proportion of IDG users among one's communication partners, the higher the probability of one's own IDG use. This might be an effect of social influences via networks [20, 26] or it might be that researchers' IDG use is stimulated by a 'critical mass' of large enough numbers of colleagues who use it [27]. Whatever the causal direction and the exact mechanism, to some extent the use of IDGs is mediated through the researcher's social networks. As a third point, the effects of the other theoretically interesting variables, namely CMC use, software knowledge, and commercialization are not significant. Moreover, none of the other control variables including the concern for being anticipated has a significant effect.

To assess whether the found effects might be due to unobserved disciplinary heterogeneities the analysis additionally includes dummy-variables for the disciplines, as shown in Model 3. Two results are most important. Firstly, the results with respect to the variables included in Model 2 hardly change. Secondly, the explanatory and control variables leave a large amount of disciplinary differences in the prevalence of IDG use unexplained. Five of the seven dummy variables that indicate the difference in the prevalence of IDG use, compared to IDG use in physics, are still significant. Researchers in management science, economics, mechanical engineering, mathematics, and sociology use IDGs more often than researchers in physics, even when disciplinary differences with regard to the concentration of communication channels, to the degree of interdependence and to social network influences in addition to other individual differences are controlled.

The evidence for the hypothesis about differential communication needs supports the idea that an incentive for the use of IDGs is the hope of receiving information that facilitates obtaining an overview of research areas that are otherwise difficult to oversee. However, the hypothesis and the data leave open the question of whether such information is really given to the researchers in a satisfactory manner. Rather, it underlines the communication deficiencies that exist in some research areas.

It would be interesting to find out whether the hypothesis can not only explain whether researchers ever started to use an IDG, as the analyses of Table 4 showed, but also whether they continue to use them. Table 5 shows the results of a multiple logistic regression on the probability of being a *current* IDG user. Current IDG users are a sub-group of those who ever started to use an IDG.

Two results are most notable. Firstly, the dispersion of communication channels does not have a statistically significant effect ($p>0.10$) on the probability of being a current IDG user when controlled for a number of other influencing factors. Secondly, the degree of interdependence is negatively associated with being a current IDG user ($p<0.01$).

The results presented in tables 3-5 make the following clear. The predictions with regard to the effects of commercial relevance, interdependence, and the compatibility between working routines and CMC use are not supported by the data. That is, hypothesis 2 on problems of trust and hypotheses 3 and 4 about differential communication needs are not supported. Moreover, it is not true that researchers in fields with a larger dispersion of communication channels tend to avoid using IDGs. As a consequence, hypothesis 1 on problems of trust does not find support either.

However, researchers in fields with a low degree of visibility, that is a high dispersion of communication channels (journals), have incentives to start using an IDG because they hope to obtain orienting information, as predicted by hypothesis 5. The positive association between the dispersion of communication channels and initial IDG use remains significant in all uni- and multivariate analyses, which strongly supports hypothesis 5 about differential communication needs.

At the same time, these researchers do not necessarily continue with their use of IDGs. It may either be the case that the information benefits are not large enough or that the costs of use are too high for some of the researchers who were initially motivated to start using IDGs. This interpretation is in accordance with other findings that show that the most prevalent benefits of IDGs are contact benefits, although some information benefits also are received [11]. Moreover, the data reveal a negative association between the degree of interdependence and IDG use, contrary to what is expected in the literature. For this unexpected finding I offer the

JIS-0805-v3 Received: 15th August 2009 Revised: 25th January 2009

following potential explanation.[10] IDGs often include many members and it is likely that in academic IDGs researchers communicate with a large number of people to whom they are only weakly related. Even researchers whose work is highly interdependent may experience the interdependence only with a limited number of other researchers so that IDGs might not offer much of the coordination benefits that hypothesis 3 supposes. Furthermore, a higher degree of interdependence tends to increase coordination difficulties [28]. Also, it tends to come along with a larger number of group meetings [29], resulting in more work interruptions and a higher burden of communication and coordination efforts. It might be that under such conditions any additional informal email communication via IDGs is too much. The findings of Talja, Savolainen, and Maula [30] suggest that researchers can experience communication in emailing lists in some phases of their research as disturbing. Future research has to test this potential explanation in detail.

Table 5: multiple logistic regression of being a current IDG user (n=409)

Variable	B	S.E.
Commercialization	-.04	.09
Interdependence	-.52**	.19
Dispersion of communication channels	.17	.16
CMC use	.20	.17
Software knowledge	.01	.12
Control variables		
PC attitude	.23	.18
Department Rank	-.25	.30
Conferences	.08	.06
Competition	.01	.15
Papers	-.01	.05
Network control variables		
Proportion of IDG users among one's external communication partners	2.49***	.51
Number of departmental colleagues using IDGs	.19***	.05
Other disciplinary heterogeneities[+]		
Management Science	2.97***	.80
Chemistry	1.77*	.84
Economics	2.92***	.81
History	2.11**	.84
Mathematics	1.92**	.81
Mechanical Engineering	2.80***	.87
Sociology	2.81***	.79

Model-χ^2=144.096, df=19, p=.0000, n=409, , Nagelkerke's R^2=0.42, Constant not shown, +:Physics as the baseline category

*: p< 0.05 level (1-tailed). **: p< 0.01 level (1-tailed). ***: p<0.001 (1-tailed)

10 Fry & Talja [8] suggest that researchers in fields with low interdependency would use IDGs to overcome their intellectual and social isolation. This is not completely supported by the data. The presented tables show that Fry & Talja [8] are right in claiming that lower interdependence comes along with a higher likelihood of using IDGs. However, this cannot be explained by higher isolation. Additional analyses of the data show that less interdependent researchers are less integrated (r=0.15, p<0.01), but it is not true that less integrated researchers use IDGs more often (B=+0.07, p>0.4 in a bivariate logistic regression). Moreover, adding indicators of integration to Model 3 of Table 4 does not remove the significance of the negative effect of interdependency (tables available on request from the author).

JIS-0805-v3 Received: 15th August 2009 Revised: 25th January 2009

5. Summary and conclusions

This paper tests empirically the often-stated claim that the successful use of a new information and communication technology (ICT) is dependent on the social context of its use. Different hypotheses argue that the use of specific ICTs by researchers is dependent on aspects of the social organization of the communication systems within disciplines. As a consequence, such hypotheses might be able to explain disciplinary differences in the use of Internet Discussion Groups (IDGs), if they are broadened appropriately.

The hypotheses, when expanded to include the realm of IDGs, can be contrasted according to the mechanisms that they specify by which disciplinary differences in the communication systems affect the decision of a researcher whether to make use of IDGs. On the one hand, some hypotheses developed here argue that trust problems inhibit the use of IDGs by researchers. The degree of trust problems, in turn, depends on different conditions within the scholarly communication system [10]. On the other hand, it is argued that disciplinary differences in the communication systems lead to different communication needs. The existence of specific communication needs, in turn, gives incentives to start using IDGs (see [9] for email use; [13] for IDG use).

Data on the use of Internet Discussion Groups (IDGs) by English and Dutch university researchers show that more researchers in the social sciences and humanities, on average, make use of IDGs than researchers in the natural sciences. The proportion of IDG users is lowest among researchers in physics and chemistry. It is highest among researchers in management science and sociology.

The testing of the hypotheses using multivariate data analyses yielded five notable results. Firstly, the examined hypotheses about problems of trust claiming that higher commercial relevance of research findings and less visibility of research would inhibit the use of IDGs did not find support in the data. Secondly, one of the tested hypotheses about diferential communication needs found support. Researchers who work in fields where research projects have a low visibility, i.e., researchers in fields with a high dispersion of communication channels (journals), have a higher likelihood of starting to use IDGs. The underlying argument is that they have a special incentive to start using IDGs because they hope to obtain some orienting information through the use of IDGs. This effect found strong support in all analyses. Thirdly, the degree of interdependency is negatively associated with the initial use of IDGs. Since a positive association was expected in the literature, the stability and relative strength of this unexpected effect is remarkable. Fourth, a large number of disciplinary differences in the prevalence of IDG use are still unexplained. After controlling for differences in the theoretically interesting variables, many of the disciplinary differences were still statistically significant. Fifth, although researchers who work in research fields with a low degree of visibility have special incentives to start using IDGs, this does not mean that they have a higher likelihood of continuing to use IDGs. The hypothesis about differential communication needs can explain why researchers start using IDGs. This, however, does not imply that they continue to use them.

Where do these results leave us with respect to the claim that the use of ICTs in the scholarly communication system is dependent on the social context of its use? How should we evaluate the idea that trust problems or differential communication needs have an impact on disciplinary differences in the use of ICTs? For the case of Internet Discussion Groups, the results make clear that the impact of the social context is, at best, only partly understood. More theory is needed about how disciplinary differences in the communication systems may have an impact on the use of IDGs.[11]

Moreover, the data demonstrate that a *general* claim that trust problems inhibit the use of all kinds of information and communication technologies would not be supported. It may be true that the use of *other* ICTs is more inhibited by trust problems. Future empirical research on other ICTs is needed to show whether this is the case.

Independently of the relevance of trust problems, the results underline the importance of another idea about *how* the social organization of a disciplinary communication system affects the use of ICTs. The *dispersion of communication channels (journals) in a research field gives incentives to make use of IDGs.* The underlying

[11] For instance, Talja [34] suggests that some researchers in the humanities avoid IDGs because they work in projects so unique that there is nobody to share information with.

JIS-0805-v3 Received: 15th August 2009 Revised: 25th January 2009

argument is that researchers hope to gain orienting information about the field that would otherwise be difficult to obtain. A low degree of visibility in research fields thus creates a special communication need. Other research supports the idea that IDGs provide some orienting information benefits to researchers in the social sciences who tend to conduct research in fields with low visibility. Such benefits include information about important conferences and the names of the most important researchers in the field (see [11]).

Additionally, the paper shows that it is important to make a *distinction between different kinds of ICTs*. Physicists, especially within high energy, theoretical, or solid state physics, may be among the most frequent users of pre-print servers. At the same time, they are among the least frequent users of Internet Discussion Groups.

If we believe that trust problems are of importance for understanding disciplinary differences in the use of ICTs, then the question emerges as to how the findings of this paper can be brought in accordance with the idea that trust problems do matter. It might be a good strategy for future research to realize that *different ICTs have different potentials for trust problems*. The usual information transfer in Internet Discussion Groups is characterized by answers and questions that may be helpful. The large majority of information items have no secrecy value. Accordingly, Internet Discussion Groups have a low trust problem potential. Pre-print servers are tools for the exchange of written information that is new and that has a preliminary, informal status. Since the information transfer conducted by this tool is based on items consisting of new papers (not emails about topics already known to the academic community), the trust problem potential of pre-print servers should be higher than for Internet Discussion Groups. Moreover, electronic journals, used as a tool for information transfer and communication in the research community, should have a higher trust problem potential than pre-print servers. The information transfer of this tool is based on official publications that have a formal status. Their value depends directly on the trustworthiness of the editorial committee and the reviewers. The higher the trust problem potential of an ICT, the stronger might be the inhibiting effects of those conditions that strengthen the trust problem (see section 2). Future research is needed to show whether it is useful to make a distinction between different trust problem potentials of ICTs in order to integrate research findings on the use of different kinds of ICTs.

A limitation of this study is that data collection took place in 1999. However, at this time IDGs in its current form were already established so that there is no reason to believe that researchers' attitudes towards them changed much. Nevertheless it would be useful to replicate the findings with newer data. Additionally, future research is required to find out whether the negative association between interdependence and use of IDGs can be replicated. It should be tested whether the proposed explanation of this finding as an effect of a high burden of coordination efforts that increase the disturbing consequences of additional email communication via IDGs is valid.

As a final point, the findings, should they be confirmed by further research, have implications for our understanding of the nature of information search in the different disciplines, science policy, and technology development in the research system. The data confirms the well-known insight [31] that the visibility of research in the social sciences and humanities is, on average, lower than in the hard sciences. As a new insight, the analyses reveal how the search for information depends on the degree of visibility. The persistence of differential visibility and its relationship with the academics' digital information search suggest that researchers in the humanities and social sciences have their reasons to prefer specific forms of information sharing and that convergence between disciplines is "not just a matter of time" [10]. Science policy could devote more attention and resources to the development of technologies that are especially adjusted to the difficulties in the communication system of the humanities and social sciences. The system would profit from technology that incorporates social forms of information sharing. The findings also have implications for general ICT development. ICTs that fulfill the researchers' special communication need of orientation in the humanities and social science could lessen important deficiencies of the scholarly communication system. Orienting functions, however, need not be restricted to Internet Discussion Groups. Professional scholarly web-sites and multifunctional research portals that are designed with an eye on a specific group of researchers as a target group can also include such functions. By doing so, designers take into account that their products have to fit in with the social environment of their users. This insight might not only make the conduct of research as a common undertaking more pleasant, but may also improve the efficiency of the scholarly communication system.

JIS-0805-v3 Received: 15th August 2009 Revised: 25th January 2009

References

[1] R. Kling, Learning about Information Technologies and Social Change: The Contribution of Social Informatics. *The Information Society*, 16(3) (2000) 217-232.

[2] J.L.Jr. Gresham, From Invisible College to Cyberspace College: Computer Conferencing and the Transformation of Informal Scholarly Communication Networks. *Interpersonal Computing and Technology: An Electronic Journal for the 21st Century* 2(4) (1994) 37-52.

[3] M. Turoff, & S.r. Hiltz, Superconnectivity. Communications of the Association of computing Machinery (ACM), (7) (1998) 116.

[4] T.M. Harrison, & T. Stephen, Computer Networking, Communication, and Scholarship. In T. M. Harrison & T. Stephen (Eds.), *Computer Networking and Scholarly Communication in the Twenty-First-Century University*. (pp. 3-36). (State University Plaza, Albany: State University of New York, 1996).

[5] A.M. Odlyzko, Tragic Loss or Riddance? The impending demise of Traditional Scholarly Journals. In R. P. Peek & G. B. Newby (Eds.), *Scholarly Publishing. The Electronic Frontier*. (pp. 91-102). (Cambridge: MIT Press, 1996).

[6] R. Kling, & L. Covi, Electronic Journals and the Legitimate Media in the Systems of Scholarly Communication. *The Information Society*, 11(4) (1995) 261-271.

[7] J.P. Walsh, S. Kucker, N.G. Maloney, & S. Gabbay, Connecting Minds: Computer-Mediated Communication and Scientific Work. *Journal of the American Society for Information Science* 51(14) (2000) 1295-1305.

[8] J. Fry, & S. Talja, The intellectual and social organization of academic fields and the shaping of digital resources. *Journal of Information Science* 33 (2007) 115-133.

[9] J.P. Walsh, & T. Bayma, Computer Networks and Scientific Work. *Social Studies of Science* (26) (1996) 661-703.

[10] R. Kling, & G. McKim, Not just a Matter of Time: Field Differences and the Shaping of Electronic Media in Supporting Scientific Communication. *Journal of the American Society for Information Science* 51(14) (2000) 1306-1320.

[11] U. Matzat, Academic Communication and Internet Discussion Groups: Transfer of Information or Creation of Social Contacts?, *Social Networks* 26 (3) (2004) 221-255.

[12] M. Merz, 'Nobody Can Force You When You Are Across the Ocean' - Face to Face and E-Mail Exchanges Between Theoretical Physicists. In C. Smith & J. Agar (Eds.), *Making Space for Science. Territorial Themes in the Shaping of Knowledge*. (pp. 313-329). (University of Manchester 1998).

[13] U. Matzat, Academic Communication and Internet Discussion Groups: What Kinds of Benefits for Whom? In B. Batinic, U. D. Reips, & M. Bosnjak (Eds.), *Online-Social Sciences*. (pp. 397-416). (Seattle-Toronto-Bern-Goettingen: Hogrefe & Huber Publishers Inc. 2002).

[14] J. Cohen, Computer mediated Communication and Publication Productivity among Faculty. *Internet Research*, (2/3) (1996) 41-63.

[15] A.J. Meadows, *Communication in Science*. (London: Butterworths 1974).

[16] R. Whitley, *The Intellectual and Social Organisation of the Sciences*. (Oxford: Clarendon Press 1984).

[17] T. Becher, *Academic Tribes and Territories. Intellectual Enquiry and the Cultures of the Disciplines*. (The Society for Research into Higher Education & Open University Press 1989).

[18] L.J.B. Mote, Reasons for the variations in the information needs of scientists. *Journal of Documentation* 18 (1962) 169-175.

[19] S. Talja, P. Vakkari, J. Fry, & P. Wouters, Impact of research cultures on the use of digital library resources. *Journal of the American Society for Information Science and Technology 58* (2007) 1674-1685.

[20] E.M. Rogers, *Diffusion of Innovations*. (New York, London, Toronto, Sydney, Tokyo, Singapore: The Free Press 1995).

JIS-0805-v3 Received: 15th August 2009 Revised: 25th January 2009

[21] S. Törma, & P. Vakkari, Discipline, availability of electronic resources and the use of Finnish National Electronic Library – FinELib. *Information Research*, 10(1) (2004) paper 204 [Available at http://InformationR.net/ir/10-1/paper204.html].

[22] S. Cole, & J.R. Cole, Visibility and the Structural Bases of Awareness of Scientific Research. *American Sociological Review* (33) (1968) 397-413.

[23] C.M. Borden, G.R.Jr. Lucas, P. Daniel, S.F. Miller, M.M.J. Fischer, & M. Abedi, Knowledge Collaborations in the Arts, the Sciences, and the Humanities. Edited Excerpts from a Smithsonian Seminar Series. Part 3: The Humanities and the Social Sciences. *Knowledge: Creation, Diffusion, Utilization* 13 (1992) 110-142.

[24] W.O. Hagstrom, Competition in science. *American Sociological Review* 39(1) (1974) 1-18.

[25] D. Crane, *Invisible Colleges. Diffusion of Knowledge in Scientific Communities*. (Chicago: The University of Chicago Press 1972).

[26] R.E. Rice, A.E. Grant, J. Schmitz, & J. Torobin, Individual and Network Influences on the Adoption and Perceived Outcomes of electronic Messaging. *Social Networks* 12 (1990) 27-55.

[27] M.L. Markus, Toward a "Critical Mass" Theory of Interactive Media. *Communication Research* 14 (1987) 491-511.

[28] J.P. Walsh, & N.G. Maloney, Collaboration structure, communication media, and problems in scientific work teams. *Journal of Computer-Mediated Communication*, 12 (2007).

[29] A.H. Van de Ven, A.L. Delbecq, & R. Koenig, Determinants of coordination modes within organizations. *American Sociological Review* 41 (1976) 322-338.

[30] S. Talja, R. Savolainen, & H. Maula, Field differences in the use and perceived usefulness of scholarly mailing lists. *Information Research* 10(1) (2005) paper 200. [Available at http://InformationR.net/ir/10-1/paper200.html].

[31] W.D. Garvey, N. Lin, & C.E. Nelson, Communication in the Physical and the Social Sciences. In W. D. Garvey (Ed.), *Communication: The Essence of Science*. (pp. 280-299). (Oxford, New York, Toronto, Sydney, Paris, Frankfurt: Pergamon Press 1979).

[32] H. Goldstein, *Multilevel Statistical Models*. (2 ed.). (London, Sydney, Auckland: Edward Arnold 1995).

[33] U. Matzat, *Social Networks and Cooperation in Electronic Communities. A theoretical-empirical Analysis of Academic Communication and Internet Discussion Groups* . (Amsterdam: Thela Publishers 2001).

[34] S. Talja, Information sharing in academic communities: Types and levels of collaboration in information seeking and use. *New Review of Information Behavior Research* 3 (2003) 143-159.

[35] B.H. Loyd, & C.P. Gressard, Reliability and factorial validity of computer attitude scales. *Educational and Psychological Measurement* 44 (1984) 501-505.

[36] D. Bandalos, & J. Benson, Testing the factor structure invariance of a computer attitude scale over two grouping conditions. *Educational and Psychological Measurement* 50 (1990) 49-60.

Appendix

Appendix A: The Sampling Design

Within every randomly selected university the following departments belonging to one of the eight disciplines were deliberately selected. Within economics the departments that include micro- or macro-economics were selected, within management science those for Human Relation Studies/ Organizational Behavior were chosen. The chosen departments within chemistry are related to organic or inorganic chemistry. Physics departments

JIS-0805-v3 Received: 15th August 2009 Revised: 25th January 2009

include research within theoretical or solid state physics. The mechanical engineering departments cover research on topics like material science, production or design management or mechanics. Within sociology, mathematics and history no selection was made. Selection of the departments was done in such a way that the chosen research areas are represented by a large number of university departments. Within a selected department a random sample of university researchers, including Ph.D. students and postdoctoral researchers, was taken – with one exception. A small number of departments had a very high proportion of Ph.D. students. In such departments I sampled researchers with a permanent position disproportionately often to ensure that the sample included a large enough number of them. I detected only one minor bias mentioned below in the sample. The immediacy of response is not related to whether the respondent has an email connection, whether he makes use of IDGs, or how intensively he makes use of email. I interpret this as a hint that the use of email and IDGs is something 'ordinary' for those who use email/IDGs and hence does not give extra motivation for survey participation. As a consequence, there is no indication of a bias in the response rate in favor of IDG users. The response rate does not differ between Dutch and English respondents ($p>0.9$). It does not differ between respondents of different disciplines, with the single exception of mechanical engineers who answered significantly less often. Just 30.4% of them returned a completed questionnaire ($Chi\text{-}Square=15.1, df=7, p<0.05$ for all 8 disciplines and $Chi\text{-}Square=5.2, df=6, p>0.45$ for the remaining 7 disciplines). Filling in the questions took 45-60 minutes.

Appendix B: The measurement of the control variables:

Conference participation: "How often did you attend conferences and official scientific meetings during the last 12 months?", Written research output (papers): "*How many research papers did you write (published and unpublished papers including those articles already mentioned) during the last 12 months*?", Prominence: "*How well known is your work within your most important field of research?*" (seven point Likert scale), Competition: *"Researchers are sometimes anticipated by others in the presentation of research findings. That is, after they have started to work on a problem, another researcher publishes its solution. ... How concerned are you that you might be anticipated in your current research?"* The respondent could choose between 5 answer categories. PC attitudes: The first factor measuring "computer liking" of the Computer Anxiety Scale (CAS) developed by Loyd and Gressard [35] was used, since this measure has proven to be useful in different samples (see Bandalos & Benson [36] for the details). The factor analysis resulted in one factor with an eigenvalue larger than one which can explain 44.5% of the variance of the seven used items (KMO measure of sampling adequacy=.81), Department ranking: Every respondent was ranked within his discipline according to the number of manuscripts reviewed for a journal during the previous 12 months, the number of conferences visited, the number of research papers written, and his prominence. These four discipline-specific ranking variables were combined in a factor analysis leading to one factor score for every respondent. For every department the arithmetic mean of the factor scores of its researchers was taken. Network variables: Number of IDG users among the respondent's department: *"From how many researchers in your university department do you know that they use such Internet Discussion Groups?"*, Proportion of IDG users among the 5 most important discussion partners: *"If you discuss any parts of your research sometimes with national or international colleagues outside of your own department, please write down the number of such colleagues who strongly influence your own research through these questions." ... "Do some of these colleagues use Internet Discussion Groups? Think about at most 5 external colleagues who are most influential on your research through these discussions."*

JIS-0805-v3 Received: 15th August 2009 Revised: 25th January 2009