of formal authority in academic and publishing institutions and may possess more formal power, influence, and control over resources (Massie, 1965; Weber, 1946). Contacts at a higher position in terms of years worked and research impact also have a broader perspective on relevant issues and greater access to information on which to base decisions (Galbraith, 1974; March & Simon, 1958). With the higher visibility, legitimacy, and social credentialing that associating oneself with such social contacts provides, an ego can also leverage such associations to advance their career (Burt, 1997; Lin, 1999; Katz & Martin, 1997). These attributes make social contacts in higher positions more coveted than those in lower positions. As a result, when at least one co-author is in a position at a higher level, more egos will likely associate themselves with the research undertaking[6]. Thus, we hypothesize that:

Hypothesis 5: Papers with highly experienced authors have more co-authors.

Hypothesis 6: Papers with high-impact authors have more co-authors.

2.3 Cost of Time: Opportunistic Co-authorship

Increasingly, researchers have found that academics' salaries have become more closely tied to publication output (Mittal, Feick, & Murshed, 2008; Miller, Taylor, & Bedeian, 2011) which has resulted in a paucity of available researchers and colleagues who are willing to provide input on research in the form of pre-submission review because they are likely to incur expenses in terms of the time that they spend on reviewing and providing feedback. In academic circles, the accepted remuneration for providing pre-

[5] Lee (2000) provides additional rationales for industry-academia collaborations in the pure sciences. Some of these rationales may be relevant for academics in business and social science (e.g., gaining insight into one's own academic research, supplemented funds, field testing research and acquiring practical knowledge, creating business opportunities, and creating internship opportunities for students).

[6] There is an additional rationale based on the purported seniority of the experienced and impactful author. As researchers tend to gain seniority, their activity profile changes and they take on more supervisory roles in research. In such situations, they often provide wisdom in positioning and shaping papers to teams of colleagues or students, which typically involves higher co-authorship.

submission review often takes the form of an acknowledgement. Depending on the researcher's social network and relationships, it is quite possible that some of them are still able to reward colleagues' effort with a mention in the acknowledgement footnote or perhaps offer to reciprocate with a pre-submission review in the future. On the other hand, when such remuneration arrangements are unlikely, it may be necessary to reward the increased cost of colleagues' time by offering co-authorship to elicit the level of effort required for a thorough review of the paper (Barnett, Ault, & Kaserman, 1988). Thus, co-authorship's extent may simply be determined by the extent to which it is possible to reward colleagues' effort through acknowledgements or by conferring authorship rights. Thus, we hypothesize that:

Hypothesis 7: Papers with more acknowledgments have fewer co-authors[7].

2.4 Convenience: Spatial Collocation

Authors collaborate because they are collocated in the same university or department and, thus, have valuable information processing resources in close proximity. Prior research shows that spatial proximity encourages collaboration because it is a means for researchers to engage in richer face-to-face communication that often leads to frequent informal communication and the exchange of tacit ideas (Allen, 1977; Kraut, Egido, & Galegher, 1988). While electronic tools such as Skype are mitigating this effect, we still believe spatial collocation facilitates co-authorship. Thus, we hypothesize that:

Hypothesis 8: Papers that are co-authored by two or more authors working in the same university have more co-authors than papers whose co-authors work in a different university.

3 Methodology

To test the hypotheses, we sampled papers from IS journals that met the following criteria: 1) they were in journals that represent quality academic research in the IS field, 2) they needed to include empirical and non-empirical papers on mainstream IS research topics, and 3) they needed to include all the information that we needed for our proposed measures (e.g., number of acknowledgements, author's institutional affiliation, etc.).

3.1 Journals and Sample

We focused on six major IS journals in the Senior Scholar's basket of eight top journals. Of these, four are from North America (*MIS Quarterly, Journal of Management Information Systems, Information Systems Research,* and *Journal of the Association for Information Systems*) and two are European journals (*European Journal of Information Systems* and *Journal of Strategic Information Systems*). The journals selected for our study fit the three aforementioned criteria. *MISQ*, *ISR*, *JMIS*, and *JAIS* have been cited in numerous prior research papers as North American outlets with a mainstream IS and management focus (Wilcocks, Whitley, & Avgerou, 2008; Galliers & Whitley, 2007; Straub & Anderson, 2010; Lowry et al., 2013). These journals have also consistently rated as the top-tier North American journals in numerous journal rankings (Rainer & Miller, 2005; Lowry, Karuga, & Richardson, 2007; Peffers & Ya, 2003; Mylonopoulos & Theoharakis, 2001). The same rankings have rated *EJIS* as the highest-ranked European journal (with an average of ninth place) and *JSIS* as the next highest-ranked European journal (which rankings have placed as high as 16th place) (Peffers & Ya, 2003). Lowry et al. (2013) rank both *JSIS* and *EJIS* comparably (composite ranking of 33 and 36). The sampled journals from the basket of eight journals also count as being among the most-cited IS journals in North America and Europe (Galliers & Whitley, 2007; Gallivan & Benbunan-Fich, 2007). Thus, we believe that the six journals represent "top (A-level) mainstream IS journals" (Lowry et al., 2013, p. 1005) and reasonably represent all IS research (Dwivedi & Kuljis, 2008; Lowry, Romans, & Curtis, 2004).

We used individual papers as the unit of analysis and included all empirical and non-empirical research papers dealing with macro- or micro-IS phenomena in our study. We did not include editorials, research commentaries, and state-of-the-field papers in our study. Additionally, since we deal with the extent of co-

[7] We argue that the presence of a statistically significant negative relationship between the number of acknowledgements and the extent of co-authorship indicates opportunistic co-authorship. Opportunistic co-authorship occurs when authors remunerate colleagues for providing pre-submission feedback by conferring authorship rights. As opportunistic co-authorship increases, the number of acknowledgements decreases and the extent of co-authorship increases. Thus, a negative relationship between the number of acknowledgements and the extent of co-authorship exists.

authorship, we included only papers with two or more authors. We sampled papers in the aforementioned six journals between 1994 and 2008 (2000-2008 for *JAIS*). Since papers authored by four or more authors are considerably rare, we included every such paper in our study and randomly selected only one out of every two papers with two or three authors. To alleviate the effect of heteroscedasticity, we recorded all papers with five or more authors as having four authors. From this process, we obtained a sample of 283 papers (44.1%) with two authors, 218 papers (34%) with three authors, and 140 papers (21.9%) with four or more authors for a total sample size of 641 papers. Our final sample comprised 158 papers that appeared in *MISQ*, 158 in *ISR*, 104 in *JMIS*, 47 in *JAIS*, 82 in *JSIS*, and 92 in *EJIS*.

3.2 Measures

We obtained the data for our measures from two sources. We obtained all variables except those pertaining to author characteristics (see Section 3.2.6) from the papers themselves. We obtained data on author characteristics by using Harzing's Publish or Perish software (version 4.0.10, available from http://www.harzing.com/pop.htm). We describe our data collection in detail below.

3.2.1 Type of Research

The first author analyzed the content of each paper to classify it as empirical or non-empirical. We used the classical scheme elaborated by Van Horn (1973) and used by others (Hamilton & Ives, 1982; Coviello & McAuley, 1999) to classify a paper as empirical if the research methodology it employed included a case study, field study, field experiment, or laboratory experiment. Additionally, we used the description provided in the methodological approach section (data collection method, sample size, sample frame, usable response rate, key informants, analytical approach, and time frame of the research) to corroborate the classification. We classified papers that met the above criteria as empirical and coded them as 1 for analysis. We classified papers that did not meet the above criteria as non-empirical and coded them as 0.

3.2.2 Papers' Length

To determine the length of each research paper, we first conducted a simple count of each paper's pages excluding the references and appendices. We then normalized the page count to account for the differences in the average length of papers in each journal. As journal policies regarding papers' length can change from one year to another, we also normalized the page count by publication year. Thus, we normalized the measure used for papers' length by publication outlet and publication year[8].

3.2.3 Industry and Academia Collaboration

To determine industry-academia collaboration, we scanned each author's institutional affiliation as it appeared on the first page of each paper. We coded a paper as 1 when at least one author's institutional affiliation listed a corporation or business organization. We coded industry-academia collaboration as 0 when there was no heterogeneity in institutional affiliation (i.e., all authors were either from an academic institution or a business organization) among authors. As a side note, our sample did not include any paper in which all authors had an industry affiliation alone.

3.2.4 Spatial Collocation

To determine the spatial collocation, we counted the number of authors with shared institutional affiliations. We then divided this number by the total number of authors listed in the paper. Using this scheme, when none of the listed authors shared institutional affiliation, we coded the spatial collocation as 0. When all the authors were listed with the same institutional affiliation, we coded the spatial collocation as 1. This measurement scheme raises an interesting problem when, for instance, two authors are listed as being affiliated to one institution and the other two are listed as being affiliated to a second institution. In such instances, in the interest of making the output more interpretable, we calculated spatial collocation as 1. Again, this calculation uses the rationale stated above (i.e., the number of authors with shared institutional affiliation divided by the total number of authors). Since each author in our example had at least one co-author that was affiliated to the same institution, we calculated spatial collocation as the

[8] While these journals have page limits, we still observed a wide variance in papers' length. Tams and Grover (2010) indicate that journals often handle page limits very flexibly and do not appear to limit the study of the relationship between papers' length and impact.

division of 4 (number of authors with shared institutional affiliation) by 4 (total number of authors) and equals 1. The values for spatial collocation vary from a minimum value of 0 to a maximum value of 1.

3.2.5 Acknowledgements

To determine the number of acknowledgements, we simply counted the number of people listed in papers' acknowledgments section. We did not include acknowledgements to the journal's senior editor, associate editor, and anonymous reviewers in this count[9].

3.2.6 Variables Pertaining to the Characteristics of Co-Authors

To measure the antecedents of the extent of co-authorship, we had to measure some of our independent variables at a time before a paper's publication. Since we wanted to capture the particular factors that lead to the decision to extend or constrain the extent of co-authorship, the independent variables should, ideally, be captured at a stage of research when these decisions are made by the participants of a research paper. However, it is difficult to pinpoint exactly when these decisions are made. In the case of some research papers, these decisions may be made at a very early stage when authors are simply exchanging tacit ideas among themselves. In other instances, the decision to include co-authors may be made much later based on availability or the need for specialized knowledge and data-collection abilities. Thus, the extent of co-authorship could be decided at any time between the genesis of the research idea and its eventual publication.

Whereas collaborating authors may tacitly acknowledge the extent of co-authorship and authorship credit while working on the manuscript, the first instance when it is formally acknowledged occurs while submitting the manuscript to a journal. For this reason, we used the month and year of submission as the event date for collecting bibliographic data regarding the listed authors. *EJIS* and *ISR* publish the month and year of each paper that is published as a footnote on the first page. For papers in these journals, we used the published submission month and year to collect author bibliographic data.

In contrast to *EJIS* and *ISR*, papers appearing in the remaining journals in our sample did not publish the month and year of manuscript submission. To estimate the event date for these papers, we used statistics on publication delay and the typical time taken by the review process for top IS journals that Bhattacharjee, Tung, and Pathak (2004) report. For instance, Bhattacharjee et al. (2004) report that manuscripts accepted at *MISQ* went through an average of 2.63 rounds of review. This number implies that a large majority of the accepted manuscripts at *MISQ* went through at least two rounds. The average value of 2.63 also suggests that many of the manuscripts that went through two rounds of review also underwent a third round of review. Justifiably, for the purpose of our estimation, we assumed that accepted manuscripts at *MISQ* went through three rounds of review. Bhattacharjee et al. also report the average time that each round took. The corresponding figures for *MISQ* were 4.9 months in the first round, 4.6 months in the second round, and 3.3 months in the third round for a total of approximately 13 months in the review process. Additionally, the average publication delay reported by the study was 6.7 months. Thus, the total time elapsed between submission of manuscript and publication was twenty months or nearly two years. Thus, for the papers appearing in *MISQ*, we predated the submission event date by two years from the month and year of each paper's publication. Using the same method, we estimated the submission event date for *JMIS* (18 months), *JAIS* (15 months), and *JSIS* (2 years).

To collect author-related bibliographical information for the remaining independent variables, we used Harzing's Publish or Perish software (version 4.0.10 available from http://www.harzing.com/pop.htm). To refine author searches using the software, we used the prescriptions provided in the accompanying online documentation (Harzing, 2013, Chapter 3.2.1). To mitigate the effect of record duplication for a given author, we took the following steps. First, we used the author's full name as our search parameter (e.g. "John Doe" instead of "J. Doe"). Where applicable, we conducted the search using the author's middle

[9] For example, for the following acknowledgment section, we coded the acknowledgement variable as 0: "The authors thank the Senior Editor, the Associate Editor, and the anonymous reviewers for their helpful comments, which significantly enhanced the quality of the manuscript.".
In contrast, we coded the following section as 2: "The authors are grateful for comments and suggestions offered by John Doe and Jane Doe on previous drafts of this paper. The authors would also like to express gratitude to the anonymous reviewers, the Associate Editor, and the Senior Editor for their numerous suggestions and constructive criticism of earlier versions of this paper.".

name or initial. Second, we limited our search of author citations to the fields of business, computer, and social sciences. Third, in cases where the search involved authors with widely prevalent last names (e.g. Smith, Johnson, Williams, Jones, etc.), we randomly checked the author's full name and university affiliation by accessing the biographical (first) page of the journal paper in the citation record. We excluded all records that did not match the expected first name/middle initial or university affiliation from our dataset. Finally, we excluded authors (and, by extension, papers with such authors) with more than 450 papers from our analysis. We collected bibliographic data prior to the event date for each of the listed authors that met the above criteria. The variables we describe below used data that we collected using the Publish or Perish software.

Table 1. Summary of Measures

Attribute	Variable	Measure
Dependent Variable	Extent of co-authorship	Simple count of the total authors listed in a paper minus 1.
IV: Co-authorship as a resource for information processing	Type of paper	Binary variable coded as 0 for non-empirical studies and 1 for empirical studies.
	Papers with prolific researchers	Average papers published per year by each author. Assigned variable the maximum average value.
	Length of paper	Simple count of number of pages in a paper not including the references.
IV: Co-authorship for accessing social resources	Industry-academia collaboration	Binary variable coded as 1 when the institutional affiliation of at least 1 author was listed as a corporation or business organization. Coded 0 if no industry academia heterogeneity.
	Papers with experienced researchers	The maximum value of the years since first publication among all listed authors.
	Papers with high-impact researchers	Maximum h-index among all the listed authors.
IV: Opportunistic co-authorship	Acknowledgements	Simple count of the number of people acknowledged in the acknowledgements section.
IV: Convenience	Spatial collocation	The number of authors with shared institutional affiliations divided by the total number of authors listed in the paper.
Control variables	Year of publication	4 digit year of publication.
	Type of issue	Coded as 0 for regular issue and 1 for special issue.
	Journal	Coded as 0 for *MISQ*, “1” for *ISR*, 2 for *JMIS*, 3 for *JAIS*, 4 for *JSIS*, and 5 for *EJIS*
	Presence of researchers with no publications	Binary variable where we coded papers that had a researcher with no publications as "1"; "0" otherwise.

3.2.7 Papers with Prolific Researchers

To measure the magnitude of productivity of the most prolific researcher among the listed authors, we calculated the average papers published per year by each author. We assigned the maximum value to the variable for prolific researcher.

3.2.8 Papers with Experienced Researchers

To assign a value for our variable on researcher experience, we first collected information on the number of years since first publication for each of the listed authors. Our variable was then assigned the highest numerical value. This value represents the academic experience of the most experienced researcher among the authors listed in the journal paper.

3.2.9 Papers with High-impact Authors

We measured this variable by using the maximum h-index among all the listed authors. This index is widely acknowledged as an important metric of a scientist's impact.

3.2.10 Control Variables

We coded year of publication simply as the year in which the paper was published. We coded the journal outlet based on Lowry et al.'s (2013) composite journal rankings: 0 for *MISQ*, 1 for *ISR*, 2 for *JMIS*, 3 for *JAIS*, 4 for *JSIS*, and 5 for *EJIS*. We coded the type of issue as 0 for regular issue and 1 for special issue. Since some journal publications arise from doctoral dissertations where it is common practice to include committee chairs as co-authors, such papers likely have a greater extent of co-authorship. To control for this effect, we coded such papers using a binary variable. When a paper had a researcher with no publications, we coded it as 1; otherwise, we coded it as 0. We concede that a researcher with no publications might not necessarily be a doctoral student and might instead be an inexperienced co-author. However, without a more finely tuned measure, this distinction is difficult to make. Rather, our gross measure is just as effective in controlling the effects of alternate explanations and in increasing the validity of the explanations proposed in this study (i.e., to demonstrate the statistical significance of our explanatory variables in spite of the inclusion of the no publications control variable).

3.3 Analysis

We used ordinary least squares (OLS) regression to analyze the data. We excluded rows with missing values from the OLS regression analysis. Prior to regression analysis, we conducted diagnostic tests to reveal the presence of any unusual or influential data and to test whether the data met the assumptions of linear regression. To reveal the presence of predictors with unusually high leverage, we saved the studentized deleted residual values after running the OLS regression model. The studentized deleted residual is the residual that would be obtained if the regression was re-run omitting that observation from the analysis. We plotted the studentized residuals on a histogram: we removed all observations that were more than three standard deviations away from the mean from further analysis (Rousseeuw & Van Zomeren, 1990). We used Cook's D values to get an overall measure of influence. The higher the Cook's D value, the more influential the case is. We dropped all data points with a Cook's D value above the conventional cutoff point of 4/n (Cook, 1977; Rousseeuw & Van Zomeren, 1990; Leroy & Rousseeuw, 1987), where n is the size of our sample, from further analysis. As a result, we dropped a total of eight cases, which left the final sample size at 633. We used the Kolmogorov-Smirnov test to test for the normality of residuals. This test was not significant, meaning that the residuals were normally distributed. We checked the assumption of homoscedasticity by plotting a graph of predicted values versus the standardized residuals. We did not observe any pattern (widening or narrowing of the residual distribution depending on the predicted value) that indicated the presence of heteroscedasticity.

4 Results

Table 2 shows the descriptive statistics and correlations of the variables in our study. Table 3 shows the results of the regression analysis. To test for multicollinearity, we observed the collinearity statistics of variance inflation factor (VIF) and tolerance. There were no tolerances below 0.82 and no VIF's above 1.22. This indicates that there were no multicollinearity problems and the independent variables were mostly unrelated.

As Table 3 shows, we found support for all three hypotheses related to the information-processing rationale of co-authorship. Positive unstandardized coefficients for type of paper (B = 0.157***, SR^2 = 0.008), prolific researchers (B = 0.061***, SR^2 =0.06), and papers' length (B = 0.134***, SR^2 = 0.024) provide support for an information-processing driven motive for co-authoring research papers. We found support for two out of the three hypotheses concerning co-authorship and social resources with the strongest support being for industry-academia collaboration (B = 0.528***, SR^2 = 0.06). Papers with experienced researchers had more co-authors (B = 0.008***, SR^2 = 0.024), but the data for papers with high-impact researchers was not supported. We did not find any support for the opportunistic rationale for co-authorship. Finally, we found statistically significant support for spatial collocation as a predictor of the extent of co-authorship (B = 0.562***, SR^2 = 0.066). Table 4 summarizes our data's support for our hypotheses.

Table 2. Means, Standard Deviations, and Correlations of Study Variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Type of paper	1											
2. Prolific researchers	<0.01	1										
3. Paper length	-0.07	-0.06	1									
4. Industry-academia collaboration	-0.05	-0.05	0.13*	1								
5. Experienced researchers	-0.09*	-0.12*	0.01	-0.09*	1							
6. High-impact researchers	-0.09*	0.04	0.04	<0.01	0.04	1						
7. Acknowledgements	-0.08	0.02	0.05	0.03	-0.02	0.13*	1					
8. Spatial collocation	0.01	0.08*	0.04	-0.01	-0.08	-0.09*	-0.08*	1				
9. Type of issue	0.23*	-0.11	-0.09*	0.08	-0.14	0.10*	-0.08*	0.12*	1			
10. Journal	0.02	-0.01	<0.01	-0.07*	0.07	-0.25*	-0.17*	-0.01	-0.06	1		
11. No publication researchers	0.12*	0.01	0.01	0.07	-0.23*	-0,23*	-0.12*	0.26**	0.10*	0.04	1	
12. Number of authors	0.10*	0.23**	0.18*	0.27**	-0.01	0.02	-0.04	0.36**	0.08*	-0.11*	0.35**	1
Mean	0.57	3.21	0.01	0.18	25.94	15.99	1.92	0.27	0.91	2.75	0.32	2.78
Std. Dev.	0.49	3.29	0.94	0.38	15.56	13.30	2.31	0.38	0.31	1.95	0.46	0.79

Note: * and ** indicate significance at the 0.05 and 0.01 levels, respectively

Table 3. Result of Regression Analysis (Slopes, Standard Error, and Significance)

Attribute	Variable	B	Std. Error	t-value	Semi-partial R^2	Tolerance	VIF
Co-authorship as a resource for information processing	Type of paper	0.157	0.053	2.984***	0.008	0.916	1.092
	Papers with prolific researchers	0.061	0.008	7.805***	0.060	0.950	1.052
	Length of paper	0.134	0.027	4.987***	0.024	0.957	1.045
Co-authorship for accessing social resources	Industry-academia collaboration	0.528	0.067	7.822***	0.060	0.942	1.062
	Papers with experienced researchers	0.008	0.002	4.939***	0.024	0.896	1.116
	Papers with high impact researchers	0.002	0.002	1.032	0.001	0.849	1.178
Opportunistic co-authorship	Acknowledgements	-0.005	0.011	-0.444	<0.001	0.934	1.070
Convenience	Spatial collocation	0.562	0.069	8.168***	0.066	0.897	1.114
Control Variables	Year of publication	-0.007	0.007	-1.023	0.001	0.915	1.092
	Type of issue	0.095	0.084	1.138	0.001	0.873	1.145
	Journal	-0.039	0.014	-2.884***	0.008	0.879	1.138
	Presence of researchers with no publications	0.503	0.059	8.523***	0.071	0.821	1.217

Note: *, ** and *** indicate significance at the 0.05, 0.01 and 0.001 levels, respectively.

Table 4. Summary of Support Provided for the Hypotheses

Attribute	Hypothesis	Support provided
Co-authorship for information processing	H1: Empirical research has more co-authors compared to non-empirical research.	Supported***
	H2: Papers authored by prolific researchers have more co-authors.	Supported***
	H3: Longer research papers have more co-authors.	Supported***
Co-authorship for accessing social resources	H4: Papers that have at least one author from industry have more co-authors than papers in which all authors are from academia alone.	Supported***
	H5: Papers with highly experienced authors have more co-authors.	Supported***
	H6: Papers with high-impact authors have more co-authors.	Not supported
Opportunistic co-authorship	H7: Papers with more acknowledgments have fewer co-authors.	Not supported
Convenience	H8: Papers that are co-authored by two or more authors working in the same university have more co-authors than papers whose co-authors work in a different university.	Supported***
Note: *, ** and *** indicate significance at the 0.05, 0.01 and 0.001 levels, respectively.		

5 Discussion and Implications

In this paper, we present four broad reasons for why researchers' co-author papers with many of their peers. We suggest that co-authorship is an adaptation mechanism that researchers use to address the challenges that each of our four rationales present. Tying specific rationales to the extent of co-authorship not only shows the kind of social interactions we value as a field but also provides legitimate empirically validated evidence for why researchers work in increasingly larger teams.

Our first rationale uses the information-processing view to explain the increasing extent of co-authorship. The fact that we found support for all three of our hypotheses suggests that researchers may be using the information-processing benefits of co-authorship as an adaptation strategy to achieve publication success. Getting accepted in quality journals can be broadly classified as depending on the substantive and methodological contributions that one's paper makes to IS research. Substantive contributions include factors such as the research theme's popularity, whether the basic idea is exciting (novelty), research questions' significance, sufficient use or development of native and referent theories, coverage of key literature, and, to a certain extent, how well it navigates the extant theoretical landscape to carve a niche or extend the theory without contradicting the work of major "movers and shakers" (Straub, 2009). Methodological contributions include such things as novelty of the sample, a novel design, and novel statistical/analytical techniques (Straub, 2009).

Support for our first hypothesis suggests that the information-processing inputs for empirical papers include a broad repertoire of capabilities that are often not found in one person. For instance, good abstract thinkers who can formulate tight conceptual theoretical arguments have very different skills from those who are analytical and can play with data and statistics. Further, access to data and data collection may be another exclusive skill set. Hence, as our first hypothesis suggests, the diversity of skills required in empirical pieces could benefit from greater extent of co-authorship. Our own experience indicates that "experts" in certain methodologies are often solicited for their specialized skills. On the other hand, non-empirical work (e.g., theory and review papers, among others) could also be complex, but the diversity of skill requirement or the breadth of information processing is relatively limited. Admittedly, our measure is gross, and we cannot derive fine-tuned implications, but it provides, at a minimum, some evidence suggesting that the nature of research is related to the extent of co-authorship. Future work could parse this further and examine whether specialized or novel methods enhance co-authorship.

Support for our second hypothesis indicates that highly productive researchers work in more co-authorship arrangements with multiple peers, which allows them to diversify the risk in publication by participating in a broader portfolio of projects. This result raises an interesting question regarding causal agency. Do productive authors tend to have co-authorship arrangements because they are solicited in

such arrangements or does their participation in co-authorship actually influence their productivity? We suspect both agencies are at play. The other implication of this finding pertains to how researchers should approach their publishing strategy. Should they specialize in niche methodologies to increase their involvement in multiple research papers? This practice would indicate an approach to publishing where a researcher with expertise in modeling or content analysis provides only methodological (specialist) input in co-authored papers. Further research could provide evidence for the specialization view of science in which researchers increasingly focus on niche areas to provide expertise and input while conducting research. In an environment where specialization thrives, should the extent of co-authorship be held against a researcher during the tenure and promotion review process, especially when such a strategy is deemed as a valid adaptation strategy in an increasingly specialized field (c.f. Fleischman & Schuele, 2009, p. 301)? Support for our third hypothesis regarding page length and extent of co-authorship implies that researchers in IS use co-authorship as an adaptation strategy for making substantive contributions. More authors can have greater capacity to handle projects of more substantive scope, which increases their likelihood of acceptance in top journals.

Taken together, the significance of our results harkens to the increasing stock of knowledge in the IS field and the increasing complexity of IS phenomena being studied by researchers as factors that necessitate a greater extent of co-authorship. As the IS field matures, the wide repertoire of native and referent theories, methodological variety, and evolving data-analysis techniques make it incumbent on researchers to engage and interact with researchers who possess specialized skill sets. Likewise, the increasing complexity of the IS phenomena being studied necessitates a wider perspective that encompasses the viewpoints of multiple researchers and numerous paradigms. The resulting vast, often conflicting explanation of the substantive phenomena being studied may require greater information processing and reliance on numerous co-authors to translate the research into a journal-quality submission. Increasing information processing can also be a product of the changing institutional nature of the IS field. Although, we did not explicitly measure it, we can see the pressure to publish as a catalyst for researchers who then respond by increasing their research productivity by co-authoring more frequently and with many other researchers. Thus, we can see increasing information processing by co-authoring papers as a plausible strategy that authors can use to propitiate some of the challenges of conducting high-quality IS research.

Our second rationale uses the social resources perspective to elucidate how access to vestiges of social resources motivates co-authorship. The strong support for industry-academia collaboration lends credence to the fact that access to organizational information, actors, social context, and insights is indeed a valuable resource that makes the provider of such information a valuable social tie. Our findings indicate that such collaborations lead to a higher extent of co-authorship. This finding suggests that the IS field values such collaborations. Collaboration between industry practitioners and academicians is healthy for the field because "all information systems studies are contextual; they address issues of technology implementation and use within organizations rather than in a laboratory setting" (Avgerou, 2001, p. 11). Thus, studying the role of technology as a social system, the socio-technical link (Land & Hirschheim, 1983; Kling, 1980), in its social context, has been crucial for the theoretical and methodological sophistication of IS research since the 1990s (Hirschheim, Klein, & Lyytinen, 1996). Additionally, due to the influence of socio-technical theoretical ideas such as the duality of technology and structurational analysis (Orlikowski, 1992), actor networks (Law & Callon, 1992), and social constructionism (Grint & Woolgar, 1997), industry-academia collaboration carries great value not only in micro-level (individual level) IS research but also macro-level (group, firm, industry level) research. In some circumstances, industry-academia collaborations may simply be unavoidable, such as while studying phenomena involving access to unique or expensive technology (such as ERP) and while studying phenomena in field settings (e.g., interactions of employees in an office environment). Additionally, such collaborations are often indispensible for researchers aiming to bridge the gap between research and practice (Zmud & Price, 1998). In this context, our finding suggests that greater extent of co-authorship is a necessary property of collaborative work involving industry phenomena. Our findings corroborate findings from bibliographic research in other academic fields (c.f. Pechter & Kakinuma, 1999; Butcher & Jeffrey, 2005).

Table 5. Implications for Researchers and the Field

Significant result	Implication for researchers	Implication for field administrators/policy makers
• Empirical papers and longer more substantive papers require more authors. • Prolific researchers collaborated with more co-authors than less prolific researchers.	• Increasing extent of co-authorship can enable researchers to pool diverse skills and produce empirical or substantive papers in A-level IS outlets. • Risk-averse researchers may find it more fruitful to work with multiple co-authors to sustain publication success. • Vice versa, productive researchers can use the information-processing capabilities of larger teams to augment individual productivity.	• Policy makers should be cognizant that research attributes such as the nature of research and the substantive contribution of research dictate the extent of co-authorship and apply collaboration discount accordingly. • The pressure to publish may necessitate increasing the extent of co-authorship for achieving an acceptable level of publication success in A-level IS journals. Thus, institutions requiring higher productivity as a criteria for tenure or promotion should consider relaxing the application of collaboration discount while evaluating candidacy.
• There is evidence of a greater extent of co-authorship when research involves industry academia phenomena • There is evidence of a greater extent of co-authorship when research involves senior experienced researchers.	• Awarding authorship to industry collaborators appears to be a normatively accepted practice in IS research. In so far as the industry contact values such credit, academic researchers can use it as an incentive to obtain support from industry practitioners. •	• Greater extent of co-authorship is a necessary property of collaborative work involving industry phenomena. Discounting co-authored work may be detrimental for future industry-academia research. • There is evidence that senior researchers work in larger teams. This may be either as a result of engaging in more managerial or mentoring facets of collaborative research or as an adaptation to counter the gradual obsolescence of research skills.
• Researchers located in the same university/department tend to work in larger teams.	• Young researchers entering the academic job market will serve themselves well to carefully appraise the research portfolio of academic faculty in prospective universities. • As spatially close collaboration involves larger teams, a more diverse portfolio can indicate possibilities for broader, multi-domain, exploratory research. A narrower research portfolio may indicate future possibilities for incremental and exploitative research.	• Since spatially near collaboration involves larger teams, administrators involved in academic hires would do well to carefully assess how their hiring practice renders the composition of departmental faculty (i.e. whether the composition facilitates narrow (exploitative), broad (exploratory), empirical, theoretical, or practice-oriented research among departmental faculty).

The significant statistical support for our hypothesis linking greater researcher experience to greater extent of co-authorship suggests that access to researchers at more senior levels is a valid reason to co-author papers with them. These results suggest an adaptation strategy that is beneficial both while the research is being conducted and after the research is conducted. First, access to resources and information while conducting the research can be a primary driving factor. Co-authors at higher levels are more likely to be in administrative positions in universities and to have more networking experience with peers in academia and industry. Thus, while conducting research, an ego is more likely to obtain access to software (e.g., expensive data-analysis software) and data (e.g., sponsorship for a paid online survey) if they work with contacts at higher levels. Those with greater research experience are also likely to have more experience working with multiple co-authors and can, thus, be more adept at managing the research process more smoothly. Leveraging an experienced researcher's network can be also beneficial while soliciting pre-submission reviews. Thus, researchers can use working with co-authors at higher levels as an adaptation strategy to ameliorate multiple issues that can arise while conducting research. At the same time, when it is time to send the work to journals for publication, researchers with greater experience can provide invaluable input in selecting the right journal outlet. Many journal outlets such as *MIS Quarterly*

also solicit researchers' input (usually in the cover letter) to nominate senior reviewers that are well versed in a paper's topic. Researchers at higher level can provide valuable input in making these decisions.

Surprisingly, we did not find any statistically significant support tying high impact-researchers to the extent of co-authorship. One way of interpreting this finding is that, as a field, we do not value the input of high-impact researchers. However, such an interpretation sounds unlikely, and so an alternate explanation could be to contrast this finding with that of productive and experienced researchers. Productivity and experience are valued skills solicited by co-authors since they pertain to the ability to help in getting a manuscript published. High-impact researchers are cited and arguably possess an ability to make substantive or methodological contributions. Therefore, their co-authorship behavior may vary significantly as they may make their contribution alone, with small groups, or with larger groups. Thus, the lack of a statistically significant result between the presence of high-impact researchers and the extent of co-authorship may be attributed to the possibility that high-impact researchers are equally likely to work in big, medium, or small groups.

We did not find statistically significant results for our cost of time/opportunistic rationale. This result is significant by itself. Consider the alternative. A significant negative correlation between the number of acknowledgements and the extent of co-authorship would have confirmed our belief that co-authorship is used as a mode of remuneration for pre-submission feedback and reviews. While such feedback necessitates a substantial amount of time investment by the providing researcher, remuneration for such efforts with co-authorship is wrought with ethical dilemmas and can encourage opportunistic behavior. Our statistically insignificant results suggest that such is not the case in IS research. Rather, an optimistic appraisal of the situation suggests that IS researchers provide earnest feedback and that no established normative practice of giving authorship credit where credit is not due exists.

Our fourth rationale argues that, when researchers are located in the same university (spatially collocated researchers), they tend to collaborate with one another in bigger groups. Thus, research papers born out of such collaborations tend to have more co-authors than research papers whose collaborators work in different universities. We attribute this increase in extent of co-authorship to the availability of the richest media for interaction; namely, face-to-face interaction. The preference for spatial proximity has also been noted in economics where Hamermesh and Oster (2002) found reticence among researchers to engage in distant collaboration because they were less productive than spatially proximal or collocated collaboration. While the result of our study is fairly apparent, it holds in the context of an increasing array of information technologies that allow such rich synchronous one-to-one and even many-to-many communication. However, one question arises about this finding's sustainability: at some point, will spatial proximity not matter?

From a policy perspective, our results provide valuable insight into reasons for why researchers collaborate. In IS, collaboration increases in empirical work, with productive researchers, on longer and more substantive papers, with practitioners or researchers that have experience but not necessarily impact, and with co-authors that are in physical proximity. We argue through our various rationales that the extent of co-authorship is sometimes a necessary response to the changing environment of research or to gain valuable resources. In other instances, the extent of co-authorship results from the access provided by spatial collocation. These insights can be useful for institutional administrators when deciding whether or not to discount the contribution of researchers in co-authored work. For instance, our results suggest that empirical research is typically conducted with more co-authors than non-empirical research, and we argue that this is a necessary adaptation to higher information-processing needs of such research. This finding provides evidence to counter policies that discount the contribution of a researcher in multi-authored work. Our finding that spatial proximity results in large collaborative teams provides fodder for thought for administrators involved in faculty hiring decisions. Because larger collaborations occur in departments, what should the composition of departmental faculty be? On the one hand, departments composed of heterogeneous content specialists (e.g., strategic IS, behavioral studies in IS, social media, business analytics, etc.) can engage in richer theoretical formulations and impactful research. On the other hand, departments with faculty that have a mix of content and method specialists may become breeding grounds for more impactful empirical research.

6 Limitations

Our research has several limitations that we need to mention in the hope that future research can mitigate their effect. We used citation analyses as our method to study the extent of co-authorship in IS research. We believe that our approach using archival data was adequate for our investigation on the relationship between rationales for co-authoring papers and the extent of co-authorship[10]. Using scientometric methodology has numerous advantages such as verifiability, stability over time, data availability, and ease of measurement (Katz & Martin, 1997). However, this approach also limits the substantive versatility of the implications that can be derived (at least not without severely compromising the internal validity of the study). Thus, for instance, while we can hypothesize regarding the effect of spatial proximity on co-authorship, we cannot unveil the much richer evolution of such collaboration from informal conversations to more formal collaborative arrangements.

We sampled papers from six major journals in North America and Europe, which places some limitations on our findings' generalizability. First, our sample of journals limits our ability to make any arguments regarding the quality of the work produced and testing whether it drives co-authorship beyond the top-two tiers of IS journals. Further research should take a more comprehensive sample of papers from multiple tiers of IS journals and use published quality rankings of journals to include a quality hypothesis in co-authorship research. Second, while our sampled journals represent top-quality research by researchers in the IS field, positivistic research is represented more than others such as interpretive and other post-positivistic ontologies. Thus, our research's implications apply more to the positivistic tradition of IS research. Third, authors' institutional affiliations listed on the research papers indicate that the research contributions contained therein arise largely from those in North America, Europe, Australia, and, to some extent, regions in Asia such as China, India, and South Korea. Research from other regions is under represented where different traditions or target audiences may govern IS research.

Our use of citation data in our study has two limitations. First, self-citations can inflate the H-index metric. However, we chose not to eliminate self-citations because evidence shows that doing so would have little effect on the final results (Gottfredson, 1978) and would not be commensurate with the effort expended on removing self-citations. Second, in spite of using numerous precautions to eliminate authors with similar names, it is difficult to eliminate false hits using citation software. To reduce the adverse effects of H-index inflation, we narrowed our search parameters by limiting an author's citations to the fields of business, computer, and social sciences. While, this provides a more manageable avenue for conducting our research, the result is an under-inflation of the H-index. Whereas the overall inflationary and deflationary effects on the H-index are cancelled out, we advise researchers to be cognizant of this methodological caveat while using some of our methods in their research.

7 Conclusion

We started this research with a simple question: "why do researchers in IS collaborate with more researchers?". This question was not that pertinent several years ago since social scientists tended to work in much smaller groups than their pure science counterparts. This situation has changed. The growing co-authorship in our field could reflect a changing environment, institutional pressures to publish, need for access to resources, growing diversity of methods, complexity of phenomenon, opportunism, and a myriad of other reasons. The study reported in this paper takes a first step in addressing this question. Our findings suggest that information processing, access to social capital, and convenience are broad rationales for collaboration. Future work can further refine these findings to deal with important policy and evaluative questions regarding collaborative work in IS.

[10] We strongly considered using the survey methodology for this study. However, we believe that citation analysis affords several advantages compared to survey methodology. First, we felt it would be difficult for respondents to precisely recall why they collaborated with more co-authors (e.g., three co-authors instead of two). We feel that the survey methodology would be more appropriate for investigations contrasting collaboration versus solo-authoring papers. Second, using the survey methodology, we felt, would lead to respondents providing an aggregate (possibly speculative) assessment of their co-authorship rationales. Finally, citation analysis provides access to a large verifiable sample.

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