ELINA LATE

Cultural and Contextual Shaping of Scholarly Communication

Publishing and Reading Practices in Finnish State Research Institutes

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ACADEMIC DISSERTATION
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Abstract

Communication has been portrayed as the essence of science. Thus, communication practices such as publishing and reading are one of the main tasks in scholarly work. In recent years, communication has become even more important, as for example governments have started to evaluate research primarily by visible outcomes: publications. Consequently, researchers are not only encouraged but also required to show the impact of their work by this form of productive output.

This study examines scholarly publishing and reading practices in state research institutes. Earlier studies of scholarly publishing and reading practices have focused mainly on universities, while studies focusing on state research institutes are in minority. State research institutes are important actors along universities in national innovation systems. The traditional role of state research institutes has been to produce 'policy-oriented research' for the needs of Finnish society and decision-making.

Publishing and reading practices in research institutes were studied by collecting both qualitative and quantitative data. Qualitative interviews yield insight into the everyday work practices of researchers in Finnish research institutes. Quantitative data from a survey covering all 18 state research institutes in Finland forms the core of the study and shows the big picture concerning publishing and reading practices and their variation in different disciplines. Study includes various academic, professional and general publishing forums. Results also show how different cultural and contextual factors influence publishing and reading practices. Indicators derived from Becher's (1989) and Whitley's (1984) theories of academic cultures are applied to explore the impact of cultural factors such as nature of research, field interdependence, and dependence between researchers, on publishing and reading practices. In addition, the influence of amount and types of collaboration partners, types of research funding and nature of research projects are examined.

The research conducted in state research institutes is mainly empirical, often consisting of development/engineering and specialist work/consulting. This is not surprising when one looks at the tasks and roles assigned to research institutes.

Researchers in research institutes engage in collaborations with many types of organisations. The main collaboration organisations are Finnish universities and public research institutes. In the technical sciences, collaboration with the private sector is common. Research funding in state research institutes is covered mainly by governmental basic funding. The main external funders are ministries, Tekes, and the EU. Researchers typically work on many research projects at the same time.

Four publishing orientations were identified from the survey data. These were: professional, academic article, academic conference, and industrial. Three types of reading orientations, academic, professional and fact orientation, were detected. In all, active reading is associated with active publishing. Professional publishing and reading are most typical in bio and environmental sciences, social sciences and humanities. Academic article publishing and reading is most typical in health care sciences and bio and environmental sciences. Conference and industrial publishing is most common in technical and natural sciences.

Academic publishing and reading is especially related to conducting theoretical and empirical research. Of the contextual factors academic publishing and reading was related to collaborating with other academic organizations such as universities working without external research funding or funding from the Academy of Finland. Those working with multiple research projects at the same time and with long projects were most active publishers and readers of academic literature. Professional publishing and reading was related to specialist work / consulting. Most active publishers and readers of professional literature worked without external funding and collaborated with various other research organizations. Industrial publishing on the other hand was highly related to collaborating and having research funding from the private sector. Working with many projects at the same time and long projects were related to professional communication. Short research projects were related to active industrial publishing.

In sum, the study shows that different types of research, conducted in different disciplines, with different research funding, in collaboration with different types of organisations and in different types of research projects, are related to differences in publishing and reading practices. Therefore, it is reasonable to argue that studies focusing only on academic outputs of research (such as journal articles) give only a limited picture of scholarly communication practices. In state research institutes in addition to academic audience, communication with professional and industrial audiences is important.

In research institutes, where the nature of research is often applied and research outputs are not always academic publications, research outcomes cannot be evaluated with the same criteria as those used in the evaluation of universities. Also disciplinary differences in communication practices should be taken into account. According to the results, the nature of the research and the aims of the research projects should be taken as points of departure in research evaluation. State research institutes are engaged in structural reorganisation at the moment. Forthcoming changes such as mergers of research institutes and the changes in funding structure may have an effect on researcher's ways of publishing and reading. In the future research it will be interesting to follow how the reorganisation works out and what consequences it may have for research and communication practices.

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Tampere, 10.9.2014
Elina Late

Contents

1 Introduction

1.1 General orientation

Scholarly communication has been said to be the essence of science. For new research results to become part of scientific knowledge, they have to be made public and subjected to critical evaluation by the scientific community (Garvey 1979). Otherwise, they are nothing but 'private intellectual property fated to accompany its owner to the grave' (Becher & Trowler 2001, 104). On the other hand, the cumulative nature of research requires researchers to follow research literature to be able to produce new knowledge. Accordingly, reading is the other side of the coin of communication and among the central tasks in academic work. In recent years, communication has become even more important, as governments and others who fund research have started to evaluate research by visible outcomes: publications. Researchers are encouraged to show the impact of their work in terms of this form of productive output. At the same time governments have emphasized the role of scientific knowledge and technology as an asset for countries and the number of academic researchers has grown rapidly (Etzkowitz & Leydesdorff 2000). In consequence, more academic publications are being produced (Late & Puuska 2014; Kyvik 2003; Puuska & Miettinen 2008; Mabe & Amin 2001) and, consequently, scholars have to be able to handle the increasing quantity of academic publications.

The 21st century has thus far been a time of active research focusing on communication practices in the field of information sciences and in sociology of science. Rapid growth of information technology has offered new topics and perspectives for study of scholarly communication (Borgman 2000), and, at the same time, emphasis on the role of innovation and research in knowledge-based societies has led to an increase in interest in research and communication practices (Etzkowitz & Leydesdorff 2000). It has been widely recognised that individual disciplines have distinct ways of communicating (e.g., Kyvik 1991; Puuska & Miettinen 2008), with these differences in communication practices having been explained in terms of, for example, differences in academic cultures (Becher 1989; Whitley 1984). However, cultural factors on their own cannot explain the variation in communication practices seen in the different research environments. Changes

in research practices and in knowledge production environments are affecting traditional research cultures and the nature of the work (see Borgman 2007; Gibbons et al. 1994). It has been argued that research has become transdisciplinary and tightly intertwined with the private sector and society at large, so research context too has to be taken into account in studies of scholarly communication.

Although communication practices have been fairly well studied, most of the studies in this area have focused on universities. Studies centred on other research environments have been in the minority. In addition to universities and private companies, state research institutes (also examined as, for example, government laboratories and public research institutes) play a significant role in national innovation systems (Mazzoleni & Nelson 2007; Laredo & Mustar 2004). The traditional role of state research institutes in Finland has been in producing 'policy-oriented research' for the needs of Finnish society and decision-making alongside completion of their other official tasks. However, the division of tasks and functions between universities and state research institutes has become blurred for about the last decade. In some fields of research, universities and state research institutes focus on the same research topics and compete for the same research funding. At least partially in consequence, research institutes have been seeing a process of large-scale structural reorganisation, which has led to much public debate in Finland in recent years. Yet there remains a clear lack of knowledge about work and communication practices in these institutes (Loikkanen et al. 2010).

This study focuses on communication practices of researchers working in state research institutes in Finland. Its contribution lies in offering both quantitative and qualitative knowledge of communication practices employed in different disciplines. The study also contributes knowledge about the relationships of publishing and reading practices with various cultural and contextual factors.

1.2 Aims of the research

The aim of the research is to study formal communication practices, such as reading and publishing practices, of researchers working in various disciplines in state research institutes in Finland and to study the effects of diverse cultural and contextual factors on communication practices. Communication is understood

here as an umbrella concept covering both publishing and reading practices. Focus of the research is on formal communication that is written texts. The research questions are:

1. How are research institutes shaped as 'academic' institutions?

2. What kinds of reading and publishing practices do researchers engage in, and how do these practices differ between disciplines?

3. How do the academic culture and research context affect formal scholarly communication practices?

4. Can theories about academic cultures be used to explain differences in formal communication practices in state research institutes?

The first research question refers to the work context that is typical in state research institutes. Communication practices of scholars in various fields of research, countries, and institutions have been studied extensively in the last few decades. Most of the studies have focused on universities (e.g., Piro et al. 2013; Tenopir et al. 2012a; Puuska 2010; Puuska & Miettinen 2008; Kyvik 1991), and those focusing on state research institutes are in the minority (Late & Puuska 2014). It can be said that in this sense state research institutes are the least well-known part of the Finnish innovation system. The present study is an attempt to fill this gap in knowledge by exploring research and communication practices in 18 state research institutes in Finland.

The second research question is related to communication practices in different disciplines in state research institutes. Instead of taking all disciplines into account, most previous studies focused on only one discipline (e.g., Bourke & Butler 1996; Montesi & Owen 2008; Costas et al. 2010). While studies have recently been conducted that look at a broad range of disciplines (e.g., Puuska & Miettinen 2008; Piro et al. 2013; Tenopir et al. 2012a), all of them focus on universities. The present study, in contrast, considers all major disciplines represented at state research institutes in Finland.

Earlier studies focused mainly on communication in academic forums, such as academic journals. Few studies took into account also communication for other audiences, such as practitioners or the general public (e.g. Tenopir et al. 2012a; Puuska & Miettinen 2008; Kyvik 1991). The aim with this thesis is to study

publishing and reading practices in different types of communication forums, both academic and professional.

The third research question is related to how communication practices are related to various cultural and contextual factors. Becher's (1989) and Whitley's (1984) theories are taken as a point of departure for studying the influence of academic cultures on communication practices. Attempts to operationalise concepts defined by Becher and Whitley are made in this study. In recent years, both authors' theories have been applied in studies examining academic cultures (e.g., Hammarfelt 2012; Kjellberg 2010; Nolin & Åström 2010; Åström 2008; Puuska & Miettinen 2008; Kautto & Talja 2007; Fry & Talja 2004; Rochester & Vakkari 2003; Fry 2003; Ylijoki 1998; Kyvik 1991), yet studies that operationalise concepts presented in those theories are in the minority (e.g., Al-Aufi & Lor 2012; Krampen et al. 2011; Talja et al. 2007). The present work contributes to knowledge of this nature by developing measurements for factors that describe academic cultures and for studying their relations with communication practices. In addition to academic cultures, research context in state research institutes is studied and the influence of various contextual factors on communication practices is examined. The study thus provides understanding of how diverse contextual factors influence researchers' publishing and reading practices.

Application of Becher's and Whitley's theories regarding differences in academic cultures in contexts of state research institutes is brought in with the final research question. Earlier studies applying these theories have focused on universities; therefore, there is no prior experience of how well they correspond with the research cultures that are especially characteristic of state research institutes.

1.3 The research strategy

The study was carried out in two phases. The aim in the first phase (Figure 1) was to gain preliminary understanding of work and communication practices in state research institutes, to inform the design and hypotheses for the second part of the study. The initial part of the study was based on a review of earlier empirical studies and theories about scholarly communication and qualitative research data. Literature was drawn primarily from the fields of information studies, social studies of the sciences, and sociology of science; therefore, the research takes an

interdisciplinary approach to the theory examined. Because of the dearth of earlier research on work and communication practices in state research institutes, qualitative data were collected so as to allow understanding of work and communication practices especially in state research institutes. Qualitative data were collected via interviews with researchers at two state research institutes in Finland. It was with this backdrop that the theory- and empiria-oriented hypotheses were chosen and the second stage of data collection designed.

Figure 1: Research stages in the first phase of the study

In the second phase of the study, communication practices in state research institutes were studied more broadly and the hypotheses developed in the first phase were tested (Figure 2). Both quantitative and qualitative approaches were used. Quantitative data were collected from 18 state research institutes in Finland, with an electronic-format survey used to collect data about reading and publishing practices and on the nature of work in state research institutes. In the analyses, relations between variables were examined. Qualitative data gathered in the first phase of the study were used in preparation of examples of researchers' work at the institutes. This complements the quantitative data in the attempt to answer the questions raised and form explanations. The quantitative data form the structure or 'skeleton', of the results and reveal the 'bigger picture' of the research phenomenon by introducing the average behaviour seen in the various discipline groups and the influence of various factors on behaviour, while qualitative data yield insight into the day-to-day work of the individual researcher.

Figure 2: Research stages in the second phase of the study

1.4 The structure of the thesis

The thesis is divided into eight chapters. The introductory chapter is followed by material presenting the state research institutes in Finland and their function in the national innovation system, in Chapter 2. Each institute and its functions are presented in brief.

Chapter 3, consisting of a review of previous empirical studies of scholarly communication, is divided into three sections: firstly, focusing on scholarly communication systems; then, looking at studies of publishing practices; and, finally, considering studies that examine reading practices. After this, Chapter 4 presents the theoretical background of the present study, rooted in studies by Becher (1989) and Whitley (1984).

Chapter 5 presents the methodology. The qualitative part of the study is presented first, including the data collection, analyses, and results. On the basis of the analyses of the qualitative data and theoretical background, the research hypotheses are set forth in Section 5.2. The second part of the study, including its quantitative data collection and statistical analyses, is outlined in Section 5.3.

The key research results are presented in Chapter 6. They are presented in four sections, the first focusing on academic culture and research context in state research institutes, the second on publishing practices, the third on reading practices, and the final one on the relationship between reading and publishing practices. The results are presented in Chapter 7, a discussion chapter built around the hypotheses in Chapter 3. Final conclusions from the results are stated in Chapter 8.

2 State research institutes

State research institutes as a research context are not as well known as, for example, universities. Also, structures of innovation systems vary between countries, and the concepts used may vary with national and other context. Therefore, what is meant by 'state research institute' in this study, in Finland, and internationally needs clarification. In this chapter, the Finnish innovation system and state research institutes as a part of that system in the 21st century are presented. Brief introduction is given to each of the 18 state research institutes, in Section 2.3.3. Before that, however, the role of state research institutes internationally is described.

2.1 State research institutes internationally

Internationally, 'state research institutes' refers to many kinds of institutes, which vary in their degree of 'publicness'. In general, the term is taken to refer to government influence on research, not to state ownership (Crow & Bozeman 1998). State research institutes vary in structure, function, and performance across national borders; their tasks might include, for example, basic and applied research, policy support, training, knowledge and technology transfer, service provision, research funding, provision of technological facilities, and standardisation and certification (OECD 2011a).

The Organisation for Economic Co-operation and Development (OECD) studied sector-level trends in state research institutes by means of a survey and case studies from several OECD countries. Among the findings was that applied research was the key activity in most institutes, with many of the research institutes having multiple goals and a number of other tasks (OECD 2011b). Applied research and popularising of research results have been on the rise in recent years.

Also, transdisciplinary and multidisciplinary[1] research have increased. State research institutes operate in close collaboration with other sectors in joint research projects and participate in the work of international committees. As are tasks and roles, the funding sources are quite varied. In many countries, absolute research and development (R&D) expenditure of state research institutes has risen; however, state research institutes' share of R&D funding has decreased. In most cases, funding from the government budget is the main form of institutional funding. However, the role of competitive bidding and private-contract-based income has grown in most countries. (Ibid.)

The OECD has recognised four ideal types of state research institutes (see Table 1). Mission oriented centres (MOCs) are the most traditional type of state research institute; MOCs are owned and sometimes run by government departments or ministries. 'Their role is to undertake research in specific topics or sectors in order to provide knowledge and technological capabilities to support policy-making', according to the OECD (2011a). Because of the tight link to governmental bureaucracies, MOCs are likely to have experienced fewer changes recently. Some MOCs have added to their functions measurement, certification, and standardisation.

Public research centres and councils (PRCs) perform and/or fund research in several fields. In many countries, PRCs represent a significant share of national R&D capabilities. In some countries, the role of PRCs have diminished on account of the increase in external research funding. The role of PRCs in technology transfer has grown (OECD 2011a).

Research technology organisations (RTOs) are also known as industrial research institutes. They are mainly 'dedicated to the development and transfer of sciences and technology to the private sector and society' (OECD 2011a). Administrative links are usually looser between governments and RTOs than with other organisation types (although RTOs still are owned by the government), and RTOs are in the semi-public sphere and the not-for-profit sector. The importance of RTOs as a link between public research and the private sector has increased in many countries (OECD 2011a).

Independent research institutes (IRIs) perform both basic and applied research focused on 'issues' or 'problems' instead of fields. While they often work at the boundary between public and private and are referred to as semi-public, IRIs

[1] The aim of multidisciplinarity is the juxtaposition of theoretical models belonging to different disciplines. Going further, transdisciplinary work strives for articulation between disciplines, rather than their relations (Ramadier 2004).

usually receive sustainable public support and show public representativeness in their governance. The IRI is a relatively new form of organisation, and IRIs have proved highly innovative in many cases, with outstanding performance (OECD 2011a).

Table 1: Ideal types of state research institutes (Adapted from OECD 2011a)

	Status	Main focus	Recent changes	Examples
Mission oriented centres (MOC)	Owned and sometimes run by government departments or ministries at the national or sub-national level.	Perform research in specific topics or sectors; support to policy making.	Some diversification of outputs to include measurement, diversification and standardization.	National research centres specialised in agriculture (CSIRO - Australia), defence and aerospace (NASA –US), energy & environment (NREL –US)
Public research centres and councils (PRC)	Overarching institutions of considerable size.	Perform (and in some cases fund) basic and applied research in several fields.	More pressure on technology transfer. Diminishing funding role.	CNRS-France; CNR-Italy; CSIC-Spain, Max Planck Society-Germany; NRC-Canada; CONACYT-Mexico.
Research technology organisations (RTO)	Often in the semi-public sphere (although some are owned by governments); private not for profit. Also known as industrial research institutes.	Link research and private sector innovation; development and transfer of S&T to the private sector and society.	Increasing internationalizati on to access markets and competencies	Fraunhofer Society – Germany; TNO – Netherlands; VTT Finland; Tecnalia – Spain; SINTEF - Norway

	Status	Main focus	Recent changes	Examples
Independent research institutes (IRI)	Semi-public; founded under different legal forms, at the boundaries between the public and the private sector.	Perform basic and applied research focused on issues or problems.	More recently created, highly innovative in organizational terms and outstanding performance.	"Centres of excellence"; "cooperative research centres"; engineering research centres"; "competence centres" "Multidisciplinary research centres". CNIO – Spain.

Finnish state research institutes are mainly of the first type: mission-oriented centres (MOC) and to research technology organisations (RTO). The institutes are owned and run by ministries, and their role is to output research into specific topics and in certain fields, to produce knowledge and technological capabilities in support of decision-making. In addition to research, state research institutes have taken on other tasks (OECD 2011a).

Also, the degree to which institutes are dependent on the state (for example, for funding) varies. Autonomy is likely to be lower in MOCs than RTOs. According to Whitley (2010), low autonomy is connected to limited ease of establishing new goals unless new state resources are allocated. Producing innovations and excelling in performance may be difficult in situations of restricted autonomy. Institutes have sought greater autonomy by looking for new external funding sources.

As in Finland, also in other countries governments have emphasised competitive and programme funding for state research institutes to steer research. However, changes in the funding systems have not been equal for all research institutes. Depending on the research field and the degree of autonomy, research institutes differ in their ability to compete and collaborate. Also, research institutes have different capabilities of collaborating with the private sector through research contracts, service provision, etc. In particular, RTOs have been collaborating closely with the private sector for many years. New funding regimes have also

increased part-time and fixed-term employment, and more positions are funded under project-based arrangements (OECD 2011a).

2.2 The Finnish innovation system

In Finland, as in most countries, the innovation system is divided into three main branches: universities, state research institutes, and private companies. Traditionally, universities have focused on basic research while state research institutes have produced policy-oriented applied research for the needs of the society. Private companies have concentrated on applied research and product development. Organisations in different branches collaborate and compete with each other, producing knowledge for society. The various branches of research also complement and in some cases compensate for each other. For example, strong emphasis on agriculture and forest research in state research institutes in Finland has led to this research area being less present at universities. Also, strong emphasis on technical sciences at both state research institutes and universities may have decreased research in this area in industry (Lemola 2009).

Research in Finland is strongly supported by the government. Since the late 20th century, the Finnish government's investment in R&D work has grown rapidly[2]. Finland's government contributed 2,055.2 million euros to funding of research and development in 2010, and R&D funding accounted for 1.15% of the gross national product (Official Statistics of Finland, OSF 2010a). This was the highest percentage in any European Union (EU) country (OSF 2012). In total, research expenditure in Finland accounts for four per cent of the government's spending (OSF 2010a). Universities' share of government funding in 2010 was 25% and state research institutes' 14% (see Table 2). Finland's distribution of government R&D funding by research sector is similar to the average across other OECD countries (Lemola 2009).

[2] Government R&D funding grew by 59% between 2000 and 2010. (OSF 2010a).

Table 2: Government R&D funding in 2010 (OSF 2010a)

Organization	R&D funding (million euros)	Share of R&D funding (%)
Universities	506,3	25
University hospitals	40	2
State research institutes	295,7	14
Tekes	610,8	30
Academy of Finland	384,4	19
Other*	218,8	11
Total	2055,2	100

*e.g. Research work done in ministries

The majority of the government's research funding is distributed through research funding bodies such as Tekes and the Academy of Finland. Tekes, the Finnish Funding Agency for Technology and Innovation, is a research funding agency supporting both academic and business research and development projects in Finland. In 2010, Tekes supplied 610.8 million euros of funding; this accounted for 30% of total government R&D expenses in Finland that year (OSF 2010a). Tekes directs nearly half of its funding to specific areas of focus: 40% of funding was targeted at the higher education sector and state research institutes. The remaining Tekes funding was directed to private companies (tekes.fi).

The Academy of Finland is another major scientific research funder in Finland. Funding from the Academy of Finland accounted for 19% of Finnish R&D expenses in 2010 (OSF 2010a). Academy funding is focused more on basic research, and funding is provided for research projects, research programmes, centres of excellence in research, research posts, foreign visiting scholars' work in Finland, and international networking (aka.fi).

2.3 State research institutes as part of the Finnish innovation system

State research institutes have had an important role in the Finnish innovation system ever since the early days of independent Finland (1917). Even at the beginning of the 20th century, the importance of knowledge for development of society and

industry was recognised. Research was needed for the needs of developing industry in diverse fields of research, to maintain competition in global markets. However, universities were not able to produce applied research rapidly enough in response to the needs of a changing society. Therefore, governments internationally started to establish state research institutes, especially in technical fields. For example, in the United States, there were many state research institutes or semi-public research institutes getting half of their funding from the government and half from private companies (Michelsen 2002, 168–176).

Most of the research institutes in Finland were established after World War II, to satisfy the research needs of government and industry at that time. However, in the early 20th century Finland already had many research institutes or laboratories in the natural sciences and agriculture, and discussion about the roles and boundaries of basic and applied research and the ideal balance between universities and research institutes had begun not long after Finland became independent, continuing to this day (Michelsen 2002, 168–176).

2.3.1 Tasks and functions of state research institutes

In 2010, there were 18 state research institutes in Finland, operating under various ministries. Depending on the calculation methods used, one can estimate that state research institutes account for somewhere between nine per cent and 14% of R&D work in Finland (Lemola 2009). These institutes have been referred to as, for example, public research institutes, sector-specific research institutes, government research institutes, and government research laboratories. State research institutes are the main produces of sector-based research, which aims at supporting political decision-making and social services by expanding the knowledge base in the various branches of administration for the development of Finnish society (Ministry of Education 2007). Huttunen (2004) has defined three aims for these institutes within the Finnish innovation system. The first aim is to provide, produce, and transfer knowledge for supporting decision-making and developing society (sector-level research). The second aim is to sustain high-quality applied research and predict future research needs. The third involves handling the organisation specific functions and tasks (other than R&D) assigned to the institutes by law.

The balance between research and other tasks varies among the 18 research institutes. For Statistics Finland, the institutes have estimated the share of R&D work

in their tasks. Six research institutes estimated that R&D covered 100% of their tasks (see Table 3). In six institutes, the share of R&D work was under 50%. The average was 68%. However, the reliability of the estimates can be questioned: it seems that research institutes differ in their definitions of R&D work, so their estimates are not entirely comparable. (Lemola 2009)

State research institutes are engaged in structural reorganisation at the moment. Back in 2007, an advisory board for sector-organised research was established in the Ministry of Education as part of a process there. That board has produced many reports (see Loikkanen et al. 2010; Hyytinen et al. 2009; Lemola 2009; Rantanen 2008) on the functions, roles, internationalisation, and reorganisation of state research institutes. It was acknowledged that there was a clear lack of knowledge about state research institutes in Finland (Hyytinen et al. 2009). In 2012, the board issued a proposal for compre¬hensive reform of state research institutes. In autumn 2013, the Finnish Government made a decision, based on this proposal, for reorganisation of state research institutes' structure and of research funding.

A decision was made to reduce the number of state research institutes from the current 18 to 12 via the merging of institutes working in closely related research areas as IRI type of research institutes. Two research institutes will be merged into universities. Also, the funding structure of state research institutes will change. A new funding instrument for strategically targeted research will be established in early 2015 as apart of Academy of Finland. Competitive research funding will be apportioned in 2015–2017 from the budgets of state research institutes (52.5 million euros), of the Academy of Finland (7.5 million euros), and of Tekes (10 million euros). Strategic research funding is competitive research funding that is open to all applicants, also to universities. In addition, funding for research supporting government decision-making will be distributed from the budgets of state research institutes. This research funding is meant for production of such output as literature reviews, evaluations, and follow-up needed by the government. In total, 65.5 million euros will be cut from state research institutes' budgets for application to new funding instruments. (Government resolution 2013)

Changes similar to those coming in Finland have already been made in some countries (Schimank & Stucke 1994; Cruz-Castro & Sanz-Menéndez 2007, here OECD 2011a). For example, some research institutes in the United Kingdom are partially or totally privatised (Boden et al. 2006), and state research institutes in Denmark have been merged into universities (OECD 2011a). Also, more business-style models of operation have been introduced. In general, growth of institutes and the size of research groups have been on the rise in the last decade (OECD 2011b).

Key drivers for the changes have been changing of goals and rationales, trends towards increased openness and market responsiveness, budget pressures, and clarification of research roles.

2.3.2 Funding of state research institutes

Total research expenditure at state research institutes in Finland in 2010 was 551.6 million euros. Total research spending varies greatly between state research institutes, from 1.8 to 254 million euros (see Table 3). The four largest research institutes cover 74% of state research institutes' research spending. The largest institutes work in technology, health, and the biological and environmental sciences, while the smallest work in the social sciences, humanities, and natural sciences. (OSF 2010b)

Table 3: State research institutes in Finland by size and funding in 2010

Guiding ministry	State research institute	R&D funding million € (share of budget funding)*	Number of researchers 2010**	Share of R&D work***
Ministry of Employment and the Economy	VTT Technical research centre of Finland	254 (34%)	1957	99,5
	Geological survey of Finland (GTK)	13,3 (83%)	263	29
	National consumer research centre (NCRC)	3,2 (72%)	24	100
	Centre for metrology and accreditation (Mikes)	3,0 (83%)	38	39
Ministry of Social Affairs and Health	National institute for health and welfare (THL)	63,2 (54%)	565	61
	Finnish institute of occupational health (FIOH)	30,3 (67%)	205	50
	Radiation and nuclear safety authority (STUK)	7,0 (89%)	62	45

Guiding ministry	State research institute	R&D funding million € (share of budget funding)*	Number of researchers 2010**	Share of R&D work***
Ministry of Agriculture and Forestry	Agrifood research Finland (MTT)	50,3 (67%)	300	100
	Finnish forest research institute (Metla)	48,7 (89%)	379	100
	Finnish game and fisheries institute (RKTL)	12,3 (73%)	85	56
	Finnish geodetic institute (FGI)	5,5 (65%)	66	100
	Finnish food safety authority (EVIRA)	2,7 (56%)	111	7
Ministry of Transport and Communication	Finnish meteorological institute (FMI)	23,5 (69%)	330	35
Ministry of Environment	Finish environment institute (SYKE)	18,5 (61%)	254	34
Ministry of Education	Research institute for the languages in Finland (Kotus)	5,7 (91%)	80	100
Ministry of Finance	Government institute for economic research (VATT)	5,2 (81%)	49	100
Ministry of Justice	National research institute of legal policy (OPTULA)	1,8 (67%)	22	70
Parliament of Finland	Finnish institute of international affairs (FIIA)	3,4 (91%)	32	100
Total		551,6 (54%)	4822	68

*OSF 2010b, ** Each state research institute was asked the number of researchers working there in spring 2010. *** Lemola 2009

In 2010 government budget funding covered 54% of the total research expenditure of state research institutes. The proportion of external funding to total expenditure of state research institutes (including EU research funding) was 46%. The share of external funding in research expenditure varies between seven per cent and 66%, depending on the institute. (OSF 2010b) External funding for state research institutes has increased over the last decade, and, in total, external research funding increased by 31% from 2006 to 2010 (OSF 2012). Growth of external funding for research has been an international trend (Geuna 2001).

Statistics Finland has collected information about the sources of external research funding for research conducted under the various branches of state

administration. These branches include state research institutes but also other research done under the administrative branches, such as research by the Ministry of Defence; however, state research institutes cover the majority of the research conducted under this umbrella (Lemola 2009). According to the Statistics Finland information, most of the external research funding is gained from Tekes and domestic companies (see Table 4). Other external funders are the European Union, national ministries, and the Academy of Finland.

Table 4: External funding sources for the various branches of state administration in Finland in 2010 (OSF 2010c)

	External funding total	Tekes	Domestic companies	EU	Ministries	Other foreign	Academy of Finland	Other*
Branches of state administration	280,3 million euros	23%	22%	17%	14%	10%	7%	7%

* Not-for-profit foundations, municipalities, and other public entities.

2.3.3 An introduction to state research institutes

State research institutes are operated by different ministries, in line with their field of research. Next, the 18 research institutes are presented, by their controlling ministry. The tasks and roles of state research institutes have been defined in specific acts and decrees. However, these acts may be very general and for some institutes outdated (Hyytinen et al. 2009). That is why information for the following presentations was collected from institutes' Web sites, for the most up-to-date description of the roles and functions of state research institutes today. The number of publications by researchers working in state research institutes is presented to give a picture of the publishing activity in the various institutes. Publication data (see Table 5) from 2010 were collected from institutes' Web sites in March–April 2012. Data were available, for example, in institutes' publication archives and annual reports (see references; publication data). If information was not available on the institute's Web site or there were any difficulties, information was requested from the institute.

Information was collected in three categories:

1. Number of articles published in national and international peer reviewed journals
2. Number of other academic publications, such as academic monographs (including Ph.D. theses); articles in edited works; and articles, review pieces, abstracts, or posters produced at conferences
3. Number of other publications, such as research reports, working papers, articles in professional publications, articles in newspapers or magazines, and material on Web sites

Broad groupings of publication types were used because of the differences in practices of compilation of statistics. In some institutes, statistics were very precise, while in other cases statistics were given at a more general level. It is clear that, for example, conference papers, abstracts, and posters are not all of the same level, but in some research institutes all conference-related publications were counted together; therefore, the same grouping has to be used in the categorisation here.

Because state research institutes do not have common guidelines for presenting statistics, there might be some variation in the interpretation of various publication types. The number of publications in the third category should be analysed with particular care. As already mentioned, some institutes are more precise in reporting on publications than are others. For example, the Research Institute for the Languages of Finland reported blog writings. Other research institutes have blogs to which researchers post regularly; however, because other institutes did not report any blog writings, blog posts were not taken into account. The National Institute for Health and Welfare (THL) reported publications in the third category only with respect to selected publishing forums. Also, it is possible that not all publications from 2010 had been incorporated into the statistics at the time of data collection. However, it can be assumed that at least most of the publications are included in the collected data. Because of the limitations, publication data cannot be used for comparison between research institutes. Average academic (categories 1 and 2) and other (category 3) publishing activity per researcher was calculated on the basis of the number of researchers working in each state research institute in 2010 (see Table 3).

2.3.3.1 The Ministry of Employment and the Economy

The Ministry of Employment and the Economy operates four research institutes: VTT Technical Research Centre of Finland, the Geological Survey of

Finland (GTK), the Centre for Metrology and Accreditation (MIKES), and the National Consumer Research Centre (NCRC).

VTT is a multi-technology applied research organisation established in 1942. The largest research institute in Finland, VTT provides high-end technology solutions and innovation services for clients such as domestic and foreign companies and public-sector organisations. As services, VTT provides technology and business foresight, strategic research, product and service development, licensing, assessment, testing, certification and inspection, innovation and technology management, and technology partnership (vtt.fi). This institute evaluated R&D work as covering 99.5% of its tasks (Lemola 2009). The areas of focus in its research are applied materials, biochemical and chemical processes, business and innovation research, energy, industrial systems management, information and communication technologies, microtechnologies and electronics, and services and the built environment (vtt.fi). In 2010, VTT's total research costs came to 254 million euros. One third of the research expenditure was covered by budget funding. This institute differs from the other institutes in its looser connections to the controlling ministry. Most of VTT's research funding comes from external sources. Although VTT's total budget accounts for 46% of the total budget of state research institutes, VTT's budget funding is only 29% of the total budget funding for state research institutes (OSF 2010b). This indicates that, when compared to other institutes, VTT has significantly more external funding. If VTT is not included, the share of external funding in state research institutes' research expenditures is less than 30%. (OSF 2010b)

VTT employed 1,957 researchers in 2010, who that year produced 542 academic journal articles and 1,032 publications at conferences and in edited works (see Tables 3 and 5). Articles were published in journals such as *Applied Microbiology and Biotechnology*, *Applied Physics Letters*, *BioResources*, *Chemical Engineering Science*, *IEEE transaction publications*, *Journal of Nuclear Materials*, *Nordic Pulp and Paper Research Journal*, and *Surface and Coatings Technology*. The research also comprised papers published through such forums as IEEE and ACM conferences. Academic publishing activity averaged 0.8 publications per researcher. In addition to refereed publications, more than 500 research reports and popular articles were published.

Established in 1991, the Centre for Metrology and Accreditation maintains and develops the system of measurement units in Finland, performs metrological research, and develops measurement applications in partnership with industry

(mikes.fi). The institute estimated that R&D work covers 39% of its tasks (Lemola 2009). This research institute also provides calibration services, specialist services, and training and works as a national accreditation body (mikes.fi). Its research funding in 2010 totalled three million euros, of which 83% was covered with budget funding (OSF 2010b).

In 2010, MIKES employed 38 researchers, who published 22 academic journal articles and 38 publications in other academic forums (see Tables 3 and 5). Articles were published in such journals as *Metrologia* and *Applied Optics*. Other academic publications were mainly articles in conference proceedings such as *CPEM Digest* (for the Conference on Precision Electromagnetic Measurements). Average academic publishing activity per researcher was 1.6 publications and for other type of publication 0.7. In 2015, the Centre for Metrology and Accreditation and VTT will be merged into a single multi-technology research and development centre. (Government resolution 2013)

The Geological Survey of Finland was founded in 1977. This institute produces and disseminates geological information for industry and society, and it promotes systematic and sustainable use of crustal resources and the national geological endowment (gtk.fi). The institute assessed R&D work as covering 29% of its tasks (Lemola 2009). The main research focus is on mineral resources and their sustainable utilisation. In addition to research, the research institute provides expert and information services, with the expert services being focused on exploration of natural resources, the land use and environmental sectors, and laboratory and support functions. The information services of GTK focus on dissemination of geological information and publications (gtk.fi). Budget funding covered 82% of GTK's 13.3 million euros in research expenditure in 2010 (OSF 2010b).

In 2010, GTK employed 263 researchers and published 41 articles in academic journals and 86 articles in refereed conferences and edited works (see Tables 3 and 5). Articles were published in, for example, *Bulletin of the Geological Society of Finland* and *Precambrian Research*. Academic publishing activity averaged 0.5 publications per researcher. GTK produced 0.4 other type of publications per researcher. The other publications were mainly research reports and other non-refereed publications.

The National Consumer Research Centre, founded in 1990, is a research organisation promoting consumer well-being by predicting the change and risk factors of a consumer society and strengthening the consumer perspective in

societal policy and in the marketplace (ncrc.fi). The focus of the institute is on research, and, accordingly, the institute judged R&D work to cover 100% of its tasks (Lemola 2009). Its main research interests are in household activity and changes in consumption, quality of products and services, and market functionality and price structures (ncrc.fi). Total research expenditure in 2010 came to 3.2 million euros, of which 72% was covered by budget funding (OSF 2010b).

In 2010, NCRC employed 24 researchers, who produced 13 articles in academic journals and 17 publications in other academic forums (see Tables 3 and 5). Articles were published in such journals as *Energy Policy*, and *Journal of Consumer Policy*, in conference proceedings, and in edited works. Publishing for other audiences is very active. Research results were popularised in, for example, newspapers and the institute's own publications (www.ncrc.fi). Average academic publishing activity per researcher was 1.3 publications and non-academic activity 3.5 publications. In 2015, NCRC will be merged into the University of Helsinki (Government resolution 2013).

2.3.3.2 The Ministry of Social Affairs and Health

The Ministry of Social Affairs and Health is responsible for three research institutes: the National Institute for Health and Welfare, the Finnish Institute for Occupational Health (FIOH), and the Radiation and Nuclear Safety Authority (STUK).

THL is a research and development institute promoting health and welfare, preventing diseases and social problems, and developing social and health services in Finland (such as new models for organising social and health services, good practices for promotion of health and well-being, and expertise and tools related to implementation of good practices) (thl.fi). The institute evaluated R&D as covering 61% of its tasks (Lemola 2009). In addition to a scientific audience, THL seeks to serve broader society, actors in the field, and decision-makers in central government and the municipalities. The institute was founded in 2009 with the merging of the National Research and Development Centre for Welfare and Health (STAKES) and the National Public Health Institute (KTL) (thl.fi). In 2010, 54% of THL's full 63.2 million euros in research expenditure was covered with budget funding (OSF 2010b).

In 2010, THL employed 565 researchers, who produced 690 articles in academic journals and 85 publications in other academic forums (see Tables 3 and 5). Articles were published in such journals as *Public Health Nutrition*, *Diabetes*,

Vaccine, *Nature Genetics*, *International Journal of Cancer*, *Duodecim*, and *Finnish Medical Journal*. Academic publishing activity averaged 1.4 publications per researcher. The researchers also published popular articles and research reports.

The Finnish Institute for Occupational Health was established in 1950 by a private foundation. Since 1978, FIOH has been operated by the Ministry of Social Affairs and Health. A research and specialist organisation in the field of occupational health and safety, FIOH offers expert services for private- and public-sector organisations (www.ttl.fi). It stated that R&D work covers half of its tasks (Lemola 2009). Its areas of research and work are chemical safety, ergonomics, health and work ability, occupational health services, organisation and management, safety at work, work careers, and work environments (www.ttl.fi). In 2010, 30.3 million euros went toward the institute's research activities, with 67% of that coming from budget funding (OSF 2010b).

In 2010, FIOH employed 205 researchers, who produced 290 academic journal articles and 153 other academic publications (see Tables 3 and 5). Academic publishing activity per researcher came to 2.2 publications. Articles were published in, for example, journals such as *Duodecim*, *Occupational Medicine*, *Journal of Epidemiology & Community Health*, *Ergonomics*, and *People and Work*. Publishing also for more general audiences is vital. The institute's researchers published, on average, 2.4 non-academic publications in 2010.

The Radiation and Nuclear Safety Authority is a regulatory authority, research centre, and expert organisation established in 1958. It formulates and controls the safety requirements related to the use of nuclear energy and nuclear waste in Finland (stuk.fi). This institute evaluated R&D work as covering 45% of its tasks (Lemola 2009). Research at STUK is focused on health effects of radiation, exposure of Finns to natural radioactivity, preparedness for nuclear and radiation accidents, and radiation detection methods and dosimetry. Also, STUK offers companies and private citizens radiation-associated measurement and expert services such as radioactivity measurements (stuk.fi). Total research costs in 2010 came to seven million euros, 89% of this covered by budget funding (OSF 2010b).

In 2010, STUK employed 62 researchers, who that year produced 61 articles in academic journals and 108 other academic publications (see Tables 3 and 5). Article publication venues included *Journal of Environmental Radioactivity*, *Cancer Causes and Control*, and *Applied Radiation and Isotopes*. Researchers gave presentation at conferences such as a meeting of the Nordic Society for Radiation Protection held

in Helsinki. Academic publishing activity averaged 2.7 publications per researcher and other publication activity 0.9 publications per researcher.

2.3.3.3 The Ministry of Agriculture and Forestry

Five research institutes operate under the Ministry of Agriculture and Forestry: Agrifood Research Finland (MTT), the Finnish Forest Research Institute (Metla), the Finnish Game and Fisheries Research Institute (RKTL), the Finnish Geodetic Institute (FGI), and Finnish Food Safety Authority EVIRA.

Agrifood Research Finland was established back in 1898. This research institute conducts research in the fields of biotechnology and food research, animal production research, plant production research, and economic research (mtt.fi). The institute indicated that R&D work covers 100% of its tasks (Lemola 2009). Research themes in its 2010 strategy were food, energy, bioeconomics, sustainability, and responsibility (MTT 2010). In addition to research, MTT is responsible for various expert duties related to consultation, testing, and research (mtt.fi). In 2010, its total research funding came to 50.3 million euros, of which 69% was covered by funding from the state budget (OSF 2010b).

In 2010, MTT employed 300 researchers, who produced 182 academic journal articles and 314 publications in other academic forums, such as articles in conference proceedings and edited works (see Tables 3 and 5). Forums for journal articles included *Agricultural and Food Science*, *Animal*, and *Journal of Dairy Science*. Academic publishing activity came to 1.7 publications per researcher. Publishing in other than academic forums too is active. The researchers made more than 1,000 non-academic publications in 2010, of which over 500 were articles in professional journals. Also common was publishing in MTT's own publication series (*MTT Kasvu*, *MTT Tiede*, *MTT Raportti*, *MTT discussion papers*, *MTT ELO*, *Maaseudun tiede*, and *Suomen maatalous ja maaseutuelinkeinot*). Other than academic publishing activity came to 3.5 publications per researcher.

The Finnish Forest Research Institute, founded in 1917, conducts research and generates research information about forest nature and the environment, the various uses of forests, forestry, and the forest cluster (metla.fi). Research and development work covers 100% of the institute's tasks (Lemola 2009). Among the research programmes at Metla in 2010 were 'Forest-based enterprise and business activities', 'Social impacts of forests', 'Structure and function of forest ecosystems', and 'Information reserves on forestry and the forest environment'. As a state authority, Metla is responsible for diverse tasks related to forests, such as collecting

statistics, carrying out monitoring and inspection, forests trees' breeding, and damage diagnostics (metla.fi). Budget funding covered 89% of the institute's 48.7-million-euro research expenditure in 2010 (OSF 2010b).

In 2010, the research institute employed 379 researchers (see Table 3). It produced 212 articles in academic journals and 237 publications in other academic forums (see Table 5). Among the important publishing forums were *Silva Fennica*, *Scandinavian Journal of Forest Research*, *European Journal of Forest Research*, *Forest Ecology and Management*, *Plant and Soil*, and the Finnish *Metsätieteen aikakauskirja*. Academic publishing activity averaged 0.9 publications per researcher. Publishing for other than academic audiences is also vital. In all, researchers at Metla produced more than 400 non-academic publications in 2010 (1.1/researcher). These were mainly popular articles and reports in Metla's own series.

The Finnish Game and Fisheries Research Institute was established in 1971 (rktl.fi). This institute judged R&D work to account for 56% of its tasks (Lemola 2009). The institute's main tasks include evaluation, projection, and statistical assessment of fish and game resources. This research institute is also responsible for maintaining the diversity of fish stocks and fostering the economic activities related to fish, game, and reindeer. Its research results may be used in political decision-making related to the planning of management and sustainable use of fish, game, and reindeer resources (rktl.fi). Its total research expenditure in 2010 came to 12.3 million euros. Budget funding covered 73% of the institute's research activities (OSF 2010b).

In 2010, the research institute employed 85 researchers. These researchers published 78 articles in academic journals and 12 publications in other academic forums (see Tables 3 and 5). Articles were published in such journals as *Freshwater Crayfish*, *Fisheries Management and Ecology*, *Journal of Fish Biology*, and *Fisheries Research*. Publishing in more general arenas is also active. On average, researchers made 1.1 academic publications and 2.6 non-academic publications in 2010. In 2015, Agrifood Research Finland, the Finnish Forest Research Institute, and the Finnish Game and Fisheries Research Institute will be merged into one research centre for natural resources (Government resolution 2013).

The Finnish Geodetic Institute provides expertise in the area of geodetic research. The institute was established in 1918. This research institute is responsible for nationwide geodetic base measurements and for ensuring solid geodetic, photogrammetric, and spatial data metrology (fgi.fi). Research and

development work covers 100% of the institute's tasks (Lemola 2009). The research focuses on geodesy, positioning, navigation, cartography, geographic information sciences, photogrammetry, and remote sensing (fgi.fi). There were four strategic research areas in 2010: reference systems, mobile geomatics, spatial data infrastructures, and the changing Earth (FGI 2010). Total research expenditure came to 5.5 million euros in 2010, and budget funding covered 65% of the amount (OSF 2010b).

The research institute employed 66 researchers in 2010, who produced 52 academic journal articles and 32 publications in other academic publishing forums (see Tables 3 and 5). Articles are published in, for example, the journals *Remote Sensing*, *Journal of Geodesy*, *GPS Solutions*, and *GPS World*. Other academic publications were mainly articles in refereed conference proceedings. Average academic publishing activity per researcher was 1.3 publications and other publishing activity 0.8 per researcher. In 2015, the Geodetic Institute will be merged with parts of the National Land Survey of Finland to form a research centre for metrology (Government resolution 2013).

Finnish Food Safety Authority EVIRA is a research institute and controlling authority. It was founded in 2006 through the merger of three research institutes operating under the Ministry of Agriculture and Forestry, in the areas of food safety and animal and plant health (evira.fi). Academic research is only one part of this research institute's activities, and the institute evaluated R&D work as covering only seven per cent of its tasks (Lemola 2009). In addition to research, the research institute is responsible for ensuring and monitoring food safety, promoting animal health and welfare, developing the prerequisites for plant and animal production in collaboration with the food industry, handling diagnostics and analytics pertaining to animal and plant diseases and food safety aimed at greater food safety, operating as a laboratory in diverse fields, conducting risk evaluations and follow-up, and handling risk-related communications (evira.fi). Its total research expenditure in 2010 came to 2.7 million euros, of which 56% was covered with budget funding (OSF 2010b).

In 2010, EVIRA employed 111 researchers, who may work on tasks additional to research. These researchers produced 56 articles in academic journals and 59 publications in other academic forums (see Tables 3 and 5). Journal articles were published mainly in various international journals. Academic publishing activity averaged one publication per researcher and other publishing activity 0.5 per researcher in 2010.

2.3.3.4 The Ministry of Transport and Communications

The Finnish Meteorological Institute (FMI) operates under the Ministry of Transport and Communications (the predecessor of FMI, the Magnetic Observatory of Helsinki University, was founded in 1838). This institute produces weather, sea, and climate services for Finnish society. It observes the physical state of the atmosphere, its chemical composition, and electromagnetic phenomena (fmi.fi). Research work accounts for 35% of the institute's tasks (Lemola 2009). The focus of this research is on meteorology, air quality, climate change, earth observations, and marine and Arctic research. In addition to research, FMI has other responsibilities. Services such as weather forecasts and warning services are developed at this research institute. In 2009, a portion of the Finnish Marine Research Institute was merged into the Finnish Meteorological Institute (fmi.fi). In all, 23.5 million euros was used for research expenditure in 2010, with 69% of the amount being covered with budget funding (OSF 2010b).

In 2010, the Finnish Meteorological Institute employed 330 researchers, who produced 257 articles in academic journals and 348 publications in other academic forums (see Tables 3 and 5). Articles were published in, for example, *Atmospheric Chemistry and Physics*, *Annales Geophysicae*, *Boreal Environment Research*, and *Journal of Geophysical Research*. On average, a researcher at FMI produced 1.7 academic publications in 2010. Also, FMI researchers averaged 250 non-academic publications (0.7/researcher), such as publications in the institute's own series.

2.3.3.5 The Ministry of the Environment

The Finnish Environment Institute (SYKE) is operated by the Ministry of the Environment. Established in 1995, SYKE contributes to sustainable development by evaluating it and by preparing initiatives and proposals (environment.fi). Its R&D work covers 34% of its tasks (Lemola 2009). The focus in its research is on climate change, ecosystems, sustainable communities, the Baltic Sea, and inland and aquatic resources. The Ministry of Agriculture and Forestry operates the part of SYKE that deals with water supplies. The institute provides expertise for ministries, industry, municipalities, and communities by performing evaluations and forecasts and by monitoring the state of the Finnish environment (environment.fi). In 2010, its research funding totalled 18.5 million euros. Budget funding covered 61% of the research activities (OSF 2010b).

In 2010, the Finnish Environment Institute employed 254 researchers, who produced 178 academic journal articles and 182 other academic publications (see Tables 3 and 5). Articles were published in, for example, *Science of the Total*

Environment, *Boreal Environment Research*, and *Hydrobiologia*. Other academic publications were articles in edited works and conference proceedings. Academic publishing activity averaged 1.4 publications per researcher. Publishing in other forums is also active. This involved mainly non-refereed articles in Finnish academic and more general forums and the institute's own publications and non-refereed conference-related publications (environment.fi). The researchers produced, on average, 1.1 non-academic publications.

2.3.3.6 The Ministry of Education

The Ministry of Education operates the Research Institute for the Languages of Finland (Kotus). Kotus was founded in 1976. This research institute is a language planning authority steering and developing the Finnish and Finland Swedish standard languages. It co-ordinates the activities of the Sami, Roma, and sign-language boards, compiles dictionaries, and studies languages. Kotus also provides expert services such as linguistic guidance (kotus.fi). The institute estimated that R&D work covered 100% of its work in 2010 (Lemola 2009). However, in a new legal act on research institutes (1403/2011), the research duties of Kotus were delimited from the institute's basic tasks. In 2012, 11 man-years of work was moved from Kotus to the University of Helsinki (Kotus 2010). Accordingly, it is likely that the share of R&D work has decreased since the passing of the new act. Kotus publishes three professional magazines: *Kielikello*, *Språkbruk*, and *Hiidenkivi* (kotus.fi). Total research expenditure in 2010 came to 5.7 million euros. In all, 91% of the institute's research activities were covered by budget funding (OSF 2010b).

In 2010, the research institute employed 80 researchers, who produced eight articles in academic journals and 40 publications in other academic forums (see Tables 3 and 5). The majority of the academic publications were articles in national and international edited works in the field of language studies. Most of the journal articles were published in the Finnish journal *Virittäjä*. Average academic publishing activity was 0.6 publications per researcher in 2010. Publishing for other than academic audiences is vital, and the researchers produced more than 300 non-academic publications in 2010. Articles were published in, for example, the institute's own publication series, in popular magazines, and on Web sites. There were also more than 100 presentations at conferences, seminars, and other events. In all, other than academic publishing activity came to 3.8 publication per researcher.

2.3.3.7 The Ministry of Finance

Operating under the Ministry of Finance is the Government Institute for Economic Research (VATT). It was established in 1990 in the merger of the Ministry of Finance secretariat and the Center for Economic Planning. This research institute produces applied economic research for economic policymaking (vatt.fi). The institute's main focus is on research; this is borne out in the fact that R&D work covers 100% of its tasks (Lemola 2009). The research is divided into three main areas: the effectiveness of public services, taxation and social transfer, and the labour market and policies promoting growth. There is also a unit for policy analysis and modelling, engaged in maintaining and developing economic models and promoting their wider use. The Ministry of Finance, the Prime Minister's office, and other ministries are the main audiences or clients for the research (vatt.fi). In 2010, 81% of the institute's 5.2 million euros in research expenditure was covered by budget funding (OSF 2010b).

In 2010, the research institute employed 49 researchers, who produced 17 articles in academic journals and three publications in other academic forums (see Tables 3 and 5). Refereed articles were published in, for example, *The Finnish Economic Papers*[3], *Scandinavian Journal of Economics*, and *Journal of Population Economics*. Academic publishing activity averaged 0.4 publications per researcher. Publishing for other audiences is also active at VATT. Its researchers produced more than 70 non-academic publications in 2010 (2.1/ researcher), such as reports, working papers, and popular articles. Researchers also made presentations at national and international conferences, seminars, and other events.

2.3.3.8 The Ministry of Justice

The Ministry of Justice is responsible for the National Research Institute of Legal Policy (Optula). Optula was established in 1963 (optula.om.fi). This research institute's main focus is on research. The institute evaluated R&D work as covering 70% of its tasks (Lemola 2009). The mission of Optula is to produce independent research on legal policy for the need of the Ministry of Justice and society, follow judicial conditions and criminality, and analyse and report on their development (optula.om.fi). The core themes of its research projects in 2010 were criminality, the penal system and its reform, the judiciary and judicial conditions, liability and debt collection, and legislation. Researchers also had expert duties related to legal

[3] *Kansantaloudellinen aikakausikirja*

drafting (Optula 2010). Research expenditure in 2010 totalled 1.8 million euros, of which 67% was covered with budget funding (OSF 2010b).

In 2010, the National Research Institute of Legal Policy employed 22 researchers, who produced eight articles in academic journals and 39 other academic publications (see Tables 3 and 5). Most of the journal articles (i.e., six of them) were in national refereed journals. Popular forums for articles are the Finnish journal *Oikeus* ('Justice') and *Lakimies* ('Lawyer'). Two articles were published in international journals, in *European Journal of Criminology* and *International Journal for the Study of Legislation*. Other academic publications were articles in conference proceedings and in edited works. Academic publishing activity averaged 2.1 publications per researcher. Publishing in other forums is active also. Researchers made 32 non-refereed publications such as non-refereed articles, bulletins, reports, and popular articles. Non-academic publishing activity was 1.3 per researcher. The National Research Institute of Legal Policy will be merged into the University of Helsinki in 2015 (Government resolution 2013).

2.3.3.9 The Parliament of Finland

The Finnish Institute of International Affairs (FIIA) operates under the Parliament of Finland. It was established in 1961 (fiia.fi). Research and development work covers 100% of the institute's tasks (Lemola 2009). This research institute's main task is to produce information on international relations and the EU. Three of its research programmes have to do with the European Union, the EU's eastern region and Russia, and global security (fiia.fi). Research is done for the use of the academic community and decision-makers and for engaging in public debate. Information is disseminated via publishing of reports and publishing of the institute's non-refereed journal on research and current international issues (*Ulkopolitiikka*), organisation of domestic and international seminars, and maintaining of a specialist library (fiia.fi). In 2010, total research expenditure was 3.4 million euros, of which 91% was covered with budget funding (OSF 2010b).

In 2010, the research institute employed 32 researchers, who produced three articles in academic journals and seven other academic publications (such as chapters in edited works) (see Tables 3 and 5). Journal articles were published in *The Journal of Contemporary European Studies*, *Journal of Transatlantic Studies*, and *Journal of Environment & Development*. Average academic publishing activity was 0.3 publications per researcher. Publishing for other than academic audiences is active. Researchers published 44 non-academic publications (1.4/ researcher), with the

non-academic publications mainly consisting of briefing papers, comments, working papers, and reports in the institute's publication series.

Table 5: Number of publications produced in state research institutes in 2010 (see references; Publication data)

	Articles in referee journals	Other academic publications	Other publications	Total number of publications/ researcher*
Ministry of Employment and the Economy				
VTT	542	1032	532	1.1
GTK	41	86	114	0.9
NCRC	13	17	85	4.8
Ministry of Social Affairs and Health				
THL	690	85	111	1.5
FIOH	290	153	486	4.5
Ministry of Agriculture and Forestry				
MTT	182	314	1037	5.1
Metla	212	237	433	2.3
RKTL	78	12	219	3.6
FGI	52	32	51	2
EVIRA	56	59	60	1.6
Ministry of Transport and Communication				
FMI	257	348	254	2.5
Ministry of Environment SYKE	178	182	279	2.5
Ministry of Education				
Kotus	8	40	305	4.4
Ministry of Finance				
VATT	17	3	103	2.4
Ministry of Justice				
OPTULA	8	39	28	3.4
Parliament of Finland				
FIIA	3	7	44	1.7
Total	2736	3855	5055	9184
Number of publications/researcher*	0,6	0,8	1	1,9

*Total number of publications is divided with the number of researchers working in each research institute (see Table 3).

3 Scholarly communication

Communication has been portrayed as the essence of science (Garvey 1979) and the life blood of academia (Becher & Trowler 2001). Clearly, communication has a central role in science. Scientific communication is the bridge between the researcher and his environment, to his research colleagues, and with his research field. Scientific communication has also been referred to as selling and buying (Meadows 1974) and in terms of giving gifts (Hagstrom 1965). The researcher 'sells' or gives results as a gift to scientific journals or other media and at least hopes for rewards or recognition from his peers. By accepting the gift, the community recognises the publication and the author as a part of the community. The publication by accepting the gift is read by others and cited in new publications. Thus the publication becomes an element of knowledge for the field, upon which new knowledge can be built. By publishing research results, researchers also 'patent' their study and take credit and, at the same time, responsibility for the study.

In the field of information science, communication has traditionally been categorised into formal and informal communication (Meadows 1974). Formal communication refers to published literature, whereas informal communication is unpublished communication such as conversations. Formal communication is intended to reach a wide audience, while the audience of informal communication is more limited and finely selected. This study focuses on formal communication, by studying publishing and reading practices in state research institutes.

Communication can be seen in two ways. On the one hand, scholars communicate with their peers in the form of scholarly communication that involves publishing and reading of articles in scholarly journals, books, and chapters in edited works. Scholarly communication may be focused on peers in one's own speciality (intraspecialism) or researchers in different specialities (interspecialism) (Bucch & Trench 2008). On the other hand, scholars communicate with larger audiences also, by publishing and reading such material as articles in professional magazines, newspapers, and textbooks.

This literature review is divided into three parts. Firstly, the scholarly communication system is presented in brief. Secondly, empirical studies of researchers' publishing practices are reviewed. The chapter ends with a review of empirical literature examining researcher reading practices. In general, empirical studies have focused more on publishing than on reading practices.

3.1 The scholarly communication system

Journals, monographs, conferences, reports, magazines, and newspapers are communication forums where research results may be published and read[4]. Kling and McKim (1999) have defined three criteria for publication: publicity, trustworthiness, and accessibility. The first criterion, publicity, refers to the announcement of the publication to its primary and secondary audiences. Trustworthiness refers to fulfilling community-specific norms; readers must be able to trust in the content of the publication. Trust can be marked by peer review, publishing house / journal quality, or sponsorship. Also, readers must remain able to access the publication over time. Accessibility is usually guaranteed by libraries, publishing houses, and stable identifiers such as ISBN and ISSN.

Results are most typically written up in article form, and journals have become the main academic communication forum (Nicholas et al. 2010; Puuska & Miettinen 2008; Kyvik 1991). The first academic journals were established in the 17th century, in England and France. Originally, journals were published by learned societies of various disciplines and distribution of volumes was based on trades between the societies. After the Second World War, the status of commercial publishers strengthened and many became academic publishers. With the commercial publishing, the circulation of journals increased (Willinsky 2006, here Lilja 2012).

According to the Ulrichsweb Global Serials Directory, there were 28,325 active, refereed academic journals in 2010, with 20,928 of them available online (Tenopir et al. 2011). Björk and colleagues (2009) have estimated that in 2006 the total number of scholarly articles published was approximately 1,350,000 – and the number of scholarly journals continues to grow (Mabe & Amin 2001). Decades ago, Price (1963) estimated that the number of journals would double every 15

[4] Here only a brief summary of the scholarly communication system is given. For more extensive historical reviews see for example books by Tenopir and King (2000) and Meadows (1974).

years. The emergence of electronic journals and journal databases in the late 20th century had a significant influence on communication. With electronic publishing, the availability of journals has increased dramatically. However, at the same time, the costs of journal subscriptions have been raised beyond the budgets of libraries, creating a 'journals crisis' that has been a central topic in the discussion surrounding the scholarly communication system in the early 21st century. According to the Association of Research Libraries (ARL), expenditure on periodicals has risen 260% and monograph expenditure 66% between 1986 and 2003 (Kyrillidou & Young 2003). In consequence of the crisis, Open Access (OA) publishing was created as an alternative to commercial publication. Open Access publications may involve either self-archived publications in, for example, institutional repositories (green OA) or traditionally edited and peer-reviewed publication in Open Access journals (gold OA) (Borgman 2007).

The quality of scholarly publications varies. Quality is usually controlled by the peer review process, in which referees evaluate the work and give their opinion on whether it should be published or not. For the most respected journals, the article rejection rate may be as high as 90%. It has been noted that the rejection rates of academic journals in the humanities are higher than in the natural sciences and somewhat higher than in the social sciences (Zuckerman & Merton 1971). Although peer review is usually blind[5], it is likely for researchers, especially in narrow specialities, to learn to recognise each other's style of writing, and evaluators can be affected by personal connections. However, peer review has been the only way to control the quality of publications and, regardless of all of its shortcomings, is respected by researchers (Rowlands & Nicholas 2005).

Research evaluation, which has been a central topic since the late 20th century, has increased the importance of scholarly communication (Tien & Blackburn 1996). Individual researchers, research organisations, and countries are evaluated in terms of quantity and quality of publications. In some cases, researchers are rewarded for producing many publications. However, money has not been shown to be a very good motivator for researchers (Jindal-Snape & Snape 2006). In Australia, linking of university funding to publication count led to a significant increase in publication in lower-ranked journals (Butler 2004). Evaluating research by publication count is far from straightforward. Using quantitative metrics in

[5] Peer review can be conducted as single blind, double blind or open. In double blind peer review either the author or the referees do not know each other's identity. In single blind peer review the authors will not know the identities of the referees and in open peer review referees' identity is known to the authors. (Rowland 2002)

evaluation may lead to the point where researchers publish just for the sake of publishing. Simultaneously with the increase in the number of publications per researcher, the number of pages per article has decreased. It has been argued that publishing has become 'fragmented' (Kyvik 1991). However, according to Tenopir and King (2009a), article lengths have decreased in only some disciplines, such as the life sciences.

One way to evaluate the quality of journals is by impact factor (Garfield 1955). Impact factor refers to the average number of citations of articles published in the journal. Impact factor too has been criticised (e.g., Bordons et al. 2002). Firstly, because impact factor varies between disciplines, it can be argued that impact factor cannot be used for comparing journals across disciplines. In the medical sciences, impact factors can rise above 50, while the highest impact factors in the social sciences are around 3. Secondly, the journal impact factor does not necessarily say anything about the impact of any given article in the journal. Journal impact factor is the mean impact of articles in the journal, and the impact of an article varies considerably. One article can increase the impact of the journal, as was seen in 2008 with Acta Crystallographica: the impact factor rose dramatically after one article received more than 6,000 citations (see Grant 2010). Also, journals may attempt to affect impact via such editorial policies as favouring publication of pieces such as reviews that receive many citations (The PLoS Medicine Editors 2006). Thirdly, the use of impact factor assumes that citations are positive, which is not always the case.

More recently "altmetrics" has been introduced for calculating the impact of a single article. Altmetrics refers to calculating the amount of recognition, such as conversations and bookmarks, article receives on the Internet – for example, in social media. Thus, unlike impact factor, altmetrics can take into account impact outside the academy, impact of uncited work, and impact from sources that aren't peer-reviewed. Data can be also collected immediately after publication. However, immediate collection of the data has also been criticised, as it may take time for the quality of the research to be clearly understood. Also the vulnerable nature of social media and usage statistics to manipulation and differences between disciplines and subjects within the same discipline in ability to produce a measurable impact in social media are seen as weaknesses of altmetrics. (Barbaro et al. 2014)

3.2 Publishing

Researchers may publish their research results for their peers in academic publishing forums such as academic journals, edited works, monographs, conferences, etc. In addition to academic audiences, researchers popularise their results for larger audiences such as professionals in the field and the general public. Forums for such publishing include newspapers and magazines, professional magazines, and public research reports. Publishing occurs when a document is 'made public' to be read by others (Borgman 2007). Publishing practices for both academic and other audiences vary, for example, between disciplines, organisations, research context, and individual researchers. Next, empirical studies of publishing practices and factors influencing those practices are reviewed.

3.2.1 Academic publishing

Scholarly publishing has been an important research topic in information studies and science studies since the 1960s (Borgman 2000). Rapid technological development and research evaluation has been one of the reasons for the lively discussion of scholarly publishing seen especially in recent years. Several studies of publishing practices that take into account all major disciplines have been conducted (Puuska & Miettinen 2008; Piro et al. 2013; Tenopir et al. 2012a; Kyvik 1991). As different studies have used different research methods, different kinds of categorisation, and different discipline groupings, results of the studies are difficult to compare. In general, studies have ended up with similar findings. According to the studies in question, articles are the main forms of academic publishing and most articles are published in peer-reviewed journals.

Puuska and Miettinen (2008) studied publishing practices in various disciplines in Finland in 1998–2005 at three Finnish universities. Covering all major disciplines, their research data consist of bibliographic data for almost 75,000 publications from the publishing registers of the three universities. Moreover, 44 professors, from 24 research fields, were interviewed. Puuska and Miettinen (2008) found that 45% of the academic publications were in peer-reviewed journals. Most (80%) of the published journal articles were in international journals. A fifth of the

publications were articles in edited works and 14% articles in conference proceedings. About 18% of the academic publications were articles that had not gone through a peer-review process, such as editorials or review articles. Only two per cent of the publications were academic monographs.

Tenopir and colleagues (2012a) studied scholarly reading and publishing practices at six universities in the UK. Data were collected via a survey (N = 1,102) in 2011 from all major disciplines. In the UK, 81% of the respondents had published at least one article in a scholarly journal within the previous two years and more than half had published at least one article in conference proceedings. One third of respondents had published at least one article in a non-refereed journal and at least one chapter in an edited work. Under 20% of respondents had published at least one monograph.

Many studies (e.g., Lotka 1926; Puuska 2010; Price 1963; Kyvik 1991; Ramsden 1994) have shown that very few researchers produce publications in large numbers. Puuska (2010) discovered in her study of publishing practices of researchers working at Finnish universities in 2002–2004 that 11% of researchers produced 50% of the publications. One third of the researchers did not publish anything in the three-year period examined. In Norway, Kyvik (1991) found that over a span of three years, 86% of academic staff had produced at least one academic publication.

Reasons for differences in publishing activity between individual scholars can be explained by many factors, such as ability, the time available, the resources needed, one's scientific network, and organisational context (Kyvik 1991). Together these factors can be seen as forming a cumulative advantage, the Matthew effect (Merton 1973). The term refers to accumulation of advantages for a small group of people. The Matthew effect can be seen also in citations. Well-known researchers who have published many works are cited more often than are lesser known researchers, regardless of the quality of the work.

3.2.2 Publishing for professional and popular audiences

The scope of research is not limited to the academic world. Research results are also communicated to professional and general audiences. Results for a professional audience may be published in such forms as articles in professional journals or research reports. In addition, research results may not be published at

all. They may be used in patent applications or in confidential research reports for the clients of the study. For more general audiences, research is popularised through such means as textbooks and articles in newspapers and magazines. Some studies have found a decreasing trend in the percentage of publications being produced for other audiences or in other languages than English while, at the same time, that of academic publications has increased (Late & Puuska 2014; Puuska & Miettinen 2008).

Kyvik (2005) has discussed scientists' role as civic scientists. 'Civic scientist' refers to a scientist who communicates research results and makes them public for a general audience. Newspapers, magazines, monographs, and textbooks are the most common forums of publishing for a general audience. Kalleberg (2000, here Puuska & Miettinen 2008) defined two ideal types of civic scientist. First is an expert who disseminates knowledge from a specialist field to the general public but also for colleagues outside the discipline. Second is a citizen acting as an intellectual who brings new issues to the public agenda with the aim of influencing political, economic, social, or cultural issues.

Opinions about publishing results for the general public differ. Some think that this kind of publishing may be harmful for an individual researcher or that these forums can be left for non-scientists, failed scientists, and ex-scientists. However, others say that popularising research topics may be helpful when one is applying for funding. It has also been shown that researchers, as all others do, use media to monitor what is going on in science. (Dunwoody 1986, here Kyvik 2005) Thus, through popular publishing, one's chosen research topic may gain the attention of academic audiences. Either way, the reward system in science does not encourage researchers to publish in general arenas (Kyvik 2005).

Scholarly communication for other than academic audiences has not yet been widely studied. However, in state research institutes, communicating with these other audiences is central. Late and Puuska (2014) conducted a bibliometric study of three state research institutes in Finland in 2007–2008. According to these results, approximately 10% of publications from institutes operating in the technical sciences and health-care sciences were research reports and 15% other, non-refereed articles. In an institute working in the agriculture and forestry field, seven per cent of the publications were research reports and more than 50% non-refereed articles. According to Puuska and Miettinen (2008), approximately 10% of publications by university researchers were for professionals and five per cent for a more general audience. Most of the publications intended for a professional audience and written by university researchers were articles in professional

magazines and research reports. The main forums for popular publishing were newspapers and magazines.

As in scientific publishing there are individual-to-individual differences in popular publishing activity. In Kyvik's study (2001), six per cent of the faculty members published half of the popular publications. Kyvik's study also showed that those researchers who published actively in popular arenas were productive also in academic arenas. Those researchers who published popular articles produced 43% more scientific publications than those who did not publish popular articles (Kyvik 2001).

3.2.3 Factors that influence publishing practices

Researchers' publishing practices are influenced by diverse factors, including discipline and research context. Studies have also found differences in publishing activity and practices between men and women and by age group or professional position. Next, empirical studies focusing on factors that influence publishing practices are presented.

3.2.3.1 Discipline

Studies have found significant differences between disciplines in publishing practices. Individual disciplines have created their own ways to communicate. In general, in the medical and natural sciences, journal-orientation is strongest (e.g., Piro et al. 2013; Puuska & Miettinen 2008; Kyvik 1991). Piro (2013) and colleagues studied academic publishing practices in all major disciplines in 2005–2008, with data collected from a Norwegian database covering all academic publications by researchers working at four Norwegian universities. The dataset contains almost 60,000 academic publications such as journal articles, book chapters, books, and conference papers. According to their study, 90% of publications in medicine and the natural sciences were journal articles. Also in the technical sciences, 70% of publications were journal articles. In the social sciences and humanities, the share of journal articles was 49% and 39%, respectively.

The tradition of publishing at conferences is strongest in technology fields (Puuska 2010; Piro et al. 2013; Puuska & Miettinen 2008; Kyvik 1991). Conferences have different roles in different disciplines. In technology-oriented

disciplines, conference papers are usually treated as a significant form of publications. In other fields, conferences may be places for developing research ideas and papers. In technical sciences, researchers may publish new, improved versions of journal articles in conference proceedings. In contrast, in the natural sciences it is journals that are the primary forum for publication, and most respected journals do not even publish extended versions of articles (Kling & McKim 1999).

The tradition of publishing book chapter and books is strongest in the humanities and social sciences (Puuska 2010; Piro et al. 2013; Puuska & Miettinen 2008; Kyvik 1991). According to the study by Piro and colleagues (2013), a third of the publications in the humanities and social sciences were articles in books and a fifth were academic monographs. In other disciplines, book articles and monographs were considerably less common (Piro et al. 2013). The role of books varies from one discipline to the next. In the natural sciences and medicine, books are seen as summing up the current state of knowledge in the field. In the humanities and social sciences, books are more often written because of the lack of codified language. Explaining research settings, methods, and the right interpretation takes many pages. Also, the pace of development in these fields is not so quick, and there is usually no competition for priority. In addition, if publication is intended to go beyond an academic audience, publications have to be more comprehensive (Kyvik 1991, 71–72).

Studies have also attempted to compare publishing activity between disciplines (Piro et al. 2013; Puuska 2010; Puuska & Miettinen 2008; Kyvik 1991). Comparing activity between disciplines has proved to be very difficult, because of the publishing practices characteristic to each field. One cannot compare the work demanded by writing journal article and that required for a monograph. As a solution to this problem, many studies have used 'article equivalents'. Typically, a monograph has been counted as worth four to five journal articles (Puuska & Miettinen 2008; Puuska 2010; Kyvik 1991).

There are also differences in the number of authors of publications. In general, articles in journals and conference papers are more commonly written by a group while monographs are often written alone (Puuska & Miettinen 2008). Disciplines differ in their practices related to co-authoring. Most of the publications in the natural sciences, medical sciences, and technology are co-authored, while in the humanities and social sciences the situation is the opposite (Kyvik 1991; Puuska & Miettinen 2008). In the so-called hard sciences, experimental research work requires expertise in multiple specialities, so working alone is not necessarily

possible in the way it is in the humanities and social sciences. In fields that require expensive equipment, collaboration for sharing expenses is needed. There is also variation between disciplines in who is included in the authors of a publication. In some cases in the natural and technical sciences and in medicine, the whole research group, project managers, and supervisors may be automatically added as authors while in the humanities and social sciences all of the authors usually participate in the actual writing process (Puuska & Miettinen 2008). However, it has been shown that the number of authors has increased also in the humanities and social sciences, and the death of the 'sole author' practice as predicted by Lotka (1962) a full 50 years ago seems to be taking place (e.g. Kyvik 2003; Puuska & Miettinen 2008; Liu 2003). In any case, the work demanded by writing a journal article alone and with 10 co-authors is not comparable. Therefore, techniques such as 'fractionalisation' have been created. This refers to a number of publications wherein the weight of each article is determined by division by the number of authors. Both article equivalents and fractionalising have produced varying results (Piro et al. 2013), and the problem remains without a good solution.

Regardless of the problems, different studies have come to similar conclusions. If bare publication counts are used, researchers in medical fields and natural sciences are the most productive, followed by those in technology, the social sciences, and the humanities (e.g., Piro et al. 2013; Puuska 2010). However, when co-authoring patterns are taken into account via fractionalisation (dividing the number of publications by the number of authors), social scientists turn out to be the most productive (Piro et al. 2013; Puuska 2010). Using article equivalents produces a similar result (Kyvik 1991).

Professional publishing activity too varies between disciplines. According to the study by Puuska and Miettinen (2008), publishing for a professional audience is most typical in the humanities, social sciences, and natural sciences. Approximately one fifth of all publications in these fields were for professional audiences.

Kyvik (2005) studied publishing for more general audiences in various disciplines at a Norwegian university, using two surveys. According to Kyvik (2005), publishing for a public audience was most commonplace in the humanities and social sciences. From 1998 to 2000, the humanities and social sciences researchers published, on average, more than two popular articles each. Publishing for the general public was least common in fields in the natural sciences and technology. In the humanities and social sciences, research topics are usually more interesting for general audiences than those studied in other fields. Also, differences in reward systems may explain the divergences. Whitley (1984) has

argued that humanists and social scientists may gain reputation value from general audiences and, therefore, are less dependent on specialist colleagues than are researchers in sciences or technology. However, in all disciplines, academic publishing is seen as more important than popular publishing (Kyvik 2005).

Studies have also noticed differences in publishing practices between research fields within disciplines (Kyvik 1991; Piro 2013; Puuska & Miettinen 2008). Research fields and even areas of specialisation within disciplines may have their own communication practices. According to Piro and colleagues (2013), the greatest differences between sub-fields in terms of number of publications were found in the natural sciences. However, according to Kyvik (1991) and Puuska and Miettinen (2008), the greatest variation between research fields was seen in the social sciences and the least in the natural sciences. Puuska and Miettinen (2008) found that writing of monographs and book chapters varied between fields. Also, publishing for national and international and academic and professional audiences varied. For example, publishing practices in biology, agriculture, and forestry differed from those in other natural sciences and the patterns were closer to those in the social sciences. In these fields, publishing for national audiences was also more common than in other natural sciences. In addition, publishing cultures in technical sciences could be divided into two categories: national and international. Those fields whose audience was mainly national industry published mainly in national forums. Fields wherein the main audience was international researchers published more in international forums. Puuska and Miettinen (2008) discovered also that in the social sciences and humanities publishing practices varied greatly between research fields. Most fields used many, quite different publishing forums regularly. Results were published in edited works, national and international journals, monographs, and conference proceedings, and researchers published regularly for professional and public audiences. Also, the number of co-authors varied considerably between research fields (Puuska & Miettinen 2008).

3.2.3.2 Research organisation

Although not many studies compare publishing practices or activity between types of organisations, there is some evidence that work organisation correlates with researchers' work and publishing practices (e.g., Late & Puuska 2014; Tenopir & King 2002; Allison & Long 1990; Long & McGinnis 1981; Cole & Cole 1973). Comparing organisations is difficult, because of lack of comparable data. Also, differences in organisations' discipline structures make comparisons difficult.

Sometimes comparing organisations with different tasks and aims is not even appropriate. Researchers working in, for example, industry do not have the same motivation for writing scientific articles, because of the low promotional value these have in industry. Other forums may play an important role in visibility and promotion.

A bibliometric study of Finnish science based on Finnish papers in the Science Citation Index (SCI) showed that between 1986 and 1998 77 % of Finnish papers were produced by researchers in higher education sector (universities) and 12 % by researchers in state research institutes. (Persson et al. 2000) Another a bibliometric comparison between researchers working at two Finnish universities and three state research institutes in Finland in the fields of technology, agriculture, and public health revealed that researchers working in universities publish significantly more in academic forums than do researchers in similar research fields at state research institutes. For example, the proportion of publications consisting of academic journal articles in the field of agriculture was 42% at universities and 12% at state research institutes. Similarly, in public health, the share of journal articles in university research work was 78% and in state research institutes 65%. However, on average, the articles published by researchers working in state research institutes were cited more often than articles published by researchers at universities. Accordingly, number of publications does not necessarily tell of the quality or impact of the research. Furthermore, researchers in state research institutes published more often in other than academic forums. In consequence, the share of Finnish-language publications at state research institutes was higher than at universities. For example, in the field of agriculture, 30% of publications by researchers working at universities and 58% of publications by researchers working in state research institutes were in the Finnish language (Late & Puuska 2014).

At least some differences between universities and state research institutes can be explained by differences in the nature of the research. In the study by Late and Puuska (2014), university and state research institute directors were asked in a survey (N = 379) about the nature of the research done at the institution. Applied research was significantly more typical in state research institutes than at universities. There were also clear differences in external funding sources between universities and state research institutes. State research institutes obtain more research funding from private companies and ministries, while the main source of external funding for universities was the Academy of Finland (Late & Puuska 2014).

Also, the organisation's status and work atmosphere have been proved to be connected to research productivity. Those working at well-recognised institutes will probably have more visibility (Meadows 1974). It has been shown that those working in prestigious university departments publish more and receive more citations than do those working in lower-ranked departments (Cole & Cole 1973). Also, scientists moving to more prestigious departments improve their productivity while scientists moving to less prestigious institutions show a decrease in productivity (Allison and Long 1990).

Long and McGinnis (1981) studied the effect of organisation atmosphere on research productivity among male biochemists. Their study showed that researchers working in organisations that encourage publishing were more productive than researchers working in other organisations. Researchers at state research institutes encouraging publishing were as productive as researchers in universities. However, those working at state research institutes where publishing was not encouraged were significantly less productive than those working at universities where publishing was not encouraged. Results were similar with respect to the number of citations received. Long and McGinnis (1981) have argued that researchers who want to publish and have done so obtain positions where publishing is encouraged and rewarded.

A creative organisation encouraging of productivity is a sum of many factors. Autonomy of researchers, adequate facilities and funding, development of complementary disciplines and fields, solid management structures, and demonstration of leadership are factors that stimulate creative research environments (Heinze et al. 2009). Hemlin and colleagues (2008) have stated that insufficient basic funding, limited time for research, bureaucratic management, a narrow range of disciplines of expertise, and excessive evaluation and accountability pressures are among the factors decreasing creativity in the workplace. Also, research organisations where researchers communicate across disciplinary and thematic boundaries and where leaders provide strategies for integrating scientific diversity with rigorous standards of scientific excellence are argued to be creative and to make research breakthroughs (Hollingsworth 2002; 2004).

3.2.3.3 Research collaboration and research funding

Publishing practices are also influenced by research co-operation partners and funders. In state research institutes, collaboration with organisations outside the

academic world has been quite common because of the tasks assigned to the institutes. But this is not the case only for state research institutes. During the last two decades, the role of scientific knowledge and technology has been emphasised as an asset for countries (e.g., Etzkowitz & Leydesdorff 2000). Research is more often evaluated by the results' social impact, usability, and applicability. Research organisations have also been encouraged to seek more external research funding also from the private sector (e.g., Aittola & Ylijoki 2005; Hakala et al. 2003). For example, research funding from private companies has increased in all OECD countries since the late 20th century (Geuna 2001).

Increased collaboration between industry and academia is often taken as an indication of a new mode of knowledge production (Gibbons et al. 1994). Whereas mode 1 refers to traditional, academic knowledge production in a discipline-bounded, primarily academic context mainly within a university framework, the new mode 2 refers to knowledge production in a broader, transdisciplinary, social, and economic context. Mode 2 research is tightly knit into the society and private sector. Etzkowitz and Leydesdorff (1997) have discussed a similar phenomenon in their thesis of the 'triple-helix' describing the tightening relationships among universities, industry, and governments.

The shift of knowledge production toward mode 2 has increased the need to collaborate with different organisations and different disciplines (Thornsteinsdottir 2000). By collaboration, researchers may, for example, gain access to special equipment and facilities, special skills, and unique materials (Beaver & Rosen 1978). According to a study by Loikkanen and colleagues (2010), about one third of the Web of Science publications by Finland's state research institutes were produced in co-operation with foreign partners. Also, in most of the institutes, the number of co-operatively produced publications grew between 2003 and 2008. In 1991–2008, there were joint publications with organisations from 117 countries. In all, there has been increasing trend in the share of international co-authored publications in Finland (Persson et al. 2000). Finnish researchers have tended to collaborate especially with their Nordic colleagues (Luukkonen et al. 1992). Also the cross-sector collaboration between Finnish state research institutes and Finnish universities have increased (Persson et al. 2000).

Most studies suggest that research collaboration increases research productivity (e.g., Lotka 1962; Zuckerman 1967; Melin 2000). Rey-Rocha and colleagues (2002) showed that researchers working in consolidated teams were more productive in comparison to those working in non-consolidated teams or without a research team. Research groups may sometimes be more than the sum of their parts,

producing a synergistic effect. Bozeman and Corley (2004) discovered that especially 'cosmopolitan' collaboration patterns – in other words, collaborating with researchers from other universities – are linked to high publication rates. Also, Shin and Cummings (2010) found a relationship with international collaboration and productivity. Fox and Mohapatra (2007) suggest that collaboration may be a result of productivity: productive researchers find each other and collaborate. The relationship between collaboration and productivity is not so simple, however. It depends on how productivity is measured. According to Lee and Bozeman (2005), the number of collaborations correlated significantly with the number of journal articles written by US researchers in the technical and natural sciences. However, when number of journal articles was fractionalised, the number of collaborations no longer predicted productivity.

There are, however, some negatives sides to collaboration. Collaboration with others may take time: one may have to wait for others to do their work, comment, travel, and get in contact. Neither is all collaboration ideal. Especially in the natural sciences, postgraduate and undergraduate students are used as an important workforce. However, collaborating with less experienced researchers may take more time than collaborating with senior researchers or working alone (Lee & Bozeman 2005).

Similarly, research funders and funding may have a significant effect on publishing. Competitive funding systems encourage researchers to publish, because research funding is often hard to obtain without previous publications in prestigious forums. On the other hand, funders may prevent publishing, through confidentiality contracts. This is especially typical in applied technical fields, where collaboration with industry is common (Geuna & Nesta 2003).

Some studies have found a connection between external research funding and publishing productivity (Gulbrandsen & Smeby 2005; Kyvik 1991). According to the studies, the more external funding researchers had, the more they published in both academic and professional forums. According to Kyvik (1991), the correlation between external research funding and publishing productivity was stronger in the natural sciences and medical sciences than in the humanities and social sciences. The correlation held not just for academic funding; those who have had financial support from ministries, municipalities, or industry published more in international forums than did those who had not won such financial support. Also, in Gulbrandsen and Smeby's study (2005), having industrial funding for research was significantly correlated with commercial output such as patents and consulting contracts. In addition, those with industrial funding engaged in more frequent

national and international research collaboration within and beyond the university context than did those with other types of external research funding or no external research funding (Gulbrandsen & Smeby 2005). Gulbrandsen and Smeby (2005), Kyvik (1991), and Jacob (2000) suggest that mode 1 and mode 2 are not two alternative modes of research and that there was not a contradiction between contract research and academic publishing. Gulbrandsen and Smeby (2005) also conclude that industry funding seems to be related to the Matthew effect. Researchers who have managed to gain prestige and research funding may more easily receive industrial research funding too.

Today, it is common for researchers to participate in multiple projects at the same time, and funding is gained for parallel projects. Fox and Mohapatra (2007) found some evidence that researchers working with many projects at the same time are more productive than those who work on a single project. However, in their data, the majority of respondents worked with more than one project and those working with a single project accounted for under 10% of the sample.

3.2.3.4 Research markets

Ylijoki, with her colleagues (2011), studied the effect of research contexts on, among other elements, publishing practices in light of academic capitalism at Finnish universities (see also Hakala & Ylijoki 2001). The concept of academic capitalism refers to the researcher's ability and need to gain external research funding. The authors base their study on two datasets: a survey (N = 255) of university department heads from all Finnish universities and interviews with 31 academics working in Finnish universities in the humanities, the natural sciences, the social sciences, and technology. They discovered five distinct types of research markets (summarised in Table 6) – namely, the academic, corporate, policy, professional, and popular. (Ylijoki et al. 2011)

'Academic market' refers to traditional academic work. The objective is to contribute to the field by offering mainly basic research knowledge. While the academic market is open to all disciplines, it is most common in those natural sciences wherein research funding, research topics, audiences, and publications are strongly linked to the international academic community. In the academic market, results are published mainly in top-ranked scholarly journals and monographs. The academic research market is present in all disciplines: quality of research is evaluated mainly by academic criteria. (Ibid.)

'Corporate market' refers to market-driven research, wherein work is done in collaboration with private companies. Unpublished research reports, conference papers, and patents are the main output of the corporate market. The corporate research market is most common in the technical sciences, where the links to industry are closest in terms of, for example, research funding and topic selection. The corporate market is almost non-existent in the humanities. This market often is invisible in studies of publishing practices. When research results are delivered to the customer in such forms as confidential research reports, 'publication' is not registered in the publication archives where research data for bibliometric studies are often collected. (Ibid.)

In the policy market, the reference group is public administration bodies. The main outcomes are research reports reporting policy-relevant knowledge. 'Professional market' refers to a relationship between research and practitioners such as medicine with medical doctors or jurisprudence with lawyers. The results are professional practices in the form of reports, guidelines, or textbooks. Both policy and professional markets are stressed especially in the social sciences and medicine, where researchers are expected to produce policy relevant to the practitioners. However, practitioners such as medical doctors may also follow academic literature and obtain professional information from journal articles. Traditionally, both policy and professional markets have been important to state research institutes while they are steered by ministries aspiring for knowledge for decision-making and for practical development. (Ibid.)

Finally, 'popular market' refers to the relationship between research and ordinary people. Research results are popularised and societal discussions contributed to, for example, via newspaper articles and essays. In many cases, research may have many, very different audiences at the same time. In these situations, researchers have to report results in many types of forums. The popular market is the most vulnerable research market, because it lacks direct research funding. However, the popular market has a role in all disciplines except technical sciences. This market is related to the motivation of individual researchers to make their research results known to a wider audience. (Ibid.)

Table 6: Key features of five research markets (Adapted from Ylijoki et al. 2011)

Research market	Reference group	Basic objective	Outcomes
Academic market	Scientific community	Contribution to one's field	Top-ranked journals (and monographs)
Corporate market	Companies	Commercial benefit	Unpublished reports, conference papers, patents
Policy market	Public administration	Policy-relevance	Reports
Professional market	Profession	Professional development	Reports, guidelines, textbooks
Public market	Ordinary people	Empowerment	Popular publications

3.2.3.5 Demographic factors

Although it has been highlighted that, because of the collective nature of research, individual determinants have only weak ability to explain research productivity, studies have detected significant differences in publishing activity between men and women and between age groups. Professional position too affects publishing activity (e.g., Piro et al. 2013; Puuska 2010; Kyvik 1991).

Many studies (Aksnes et al. 2011; Puuska 2010; Puuska & Miettinen 2008; Kyvik 1991; Sax et al. 2002; Fox & Mohapatra 2007; Tenopir et al. 2012a; Piro et al. 2013; Lee & Bozeman 2005) have shown that there is a significant difference between men and women in publishing activity. According to these studies, men publish more than women. Puuska (2010) reports that men are more productive than female researchers for all publication types except conference papers, though the differences were not significant in the natural and agricultural sciences. In a study of UK researchers, 62% of female survey respondents and 80% of male respondents produced at least three scholarly publications in a span of two years (Tenopir et al. 2012a). However, some studies have not found differences between genders in publishing activity (Shin & Cummings 2010; Lee & Bozeman 2005; Porter & Umbach 2001; Ramsden 1994).

Either way, studies have noted some differences in work practices between male and female researchers. Female researchers have more administrative tasks and teaching, while men perform more supervision of doctoral students and have more research responsibility (Puuska 2010, Ward & Grant 1996). It has been argued that men and women differ in their styles or modes of publishing. Women are, for example, more cautious and pay more attention to details than men do, which may

affect publishing activity (Etzkowitz & Kemelgor 2001). Family-related factors such as having children or being married have not been noted to have a strong influence on productivity (Sax et al. 2002; Kyvik 1990). Stack (2004), however, discovered that, although children are not a strong predictor of productivity, women with young children publish less.

Another demographic factor affecting productivity is age. Senior researchers have more visibility than younger ones. Meadows (1974) has stated that, on average, the peak of visibility is seen when the researcher reaches the age of 60. More recently it has been shown that the average peak of productivity has been around forty to fifty years of age (Bonaccorsi & Daraio 2003, Kyvik 1990). Some studies have found differences between disciplines. Researchers in the humanities and social sciences may remain productive longer than researchers in other disciplines do (Kyvik 1990, Aksnes et al. 2011).

Professional position is a third individual factor with an effect on publishing activity (Puuska 2010; Tien & Blackburn 1996; Meadows 1974; Piro et al. 2013). In general, professors publish the most and doctoral students the least. The high productivity of professors could be explained by the Matthew effect. Advantages accumulate for talented and ambitious scholars. Professors may also have more publishing possibilities when acting as supervisors of doctoral students. In some disciplines, it is common practice for the supervisor to be a co-author no matter the actual contribution to the specific paper in question (Puuska & Miettinen 2008).

3.3 Reading

In this section of the chapter, empirical studies examining scholarly reading practices and factors influencing these practices are reviewed. Firstly, studies focusing on reading practices and similar activity involving scholarly literature are presented. Secondly, reading practices related to other than academic publications are presented. Finally, empirical studies focusing on the impact of various factors – such as discipline, work organisation, and the researcher's personal characteristics – on reading practices are presented.

3.3.1 Reading of academic literature

Several reviews of literature on scholarly reading practices have been published this century. King and Tenopir (1999) offer a comprehensive review of studies about using and reading scholarly journals. In their reviews, Jamali and colleagues (2005), Tenopir (2003), and Rowlands (2007) focus on the use of electronic resources such as e-journals. These reviews together form the main stream of research addressing scholarly reading practices.

King and Tenopir have studied scholarly reading practices since the 1970s (e.g. Tenopir & King 2000, Tenopir & King 2004). Their research has focused on researchers working in universities and other research institutions. The latest study following King and Tenopir's research tradition was done in the United Kingdom by Tenopir, Volentine and King (2012). Scholars' reading practices were studied at six universities in all major disciplines. As in Tenopir and King's earlier studies, research data were collected via a survey (n = 2,117). Unlike earlier studies, this one included, in addition to journals, also books and other materials such as government documents, magazines / trade journals, and conference proceedings. The results of the study have been reported in journal articles (Tenopir et al. 2013; Volentine & Tenopir 2013; Tenopir et al. 2012b; Tenopir & Volentine 2012). Here I refer to the research report (Tenopir et al. 2012a) published on the results of the overall study.

According to the study by Tenopir and colleagues (2012a), the average academic staff member spends 37 hours a month on scholarly reading (the equivalent of 56 eight-hour work days a year). Niu and Hemminger (2012) obtained similar results in their study of scholars working at five universities in the United States: scholars spent, on average, 11 hours per week on reading.

Journals are the most commonly read publication type. According to Tenopir and colleagues (2012a), 78% of respondents used journal articles as their last information sources. Respondents used 18 hours per month to read journal articles and read approximately 25 journal articles a month and 267 articles in the course of a year. When the results were compared to those of earlier surveys by Tenopir and King, a continual increase since 1977 can be seen. In 1977, US scientists and social scientists read, on average, 150 articles a year. Other studies have shown similar results (Boyce et al. 2004; King et al. 2003). One reason for the increase in reading is probably the greater availability of journals through online access (King et al. 2003; Voorbij & Ongering 2006). However, it seems that the number of articles read has grown simultaneously with a decrease in the amount of time spent per

article. According to the earlier study in the US, there is a declining trend in the latter (Tenopir et al. 2009a). From 1977 to 2004, the time spent on reading one journal article fell from 48 minutes to 31 minutes.

Although scholarly journals are the most important information sources, researchers read varied scholarly materials. In Tenopir and colleagues (2012a) study, 12% of respondents used books or book chapters as their last information sources. Respondents engaged in, on average, seven book readings a month and 84 readings per year. Reading was defined as reading a portion of the book, such as skimming or reading of a chapter. One book-reading occasion took approximately 23 minutes. The main purposes in reading a book or chapter were for research and for writing and teaching.

CIBER[6]'s studies (e.g. Rowlands & Nicholas 2006; Rowlands & Nicholas 2005) of scholarly reading practices have shown that reading practices in a digital environment are very different from what has traditionally been known about reading. According to their studies, scholars have moved from vertical to horizontal reading; scholars view many materials but each only for a short time. According to log data, scholars do not read on the Web. Typically only the span of a few minutes is spent on one site. It can be assumed that most of the articles are printed for reading. However, not all articles downloaded or printed are read. Most of the downloaded articles are never read, merely archived for later use. Nicholas and Clark (2012) have described scholars' behaviour in the digital environment as bouncing, flicking, and skittering. Scholars do not stay long with one article; rather, they look at many articles in a short period. Nicholas and Clark (2012) describe the phenomenon as power browsing in which users try to get a grip on the information overload.

Because of the large number of articles published every year, some articles are read widely while others are read by almost no-one. Nicholas and colleagues (2010) found that 30–50% of page views in the ScienceDirect database focus on five per cent of journals. For handling large quantities of data and to avoid extensive reading, scholars read strategically. A scholar may work with many articles at the same time, to search, filter, compare, arrange, link, annotate, and analyse fragments of content. For avoiding unnecessary reading, scholars use citations, abstracts, literature reviews, social networks (colleagues), students, and alert services to identify important pieces of literature (Renear & Palmer 2009). One cannot read every article published. The fairly well-established structure of scientific articles

[6] CIBER research Ltd. is a research group focusing on behavior in the digital environment, http://www.ciber-research.eu

enables researchers to identify the key components of an article, such as the outline of its contents, references, figures, formatted lists, equations, and scientific names (Bishop 1999).

Studies have focused also on reasons for reading. In Tenopir and colleagues study (2012a), the main purpose found for reading article was for research and writing. Other key purposes for reading were teaching, current awareness, education for oneself, presentations, and consulting. Researchers also monitor the progress of colleagues and competitors. In addition to collecting information for ongoing research projects, researchers may compile information about new and evolving research areas (Palmer et al. 2007).

3.3.2 Reading of other types of publications

Scholars read other than scholarly publications too. For example, The New York Times was cited six thousand times in academic papers in 2010 (Hicks & Wang 2013). Also, in Tenopir and colleagues's (2012a) study, respondents from six UK universities reported, on average, 12 readings per month of other than academic publications, such as technical or government reports, articles in trade journals, conference proceedings, blogs, and Web sites. Respondents spent approximately 42 minutes on reading these publications. Research and writing and maintaining current awareness were the main purposes stated for the reading. Less typical purposes were teaching, self-education, administration, consulting, engagement activities, and preparation of presentations. (Ibid.)

There is also a correlation between types of reading. In the UK, researchers who spend more time per book-reading occasion also spend more time per occasion of article reading and reading of other publications. There was also a correlation between amounts of reading of individual publication types. Respondents who read more academic articles read more books and other publications too. (Ibid.)

3.3.3 Factors influencing reading practices

As are publishing practices, scholarly reading practices are influenced by various factors, including discipline, work organisation, and the nature of the work. Reading practices and amount of reading activity differ significantly also between individual researchers. Next, empirical studies exploring the influencing factors are presented.

3.3.3.1 Discipline

Many studies have revealed differences between disciplines in reading practices (King & Tenopir 1999). At least some differences are related to publishing practices in individual disciplines. Reading scholarly journals is most common in the natural and medical sciences. In technical sciences, researchers rely more on technical reports and personal contacts instead of scholarly journals. Reading of conference proceedings too is most active in the technical sciences. In the social sciences and the humanities, researchers read more monographs than do researchers in other disciplines. Researchers in the social sciences and the humanities are also the most active readers of other than academic literature (FinELib 2012; Tenopir & al 2012a; King & Tenopir 1999).

The National Electronic Library of Finland, FinELib (2012), conducted a survey (N = 3,830) of researchers working at universities and 39 other research institutions (including state research institutes) in Finland in 2011. Respondents were asked to indicate their frequency of reading various types of publications. International academic journals were the most frequently read publication type. The majority of respondents in every discipline read international journals at least weekly. National academic journals were most frequently read in the health sciences and social sciences. One third of the respondents read academic monographs at least weekly. Respondents representing the humanities were the most frequent readers of academic monographs. Most of the respondents representing the humanities read monographs at least weekly. In spite of the improved opportunities to read books in electronic form, most respondents used printed books. Almost 25% of the respondents read conference proceeding at least weekly. Conference proceedings were read most frequently in the technical sciences, where the majority read them at least weekly. The survey measured frequency of reading of research reports and handbooks and textbooks too. Overall, a quarter of the respondents read research reports weekly. Respondents

representing the social sciences read research reports more frequently than respondents from other disciplines did. One third of the respondents read textbooks and handbooks at least weekly. More than half of the humanists read textbooks and handbooks weekly. (FinELib 2012)

There is also a difference between disciplines in the extent of using literature from other fields. Originally, Mote (1962, here Talja & Maula 2003) drew a high/low distinction between domains on the basis of the scatter of the literature. In disciplines where scatter of the literature is great, literature is used from several disciplines. In disciplines in which the scatter is low the core literature can be found in specialist journals. It is quite clear that in interdisciplinary fields researchers reading is spread more across various research fields (Meadows 1974). According to the study by FinELib (2012), in general, 61% of respondents read publications at least from other disciplines to some extent. Respondents representing the humanities and social sciences used more publications from other disciplines than did those in other fields. This was also more common at universities than at other research institutions. (Ibid.)

3.3.3.2 Research organisation

Also, the organisation where the researcher works affects reading practices. Tenopir and King (2002) showed that researchers working at universities are more active readers than are those working in government laboratories and private companies (King & Tenopir 1999). On the basis of log analyses, Nicholas and colleagues (2010) found that there was a significant difference between UK universities and government laboratories in the use of the ScienceDirect database. Use of this database was considerably lower in government laboratories than at universities. According to FinELib (2012), the availability of library electronic materials from other organisations is significant. Researchers working in smaller organisations perceived availability as weaker than did those working in larger organisations (FinELib 2012).

3.3.3.3 Other factors

Reading habits are influenced by the practices typical of the discipline but also by the researcher's personal characteristics. It has been noted that some researchers read a large amount while others do not (King & Tenopir 1999). Those reading in

large amounts are called 'stars' or 'gatekeepers' of the organisations. Stars may read twice as much as the average readers and pass on the information they have gained (Meadows 1974; King & Tenopir 1999). For a number of studies, there was a correlation between reading and publishing (Tenopir et al. 2012a; Tenopir et al. 2008; King et al. 2009; Tenopir et al. 2009b). In general, successful scholars, those who publish more or who have earned an award in the past two years, read more of all types of scholarly materials. Reading multiple types of materials had positive outcomes often, such as inspiring new thinking and improving results (Tenopir et al. 2012a). Tenopir and King (2007) showed that researchers perceived their work as being of higher quality when they read. For example reading inspired new ideas and thinking and improved research results. Only few times researchers reported reading as waste of time or as unhelpful.

Tenopir and colleagues (2012a) discovered some differences in reading practices between researchers working in different professional positions. Compared to those in other positions, associate professors read the most articles and senior lecturers the least. On the other hand, lecturers reported the most book readings while research associates reported the fewest. As for other materials, senior lectures and associate professors reported most readings and spent the most time on reading.

Scholars' age was another element connected to reading activity. Respondents under the age of 30 read the most articles and respondents over 50 years the fewest. The correlation between age and the number of book readings was the opposite. Older respondents engaged in more book readings than did younger ones. However, time spent on reading decreases as the respondent's age increases. Age has an influence also on the principal purpose behind the reading. Younger respondents read more likely for research and writing, while respondents in their forties were more likely to read for teaching purposes than were those in other age groups. (Ibid.)

According to Tenopir and colleagues (2012a), the nature of the work too had a significant influence on reading practices. Article reading was connected especially to research work. Respondents who spend more than 50% of their work time on research and writing read more articles in comparison to those spending less time on research and writing. Book reading was connected to teaching in particular. Respondents who used most of their work time for teaching read more books than did those who spent less than half of their time on teaching.

4 Cultural shaping of scholarly communication

As shown above, communication practices differ greatly between disciplines. Differences between disciplines are partly due to the differences between the academic cultures of the disciplines. Academic disciplines have created their own cultures, which are shaped by social and epistemological features (Becher 1989). Becher and Trowler (2001, 23) define culture as 'sets of taken-for-granted values, attitudes and ways of behaving, which are articulated through and reinforced by recurrent practices among a group of people in a given context'. In other words, a scientific culture is commonly shared practices of people working, for example, in the same discipline.

One of the first notions of academic cultures was that of C.P. Snow, from his famous lecture 'The Two Cultures (1959) at the University of Cambridge. Snow introduced his thesis about the split of intellectual life in Western societies into two cultures: the sciences and humanities (Becher 1989, xi). Later, Snow discussed the emergence of a third culture, the social sciences (Snow 1993, here Ylijoki 1998, 33). Later, in the field of sociological studies of sciences, cultural characteristics in different disciplines and the organisation of the sciences have been defined (e.g., Kuhn 1970; Price 1963; Zuckerman & Merton 1971; Biglan 1973; Kolb 1980). More recently, Becher (1989) and Whitley (1984) have studied scientific cultures and defined cultural factors affecting fields' behaviour. The theoretical framework of this study is based on the work of these two authors, whose theories, with their basic concepts, are presented next.

4.1 Academic tribes and territories

Becher (1989, second edition with Trowler 2001), in his book Academic Tribes and Territories, defines cognitive and social dimensions of academic cultures. By 'academic tribes' Becher refers to cultures within academic communities and by 'territories' to the ideas and knowledge produced by the community. The study was

based on literature and interviews with more than 200 researchers in the USA, Canada, and England from all major discipline groups. Becher created a categorisation for disciplines according to their cognitive and social characteristics.

4.1.1 Cognitive dimensions

The first part of Becher's study is an attempt to categorise disciplines into broader discipline groups. Cognitive dimensions describe the territories of science that focus on the nature of the knowledge produced in the discipline. Salter and Hearn (1996) have defined characteristics related to what constitutes a discipline. A discipline is a community of scholars studying topics from a certain perspective and with certain methods, having its own communication forums, such as specific journals and conferences. Disciplines are institutionalised as university departments, research councils, and societies. As a unit of analysis, they are troublesome, because they embrace a wide range of sub-specialities. Some specialities within a given discipline may have very little in common culturally while at the same time sharing cultural similarities with a speciality outside the discipline (Becher & Trowler 2001; Fry & Talja 2004). Specialities are less formalised than disciplines. Although they may have their own communication arenas, they are seldom recognised institutionally (Fry 2003).

Becher's categorisation cannot take into account differences between sub-fields. Accordingly, Becher and Trowler (2001, 39) point out that some disciplines are more difficult to classify than others and taxonomy is useful only at a broad, general level of analysis. Regardless of the difficulties, Becher's categorisation has been used in recent years in explaining disciplines' differences in communication and publishing practices (e.g., Puuska & Miettinen 2008; Kautto & Talja 2007; Fry 2003). Categorisation is needed when communication practices are compared between disciplines.

Based on the studies by Kolb (1981) and Biglan (1973), Becher (1989) classes disciplines along their cognitive dimensions, into hard and soft but also pure and applied. This categorisation creates four basic groups of 'knowledge domains', referred to as 'hard-pure', 'soft-pure', 'hard-applied', and 'soft-applied' (these are summarised in Table 7).

Table 7: Becher's discipline groupings (adapted from Becher & Trowler 2001, 36)

Group	Knowledge	Culture
'hard-pure' Physical Sciences (e.g. physics)	Cumulative; atomistic (crystalline/tree-like); concerned with universals, quantities, simplification; resulting in discovery/explanation	Competitive, gregarious; politically well organised; high publication rate; task oriented
'soft-pure' Humanities (e.g. history) & Pure Social Sciences (e.g. anthropology)	Reiterative; holistic (organic/river-like); concerned with particulars, qualities, complication; resulting in understanding/ interpretation	Individualistic, pluralistic; loosely structured; low publication rate; person oriented
'hard-applied' Applied Sciences (e.g. mechanical engineering)	Purposive, pragmatic (know-how via hard knowledge); concerned with mastery of physical environment; resulting in products and techniques	Entrepreneurial, cosmopolitan; dominated by professional values; patents substitutable for publications; role oriented
'soft-applied' Applied Social Sciences (e.g. education)	Functional, utilitarian (know-how via soft knowledge); concerned with enhancement of [semi-] professional practice; resulting in protocols and procedures	Outward looking; uncertain in status; dominated by intellectual fashions; publication rates reduced by consultancies; power oriented

4.1.1.1 Hard-pure fields

The nature of knowledge in hard-pure fields is cumulative and atomistic. The research is cumulative and progressive. The atomistic nature of the knowledge makes it possible to divide a research question into separate sub-questions. The hierarchy of research topics is commonly shared among the researchers, and this usually makes the decision on what research questions are the most important ones to study an obvious one for the researchers. The nature of the knowledge is usually universal, and research methods are mainly quantitative. In hard fields, methods tend to determine the choice of problems, while in soft fields the problems determine more typically the choice of methods. Research topics in hard-pure fields are anonymous and value-free. There are clear criteria for judging the significance of research. Research results are usually discoveries and explanations.

Physics and chemistry are examples of hard-pure disciplines (Becher & Trowler 2001, 25–26).

Publishing research results for an academic audience is a vital part of researcher work in hard-pure fields. Results are usually published as journal or conference papers, allowing one to publish as quickly as possible. The share of monographs is small and the pace of publishing rapid. In some fields – for example, in biochemistry – researchers may publish 10–15 articles in a year. However, in fields such as mathematics, researchers may publish considerably fewer articles but longer ones. (Ibid., 110–114).

4.1.1.2 Hard-applied fields

Technical sciences are categorised as hard-applied sciences. The nature of the research is pragmatic and purposive. This research is interested in mastering of the environment. Research approaches are often heuristic-oriented, and both qualitative and quantitative methods are used. Unlike in pure research, practice is at the core of the research and the results often consist of products and procedures. Research is evaluated in terms of the functionality of the products and protocols produced in the studies. Applied knowledge is more often open for external influences, while pure knowledge is more self-regulating (Becher & Trowler 2001, 36). In hard-applied fields, the publishing forums vary. Results may be published as technical reports, patents, and conference proceedings or in journal articles, depending on the topic and the audience of the research. However, publishing is not as important in applied fields as in pure fields, because the research in the former is not theoretical. Especially when research is done for private companies, results are not necessarily published at all. (Ibid., 110–114)

4.1.1.3 Soft-pure fields

The humanities and pure social sciences are placed in the soft-pure category. The knowledge produced is of a holistic nature. Researchers may study the same topic over and over again. This research is interested in details, and qualitative methods are often used. Unlike in hard sciences, research here is usually value-laden and personal. There is no common agreement about the central research topics and questions within research fields. Results bring usually understanding and interpretation of the questions (Becher & Trowler 2001, 36). In soft-pure fields,

research results are usually published as monographs and in long journal articles. Research topics are discussed comprehensively. The speed of publishing is low, and researchers may publish only one or two articles a year, writing a monograph at the same time. (Ibid., 110–114).

4.1.1.4 Soft-applied fields

Applied social sciences (such as education or law) form the last category, soft-applied. Knowledge in soft-applied fields is functional and utilitarian. Practice is at the core of the research. Case studies and study of practices are typical research approaches here. The research results take the form of protocols and procedures (Becher & Trowler 2001, 39). In soft-applied fields, the most commonly used publishing forums are journals and monographs. Results are usually published for both scientific and professional audiences. (Ibid., 110–114)

4.1.2 Social dimensions

Becher (1989) discusses also the social dimensions of academic cultures. While cognitive dimensions involve a focus on knowledge territories, social properties are related more to academic tribes and the key features of academic communities. Social dimensions describe the common atmosphere, unwritten rules, and work practices of the fields in question. Cognitive and social dimensions are not in contradiction. Examining different dimensions brings different perspectives on academic culture. Becher emphasises that some cultural features can be seen more clearly through the lens of social observation and some through cognitive observation.

Becher introduces two pairs of concepts to categorise fields by their social nature: convergent/divergent and urban/rural. These refer to the extent of coherence, the nature of the research problems, and the work practices within the fields. As with cognitive dimensions, differences in space and time in grouping of the disciplines by the social dimensions are possible (Becher & Trowler 2001, 58–130).

Becher uses terms such as ‘convergent’ and ‘divergent’ to describe coherence in the field. Convergent fields are coherent, introspective, and administered strictly by their own rules. It is hard for outsiders to enter the field and even harder to make

contributions to the field. Researchers are 'patriotic', loyal to the field, and often interpret criteria and rules fundamentally. It might be fatal to one's academic career for a researcher to break these rules. Studies that do not follow the rules and established criteria with respect to elements such as research data, materials, or methods are likely to be rejected. The researchers base their studies mainly on research and theories from their own field, and researchers also publish their results mainly in journals within their own field. Both hard and soft disciplines can be recognised as convergent fields. (Ibid., 58–59, 110) Becher takes economics and physics as examples of convergent fields. In economics, 'those who question the basic axioms of the subject are liable to find themselves cast into a wilderness of their own' (ibid., 59).

Divergent fields are the opposite of the convergent. Divergent fields do not have strict boundaries, and researchers are independent of each other. They may even consider themselves to be representatives of other fields. There are few shared rules about research practices within the field. Researchers in divergent fields may publish in many, quite different forums, in different fields, chosen on the basis of the research topic and audience. Geography is an example of a divergent field. In geography, researchers absorb ideas and techniques from neighbouring fields and might publish via journals and conferences of other fields. (Ibid., 59, 110) Other examples of divergent fields are law, biology, and chemistry (ibid., 58–60, 187).

Becher's second pair of concepts, urban/rural, describes the 'lifestyle' of the field. 'Urban' fields move rapidly in their contributions and development. The studies usually focus on narrow problems, and the outcomes are solutions for a short time span. Urban fields have a high people to problem ratio. In other words, researchers in large numbers focus only a few topics. Research is organised into research groups, which compete with each other for resources and in publishing the results. Because of the fast development, results are usually published in journals or conference proceedings. (Ibid., 103–111)

'Rural' fields are set in opposition to urban fields. Researchers in rural fields focus on broad problems, and a researcher may spend years with a single research topic. The people-to-problem ratio is low. Results are usually published as monographs or longer journal articles, mainly because of the scope of the research. Competition is very rare, because there are so many topics that researchers do not have to pick a problems that is already under research. Also, the same topic can be studied from different perspectives. The only purely urban field, according to

Becher, is physics. (Ibid., 103-111) In general, what Price (1963) calls 'big sciences' are closer to urban while 'little sciences' are similar to the rural.

4.2 The intellectual and social organisation of sciences

Whitley also (1984, second edition 2000), in The Intellectual and Social Organization of the Sciences, explains cultural differences between scientific fields. Whitley (2000) describes the nature of modern disciplines as involving 'particular kinds of coordination and control systems: reputationally controlled organizations'. According to Whitley organizations produce knowledge in a competitive environment, gaining intellectual reputation for published contributions judged by colleagues and competitors.

For comparison of scientific fields as particular kinds of organisations, Whitley proposes two factors: mutual dependence and task uncertainty. Both concepts integrate epistemological and social considerations of intellectual fields. Each factor may have a high or low value. Whitley argues that a high degree of one factor usually leads to a low degree of the other. For example, it is unlikely for a field to have high mutual dependence and high task uncertainty. Whitley discusses 'intellectual' or scientific fields rather than disciplines. This theory can be used for comparisons between fields and also for studying one field in space and time. (Ibid.)

By mutual dependence Whitley refers to 'scientists' dependence upon particular groups of colleagues to make competent contributions to collective intellectual goals and acquire prestigious reputations which lead to material rewards' (ibid., 87). In fields that exhibit high mutual dependence, researchers work with a certain group of specialist colleagues and focus on a certain audience for gaining resources and reputation. The researchers share the same standard of competence and criteria for proving the significance of the results. Organisational boundaries and identity are strong. Increasing mutual dependence leads to competition for reputation and control over the direction of research. Whitley cites physics as an example among the fields engaged in high mutual dependence. In general, mutual dependence is higher in natural and medical sciences and lower in the social sciences and humanities. Whitley (2000, 81–91) presents two types of mutual dependence, 'functional dependence' and 'strategic dependence'.

Functional dependence refers to the degree to which researchers rely on the same knowledge and follow the same criteria, methods, and standards within the field. A high level of functional dependence is seen when researchers share the same standards and knowledge base. Studies that do not apply the shared standards, methods, or materials and do not fit in with existing knowledge are unlikely to be published. (Ibid., 81–95)

Strategic dependence refers to the degree to which researchers have to confirm the significance of their research, methods, and approaches for their colleagues. When strategic dependence is high, researchers compete and argue about the best strategies and approaches and aspire to influence each other's choices. Influencing research agendas is a political activity and determines allocation of resources and organisational arrangements. (Ibid., 87–95)

Whitley uses the concept of task uncertainty to describe the coherence of the field. By task uncertainty Whitley refers to the nature of research problems and research methods and to metrics and predictability of outcomes. The term also refers to the extent to which problem definitions and theoretical goals are shared within a field. Production of new knowledge is dependent on current knowledge. A systematic and precise knowledge base enables clear criteria for significance and novelty of results. If the existing knowledge is coherent and widely shared within the field, task uncertainty is likely to be lower. Whitley cites physics and chemistry as examples of fields having low task uncertainty. Sociology and ecology are examples of fields that have high task uncertainty. (Ibid., 119–120)

Whitley divides task uncertainty into 'technical task uncertainty' and 'strategic task uncertainty'. Technical task uncertainty refers to the use of methods within the field; when technical task uncertainty is low, researchers know how to use a certain method in a certain place and know how to interpret the results. When technical task uncertainty is high, personal control over research – and local variations in work goals and processes – increases. Researchers rely on personal networks instead of broader scientific audiences. When technical task uncertainty is high, researchers publish more monographs, because researchers' personal choices must be explained in more detail (cf. rural fields). (Ibid., 121–123)

Assessing strategic task uncertainty refers to measuring the degree of standardisation of research co-ordination, strategy, and common goals. When strategic task uncertainty is high, the researchers do not share the same goals or criteria. In these fields, the diversity of research problems is high and control over significance criteria is limited. With low strategic task uncertainty, research is more

stable and coherent, because researchers then target the same goals and share the same criteria. (Ibid., 123)

Fry and Talja (2004) have investigated the usability of Whitley's theory for study of information behaviour. They defined typical information behaviour characteristics in fields that display opposing identities in Whitley's taxonomy: a high degree of mutual dependence and low degree of task uncertainty and vice versa. Fry and Talja emphasise that the dichotomy should not be read as a distinction between the natural sciences and humanities so much as used to compare specialities within and across disciplines and groups of disciplines.

Fry and Talja (2004) have argued that in fields of high mutual dependence and low task uncertainty, journal articles are preferred as publication forums. Literature reviews in such fields are formalised, and contributions are fitted in with existing research. Relevant material is concentrated within core disciplinary resources. On the other hand, when mutual dependence is low and task uncertainty is high, the publication forums are more varied and results are published via monographs, conference proceeding, journal articles, and 'grey literature' such as personal Web pages. High levels of task uncertainty will lead to greater emphasis upon local and informal communication and co-ordination processes. When research methods and significance criteria are not standardised, reporting of results must be elaborate and convince readers of a certain interpretation. Literature reviews are based on choice of theory and discourse communities. Researchers are also able to make contributions in pursuit of diverse goals without needing to discuss specific results and ideas in light of earlier studies in a systematic way. Relevant literature can be found in, and is produced across, diverse disciplines and publishing forums.

4.2.1 Contextual factors and academic cultures

In addition to the social organisation of the sciences, Whitley (2000) discusses the influence of contextual factors on mutual dependence and task uncertainty. Whitley identifies three contextual factors: reputational autonomy, the concentration of control over the means of intellectual production and dissemination, and audience plurality and diversity.

Reputational autonomy refers to the ability of the scientific field to control the research methods, significance standards, the characterisation of the domain, its problems, and the descriptive language. According to Whitley (2000, 220), 'sciences

manifestly do differ in the extent to which their leaders are able to decide how well a piece of work was done without reference to employers' criteria or the views of other groups, and these differences are related to the degree of co-ordination and comparison of task outcomes in scientific fields'. Therefore, reputational autonomy is related to the extent to which the research methods are unique to the field and to the extent to which researchers from other fields or 'amateurs' are able to make contributions to the field. Reputational autonomy is also related to the ability of external groups to influence research questions and strategies, along with significance standards. Reputational autonomy decreases when other fields and professionals from outside academia (e.g., laypersons) are able to influence the field's behaviour. This is the case when, for example, the central research phenomenon or what is 'in' or 'out' has been defined by non-scientific groups. Research funders and other professional groups who can determine areas of research focus can prevent reputational autonomy. (Ibid., 221–227)

Concentration of control over access to the means of intellectual production and distribution is another important aspect of research context, according to Whitley. By this Whitley means the centralisation of control over, for example, jobs, facilities, funds, and journal space. When a small group from a small number of employment units and research sites can dominate the field, control is centralised. Also, when, for example, major resources are concentrated with one funding source, a few elite research organisations dominate the field, or one journal is much more highly valued than other communication channels, concentration increases. Control is centralised also when those at the top of the hierarchy can determine who does what, in what way, and when. Control decreases when, for example, researchers are able to apply for research funding from various sources for their work. When scientists are able to pursue their own research strategies and gain resources for research, concentration of control is lower. (Ibid., 227)

Audience structure is a third contextual factor defined by Whitley. This factor refers to the number and variety of distinct audiences a scientific field has. Whitley takes the biomedical sciences as an example. In the biomedical sciences, results may be published in various journals, oriented to different audiences, including scientists, members of administration, and medical doctors. When audience diversity is high, the field is usually weakly bounded and theoretical integration is unlikely to be high. Audience variety is likely to be lower when the scientific field has a limited number of specialist groups and shared intellectual goals. In, for example, physics, audiences are more limited and usually it is quite clear in which journal results may be published. Also, the equality of audiences is a critical factor.

A scientist may have a number of audiences, but some of them might be more important than others. Publications reaching the most important audience are often more prestigious. In fields wherein audiences are equal, competition for attention in such terms as journal space is relatively low, because of the wide variety of publishing forums. (Ibid., 234–235)

Contextual factors have an impact on both mutual dependence and task uncertainty. Fields showing low mutual dependence are more likely to have decreased reputational autonomy and concentration of control. Also, when reputational autonomy is low and there are diverse funding agencies and audiences for the research, task uncertainty is likely to be considerable. (Ibid., 147)

4.3 Synthesis of Becher's and Whitley's concepts

When one analyses Becher's and Whitley's concepts, common characteristics can be found (see Table 8, partly adapted from Fry 2003, 26). A low level of mutual dependence and high level of task uncertainty can be connected to rural and divergent fields. These factors share the sense of a wide spread of research problems, methods, and significance criteria. Researchers may use literature produced in other fields and publish their research results in works focusing on different disciplines and for different audiences. The research is personal and done by individuals or loosely knit groups. Accordingly, the researchers are highly dependent on knowledge produced in other fields but not dependent on other researchers. Collaborating with lay and professional audiences is likely, research funding may be obtained from different sources, and research is done for various audiences.

At the same time, there are connections between a high level of mutual dependence and low level of task uncertainty with urban and convergent fields. These factors share the idea of a well-organised and coherent field. Research is done mainly in the area of one's own discipline. In the relevant fields, the pieces of research (and researchers) are more dependent on each other and follow the same criteria in their selection of research topics and research methods. Research is probably done in an academic context through centralised research funding, to serve a specific research audience.

Table 8: Connections between Whitley's and Becher's dimensions, adapted in part from the work of Fry (2003, 26).

<table>
<tr><td colspan="2">Mutual dependence
"extent of dependence upon other fields or particular colleagues to make competent contributions"</td></tr>
<tr><td>Degree of functional dependence
Low ↔ High</td><td>Degree of strategic dependence
High ↔ Low</td></tr>
<tr><td colspan="2">Divergent Convergent Divergent
"extent of uniform standards and procedures and the existence of intellectual control"</td></tr>
<tr><td colspan="2">Rural Urban Rural
"extent of people-to-problem ratio, scatter of research problems and nature of outcomes"</td></tr>
<tr><td>High ↔ Low
Degree of technical task uncertainty</td><td>Low ↔ High
Degree of strategic task uncertainty</td></tr>
<tr><td colspan="2">Task uncertainty
"extent to which work procedures, problem definitions and theoretical goals are shared between researchers"</td></tr>
</table>

In relation to the same dichotomy, Kuhn (1970) has used concepts such as the paradigmatic and pre-paradigmatic. One of Kuhn's interpretations of a paradigm is that it is an 'entire constellation of beliefs, values, techniques, and so on, shared by the members of a given community' (1970, 175). In other words, a community consists of people sharing the same paradigm. According to Kuhn, a scientific community consists of practitioners of a scientific speciality having undergone similar education and using the same methodology. However, the extent to which paradigms are developed and shared varies between communities or disciplines. While the physical sciences have relatively well-developed paradigms, the social sciences are more often in a pre-paradigmatic stage, with paradigms not shared among the researchers (Kuhn 1970).

Zuckerman and Merton (1971) have referred to a similar dichotomy by applying the concept of codification. According to Zuckerman and Merton, 'codification refers to consolidation of empirical knowledge into succinct and interdependent theoretical formulations' (1971, 303). The more codified the field is, the more comprehensive and precise are the theoretical structures in place that provide clearly defined criteria for assessing the importance of new problems, new data, and newly proposed solutions. Codification is greatest in the medical and natural sciences and weakest in the humanities and social sciences. Greater codification leads to greater consensus among researchers. In highly codified fields, researchers

base their studies on recently published research, while researchers in fields with less codification may rely on older materials.

5 Research data and methods

This chapter describes the empirical studies conducted for the present work. The work took place in two phases. The aim of the first phase was to gain a preliminary understanding of work and communication practices in state research institutes and to form hypotheses and build operationalisations for the second part of the study. The first phase is based on earlier research and qualitative interview data collected for this study. In the second phase, the hypotheses were tested in a quantitative study.

The study utilises both quantitative and qualitative approaches for increased validity, depth, and richness. Combining qualitative and quantitative methods is referred to as a mixed methods approach (Bryman 2007), triangulation (Olsen 2004), or a multi-method approach (Brewer & Hunter 1989). Whichever gloss is used, the idea in this study is to combine quantitative and qualitative data to a give richer picture of the research target. Research permission was requested for collection of both datasets from each state research institute. Both research datasets are handled in such a way that individual participants cannot be identified from the analyses.

This chapter begins with introduction of the first phase of the study and its qualitative data collection, analyses, and research results. Stemming from the first round of data collection and earlier empirical and theoretical studies, the hypotheses and operationalisations are addressed in Section 5.2. The second part of the study, quantitative data collection, used variables and the profile of the questionnaire respondents is presented in Section 5.4.

5.1 Study 1: Qualitative enquiry

The aim of the first part of the study was familiarisation with work and communication practices in state research institutes, forming of hypotheses for the study, and creation of indicators for various factors that may explain differences in

communication practices. The first part of the study was conducted to enable collection of primary research data. The research began with a literature review looking at earlier empirical and theoretical studies of scholarly communication practices and theories related to academic cultures (presented in chapters 3 and 4). Because of the lack of earlier research into state research institutes, the decision was made to use interviews for collection of qualitative research data, to yield knowledge and understanding of work and communication practices in state research institutes.

Qualitative methods have not been very widely used for studying scholarly communication practices, especially in the field of information studies. In the field of sociology of sciences, qualitative studies are more widely used. For example, Becher (1989) used interviews for studying cultural differences across academic disciplines' boundaries. Also, Fry (2003) exploited interviews in her study of academic research cultures and computer-mediated communication. Puuska and Miettinen (2008) and Kyvik (1991) have utilised interviews for secondary data in studies of publishing practices in different disciplines at universities.

5.1.1 Qualitative data collection

Before the actual interviews were conducted, interview themes and a list of interview questions were designed. For the design of interview themes, earlier studies of communication practices and theories about academic cultures were reviewed (see chapters 3 and 4). Also, interview questions used in previous studies were examined for purposes of familiarisation (e.g., Fry 2003). In addition, general information about state research institutes was gained from research reports and other material about state research institutes in Finland. The interview themes and list of interview questions were created on the basis of this information (see Appendix 1).

The actual interviews took place in 2008 and 2009. Researchers working at Agrifood Research Finland and VTT were interviewed for collection of information about work and communication practices. These two institutes were selected for the study on the basis of their size. At the time[7], VTT and Agrifood Research Finland were the two largest state research institutes in Finland, conducting research on the most commonly studied research fields in the purview

[7] In 2009, THL became the second largest institute after VTT.

of state research institutes. These institutes expressed willingness to participate in the study. The interviewees represent three distinct disciplines: food research, plant protection, and human–computer interaction. Three disciplines were selected in order to provide perspectives from different disciplines. In total, 12 semi-structured themed interviews plus two pilot interviews (one in each research institute) were conducted. The purpose of the pilot interviews was to test and develop the interview questions (Silverman 2010). In addition to researchers, administrative and library personnel at Agrifood Research Finland were interviewed, for a better picture of the administration of research institutes and the research infrastructure. In total, 16 interviews were carried out.

The selection of interviewees entailed asking research managers from different research units for contact information of possible interview candidates. Also, personal contacts were used to identify potential interviewees. Researchers were contacted, and those willing to participate were interviewed. Most interviews took place in the interviewee's office. In two cases, interviews were done at interviewees' homes. All interviews were conducted in the Finnish language. The interviews were recorded and transcribed in full for analysis. The average length of one interview was 90 minutes, and the interviews' audio data run, in total, 20 hours and six minutes.

General interview themes were sent to the interviewees by e-mail before the interview. However, only a few interviewees had familiarised themselves with the themes before the interview.

The general interview themes were:

- The nature of the research projects
- Work practices
- Publishing practices
- Reading practices
- The nature of the work environment

The interviews began with the interviewer asking for background information and research permission from the interviewees by means of a questionnaire form. After this, the interviewees were asked to describe their work at a general level. Then, conversation was directed to more specific interview themes. A variation of the critical incident technique was utilised in the interviews. The critical incident technique, originally invented by Flanagan (1954), is a fairly commonly used method in the field of information sciences. Interviewees were asked to describe an

ongoing or recent research project. Conversation about the interview themes centred on the project described. However, the themes were discussed at a more general level also if necessary. The interviewer had a specific list of questions (Appendix 1) on the interview themes. Interviews did not necessarily follow the order of that list of questions; the list was used as a checklist to enable keeping track of which topics should be discussed. Because all of the interviewees worked in research fields that were previously unfamiliar to the interviewer, during the interviews some of the interviewees also showed their printed publications and personal libraries, demonstrated their research methods, took the interviewer to their laboratories, and introduced the library facilities. This way, the interviewer could get a more accurate picture of the work of the interviewees.

5.1.2 The profile of the interviewees

Within the two research institutes (Agrifood Research Finland and VTT), the interviewees represented three research fields: food research, plant protection, and human–computer interaction (HCI) (see Table 9). Eight of the interviewees were women, and four were men. The average age of the interviewees was 42 years. The youngest was 29 and the oldest 56 years old. Respondents' average age was lowest in the field of human–computer interaction and highest in food research. Therefore, it can be assumed that the interviewees representing human–computer interaction were less experienced than those representing other fields. Seven interviewees had a doctoral degree, and five had a master's degree.

Table 9: Profile of the interviewees

Research institute	Number of interviews	Research field	Doctoral/Master degree	Age range	Female/ male
Agrifood research Finland	6	Plant protection	3/3	37-56	5/1
	3	Food research	2/1	46-51	1/2
VTT	3	HCI	2/1	29-34	2/1
Total	12		7/5	29-56	8/4

Six interviewees worked in the field of plant protection[8], in a dedicated research unit at Agrifood Research Finland that employed approximately 50 researchers. The research is divided into three categories by research topics; herbicides, garden plants, and crops. The researchers are usually specialists in pests, plant pathology, or weeds. In almost every research project, expertise from more than one speciality is needed. The main outcome or goal of the research is to improve work techniques in agriculture. Climate change is a central factor in the research. When climate changes, new plants, insects, and problems may be seen. The research can be both basic and applied. Research methods used in plant protection are experimental in nature, and research settings are built in fields, greenhouses, or the laboratory. If research data are collected from fields, study timetables are set in terms of the growing season.

Three interviewees worked in the field of food research. Food research employs almost a hundred researchers and other staff at Agrifood Research Finland. The food research, done in the same unit as biotechnology research, focuses on developing old products and production methods for especially the dairy industry and on creating new ones. Health issues are a central research area in food science. The research is mainly applied and experimental, and collaboration with industry is central. Clearly, research ideas may often arise from the needs of the practitioners.

Three interviewees from VTT worked in the area of HCI. The research focus in HCI is on how people use various technologies, such as mobile phones and their applications, and how products could be developed in view of this information. This research field is relatively new and lies at the intersection of social sciences and technology. Its research produces applied knowledge about human behaviour for development of products. Often in the course of a project, a new application or technology is produced. Collaboration with industry is very common and usually essential. The research methods are both quantitative and qualitative. For example, user evaluation is a very common form of research.

Interview data aid in understanding the work done in state research institutes. Interview data do not, however, give a picture of the work in all state research institutes and all research fields, because of the limited scope of the data. Therefore, interviews are used only for examples of the work in state research institutes. It must be recognised that other types of work practices and research projects may be found, in other research institutes and other research fields. Agrifood Research Finland and VTT are among the country's largest state research institutes (see Table 3), together accounting for 55% of state research institutes'

[8] The descriptions of the research fields are based on interview data.

research expenditure. Accordingly, it is worth noting that the perspective of small institutes is lacking.

5.1.3 Data analyses

Data analysis was performed for the 12 initial interviews. Tape recordings of the interviews were transcribed for analysis. Data were analysed in two procedures. The first round of analysis was completed in the first phase of the study. The interviews provided information about work in state research institutes in general, such as the nature of the research projects, research funding, and audiences. With this information, it was possible to form hypotheses and design a questionnaire for collection of quantitative data.

Firstly, the interview data were read through several times, to allow more learning about research practices in various disciplines, the nature of the work, and the various types of research projects in state research institutes. When the interviewees were asked to describe one research project that they were working with at the moment or that had recently finished, four of the 12 interviewees told about two distinct types of projects, so 16 individual research projects were described in the interviews. Each research project was identified from the data, and characteristics such as research funders, research audiences, collaboration partners, and work practices were identified for each project. The characteristics of each research project type described were compiled in a Microsoft Excel spreadsheet. In the analysis that followed, several types of research projects could be described. Results from the first-round analyses are presented in the next section of the chapter (see section 5.1.4).

The second round of analyses was performed for selection of quotations from the interviews related to the survey questions, to give examples and possible explanations for the results and to add richness to the survey data. This part of the analysis was done after analysis of the survey data in the second phase of the study. This time, the Atlas.ti application was used for assistance in the analyses. Data were coded in Atlas.ti on the basis of the survey questions; this ensured that each mention of themes related to the survey questions was coded in the data. Appropriate quotations were selected from the coded data to explain the survey results. The quotations were translated from Finnish into English.

5.1.4 Research projects in state research institutes

According to the interviews, research is organised into research projects at state research institutes. Researchers typically work with more than one research project at the same time. Research ideas for the projects may arise from the interests of individual researchers, from professionals (e.g., farmers), or from industry. Research projects often have a long history, and one researcher may be involved with a single research topic, in several research projects, for many years. However, sometimes researchers have to leave their comfort zone and work with topics of which they lack prior knowledge.

With respect to the ongoing or recent research project that researchers were asked to tell about, for each, the project's research funding, research collaboration partners, the audience of the project, the form of the research group, the research outcomes, and publications produced in the project were identified and recorded in a table. According to this information, four types of research projects could be identified: academic projects, research and development projects (R&D), professional projects, and research assignments (see Table 10). These are used in the forming of hypothesis for the second phase of the study.

Only one purely academic research project was identified. This project was funded by the Academy of Finland. The funding was for one researcher (an academy researcher), but that researcher could use personnel from the research institute as research assistants/technicians for the study. This researcher also had colleagues working in other research institutes and universities with whom he engaged in research and publishing collaboration. The aim of the academic project was to produce empirical and theoretical knowledge for the discipline. The research project lasted three years, and results were reported as articles in referee journals and at the core conference of the research field. An academic audience was clearly the most important audience for the project. However, the interviewee working with the academic project still had to consider the organisation's expectations with regard to working with more applied research.

R&D projects, in contrast, had two distinct aims. A project may be aimed at production of knowledge for the research community and at the same time at commercial benefit for collaborating companies. The nature of the research can be defined as empirical, on one hand, or, on the other, development and engineering. Projects were run in collaboration with universities, research institutes, and private companies. Research was carried out in a research group. The R&D projects were funded jointly by government entities (e.g., Tekes) and private companies.

Research results were published in journal articles, conference papers, research reports, and professional articles. In most cases wherein private companies were involved in the research projects, confidentiality contracts were made between the research partners. Confidentiality agreements may apply to only parts of the study or a certain time period during the study. When the study has reached some critical point, results usually may be published. However, some results may not be published of the studies because of the confidentiality issues.

The main aim for professional projects was to develop professional practices or products or to gain knowledge about a certain phenomenon for professional use. The nature of this research can be defined as empirical and specialist work / consulting. This type of research was done by research groups, and the research projects were funded by the research institute, a government ministry, or the EU. Research was done in collaboration with the state authority of the field, professionals, and private companies. Research results from professional projects were published via research reports and professional articles. Results may also be published for a scientific audience, but the main focus is on the professional audience. However, increasing competition for research funding has imposed more pressure to publish in scientific forums.

Research assignments are the fourth type of research identified from the interview data. These assignments are short-term projects funded by private companies. Both Agrifood Research Finland and VTT provide expert services for private companies. The research assignments might involve, for example, testing, certification, and approval services. Research assignments are focused for action by specialist research groups. In addition, individual researchers may receive research assignments from external actors. Lengths of research assignments also vary, and some of them might be very short lasting only for few days or weeks. The actual research is done mainly by one researcher, who may use research or laboratory assistant's services. The number of research assignments may vary considerably, which makes it difficult to plan and allocate resources. The research can be deemed empirical but also to involve specialist work / consulting. Research institutes charge companies for the research; however, the research institute may bear some of the costs via the research financing infrastructure. Some of the research assignments may be authoritative tasks assigned to the institutes. One interviewee described her work that used to be authoritative but had become a chargeable service for private companies. The results are reported mainly via confidential research reports to the customer. Because of the nature of the research, results

from research assignments are rarely published in academic forums. In addition, confidentiality contracts may prevent publishing.

Table 10: Project types and their key features

Project type	Nature of research	Group/ alone	Years	Outcome/ motivation	Collaboration	Funding
Academic project (1 described project)	Empirical, theoretical	Group	3	Contribution to the discipline	Finnish and foreign universities	Academy of Finland
R&D project (5 described projects)	Empirical, development /engineering	Group	3	Contribution to the discipline and application	Universities, research institutes, private companies	Tekes, EU, private companies
Professional project (4 described projects)	Empirical, specialist work/ consulting	Group	2-3	Protocol, development of practices	Professionals, private companies	Research institute, ministry, EU
Research assignment (5 described projects)	Empirical, specialist work/ consulting	Alone	0-1	Tests results	Private companies	Private companies

5.2 Measuring the cultural shaping of scholarly communication

In consideration of theories by Becher (1989) and Whitley (1984) (see Chapter 4), earlier empirical studies (Chapter 3), and analyses of qualitative data (see Subsection 5.1.4) collected for this study, hypotheses are formed that consider discipline-based differences in communication practices and the influence of cultural and contextual factors on communication practices. Both Becher's and Whitley's theories have been used in earlier studies too, and attempts to measure concepts presented in these theories have been made also. Therefore, the chapter begins with a review of earlier studies applying Becher's and Whitley's theories.

5.2.1 Earlier attempts at measurement related to Becher's and Whitley's taxonomies

Becher's cognitive categorisation has often been used in recent years to explain inter-discipline differences in communication and publishing practices (e.g., Puuska & Miettinen 2008; Kautto & Talja 2007). For example, Puuska and Miettinen (2008) studied publication practices in different groups of disciplines and different disciplines, using Becher's taxonomy to explain differences between discipline groups. Research data were collected from the publication registers of three Finnish universities for 1998 to 2005. In addition, data were collected through interviews with university professors from 24 disciplines. The study shows remarkable differences in publishing practices between broad discipline groups and also between individual disciplines. Puuska and Miettinen (2008) discovered that Becher's cognitive dimensions separate disciplines' publishing practices broadly. However, in some groups of disciplines, differences within disciplines are great.

Becher's social dimensions have been less widely applied in research than the cognitive dimensions have. However, some studies (e.g., Hammarfelt 2012; Kjellberg 2010; Puuska & Miettinen 2008; Kautto & Talja 2007; Fry 2003; Ylijoki 1998) have considered the social dimensions too. For example, Fry (2003) studied how cultural conditions shape the computer-mediated communication patterns in three disciplines. Fry investigated the emergence of urban and rural dimensions in high energy physics, cultural geography, and corpus-based linguistics. Fry identified high-energy physics as an example of urban fields and cultural geography as one of rural fields. Corpus-based linguistics was identified also as rural but not as purely as cultural geography was. Corpus-based linguistics is formed of two cultures in the interstices between 'soft-pure' and 'hard-applied' intellectual structures. According to Fry, Becher's concepts were harder to apply to multidisciplinary fields such as corpus-based linguistics as compared to monodisciplinary ones such as high-energy physics. Fry pointed out that also in the humanities there is urban communication behaviour (Fry 2003).

Whitley's taxonomy has been adopted in recent years in studies in the field of information science. In general, Whitley's theory has been used in two ways. Most of the studies applying Whitley's theory have used it for describing the research fields under study and in interpretation of the results (e.g., Hammarfelt 2012; Nolin & Åström 2010; Åström 2008; Rochester & Vakkari 2004). A few studies have tried to operationalise Whitley's concepts and measured them via either quantitative (e.g., Krampen 2011; Talja et al. 2007) or qualitative (e.g., Al-Aufi &

Lor 2012; Fry 2003) methods. Most of the studies have focused on one discipline and used the theory to describe the culture of the field. Only rarely have studies used the theory in drawing comparisons across disciplines (e.g., Talja et al. 2007).

Talja and colleagues (2007) tested Fry and Talja's (2004) hypothesis based on Whitley's theory of researcher's information behaviour (see section 4.2) by operationalising Whitley's concepts in a broad survey covering all major disciplines. Mutual dependence was operationalised with asking to what extent respondents used literature from their own scientific field or others. They operationalised microdependence also, by asking whether the respondent conducted research mainly alone or in a research group. Task uncertainty was operationalised through questions about the status and degree of establishment of respondents' specialities. The study found operationalisations useful, although other factors influencing e-journal use (e.g., availability and discipline) seem to have more impact.

Another attempt to operationalise Whitley's concepts was made by Al-Aufi and Lor (2012), in their study of development of Arabic library and information science (LIS). The aim of their study was to describe Arabic library and information science as a field by performing content analysis of sampled research articles, Arabic LIS educational institutions, professional associations, and scholarly communication channels. Operationalisations were created for mutual dependence, task uncertainty, and reputational autonomy. Mutual dependence was measured in terms of patterns of authorship, the state of professional associations, and the status of academic journals within a field. Task uncertainty was measured by diversity of research topics, diversity of research methods, and characterisation and description of the domain. Reputational autonomy was judged by affiliation of authors, affiliation of departments, and characterisation and description of the domain. The operationalisations were found to be useful. Arabic LIS was described with these variables as having a low degree of mutual dependence and high degree of task uncertainty.

Also Kyvik (1991) explained fields' differences in publishing practices, such as book- vs. article orientation, popular publishing, and international publishing with various factors affecting field differences. He explained the differences with Whitley's terms 'mutual dependence' and 'audience structure' (specialist/general). Kyvik found that both mutual dependence and audience structure had an influence on researchers' communication practices. For example, the degree of dependence between researchers explained differences in international publishing. Those with collaboration and contacts abroad publish more in international forums. Fields exhibiting high mutual dependence showed more international publishing, because

they feature more competition for priority. Research results must be published for an international research community if one wishes to ensure priority over results. In contrast, in fields wherein results are intended for a wider audience, researchers prefer longer publishing formats (monographs and edited works), because results have to be explained more carefully. In general, researchers in the natural sciences and medicine most often gain reputation among international academic audiences while in the humanities and social sciences reputation is gained among various academic and professional audiences. Therefore, the degree of mutual dependence is often lower in the humanities and social sciences (Whitley 1984). According to Kyvik (1991), the problem of Whitley's taxonomy is the missing link between dimensions and contextual factors. Kyvik also argues that Whitley's model is at the same time too complex and to some extent tautological when all factors are defined partially by degree of autonomy.

5.2.2 Hypotheses and operationalization

Next, the hypotheses pertaining to differences by discipline and the influence of various cultural and contextual factors on communication practices are stated (see Table 11). Also, quantitative measurements for concepts related to cultural and contextual factors are suggested. More specific description of the variables used in the survey is presented in Subsection 5.3.2.

Table 11: A frame for the hypotheses

	Theoretical background	Factors
Disciplinary differences	Becher's cognitive taxonomy, earlier empirical studies	Hard-pure, Hard-applied, Soft-pure, Soft-applied
Academic culture	Becher's and Whitley's cognitive and social dimensions, interview data	Nature of research, Dependence on other fields, Dependence on other researchers
Research context	Interview data, earlier empirical studies, Whitley's contextual factors	Research collaboration, Research funding, Nature of research projects

5.2.2.1 Differences by discipline

As is noted above, Becher (1989) divides disciplines into four groups according to the nature of knowledge produced in the field: hard-pure, hard-applied, soft-pure, and soft-applied. According to Becher and Trowler (2001) research results in hard-pure fields are published mainly for academic audiences in journal and conference papers. In hard-applied fields, results are published in varied forums, such as technical reports, patents, and conference proceedings, or as journal articles, in line with the topic and audience. In soft-pure fields, monographs and long journal articles are the main academic publishing forums. Also, according to Puuska and Miettinen (2008), professional publishing is important in the humanities. In soft-applied fields, results are published for both academic and professional audiences in articles and monographs (Becher & Trowler 2001).

Because information on communication and research practices in state research institutes is lacking, it is hard to predict how well Becher's taxonomy holds in this environment. Because most of the work done in state research institutes is applied and, in addition to traditional academic research, researchers handle various types of official and specialist tasks, it is probable that the disciplines involved here do not meet the requirements for being deemed pure research. Nevertheless, four hypotheses about differences between discipline groups in publishing practices are presented.

H1: *In hard-pure fields (the natural sciences, health-care sciences, and biological and environmental sciences), international academic journals are the main communication forums.*
H2: *In hard-applied fields (technical sciences), researchers communicate in various forums but especially via conferences and by publishing research reports.*
H3: *In soft-pure fields (the humanities), academic monographs and articles in edited works are the main academic communication forums. Research results are also actively popularised for general audiences.*
H4: *In soft-applied fields (the social sciences), researcher communication takes various forms: reading and publishing monographs, articles in edited works, and articles in national and international journals. Communication in professional forums is active.*

5.2.2.2 The nature of the research

The nature of the knowledge produced is a critical factor affecting communication practices. Research at state research institutes is mainly applied. Interview data in this study showed that researchers work with different types of research projects, producing different types of research, such as empirical, theoretical, development/engineering, and specialist work / consulting. Therefore, categorising the research only as applied might involve too general a conclusion. Also, earlier research has shown that concepts such as basic and applied research have little ability to explain differences in communication practices (Talja et al. 2007; Kyvik 1991).

On the basis of the analyses of the interview data, the researchers were asked in the survey to indicate the importance of empirical, theoretical, specialist/consulting, and development/engineering elements in their work. Two hypotheses are addressed:

H5: *Those conducting mainly theoretical or empirical research communicate primarily in academic forums.*
H6: *Those performing mainly specialist work consulting or development/engineering communicate actively in professional forums.*

5.2.2.3 Dependence on other fields

Dependence on other fields is a critical cultural factor in both Becher's and Whitley's theories. According to Becher (1989), researchers in convergent fields base their studies mainly on research and theories developed in their own field. In divergent fields, researchers may use literature from various fields and even publish in other fields. According to Whitley (2000), functional dependence refers to 'the extent to which researchers have to use specific results, ideas, and procedures of fellow specialists in order to construct knowledge claims which are regarded as competent and useful contributions' (Whitley 2000, 88). Fry and Talja (2004) have argued that dependence on literature produced in other fields is typical in fields having low mutual dependence and high task uncertainty.

Dependence on other fields was operationalised via asking to what extent respondents use literature from their own or other scientific fields. Dependence on other fields is seen to be lower for those using literature mainly from their own field. Also, Talja and colleagues (2007) operationalised mutual dependence, by asking to what extent respondents use literature from their own or other scientific fields.

H7: *Decreased dependence on other fields is connected to active communication in academic forums.*
H8: *Increased dependence on other fields is connected to active communication in professional forums.*

5.2.2.4 Dependence between researchers

Another important cultural factor is dependence between researchers. According to Becher, research in urban fields is organised into research groups competing with each other for resources and their publication. In urban fields, results are published mainly in academic journals. In rural fields, where working alone is more common, results are usually published in monographs or long articles and communication with a professional audience is common (Becher 1989). According to Whitley, strategic dependence refers to the degree to which researchers have to assure their colleagues of the significance of the research, methods, and approaches. If researchers become dependent on a specific group of colleagues for gaining reputation, mutual dependence is likely to increase. Fry and Talja (2004) argued that those working in fields of high mutual dependence and low task uncertainty rely more on academic audiences while those having lower

mutual dependence and higher task uncertainty rely more on professional and lay audiences. Also the interview data showed differences between project types in the dependence between researchers with respect to working alone or with a research group. Working alone was more common in research assignments than it was in other types of projects.

Dependence between researchers was operationalised through enquiries as to the typical number of co-authors for respondents' publications. In Whitley's terms, this measurement is more related to micromutual dependence (Talja et al. 2007). Those publishing with co-authors are seen as representing high microdependence. Al-Aufi and Lor (2012) too have used number of authors as an operationalisation for mutual dependence. Two hypotheses related to dependence between researchers and communication practices were formulated.

H9: *Respondents who are highly dependent on other researchers communicate more in academic forums than do those who have been less dependent.*
H10: *Those who have been less dependent on other researchers communicate more in professional forums than those who have been more dependent.*

5.2.2.5 Research collaboration

Research projects are often conducted in collaboration with other organisations. Analyses of the interview data showed that in different types of projects researchers collaborate with different types of organisations. Researchers working in academic research projects collaborated mainly with Finnish and foreign universities and published research results for an academic audience. In R&D projects, researchers worked in collaboration with diverse organisations, such as universities, research institutes, and private companies. Results were published for both academic and professional audiences. The main collaboration partners in professional projects were government organisations, professionals, and private companies, and the research results were published mainly in professional but also in academic forums. In research assignments, private companies were the main collaboration partners. Results were published primarily in confidential research reports. Thus, collaboration practices showed a relationship to communication practices. Ylijoki and colleagues (2011) recognised similar collaboration practices in various research markets in a university context.

Whitley's (2000) concept of reputational autonomy in also connected to research collaboration. Again, reputational autonomy refers to the ability of outsiders, such as lay audiences and collaboration partners, to influence a field's behaviour. Reputational autonomy is low when outsiders are able to influence the field's behaviour in, for instance, its choice of research topics. Low reputational autonomy is linked to low mutual dependence and high task uncertainty, whereas high reputational autonomy is more likely in fields having high mutual dependence and low task uncertainty.

In the survey, respondents were asked to what extent they engaged in research or publishing collaboration with researchers working in other organisations. Earlier, Al-Aufi and Lor (2012) used collaboration partners as a measure for Whitley's concept of reputational autonomy. Two hypotheses pertaining to collaboration partners and communication practices were formed.

H11: *Regular collaboration with academic organisations is related to active communication in academic forums.*
H12: *Regular collaboration with other than academic organisations is related to active communication in professional forums.*
H13: *Collaboration with other academic organisations is linked to increased dependence between researchers and decreased dependence on other fields.*

5.2.2.6 Research funding

Research funding is another important contextual factor affecting academic cultures and research markets. According to the interview data different types of research projects were funded by different types of research funders. Academic project was funded by Academy of Finland and for R&D projects were gained from Tekes, EU, and private companies. In professional projects research funding was gained from research institutes budget funding, ministry, and EU. Research assignments were funded together with institute's basic funding and by private companies. In addition, Ylijoki and colleagues (2011) also recognized in the university context public research market. However, they discovered that there is little available external research funding for public research market.

Research funding is connected to Whitley's concept of concentration over control. Concentration over control is decreased when scientists are able to gain resources from external sources. The extent of external funding has an influence also on reputational autonomy. With a large proportion of external funding, it is likely that outside research funders may influence behaviour in the relevant field.

Thereby, mutual dependence decreases and task uncertainty increases. On the other hand, Gulbrandsen and Smeby (2005) and Kyvik (1991) have argued that all types of external research funding increase research productivity.

In the survey, respondents were asked to indicate the importance of various types of research funding for their research. Three hypotheses as to research funding and communication practices were stated.

H14: *Those working mainly with external research funding are publishing more in academic and professional forums than are those who work without external research funding.*
H15: *Those whose main external research funding comes from funding bodies for academic research communicate actively in academic forums.*
H16: *Those working with other types of external research funding communicate actively in professional forums.*

5.2.2.7 Research projects

The length of the research projects the researchers were working with varied, as did the number. Interview data showed that some projects may take many years while others are only short-term research assignments. Communication practices varied by type of research project.

In the survey, researchers were asked to indicate the typical length of research projects. Two hypotheses as to the length of the research projects and communication practices were adopted.

H17: *Those working with shorter projects communicate actively with professional audiences.*
H18: *Those working with longer projects communicate actively with an academic audience.*

Researchers may also work on several projects at the same time. In the interviews, many researchers explained that they do not have enough time to publish and read, because they work with many projects at the same time. However, earlier research came to the opposite conclusion, claiming that the number of research projects researchers are working on at the same time has a positive effect on publishing activity (Fox and Mohapatra 2007).

In the survey, researchers were asked to indicate the typical number of research projects under work at any given time. On the basis of earlier work (Fox & Mohapatra 2007), a hypothesis pertaining to the number of research projects and communication practices was stated.

H19: *Those working with many projects at the same time publish more than those who work with one project at a time.*

5.2.2.8 The connection between publishing and reading

Earlier research (e.g., Tenopir et al. 2012a; Tenopir et al. 2008; King et al. 2009; Tenopir et al. 2009b) has shown that active readers of literature are also active publishers. Also in the interviews, subjects referred to active researchers who, for some reason, could publish more than others. Therefore, a hypothesis as to the relationship between reading and publishing was formed.

H20: *Active reading is associated with active publishing.*

5.3 Study 2: Quantitative enquiry

The aim of the second phase of the study was quantitative study of publishing and reading practices in state research institutes in Finland and testing of the hypotheses developed in the first part of the study. Quantitative research data were collected via an electronic survey from respondents working in state research institutes in Finland. Quantitative survey data enable studying communication practices in all state research institutes and covering all major disciplines. In addition, qualitative interview data were used in the second phase of the study too, to provide examples of the work of individual scholars in illustration of quantitative results (the data analyses are explained on section 5.1.3).

Self-reporting methods such as surveys have been widely used in earlier studies focusing on communication practices (e.g., Tenopir et al. 2012a; Kyvik 1991). For example, King and Tenopir have studied scholarly communication since the 1970s by carrying out series of surveys at various universities in the US and also (more recently) in the UK, covering various disciplines. Also, surveys have been used in Finland for such purposes as collection of data pertaining to scholars' use of the Finnish electronic library FinELib (e.g. Talja et al. 2007; Vakkari 2006; Vakkari & Talja 2006; Vakkari & Talja 2005; Törmä & Vakkari 2004).

Bibliometric methods are probably the most widely used methods of studying communication practices within information sciences. Bibliometric methods exploit reference and citation data. Reference data have been used in studies of

publishing practices. Citation data are exploited also for studying of reading practices. A point of departure in citation analysis is the presumption that citations reveal what publications are read. However, citation analysis cannot capture all reading, because only the minority of publications read end up being cited (Tenopir et al. 2012a). Also, researchers don't necessarily always read everything they cite.

Bibliometric data can be collected from various databases, such as the Web of Science (WoS), Scopus, and Google Scholar resources. The problem with bibliometric methods has been the coverage of the data. Bibliometric methods are most suitable for studies of international academic journal publishing in fields wherein journals are the main publishing forum. For this reason, studies have examined mainly the natural, technical, and medical sciences. The humanities and social sciences, in which journal publishing is less common, have not been studied to the same extent. For example, the Web of Science databases are biased toward journals in the natural sciences, medicine, and engineering. The databases also favour English-language publications (Van Raan 2005). It has been shown also that the coverage of the databases is decreasing (Larsen & von Ins 2010).

Institutional repositories may also offer bibliometric data for research. These repositories do not share the coverage problems seen with commercial databases. However, institutional repositories may include data from only one institute. National repositories that have been built in recent years do have potential to offer valid and comprehensive data for bibliometric studies. In the present study, bibliometric data were collected from state research institutes publishing repositories but only for offering background information about publishing practices in various institutes (see section 2.3.3). The data cannot be used for such purposes as discipline-based analyses or to study relationships of communication practices with various factors. Therefore, other data collection methods were needed.

5.3.1 Survey-based data collection

Quantitative data were collected via an electronic survey by means of the E-lomake program in April–May 2010 (19.4–14.5.2010). When compared to traditional paper surveys, electronic surveys are less time-consuming, are inexpensive to conduct, and are easy to execute (Schonlau et al. 2002). The questionnaire was piloted with the faculty of the University of Tampere and made

available in both Finnish and English. Based on the information from the pilots it was estimated that it would take approximately 20 minutes to fill out the questionnaire.

The questionnaire was sent to all 18 state research institutes in Finland. A link to the questionnaire was sent to researchers by e-mail or by posting a link to the questionnaire to the research institute's intranet. If possible, both approaches were used. Contact persons from each institute were asked to send the researchers a link to the questionnaire by e-mail. In six cases, this was not possible and researchers' e-mail addresses were collected by the author from the institute's Web site. In most cases, collecting e-mail addresses was relatively easy because of the small size of the institutes. In four cases[9], only the intranet was used, because researchers' contact information was not available on the Internet. After two weeks, a reminder was sent to the researchers, again by e-mail. At the same time, posts on institute intranets were updated.

The questionnaire included 135 questions, divided into seven categories. Most of the questions were multiple-choice items, but fields for further information were available for some of them. The questionnaire included items about the respondent's background, research practices, and reading and publishing practices and activity. Interview data and earlier surveys conducted by the National Library of Finland[10] and Tenopir and King[11] were used as an aid in designing of the questionnaire. The questionnaire can be found in Appendix 2. For the present study, 48 questions from the questionnaire have been analysed.

5.3.2 The variables studied

In this study 25 dependent variables are analysed. Variables pertain to publishing activity, the importance of publishing as a part of the work, reading activity, and reasons for reading.

Publishing activity. Publishing activity (see Appendix 2, items 7.1–7.3) was measured by asking about the number of publications the respondents had produced in the previous two years in seven academic, four professional, and three

[9] Only intranet was used in GTK, MTT, THL, and VTT

[10] See http://www.nationallibrary.fi/libraries/finelib/imapctandevaluation/userquestionnaires.html.

[11] See http://scholar.cci.utk.edu/carol-tenopir/survey-instruments-and-reports.

more general forums. Respondents estimated their publishing activity on a scale with the options '0', '1–2', '3–5', '6–10', and 'more than 10'. This scale was used because experiences of questionnaires conducted on behalf of the FinElib had shown that respondents do not necessarily remember actual numbers of publications. This has led to some information being absent from the data. In addition to the actual number of publications, the present study was interested in the influence of various factors on publishing activity – more so, in fact. This allowed less exact measurements to be used. For presentation of the results and calculation of statistical differences, variables were recoded as dummy variables: those who did not publish at all and those who had at least one publication.

The importance of publishing. Respondents were asked to what extent writing publications was part of their job (see Appendix 2, item 2.1.2). A scale with the elements 'the main part', 'a moderate part', 'a small part', and 'not a part of my work' was used.

Reading activity. Reading activity (see Appendix 2, item 5.2) was studied by asking the respondents how often they read 11 specific types of publications for their work. Reading was defined as going beyond the table of contents, title, and abstract to the body of the text and reading at least some part of it. Tenopir and colleagues (e.g. Tenopir et al. 1999; Tenopir et al. 2005; Tenopir et al. 2012a) have used the same definition of reading in their earlier studies. Reading activity was measured on a scale with the following elements: 'daily', 'weekly', 'a few times a month', 'once a month', 'less frequently', and 'not at all'. For presentation of the results and calculation of the statistical differences, variables were recoded as dummy variables: those who read at least weekly and those who read less frequently.

The importance of reading. Respondents were asked to what extent reading was part of their job (see Appendix 2, item 2.1.3). The scale items 'the main part', 'a moderate part', 'a small part', and 'not a part of my work' were used.

The purpose of the reading activity. Respondents were also asked the purposes for which they read (see Appendix 2, item 5.4). The options in the questionnaire were primary research, writing publications, writing funding applications, preparing presentations, keeping up to date, administration, teaching, and consulting. A scale whose elements were 'mainly', 'to some extent', 'little', and 'not at all' was used.

Tenopir and collegues (e.g. Tenopir et al. 2012a) has used similar question in their studies of scholarly communication.

In addition, 23 independent variables are used in the study. These pertain to discipline, academic culture, and research context.

Discipline. Respondents were asked to indicate their scientific discipline (see Appendix 2, item 1.9). The questionnaire included 50 disciplines, divided into six groups. Disciplines were computed to present seven groups of disciplines (see Appendix 3). Discipline-aligned differences in publishing (items 2.1.2 and 7.1–7.3) and reading (items 2.1.3, 5.2, and 5.4) practices were studied. Also, the discipline-aligned differences in academic cultures (items 2.3, 5.6, and 6.1) and research context (items 4.1–4.3) were studied.

Academic culture was measured with six variables. The influence of these variables on publishing (items 7.1–7.3) and reading (item 5.2) activity was studied. Also, the relationship between variables measuring the academic culture was studied.

The nature of the research. Respondents were asked (see Appendix 2, item 2.3) to indicate the proportion of individual research types, such as empirical, theoretical, development/engineering, and specialist work / consulting in their research work. The importance of each type of research was evaluated with the scale items 'mainly', 'to some extent', 'rarely', and 'not at all'. Variables were coded as dummy variables to represent 1) those conducting each type of research primarily and 2) those conducting each type of research to a lesser extent.

Interdependence of research fields. Interdependence of research fields was studied by asking the respondents whether they used literature in their work mainly from their own field, to some extent from other scientific fields, or from various fields (see Appendix 2, item 5.6).

Dependence between researchers. Respondents were asked to indicate the typical number of authors of their academic publications (see Appendix 2, item 6.1). The answer options were 'I write alone', '2–3 authors', '4–5 authors', '6–9 authors', and '10 or more authors'. The variable was coded to present 1) those publishing alone or in a small group (2–3 authors) and 2) those publishing in a

large group (four or more authors). This dichotomy was used because the most typically publications had 2-3 authors (43 %) and 4-5 authors (38 %). The share of respondents publishing typically alone (5 %) or with more than five authors (9 %) was very low.

Research context was studied with four variables. The influence of the variables related to the research context on publishing and reading activity was studied.

Research collaboration. Research collaboration (see Appendix 2, item 4.1) was studied by asking with which organisations and to what extent researchers engaged in research or publishing collaboration. The possible collaboration partners listed in the questionnaire were Finnish and foreign universities, Finnish and foreign state research institutes, other government organisations, and the private sector. Collaboration activity was measured with the scale items 'on a regular basis', 'sometimes', 'rarely', and 'not at all'. Variables were coded as dummy variables to represent those 1) taking part in regular collaboration and 2) engaged in less frequent collaboration.

Research funding. Research funding (see Appendix 2, item 4.2) was studied by asking from which sources the respondents had obtained their research funding and about the extent of the funding. The possible research funders listed in the questionnaire were 'working without external funding' (with institutes basic funding), 'ministries', 'Tekes', 'the European Union', 'the Academy of Finland', 'foundations', and 'private companies'. The importance of the various types of funding sources was measured with the options 'mainly', 'to some extent', 'rarely', and 'not at all'. Variables were coded as dummy variables to represent those having 1) primarily 'main research funding' and 2) 'less important funding' from each source.

Number of research projects. Respondents were asked the typical number of research projects they were working with at the same time (see Appendix 2, item 3.2). The options 'one', 'two', 'three to four', and 'five or more' were used in the study. The variable was coded as a dummy variable to present those working with 1) one or two projects and 2) three or more projects at the same time.

Length of research projects. Respondents were asked the typical length of their research projects (see Appendix 2, item 3.1). The scale elements 'less than one

year', '1–2 years', '3–4 years', and 'more than four years' were used. The variable was coded as a dummy variable to present those working in projects 1) lasting two years or less and 2) of three years or more.

5.3.3 Statistical analyses

Principal component analysis was used to study publishing and reading orientations in state research institutes. By means of principal component analysis, it is possible to condense a large number of variables to a smaller number of new variables. Thereby, principal component analysis decreases the incoherence of the data and helps researchers to identify common characteristics between variables. The technique also improves the economy of analyses by reducing the number of variables dealt with. In this study, the many variables measuring publishing and reading activity (see Appendix 2, items 7.1–7.3 and 5.2[12]) were condensed to fewer new variables representing the various publishing and reading orientations. According to Tabachnick and Fidel (2001), principal component analysis is the best instrument when the researcher wants to determine the structure of the data on the basis of the correlations and reduce the number of variables. A technique similar to principal component analysis, factor analysis is commonly used in cases wherein the data analysis is based on previously known theory (ibid.).

Principal component analyses consist of three stages (Metsämuuronen 2003). First, the correlation matrix and covariance matrix are generated for the variables in the study. In this study, components exceeding eigenvalue 1 were applied in the analyses. Bartlett's test of sphericity tells about the statistical significance of the correlation matrix and Kaiser–Meyer–Olkin testing about the suitability of the correlation matrix for principal component analyses. For meeting of the conditions, Bartlett's test of sphericity should yield a statistically significant value and the Kaiser–Meyer–Olkin value should be over 0.6 (Metsämuuronen 2003).

Secondly, loadings for components are estimated in accordance with these results. The value 0.3 was used as a minimum loading in this study. Factors showing loadings under 0.3 were not included in the analyses. Communalities are calculated for each variable. Communality is the total amount of variance an original variable shares with all other variables included in the analyses. Low

[12] The original scales for the variables were used in the principal component analyses.

communality (< 0.05) was used as a criterion for removal of variables from the analyses. (Hair et al. 2006) Finally, components are rotated, to make interpretation of the results easier. Varimax rotation was used in this study.

For further studies, core variables in each component were computed to present publishing and reading orientations. Computed variables were coded as dummy variables to represent those who had produced at least one publication in each orientation and who had read literature at least weekly in each orientation. Cronbach's alpha is a measure of reliability. A common guideline is that Cronbach's alpha should be above 0.5 in an explorative study (Nunnally 1967).

In addition to principal component analyses, various statistical methods were used to examine connections between variables and differences between groups. Chi-squared testing is used when one is measuring significance in the relationship between two nominal variables or between two dummy variables. One-way ANOVA variance analyses was used when means for more than two groups were compared. Post hoc testing (Tamhane testing, in particular) was used to study the statistical differences between the groups.

5.3.4 The respondents' profile and representativeness of the data

Next, survey respondents' profile and the representativeness of the data are presented.

5.3.4.1 The research institutes

In total, 793 researchers, from 18 state research institutes, responded to the questionnaire. The majority of the responses (773) were in Finnish, and 20 were in English. In all, 46 responses were disqualified because information was missing. Respondents who did not indicate their research institute or research discipline were disqualified. Also disqualified were those respondents who did not work in research. In all, 747 answers were approved for analysis. However, not all respondents answered all of the questions in the questionnaire. Large number of questions in the survey may have increased the amount of missing information in the data when respondents have skip questions. Missing information was not analysed in the study.

All 18 state research institutes are represented in the data. The research institutes were asked the number of researchers working there at the time of the

survey, for purposes of determining the response rate[13]. According to this information, the average response rate was 15.6% (see Table 12). However, response rates varied substantially between institutes. For example, almost half of the 85 researchers with the Finnish Game and Fisheries Research Institute responded, while the response rate for VTT, with 104 answers, was only five per cent. The reason for this great variety is probably related to the method of informing about the questionnaire. Contact persons from each institute were asked to send the researchers a link to the questionnaire by e-mail. If this was not possible, the questionnaire was advertised on the institute's intranet (in some cases, both e-mail and the intranet were used). This was the case at VTT, among other institutes. Clearly, e-mail reached researchers (and motivated them to respond) better than did announcements on the intranet. If VTT is not included, the response rate is 23%.

[13] The numbers of researchers working at Finnish Food Safety Authority EVIRA, the Finnish Geodetic Institute, the National Consumer Research Centre, the National Research Institute of Legal Policy, and the Finnish Institute of International Affairs were not confirmed by these institutes. The figures came from counts from the institutes' Web pages.

Table 12: Response rate per institute

Research institute	Response rate, %	Frequency	Share (%) of responses
VTT	5.2	102	14
THL	16.6	94	13
MTT	30	89	12
SYKE	27.6	70	9
FIOH	32.2	65	9
Metla	18.6	65	9
GTK	17.1	45	6
RKTL	49.4	42	6
FMI	11.5	38	5
EVIRA	27	30	4
FGI	31.8	20	3
KOTUS	23.8	19	3
STUK	30.6	19	3
VATT	32.7	16	2
NCRC	41.7	10	1
OPTULA	40.9	9	1
MIKES	21.2	8	1
FIIA	16.2	6	1
Total	15.6	747	100

In general, it seems that questionnaires for researchers conducted in electronic form often lack responses. In a survey carried out by FinELib in 2012 for researchers working at universities, the response rate was 22%. Between institutions, it varied by 0% to 36%. The same survey was conducted for some

state research institutes, which showed a lower response rate than the response rate with universities. However, the response rate could not be calculated precisely (FinELib 2012).

The best picture of the representatives of the data (see Figure 3) is obtained when the ratio of researchers at each institute to the total number of researchers working at the state research institute is compared to the percentage of responses from the institute. This comparison shows that VTT is clearly under represented. Its share of the study population is more than 40%, but it accounts for only 14% of the answers. The Finnish Meteorological Institute too is under represented. At the same time, some institutes are clearly over-represented: MTT's, SYKE's, and FIOH's share of the responses are at least four per cent higher than the respective institute's representation in the study population. Also over-represented are RKTL, EVIRA, Metla, FGI, and STUK.

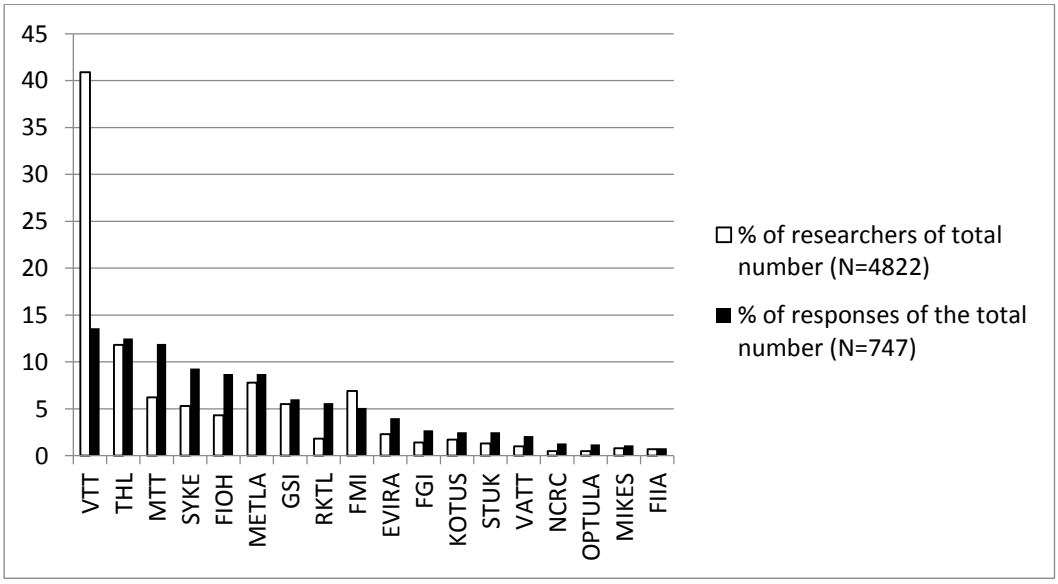

Figure 3: Representativeness of state research institutes in the data

Under- and over-representativeness of certain research institutes may have an effect on the research results. Certain organisational practices may be under- or over-represented in the data on account of this bias in the data. However, it is difficult to estimate the real impact of the bias on the research results. It is worth noting also that the representativeness of the research institutes' responses has an impact also on representativeness with respect to certain disciplines, discussed next.

5.3.4.2 Discipline

The respondents represent 41 distinct fields of research (see Appendix 3). The questionnaire covered 50 research fields, in six broader groups of disciplines (see Table 13), defined on the basis of a taxonomy developed by the Academy of Finland. In all, 48 respondents (six per cent) selected more than one research field, and their responses were counted as multidisciplinary in the broad grouping. All of the responses counted as multidisciplinary were combinations of biological and environmental sciences with some other discipline. This category was given the name 'multidisciplinary biosciences'. Accordingly, seven broad groups of disciplines are used in the present study.

Table 13: Broad groups of disciplines

	Frequency	Percentage
Biosciences and environmental sciences	250	34
Natural sciences	135	18
Social sciences	109	15
Technical sciences	98	13
Health-care sciences	85	11
Multidisciplinary biosciences	48	6
Humanities	22	3
Total	747	100

Biosciences and environmental sciences cover a third of the disciplines represented. The main discipline in the biological and environmental sciences group was ecology (a list of the disciplines included in each discipline group can be found in Appendix 3). Most respondents representing the biological and environmental sciences worked at MTT and the Finnish Forest Research Institute. Almost one fifth of respondents represented the natural sciences. The main discipline within the natural sciences was earth sciences / meteorology. Most of the respondents worked at the Geological Survey of Finland. About 15% of the respondents represent social sciences. The main discipline here was social research.

Social sciences are studied in many research institutes. The highest proportion of social scientists worked at THL.

Technical sciences were represented by 13% of respondents, and the main discipline in the technical sciences was computer science. The majority of respondents representing technical sciences work at VTT. Health-care sciences cover 11% of the disciplines represented. The main discipline in health-care sciences is public, educational, and occupational health, covering 61% of the respondents. Respondents working with clinical medicine are in the minority. Most of the health care scientists were working at THL and FIOH. Six per cent of respondents were classified as in multidisciplinary biosciences. Respondents who selected more than one discipline, from different discipline groups, were counted as in multidisciplinary biosciences. One third of the multidisciplinary fields combine biological and environmental sciences with health care sciences. A further third of the combinations are of disciplines within biological and environmental sciences and the natural sciences. The rest of the cases combine biological and environmental sciences with technical sciences, social sciences, or the humanities. The majority of respondents representing multidisciplinary biosciences worked at MTT and THL. Only three per cent of respondents represent the humanities. Most humanists specified linguistics as their discipline. Most of the respondents representing the humanities were working at the Research Institute for the Languages of Finland.

Assessing the representativeness of the data from the perspective of discipline is difficult because there is little information available on how individual disciplines are represented in state research institutes. Statistics Finland offers data on information research man-years in branches of state administration (OSF 2010c), or 'research work years'. The term refers to the full-time work (35 hours per week) done in the span of one year. In addition to state research institutes, state administrative branches include other organisations that conduct research, as seen in research by the Ministry of Defence; however, state research institutes cover the majority of the research conducted under state administrative branches (Lemola 2009).

Table 14: The percentage of respondents in the various disciplines in the survey and the proportion of 'research work years' in various disciplines in individual branches of state administrative in Finland in 2010

	Survey (%)	Research years in state administrative branches (%)
Technical sciences	13	36
Bio and environmental sciences	34	34
Social sciences	15	13
Health sciences	11	12
Natural sciences	18	3*
Humanities	3	2
Multidisciplinary biosciences	6	0

* Geography, environmental sciences, and biosciences were removed from the natural sciences and placed in the biological and environmental sciences category, to present better classification in this study.

According to this information (see Table 14), the technical sciences are clearly underrepresented in the survey data. The share of technical sciences of the research years conducted in state administrative braches is 36 %, but the share of technical sciences in the survey is only 13 %. This is due to the paucity of answers from VTT, which is Finland's only institute conducting research in technical fields on a large scale. Simultaneously, the natural sciences seem to be highly over-represented in the data. The reason for this is not clear. Biosciences and environmental sciences, the social sciences, health sciences, and the humanities seems be quite representative in the dataset.

5.3.4.3 Demographic factors

The gender balance is quite even, with 53% of respondents being women and 47% men. According to Statistics Finland (OSF 2010c), women had a 50% share in research and development tasks in state administration branches. Therefore, women are slightly over-represented in the data. Differences between disciplines are significant (chi-squared p= 0.000). In health care sciences, the social sciences, and the humanities, most respondents were women. The natural sciences are the only area in which the majority of the respondents were men. In the biological and

environmental sciences, technical sciences, and multidisciplinary biosciences, the share of male and female respondents is quite equal.

Respondents were asked to indicate the highest degree they had earned. Most respondents had a master's, licentiate, or Ph.D. degree. Only two per cent had just a lower degree. According to Statistics Finland, the percentage of the public-sector R&D personnel who had a Ph.D. in 2010 was 21%, so it seems that people with Ph.D.s are clearly over-represented in the survey. It is also possible that the dataset is biased toward more active researchers in general. In his study, Kyvik (1991) found that those who did not respond produced, on average, 30–35% fewer publications than those who did respond. Differences between disciplines are significant (chi-squared p= 0.000). The share of Ph.D.s is highest in the health-care sciences, multidisciplinary biosciences, and humanities (60%). Only 19% of respondents in the technical sciences had a Ph.D. degree.

Studying the representativeness of the survey data revealed that VTT and the technical sciences are particularly under-represented in the data, while the natural sciences seem to be over represented. The demographics revealed that the share of Ph.D.s is considerably higher in the data than in the information from Statistics Finland. These limitations have to be taken into account in interpretation of the results. Otherwise, the data seem to be fairly representative.

6 Results

This chapter presents the research results. Its various sections are organised around the quantitative results from the survey. In addition, citations from the interviews are used in interpretation of the survey results and to illustrate the work of individual researchers. The chapter is divided into four sections. The first of them presents the results pertaining to academic cultures and research context in state research institutes. The two following sections describe the publishing and reading practices in state research institutes and their relationship to factors associated with academic cultures and research context. Finally, the relationship between reading and publishing is studied.

6.1 Academic culture and research context in state research institutes

This section of the chapter presents the results to do with academic cultures and research context in state research institutes. Academic culture is examined via three factors: the nature of the research, dependence on other fields, and dependence between researchers (see Table 15). Research context is considered through study of research collaboration partners, research funding, and the nature of the research projects. The operationalisations of factors were presented in Chapter 5.

Table 15: Factors related to academic cultures and research context, as examined in the study

	Factor
Academic culture	Nature of research
	Dependence on other fields
	Dependence between researchers
Research context	Research collaboration partners
	Research funding sources
	Nature of research projects

6.1.1 The nature of the research

Traditionally, research is categorised as either basic or applied. The majority of research at state research institutes is applied. However, different types of applied research are conducted in state research institutes. In the survey, respondents were asked to indicate the share of empirical and theoretical research and share of development/engineering and specialist work / consulting in their work. Research types can overlap; therefore, respondents were not forced to select only one research type. A four-point scale ('mainly', 'to some extent', 'rarely', 'not at all') was applied for all research types. The percentage of those who indicated conducting each research type 'mainly' is presented.

According to the responses, empirical research is the main type of research at public research institutes (see Table 16). More than half of all respondents indicated conducting mainly empirical research. Theoretical research is quite an uncommon type of research in state research institutes. Under 10% of respondents indicated conducting mainly theoretical research – theoretical research is seldom the main purpose of the studies; it is more likely a secondary type of research. One of the interviewees had focused on more theoretical research when working at university:

> [T]here was a clear difference in my work. It was far more theoretical at university. It was not pure but more theoretical research in the same field, how users regard technology. I tested theories with these exact studies, which had little to do […] or it was hard to apply in reality. In the current job, practice is much more important. On the other hand, it is harder to adapt and find theories to generalise. (I12)

About one fifth of respondents stated that they conducted mainly development/engineering work. Development/engineering refers to designing and developing new products, services, processes, or solutions. Developing is often understood as referring to technological development, but it can also be understood at a more general level. Development/engineering might be only one part of a project, as was the case for one of the interviewees:

> In this project, a software platform is developed and my job is to study how it affects people's life: what applications and services we can build upon it, and what hopes users have. (I12)

Another interviewee saw that applying knowledge had become more important:

> It looks like, I could say that research is transforming from traditional research into […] innovative development some might call it. In other words, we are not just trying to gain knowledge about something but gaining knowledge and at the same time planning how to use and exploit it. (I1)

One fifth of respondents indicated that specialist work / consulting was their main research type. In addition to traditional academic research, researchers in state research institutes conduct official and specialist tasks of various types, such as monitoring and providing training and guidance. One of the interviewees explained the share of specialist work / consulting in her job thus:

> They bring me questions from the chargeable services […] sometimes […] only identification of species, and it takes an hour or two for me to look it up, but there is plenty of variety in these tasks. (I9)

The role of the researchers is also different in research assignments as compared to larger projects, as one of the interviewees explained.

> Academic freedom as seen at universities is hard to find in research assignments because the customer says what you should do and you just do it. (I3)

Different research types are orientated differently between disciplines (see Table 16). Although empirical research is the main type of research in all disciplines, it is most common in the social sciences. Theoretical research is emphasised in

multidisciplinary biosciences and in the humanities. Respondents in the technical sciences conducted development/engineering work more often than those in other fields. Specialist work / consulting is more common in the humanities and natural sciences as compared to other fields. Most respondents representing the humanities (86%) worked at the Research Institute for the Languages of Finland. One important part of researchers' work at this research institute involves developing and compiling dictionaries. Differences between disciplines in the share of respondents performing mainly empirical research and specialist work / consulting were found to be significant (chi-squared $p < 0.005$).

Table 16: The percentage of respondents, by discipline, whose main role in conducting was empirical and/or theoretical research and development/engineering and specialist work / consulting

	Empirical	Theoretical	Development / engineering	Specialist work/ consulting
Bio and environmental sciences (N=200-236)*	**59**	5	20	16
Natural sciences (N=119-131)*	**42**	10	21	**27**
Social sciences (N=100-108)*	**72**	6	15	9
Technical sciences (N=88-95)*	**41**	7	**22**	20
Health-care sciences (N=72-81)*	**52**	8	18	14
Multidisciplinary biosciences (N=48)	**42**	**17**	17	13
Humanities (N=17-22)*	**32**	**14**	18	**36**
Total (N=635-709)*	**53**	8	19	18

*Because of the missing information N varies between variables

6.1.2 Dependence on other fields

Dependence on other fields with respect to prior knowledge and research methods is a critical cultural factor explaining researchers' behaviour within a field. Interdependence is connected to Becher's (1989) concepts of convergence and divergence and Whitley's (2000) concepts of mutual dependence and task uncertainty. One interviewee explained the dependence of plant protection on other fields:

> [R]elated fields are important because, on its own, plant protection is an orphan. It is difficult to work alone, and we need others. But, on the other

hand, this field is connected to many, different fields and it is easy to find collaboration. (I7)

Interdependence was measured by asking to what extent respondents use literature from their own and other scientific fields. A scale with three items ('mainly from my own field', 'to some extent from other fields', and 'from various fields') was used.

Using literature across disciplinary borders is commonplace, with 42% of respondents indicating using literature to some extent from other fields and 17% from various fields (see Table 17). However, 42% of respondents used literature mainly from their own field.

Table 17: The percentage of respondents using literature from their own field and other scientific fields, by discipline

	Mainly from my own field	To some extent from other fields	From various fields
Bio and environmental sciences (N=244)	**50**	42	8
Natural sciences (N=132)	**48**	40	12
Social sciences (N=108)	25	**47**	**28**
Technical sciences (N=95)	39	**45**	16
Health-care sciences (N=84)	**44**	27	**29**
Multidisciplinary biosciences (N=47)	25	**45**	**30**
Humanities (N=21)	24	**57**	19
Total (N=731)	41	42	17

Differences between disciplines in the use of literature are significant (chi-squared p = 0.000). Using literature mainly from one's own research field is most common in the biological and environmental sciences, natural sciences, and health care sciences. Over 40% of respondents representing these fields use literature mainly from their own field. More than 40% of respondents representing the humanities, social sciences, technical sciences, and multidisciplinary biosciences use literature to some extent from other fields. Using literature from various fields is most common in multidisciplinary biosciences, the health care sciences, and the social sciences. Almost 30% of respondents representing these fields use literature from various fields.

Research fields in the health care sciences seem to be divided in their use of literature. This reflects differences between fields of study within individual disciplines. In fields such as biomedicine, using literature from one's own field is more commonplace than in, for example, public health, where literature is more likely to be drawn from various fields.

6.1.3 Dependence between researchers

There are also differences between disciplines in the extent to which researchers are dependent on each other. In some fields, working alone is the best way to do research, while it is not possible in others, because of the amount of work the research problems require. Dependence on other researchers is linked to Whitley's (2000) concept of mutual dependence. Also, Becher (1989) discusses dependence between researchers with his concepts of urban and rural fields. Dependence between researchers was measured by asking about the typical number of authors of academic publications. The respondents were divided into two groups, 1) those publishing alone or in a small group of two or three authors and 2) those publishing with a larger team, of at least four authors.

Half of the respondents typically published alone or in a small group and the other half in a larger group, including at least four authors (see Table 18). Differences between disciplines are significant (chi-squared $p = 0.000$). Publishing with several other authors is most typical in the health care sciences, where 80% of respondents publish in a large group. Also in the biological and environmental sciences, multidisciplinary biosciences, and natural sciences, more than half of the respondents typically published with a large group. In the humanities, social sciences, and technical sciences, most respondents typically published alone or in a small group.

Interviewees also pointed out that the number of authors may vary between projects. Also, the same researcher may sometimes write alone and sometimes with several colleagues, as one of the interviewees mentioned. Writing tasks may be divided between co-authors on the basis of their speciality. One of the interviewees explained this thus:

> Larry will write details about statistical methods, what kind of statistical model we have used in the text, and gives references for that, for example, if referees ask something. (I8)

Table 18: For each general discipline, the percentage of respondents publishing typically alone or with a small group and with a large group.

	Alone or as a small group	Large group
Bio and environmental sciences (N=240)	42	**58**
Natural sciences (N=129)	49	**51**
Social sciences (N=105)	**83**	17
Technical sciences (N=89)	**62**	38
Health-care sciences (N=83)	20	**80**
Multidisciplinary biosciences (N=46)	41	**59**
Humanities (N=17)	**88**	12
Total (N=709)	50	50

6.1.4 Research context

In state research institutes, research is done for many purposes and for different audiences. In the interviews, one researcher described the work done at the research institute in the following way:

> On the one hand, our work is done for our own administrative sector or for the ministry's needs and we offer information that is needed to support political decision making and also for general promotion of our field. On the other hand, a very important part of our work is to collaborate with the industry. (I1)

The above extract indicates that the context of research within one research institute can vary, depending on collaboration partners, research funders, and audiences. The same interviewee continued, explaining the influence of context on research work;

> [Y]ou cannot define precisely by yourself anymore what you will do, because the surrounding reality and framework bring their own spices to the work. (I1)

Therefore, it is obvious that research context has a great influence on researchers' work. Three distinct contextual factors – collaboration partners, research funding, and the nature of the research projects – were studied in the survey. Next, results related to these factors are presented.

6.1.4.1 Research collaboration

Research in state research institutes is typically conducted within research projects. Research projects are often conducted in collaboration with other organisations, possessing expertise in different areas. A research project may involve collaboration with many, quite different organisations at the same time. In collaborative projects, research responsibilities can be divided among partners on the basis of their research expertise. One of the interviewees gave an example of the responsibilities of the various partners in a joint research project:

> [T]he collaborating company builds the software and information transfer systems. Our job is to offer the knowledge about the primary production, and milk processing. Then, another company does the actual piloting. (I3)

Collaboration is needed also for obtaining research funding for projects, as one of the interviewees pointed out:

> [W]e are forced to have collaboration with organisations outside [the research institute]. This way, we are stronger when applying for research funding. In reality, that is essential nowadays. (I7)

Collaboration does not develop automatically, however. Researchers need connections and networks with other organisations if they are to be able to create collaboration. One interviewee explained constructing a research project jointly with other organisations:

> It is very dependent on people […] quite often, putting together a research project is based on knowing the right people and trusting people and knowing with whom you can collaborate. […] In the end, it is the small things that make it happen […] you can see how all the networks have formed. They are all based on personal meetings and experiences. (I7)

In the survey, respondents were asked to what extent they engage in research collaboration with other academic organisations such as universities and state research institutes. In addition, collaboration with organisations such as governmental and private-sector entities was investigated. The share of respondents who indicated engaging in regular collaboration with each organisation type is presented in Table 19.

The results indicate that universities are the most common collaborating organisations. Approximately 40% of respondents collaborated with Finnish universities and 20% with foreign universities regularly. It has been argued that tasks and research areas in Finland have become blurred between universities and state research institutes. Because of the common interests, collaboration with universities is easy as one of the interviewees explained:

> [W]e are studying similar things. On one hand, we have competition, but, on the other hand, [there are] lots of collaboration possibilities. (I3)

Approximately one in four respondents collaborate regularly with other Finnish state research institutes. One fifth of the respondents engaged in regular collaboration with foreign research institutes. International collaboration has increased dramatically in the last decade. One interviewee described the changes in international collaboration in recent years thus:

> We have international collaboration too. It started, let's say, at the end of the '90s and since the beginning of the 21st century it has increased dramatically. Before, it was mainly academic visits; people went to see what others were doing. But now we have these EU projects. I am working in one EU project where we have, say, 20 individual research organisations, from different countries. (I2)

While collaborating with researchers from other countries and with different cultural and language backgrounds can cause problems, one of the interviewees saw international collaboration as easier than national collaboration because national competition and comparisons can be left to one side:

> I feel that collaboration with foreign researchers works better compared to national collaboration. Then I realised that the competition is missing. […] Within one country comes this competition for positions […] although you don't want to admit it. […] There is this hidden, you know, 'whose name is first, who you'll cite, and who is asked to give a lecture', small

> things. But with foreign researchers this is missing because all have their own place. The collaboration is surprisingly open and fair. (I7)

Important international collaboration partners can be found in other Nordic countries. In the interviews, researchers emphasised the meaning of Nordic collaboration. Collaboration within the Nordic region is easy because the research problems and environments are similar.

Approximately 10% of respondents collaborated regularly with other government organisations such as ministries, municipalities, and private-sector organisations. According to the interviews, collaboration with private companies depends greatly on the company. Some companies have much experience of research work, and others are less familiar with the research process.

> Some companies have a lot of experience of research projects, and they have their own ways to utilise results, and they know how this works. Others are less familiar with research; they are new to the business or are smaller companies. In these cases, it is not as clear how things should be done and how the project should take off. (I1)

Discipline-aligned differences in the proportion of respondents engaging in regular vs. less frequent collaboration with organisations of various types are significant (chi-squared $p < 0.01$[14]). In all, collaborating with different organisations seems to be most usual in multidisciplinary biosciences and in biological and environmental sciences. In the humanities, respondents collaborate less frequently with different organisations than do those in the other disciplines. Collaboration with Finnish universities are most active in biological and environmental sciences, health care sciences, the social sciences, and multidisciplinary biosciences. Collaborating with foreign universities is more common in multidisciplinary biosciences as compared to other disciplines. Collaboration with state research institutes is most common in multidisciplinary biosciences and in biological and environmental sciences. On the other hand, collaborating with foreign state research institutes is most frequent in the natural sciences and multidisciplinary biosciences, where roughly a quarter of respondents collaborate regularly. Collaboration with other government organisations is most active in multidisciplinary biosciences, and collaborating with private-sector organisations is especially active in the technical sciences.

[14] Discipline-based differences were tested separately for each organisation type. In all cases, the p values were below 0.1.

Table 19: The percentage of respondents engaging in regular research or publishing collaboration with other organisations, by general discipline

	Finnish university	Foreign university	Finnish SRI**	Foreign SRI**	Other government	Private sector
Bio and environmental sciences (N=225-244)*	**49**	**23**	**32**	16	14	11
Natural sciences (N=123-132)*	30	16	24	**25**	3	13
Social sciences (N=100-107)*	**44**	22	26	14	13	5
Technical sciences (N=93-96)*	**32**	16	11	16	8	**28**
Health-care sciences (N=74-85)*	**45**	17	27	20	9	4
Multidisciplinary biosciences (N=44-47)*	**44**	**28**	**38**	**27**	**28**	**21**
Humanities (N=18-21)*	25	5	0	10	10	5
Total (N=682-730)*	41	20	26	18	11	13

*Because of the missing information N varies between variables

**State research institute

Different types of research are done in collaboration with different kinds of organisations. The percentage of respondents collaborating regularly with universities is highest among those conducting mainly theoretical and empirical research. Collaborating with other government organisations and with private-sector organisations is most active among those conducting mainly development/engineering work or specialist work / consulting.

Engaging in regular collaboration with academic organisations such as Finnish and foreign universities and state research institutes is linked to increased dependence between researchers. The percentage engaged in regular collaboration with these organisations is significantly higher (chi squared $p = \leq 0.005$) for those publishing with at least three other authors. Also, decreased dependence on other fields is connected to active collaboration with Finnish and foreign universities and Finnish state research institutes. Differences in collaboration activity relative to one's way of using literature are significant with respect to Finnish universities (ANOVA df = 2, F = 6.199, p = 0.002), foreign universities (ANOVA df = 2, F =

3.775, p = 0.023), and Finnish state research institutes (ANOVA df = 2, F = 5.603, p = 0.004). The percentage of respondents engaging in regular collaboration with these institutes is significantly higher for those using literature from mainly their own field than for those using literature from various fields (Tamhane p < 0.05).

6.1.4.2 Research funding

Research funding is another important factor in research context. In general, the majority of research institutes' funding consists of basic funding from the government. Depending on the institute, external funding covers 10–60% of the research costs. The share of basic funding in funds received by state research institutes has been declining in recent years (see section 2.3.2). In the interviews, researchers stated that they felt more pressure to gain external funding for their work.

> There is a threat: in the future, will we have the resources to be able to continue this research? I know that elsewhere institutes have been suspended and money has been cut, and there are no personnel or pieces of equipment to work with. (I5)

External research funders have their own focus and themes toward which funding is steered. Thereby, research funders have a significant influence on what is studied. However, basic funding is still needed when external funding is sought, as one of the interviewees explained:

> We have to try to get external funding. However, that [research institute] can fund some parts of the research itself is actually the starting point for being able to apply for external funding. When external funding is sought, you always have to have some funding from your own institute […]. [The research institute] have to be aware of the areas of focus of the big funders, such as Tekes and the Academy of Finland, to be in step with research targets. (I3)

In the survey, respondents were asked to what extent they receive research funding from different funding sources, such as their organisation's basic funding, ministries, Tekes, the European Union, the Academy of Finland, foundations, and private companies, for their work (see Table 20). Because researchers may work on many research projects at the same time, they may get funding from several sources

at the same time. A four-point scale with the items 'mainly', 'to some extent', 'rarely', and 'not at all' was used.

Table 20: The number of respondents with each of the main sources of research funding, by general discipline

	No external	Ministry	Tekes	EU	Academy of Finland	Founda-tion	Private company
Bio and environmental sciences (N=196-227)*	**38**	**24**	4	13	10	7	3
Natural sciences (N=111-122)*	**43**	11	13	10	**14**	4	**10**
Social sciences (N=94-102)*	**32**	**27**	9	6	8	8	1
Technical sciences (N=76-89)*	10	11	**44**	**15**	5	1	**20**
Health-care sciences (N=69-79)*	**44**	**14**	5	8	**14**	**13**	1
Multidisciplinary biosciences (N=36-44)*	**31**	14	4	**23**	6	**10**	0
Humanities (N=13-22)*	**86**	**21**	5	0	5	0	0
Total (N=618-670)*	**36**	19	12	12	10	7	6

*Because of the missing information N varies between variables

According to the results, basic funding is the major funding source for research. On average, 36% of respondents worked mainly without any external research funding – in other words, from the institute's basic funding: 23% of respondents' work is funded to some extent by basic funding. On the other hand, 23% of respondents do not have any basic funding for their research. There are significant differences by discipline in the percentage of respondents working mainly without external funding (chi-squared $p = 0.000$). Working without external research funding was most common in the humanities, where 86% of respondents were working mainly without external funding. Also in the health care sciences and natural sciences, over 40% of respondents indicated working mainly without external funding. In the technical sciences, only 10% of the respondents stated that they worked mainly without external funding.

State research institutes can also steer research to focus on special areas in which the institute wants to contribute. For example, a portion of the budgetary

funding can be given as competitive research funding, for which researchers can apply within the institute. Interviewees also described differences between their research institute's research units in the pressure to obtain external funding:

> There is variation between teams, but in our own team we are in a situation in which we have to have more external funding. About 30% external and 70% from the budget, but we should try to increase the amount of external funding to near 50%. There are already research teams with 'fifty/fifty' funding. (I9)

Ministries are important funders of research done at state research institutes. A fifth of the respondents get their research funding primarily from the ministries. The differences along discipline lines in the proportion of respondents whose main research funding came from ministries are significant (chi-squared $p = 0.004$). Research funding from ministries is most common in the social sciences, in which 27% of respondents indicated having research funding mainly from this quarter. Also more than one fifth of respondents representing biological and environmental sciences and the humanities get their research funding mainly from ministries. Ministry funding is least common in the technical sciences and natural sciences, where only 11% get their main research funding from ministries.

Interviewees reported that ministries had recently cut off research funding and started to focus their funding on specific areas of focus. One of the interviewees saw the changes as positive:

> I hope it will be competitive funding, similar to [the approach] with the Academy of Finland with international evaluation boards, which would be at least to some extent incorruptible. The old ones were pretty lobbied. It would definitely increase the quality of research. It will be tighter, but the quality will increase. (I6)

Tekes is the main source of research funding for 12% of the respondents. Differences by discipline are again significant (chi-squared $p = 0.000$). Tekes funding is most commonplace in the technical sciences, where 44% of respondents received their main research funding from Tekes. In biological and environmental sciences, the health care sciences, the social sciences, multidisciplinary biosciences, and the humanities, only five per cent or fewer received their main research funding from Tekes. Tekes projects usually take the form of collaboration between research organisations and private companies. When different types of

organisations are involved with the project, there are usually also different interests within the projects, as one of the interviewees reported:

> Tekes projects have two kinds of interests: VTT and universities have their own interests in conducting academic research, writing publications, and working with Ph.D. projects, but research funders have interests also in making reports and steering the study toward those questions they want to be studied. (I10)

The European Union is another important research funder for state research institutes. According to the survey, 12% of respondents receive their main research funding from the EU. Discipline-aligned differences are significant (chi-squared $p = 0.023$). European Union research funding is most common in multidisciplinary biosciences, where 23% of respondents receive their main research funding from the EU. None of the respondents in the humanities reported main research funding from the EU. In the social sciences and health care sciences, under 10% received their main research funding from the EU. One of the interviewees described the importance and possibilities of European Union research funding:

> Then there is the European Union research funding, which we should try to take advantage of, but preparing these applications requires a lot of work. However, our goal is to increase the EU funding. (I9)

EU projects are often very large and feature many research partners, from many countries. Sometimes it is hard for a single researcher to see or understand the big picture of the projects:

> They are massive. We work with smaller work packages, but the whole project is so large and I often wonder what kind of fakir one has to be to be able to handle all the information and know where it is heading. (I2)

The Academy of Finland is the main funder of basic research in Finland. About 10% of respondents obtained their main research funding from the Academy of Finland. There are no significant differences between disciplines in the percentage of respondents whose main research funding came from the Academy of Finland; however, the academy being the main source of research funding is most common in the health care sciences and natural sciences. Working mainly with Academy of Finland funding is least common in the humanities, technical sciences, and multidisciplinary biosciences. Interviewees explained that, because of the nature of

the research conducted at state research institutes, having funding from the Academy of Finland is not very common.

Seven per cent of respondents received their main research funding from a foundation. There are significant differences between disciplines in the percentage of respondents whose research was funded mainly by foundations (chi-squared p = 0.015). Working primarily with funding from foundations was most common in health-care sciences and multidisciplinary biosciences. None of the respondents in the humanities and only one per cent in the technical sciences indicated working mainly with foundation funding. Interviewees explained that the problem with foundations is that their area of focus is often too general and researchers from very different research fields compete for the same funding. Accordingly, opportunities to receive research funding from foundations are limited.

Six per cent of respondents received their main research funding from private companies. Discipline-aligned differences are again significant (chi-squared p = 0.000). Private company funding was clearly most common in the technical sciences, where a fifth of respondents obtained their main research funding from private companies. Also in the natural sciences, 10% of respondents received their main research funding from private companies. In other disciplines, private companies providing the main research funding was more unusual. In some cases, private companies do not actually provide research funding but participate in the research via their own work:

> They did not give us any funding but participated with their own work. They did their own tests, and we also got materials for conducting more field work. But the main funding came from the ministry and from the institute's own funding. (I7)

Projects funded entirely by private companies are in the minority. However, private companies are a good starting point for research projects, as one of the interviewees described:

> The best situation is when, for example, an industrial company comes to us with a research proposal or development idea upon which we can build the research plan. We might or might not get public research funding for the project. The project may be funded entirely by the company or use a combination of private and public funding. (I1)

Different types of research are supported by different funding sources. For example, working without external research funding was most common for those

conducting mainly specialist work / consulting. Tekes funding is most common for those conducting mainly development/engineering work. Working mainly with funding from the Academy of Finland was most typical for those conducting primarily theoretical research.

6.1.4.3 Research projects

The nature of the research projects is the third contextual factor explored in this study. In the survey, the nature of research projects was studied by means of two questions. Firstly, respondents were asked about the typical length of their research projects (see Table 21). Half of the respondents stated that they typically worked with projects lasting two years at most, and the other half referred to projects lasting more than two years. Differences between disciplines are significant (chi-squared p = 0.000). In the natural sciences, social sciences, and technical sciences, working on shorter projects is most common, while working with longer projects is more common in biological and environmental sciences, health care sciences, multidisciplinary biosciences, and the humanities.

The nature of the research is related to the length of the projects. Development/engineering was associated with short projects. Sixty per cent of those working mainly in development/engineering typically work in projects lasting two years at the most. One of the interviewees told her experiences about short research projects:

> I have done one project that was a research assignment lasting two weeks. It was really quick. The client, which was a private company, told us what they wanted and we did it in two weeks. (I12)

Table 21: The typical length of research projects, by discipline (percentages of respondents are shown for each duration)

	Max. two years	More than two years
Bio and environmental sciences (N=247)	33	**67**
Natural sciences (N=133)	**60**	40
Social sciences (N=108)	**69**	31
Technical sciences (N=98)	**70**	30
Health-care sciences (N=83)	45	55
Multidisciplinary biosciences (N=47)	45	55
Humanities (N=22)	27	**73**
Total (N=738)	50	50

Interviewees from both institutes indicated that common policy today is to try to focus on large projects and cut shorter projects off:

> [A] clear message is this: either research assignments or very big projects. I think that shorter projects were more common earlier and work was fragmented. (I12)

In longer projects, research topics can be studied in more depth and more resources are invested in planning. On the other hand, large longitudinal projects have their own issues – for example, in keeping to the timetables set:

> We have a timetable, but it does not always hold. For example, in this project we are two months behind. I have other duties also that I have planned, and I know they are not going to happen. In this job, you just cannot be too systematic […] you have to be able to look at the big picture. (I2)

Secondly, respondents were asked about the typical number of research projects they work with at the same time (see Table 22). The results indicate that researchers work typically with several projects at the same time. The majority of respondents (62%) work with more than two projects at the same time and 38% with one or two projects. Respondents may work with both short- and long term projects at any given time, as one of the interviewees described her work:

> Usually, I have at least two or three projects undergoing work at the same time. Quite commonly I work with one bigger project and two smaller projects. For smaller projects, I might use only a few days a month and work mainly with the bigger project. But I think this varies considerably between researchers. (I12)

Interviewees indicated some problems with working on many projects at the same time. For example, one of the interviewees saw difficulties in time management:

> The fact is that if you are working with multiple projects, your work will be fragmented and that is not so nice. […] If you have too much work, it is hard to know where to start […] it is a sort of time management. (I11)

Again, there are significant differences by discipline (chi-squared $p = 0.002$). The proportion of respondents reporting working with three projects or more at the same time was highest in multidisciplinary biosciences and technical sciences.

Respondents representing the humanities seem to be working less often with several projects at a time.

Table 22: The number of projects the respondents were working on simultaneously, by discipline (the percentage of respondents is given for each range)

	One or two	Three or more
Bio and environmental sciences (N=244)	36	**64**
Natural sciences (N=129)	39	**61**
Social sciences (N=107)	41	**59**
Technical sciences (N=97)	33	**67**
Health-care sciences (N=83)	35	**65**
Multidisciplinary biosciences (N=48)	27	**73**
Humanities (N=21)	**81**	19
Total (N=729)	38	62

6.1.5 Summary

The research conducted in state research institutes is mainly empirical. Respondents focusing mainly on theoretical research are in the minority. This is not surprising when one looks at the tasks and roles assigned to the institutes. Both development / engineering and specialist work / consulting are quite common types of research at state research institutes. Development/engineering is especially typical in the technical sciences. Respondents in the natural sciences and humanities are more focused on specialist work / consulting than are those in other disciplines.

Relying on literature produced within one's own field and publishing with several other authors was most typical in the biological and environmental sciences, natural sciences, and health-care sciences. The academic culture in these areas can be described as convergent in Becher's terms. If we use Whitley's notion, mutual dependence is high and task uncertainty low in these fields. In the humanities and social sciences, using literature from a variety of disciplines and publishing alone or in a small group is more typical. Their culture can be described as rural and as having low mutual dependence and high task uncertainty. The technical sciences and multidisciplinary biosciences cannot be classified so easily. In multidisciplinary biosciences, respondents typically used literature from various fields and published with several colleagues. The culture here can be defined as divergent and as having

high task uncertainty and high mutual dependence. In the technical sciences, the respondents typically used literature from both their own area and other scientific fields and published alone or in a small group, though larger teams also were commonplace. Accordingly, the culture in technical sciences at research institutes cannot be defined clearly with Becher's and Whitley's concepts.

Table 23: Summary of the results related to discipline-linked cultures

	Nature of research	Dependence on other fields	Dependence between researchers
Bio and environmental sciences	Mainly empirical	Decreased dependence	Increased dependence
Natural sciences	Mainly empirical and specialist work/consulting	Decreased dependence	Increased dependence
Social sciences	Mainly empirical	Not clear	Not clear
Technical sciences	Mainly empirical and development/ engineering	Moderate dependence	Increased dependence
Health-care sciences	Mainly empirical	Decreased dependence	Increased dependence
Multidisciplinary biosciences	Mainly empirical and theoretical	Increased dependence	Increased dependence
Humanities	Mainly empirical and specialist work/consulting	Increased dependence	Decreased dependence

Respondents engaged in research collaboration with many types of organisations. Collaborating with different organisations seems to be most frequent in multidisciplinary biosciences and biological and environmental sciences. These fields' main collaboration organisations are academically oriented. In Whitley's terms, reputational autonomy can be seen as relatively high in state research institutes, while it decreases especially when the collaboration is with elements outside academia. The respondents' main collaboration organisations are national universities and public research institutes. In the technical sciences, collaboration with the private sector is also quite common. Thus, in technical sciences reputational autonomy is likely to be lower compared to other fields.

Research costs are covered mainly by basic funding. External research funding is gained from various sources. Working mainly without any external funding is most common in the humanities, health care sciences, and natural sciences. The

technical sciences stand out from other disciplines here: only 10% of respondents work mainly with basic funding. The main external funders of research are ministries, Tekes, and the EU. Private companies also are especially important funders in the technical sciences.

Most typically, the researchers work on many research projects at the same time. Working with only one project is more common in the humanities than in other disciplines. Typical research projects last one to two years or three to four years. Respondents representing the social and technical sciences indicated typically working on shorter projects more than those in other disciplines did.

Table 24: Summary of results pertaining to research context

	Collaboration	Research funding	Research projects
Bio and environmental sciences	Mainly national academic organizations	Reliance on basic funding, Main external funder ministries	Mainly three projects or more, Mainly long projects
Natural sciences	Mainly national and international academic organizations	Reliance on basic funding, Main external funders Academy of Finland and Tekes	Mainly three projects or more. Mainly short projects
Social sciences	Mainly national academic organizations	Reliance on basic funding, main external funder ministries	Mainly three projects or more. Mainly short projects
Technical sciences	Mainly national academic and industrial organizations	Reliance on external funding. Main funders Tekes and private companies	Mainly three projects or more. Mainly short projects
Health-care sciences	Mainly national academic organizations	Reliance on basic funding, Main external funding from ministries and Academy of Finland	Mainly three projects or more. Mainly long projects
Multidisciplinary biosciences	Different national and international organizations.	Reliance on basic funding, main external funding from ministries	Mainly three projects or more. Both short and long projects.
Humanities	Mainly national collaboration.	High reliance on basic funding, Main external funder ministries	Mainly one or two projects. Mainly long projects

6.2 Publishing

This section of the chapter reports the results pertaining to publishing practices at state research institutes. As was that in the previous section, this discussion is built around the analyses of the results from the survey. Extracts from the interviews are used to give explanations and examples of researchers' work. Firstly, publishing activity involving various publishing forums in different discipline groups is presented. Then, 'publishing orientations' are conceptualised by means of principal component analyses. Thirdly, the impact of various cultural and contextual factors on publishing activity in different publishing orientations is studied. The section ends with a summary of the results.

6.2.1 Publishing activity

Making research results visible by publishing is an important part of researchers' work in state research institutes. In the survey, respondents were asked to what extent writing publications is an element of their work. A four-point scale ('the main part', 'a moderate part', 'a small part', 'not a part of my work') was used. One in four respondents reported writing publications to be the main part of their work. For 59%, writing was a moderate part and for 16% a small part of the work. Discipline-to-discipline differences in the share of writing indicate that the amount of researcher work required in writing varies with the discipline. For example, in the social sciences, where publications are usually the actual output of the study, over 40% of respondents reported writing to be the main part of their work and half a moderate part of the work. On the other hand, in the technical sciences and health care sciences, only 12% of respondents referred to writing as the main part of the work. The results also point to differences in the nature of the work between disciplines.

Interviewees perceived publishing also as important and as something that is connected to being a researcher. Publications are the concrete form of the results of a study. By publishing research results, researchers get the feeling that something is actually done and that the work is progressing.

> It is a terrible feeling of working a lot but not having anything in your hands. You don't have full stops, only open sentences. So mentally it is very important to get it published in some way. It might be either national

> or international publication. International publications are, of course, more valued, but also publishing in national forums aids in creating your own self-esteem. (I7)

In the survey, researchers were asked to describe their publishing activity in various academic, professional, and general publishing forums over the previous two years. A five element scale ('0', '1–2', '3–5', '6–10', 'more than 10') was used for indicating activity. Next, the results pertaining to publishing activity, are presented, starting with academic publishing.

6.2.1.1 Academic publications

Traditionally, scholarly communication has been understood as publishing of research results in academic forums and for the use of the academic audience. Academic publications are important for enabling researchers to participate in academic discussion and also for gaining prestige. By publishing results in academic forums, researchers and research projects gain visibility and publicity. Publishing also develops a manner of thinking in which research has to be placed in academic context and connections found with earlier research. Through their publishing, researchers also are invited to attend to academic discussion by performing peer review of others' work. Without producing academic publications, researchers are left out of this discussion.

> When you publish yourself, you'll also get papers to read and of which to give referee's evaluations. I think it is a shame that if you don't publish you won't participate in this academic discussion. (I6)

However, publishing is seen as a demanding process that requires time and effort from researchers. To get papers published, researchers have to concentrate on publishing and put time and effort into it. A common problem for all of the interviewees was lack of time. One interviewee described his point of view on time management when it comes to publishing:

> Publishing has to be your number-one priority, and you make time for it. You cannot think: 'Okay, let's write an article about this for the newspaper and if there is time we'll write an academic one.' You will never have the time. (I6)

Research institutes may set goals as to how many academic publications each researcher should produce per year. The importance of publishing has grown over the years, as one researcher pointed out:

> One researcher who worked here already in the '80s said that at that time it was not expected that people would publish any academic articles. This is quite new. One article per year per researcher – I don't know when this started. Of course, people did publish also in the '80s, but it wasn't as if they had to. (I6)

In the survey, respondents were asked to indicate the number of their publications in the last two years in academic publishing forums of various types, such as academic journals, edited works, and academic monographs (see Table 25). International academic (peer-reviewed) journals were the most common academic publishing forums. On average, 73% of respondents published at least one article in an international peer-reviewed journal within the previous two years. Almost 40% published one or two articles, 25% three to five articles, and 10% six or more articles.

Differences between disciplines are significant (ANOVA df = 6, F = 14.699, p = 0.000) when the proportion of respondents producing at least one international journal article is examined. Publishing was most active in the health care sciences, biological and environmental sciences, and multidisciplinary biosciences. More than 80% of respondents in these fields had published at least one article in international journal within the two-year span. The difference from the humanities and technical sciences is significant (Tamhane p = 0.000). A quarter of respondents representing the humanities and half of those representing the technical sciences had published at least one article in an international journal.

International journals are valued as publishing forums. However, prestige varies from one journal to the next. Well-known journals published by prestigious publishing houses are valued.

> Mainly, they are series published by international publishing houses. Everyone knows these publishers, and the journals are well known because of that. It is seen as familiarity and reliability if the journal is run by a big publisher. (I1)

Whitley (2000) have pointed out that general journals are usually more respected because of the wide audience they reach. However, researchers have to

think about several things when selecting the journal they want to offer their paper. For example, timetables may impose their own limits on publishing.

> There is a risk if you offer your paper to a good journal that it will still be rejected after second revision. So if you have to publish it quickly, it might not be worth the risk. (I6)

Publishing in national academic journals is not as active as that in international journals. In fact, 65% of all respondents did not publish any articles in national academic journals within the previous two years, while 30% of respondents published one or two articles and under five per cent more than two articles. Differences between disciplines in the percentage of respondents producing at least one publication are significant (ANOVA df = 6, F = 9.347, p = 0.000). Publishing in national journals is most active in the social sciences. Half of the respondents from that field and also of those in health care sciences had published at least one article in a national journal within the previous two years. The difference from technical sciences and natural sciences is significant (Tamhane p = 0.000). In the technical sciences and natural sciences, under a quarter of respondents had published at least one article in a national journal.

Interviewees saw national journals as problematic because of the small size of the country. There are not enough researchers for a well-running national journal to be established.

> [T]here aren't many national refereed journals, because there aren't so many researchers. One could say there is a lack of basic material that you would need to run a national journal, so it's hard. Maybe you could get it started, but keeping it up would be difficult. Where would you get enough material for the journal? (I1)

Articles are published also in edited works. One third of respondents published one or two book articles in the two-year period and, on average, seven per cent of respondents had published more than two articles in edited works. However, more than 60% did not publish any articles in edited works. Again, differences between disciplines are significant (ANOVA df = 6, F = 4.989, p = 0.000) in the percentage of respondents producing at least one publication. Publishing articles in edited works is most common in the social sciences. More than half of the respondents representing social sciences and also of those in the humanities had published at least one paper in a book.

Edited works are published in the natural sciences too; however, they are not perceived as being such established publishing forums as journals are. One of the interviewees explained his thoughts about publishing in edited works:

> We were considering sending one of our articles for this book, but in the end we were afraid it would vanish within the book. It was also unclear when it would be published and what its readership would be. So we submitted the article to a journal. (I6)

Writing academic monographs is not very common among those at state research institutes. Only 16% of all respondents had published academic monograph within the previous two years. The difference between disciplines in the proportion of respondents producing at least one monograph is significant (ANOVA df = 6, F = 7.620, p = 0.000). Publishing of monographs was most active in the social sciences and the humanities: 34% of the social scientists and 28% of the humanists had published at least one academic monograph in the two years. The difference between those in the social sciences and those in the technical sciences, biological and environmental sciences, and natural sciences is significant (Tamhane p = 0.000).

Table 25: The percentage of respondents with at least one publication in various types of academic publishing forums, by discipline

	Article in international journal	Article in national journal	Academic monograph	Chapter in edited work
Bio and environmental science (N=238-248)*	**83**	**40**	12	39
Natural science (N=128-131)*	69	19	11	31
Social science (N=106-108)*	67	**50**	**34**	**56**
Technical science (N=90-96)*	51	14	7	23
Health-care science (N=84-85)*	**84**	**48**	17	34
Multidisciplinary (N=44-48)*	**94**	33	20	**46**
Humanities (N=21)	24	38	**29**	**48**
Total (N=715-737)*	73	35	16	38

*Because of the missing information N varies between variables

Conferences too are important forums for publishing research. In the survey, respondents were asked how many articles they had published in the previous two years in international and national refereed conference proceedings (see Table 26).

Almost half of the respondents had not published any international conference papers. A third published one or two, and 16% published three or more conference papers. The difference between disciplines in the proportion of those producing at least one international conference paper is significant (ANOVA df = 6, F = 4.966, p = 0.000). Publishing by means of international conference is most common in the technical and natural sciences, with 70% of respondents in the technical sciences and 63% of respondents in the natural sciences publishing at least one paper in international conference proceedings. The difference from the humanities is significant (Tamhane p = 0.000). In the humanities, only one fifth had published at least one article via international conference during the two-year period.

In the interviewees, researchers explained reasons for attending conferences. With conferences, results can be published more quickly:

> The reason results are published at conferences in this field is, for example, because this field is developing so quickly, technical development is so quick that journal articles are always a few years behind. Our results are published sooner via conferences. (112)

On one hand, conferences are good forums for publishing research results and making one's work and organisation known. At the same time, conferences allow researchers to meet other researchers and build networks:

> They are meeting places where you can present your own work and also attend discussions. For example, if people are interested in developing a common EU project, they can meet. Personal contacts are possible. And also you can see Finnish researchers from your own field there. (I3)

At conferences, researchers can be in touch with their international colleagues. An invisible colleague can become visible at conferences. Conferences are also excellent places for monitoring what is happening on the research front:

> You'll get the latest information from conferences – for example, information about research or markets or political issues. That kind of background information. (I1)

Publishing via national conferences is not as common as publishing via international conferences. Most respondents did not publish any articles in proceedings of national conferences in the two-year period. A quarter of the

respondents published one or two papers. This publishing is most common in multidisciplinary biosciences and in biological and environmental sciences. However, the difference from other fields is not significant.

The small size of the country is one of the key reasons for researchers not publishing via national conferences. It is not always worth the work of arranging national conferences, because of the small number of researchers. However, interviewees did see national conferences as good places to for tracking what is happening in Finland. When demands for one's time are great, it might be hard to stay informed of what is happening even in the next room:

> It's nice to hear what your neighbours were doing last summer, what the common problems in the field are. It's a place for updating knowledge. […] Your sector is so narrow, and you don't have the time to delve deeply into what others are doing, even though they work in the same field. (I4)

Respondents were also asked to indicate the number of publications that are not refereed but still are published in academic forums such as editorials or posters (see Table 26). Almost 40% of the respondents had one or two unrefereed academic publications, one fifth three to four of these publications, and eight per cent more than five. The difference between disciplines in the percentage of respondents producing at least one publication is significant (ANOVA $df = 6$, $F = 7.287$, $p = 0.000$). Such publishing is most common in the health care sciences. About 85% of respondents in that field produced at least one unrefereed academic publication over the two years. The difference from the technical sciences and the humanities is significant (Tamhane $p < 0.05$). For example, 65% of respondents representing the humanities did not produce any unrefereed academic publications.

Table 26: The percentage of respondents with at least one conference paper or non-refereed academic publication, by discipline

	Article in international conference	Article in national conference	Un-refereed academic article
Bio and environmental science (N=236-240)*	49	**29**	71
Natural science (N=128-132)*	**63**	26	66
Social science (N=105-107)*	50	25	59
Technical science (N=93-95)*	**70**	15	49
Health-care science (N=85)	48	24	**85**
Multidisciplinary (N=45-47)*	**60**	**29**	79
Humanities (N=21)	19	14	38
Total (N=717-723)*	54	25	67

*Because of the missing information N varies between variables

6.2.1.2 Professional publications

Research is published not only in academic forums but also in professional ones. Publications in professional forums have not gone through the peer review process; accordingly, their function is different from that of academic publications. They offer information to professional audiences such as medical doctors, farmers, and industry. One of the interviewees explained the differences in the functions of academic and professional publishing:

> To be able to work as a serious player in this field requires publishing via prestigious scientific forums. On the other hand, because our job is to support decision-making and industrial life, publishing through professional forums is important for pursuit of these goals. It cannot be underestimated or seen as less important just because these publications don't have impact factors. The two go hand in hand, and both have important functions. (I1)

In the survey, respondents were asked how many publications they had made in the previous two years in various professional forums, such as research reports and articles in professional magazines (see Table 27). Also the number of patents was solicited. Professional magazines are publishing forums wherein issues and development of certain profession are discussed. Professional magazines are important forums for researchers who want to popularise research results for

certain professional audiences. The content and style of writing in professional magazines differ from those seen with academic articles. Reporting in professional magazines does not have to as exact, and the emphasis may be on implications.

A third of all respondents published one or two articles in professional magazines and a quarter of them more than two. The difference between disciplines in the proportion of respondents producing at least one publication is significant (ANOVA df = 6, F = 11.321, p = 0.000). Most commonly, publishing in professional magazines was seen in biological and environmental sciences and in the humanities. More than 70% of respondents in biological and environmental sciences and the humanities had published at least one article in a professional magazine. The difference between biological and environmental sciences and, on the other hand, the natural sciences and technical sciences is significant (Tamhane p = 0.000). However, almost half of the respondents in the natural and technical sciences still had published a professional article.

Most of the respondents had also published research reports. In the last two years, more than 40% of the respondents had published one or two reports and a quarter of them more than two. Under one third did not publish any research reports. The difference between disciplines in the proportion of respondents producing at least one research report is significant (ANOVA df = 6, F = 8.151, p = 0.000). Publishing research reports is most common in the social sciences. The majority of social scientists had published at least one research report in the two-year span. The difference from other disciplines, apart from multidisciplinary biosciences, is significant (Tamhane $p \leq 0.001$). For example, only a quarter of the humanists had published a research report.

Sometimes researchers produce research reports that are confidential and not made public. This is very often the case when a private company has commissioned a research assignment from the institute. Unpublished confidential research reports are a less common form of publication than public reports, for 60% of respondents did not publish any confidential research reports. However, one in four respondents made one or two reports and 13% more than two. The difference between disciplines in the proportion of respondents preparing at least one report is significant (ANOVA df = 6, F = 16.129, p = 0.000). Producing confidential research reports is most common in the technical sciences. The difference with respect to other disciplines is significant ($p < 0.01$). Producing confidential research reports is commonplace in the natural sciences also. Half of the respondents representing the natural sciences and 76% of those representing the technical sciences had produced at least one confidential research report.

Almost one fifth of respondents in the technical sciences had produced more than five confidential research reports during the two years.

Patenting is another way to publish results. The aim with a patent is to show ownership of the innovation or product. Patenting is not very common in state research institutes[15]. Only four per cent of all respondents had applied at least one patent in the two years. The difference between disciplines in the proportion of respondents applied at least one patent is significant (ANOVA df = 6, F = 5.435, p = 0.000). Patenting is most commonplace in the technical sciences and multidisciplinary biosciences. In the technical sciences and multidisciplinary biosciences, almost 12% of respondents had obtained one or two patents in the previous two years. The difference between technical sciences and the social sciences, humanities, and health care sciences is significant (Tamhane $p < 0.05$). In these fields, the respondents had almost no patents.

Patent applications are often prepared in collaboration with private companies. Patent applications may limit the possibilities for publishing, at least until the application is accepted, as one of the interviewees pointed out:

> One thing restricting publishing is patent applications we have filed with companies, which is limiting our freedom to publish. (I3)

Table 27: The percentage of respondents producing at least one professional publication, by discipline

	Research report	Unpublished research report	Article in professional magazine	Patent
Bio and environmental science (N=239-248)*	67	28	**74**	3
Natural science (N=127-131)*	62	**51**	35	5
Social science (N=102-108)*	**91**	33	**63**	0
Technical science (N=95-98)*	62	**74**	49	**13**
Health-care science (N=81-83)*	68	29	**64**	1
Multidisciplinary (N=43-47)*	68	35	52	**12**
Humanities (N=20-21)*	25	5	**71**	0
Total (N=710-728)*	68	39	59	4

*Because of the missing information N varies between variables

[15] This may be due to the fact that technical sciences are under-represented in the data.

6.2.1.3 Popular publications

Sometimes researchers want to popularise research results for a more general audience or media actors want to report about interesting research projects and results. The respondents were asked the number of articles in newspapers and magazines, and the number of study and other popular books, they had published in the previous two years (see Table 28). The most common way to popularise research is to write articles for newspapers and magazines. More than 40% of the respondents had published at least one article in a newspaper or magazine. Differences between disciplines in the proportion of respondents producing at least one article are significant (ANOVA df = 6, F = 7.215, p = 0.000). Popular article publishing is most common in the humanities and social sciences, with more than 60% of the respondents representing the humanities and more than half of the social scientists having published at least one article in a newspaper or popular magazine. The difference between these disciplines and the natural sciences is significant (Tamhane $p < 0.05$).

More than 10% of the respondents had published a study book during the two-year span. The difference between disciplines in the proportion of respondents producing at least one study book is significant (ANOVA df = 6, F = 3.958, p = 0.000). The most active publishers of study books are respondents representing the humanities and health care sciences. Approximately a quarter of the respondents in these fields had prepared a study book in the course of the two years. The difference from the natural sciences in this respect is significant (Tamhane p = 0.018).

A fifth of the respondents had published a popular book of another type. The difference between disciplines in the percentage of respondents producing at least one popular publication is again significant (ANOVA df = 6, F = 3.390, p = 0.003). Publishing other popular books was seen most commonly in multidisciplinary biosciences, biological and environmental sciences, and the social sciences. More than a quarter of respondents in these fields had published at least one such book.

Table 28: The percentage of respondents producing at least one popular publication, by discipline

	Newspaper/ magazine	Study book	Other popular book
Bio and environmental science (N=243-247)*	48	15	**26**
Natural science (N=128)	23	6	11
Social science (N=107)	**54**	11	**25**
Technical science (N=95-96)*	29	7	15
Health-care science (N=82-84)*	47	**23**	18
Multidisciplinary (N=44-46)*	44	21	**31**
Humanities (N=20-21)*	**67**	**29**	10
Total (N=722-729)*	42	13	21

*Because of the missing information N varies between variables

6.2.2 Publishing orientations

Principal component analysis is used to group publication types into publishing orientations for further analyses. Monographs, patents, and study books had to be removed from the analysis because of the skewness (3,196, 5,161, and 2,648, respectively) and low communalities (< 0.5) of the measure¬ments. The skewness was due to the relative lack of publication in the forums omitted – most respondents did not publish in these forums. Therefore, there were 10 variables retained for further analyses[16].

Four components were discovered (meeting the Kaiser–Meyer–Olkin condition: 0.708, Bartlett's test of sphericity p = 0.000) that exceeded eigenvalue 1 (see Table 29). Together these components explain 62.5% of the total variance in the variables included. Core variables of each component were computed for presentation of four publishing orientations. Before computing, each variable was coded as a dummy variable to represent those who had produced at least one publication (1) and for those who had not produced any publications (0) in the two-year span.

[16] Original scales of the measures were used in the analysis

Table 29: Factor loadings in the principal component analysis

	Professional	Academic article	Academic conference	Industrial
Article in newspaper or magazine	,827			
Article in professional magazine	,782			
Article in Finnish academic journal	,535			
Research report	,460			,440
Article in international journal		,755		
Unrefereed academic publication		,749		
Chapter in edited work		,527		
Article in Finnish conference proceedings			,820	
Article in international conference proceedings			,757	
Confidential research report				,883

Rotation method: Varimax with Kaiser normalisation.

The first component can be called professional publishing orientation (explaining 28% of the variance, Cronbach's alpha 0.656). This orientation includes articles in general newspapers and magazines, articles in professional magazines, articles in national academic journals, and research reports. Articles in national academic journals were prominent in the loading of this component probably because the audience of these journals often includes, in addition to the academic one, a national professional audience. The second component can be called academic article publishing orientation (explaining 13% of variance, Cronbach's alpha 0.528). This orientation consists of international academic journals, non-refereed academic articles, and articles in edited works. The third component (explaining 12% of variance, Cronbach's alpha 0.543) is called academic conference publishing orientation. This orientation covers articles in proceedings of international and national conferences. The fourth and final component (explaining 10% of variance), called industrial orientation, features only one type of publication, unpublished research reports. Public research reports were part of the loading of this component too, but not as heavily as in the professional orientation. Therefore, these were counted as professional publications. Research reports are a

very common form of publication, and it seems that there are at least two kinds of public research reports. Firstly, public research reports may be prepared for industry; secondly, they may be created for other audiences, such as ministries. The low Cronbach's alpha (0.192) of public and confidential research reports supported the decision to count public research reports as professional publications.

Different publishing orientations reflect tendency to publish research results for different audiences, and publishing activity varies between orientations. Also, orientations are focused differently in different disciplines.

More than 80% of respondents had produced at least one publication during the two years in professional publishing orientation (see Table 30). There are significant differences between disciplines in the percentage of respondents producing at least one professional publication (ANOVA df = 6, F = 4.386, p = 0.000). Professional publishing is especially active in the social sciences, where 97% of respondents had produced at least one professional publication during the two-year span. The difference is significant (Tamhane p = 0.000) when this field is compared to the natural and technical sciences, in which under 80% had produced a professional publication.

On average, 90% of all respondents had produced at least one academic article during the two years (see Table 28). There are significant differences between disciplines in the level of academic article publishing activity (ANOVA df = 6, F = 7.872, p = 0.000). Academic article publishing is most commonplace in multidisciplinary biosciences and health care sciences. All respondents representing multidisciplinary biosciences and 97% of respondents representing the health care sciences had published an academic article. The difference from the technical sciences is significant (Tamhane $p < 0.05$). Two thirds of respondents representing the technical sciences and also the humanities had published at least one academic article within the previous two years.

On average, 60% of the respondents had produced at least one conference-linked publication in the course of the two years (see Table 30). There are significant differences between disciplines in academic conference publishing activity related to conferences (ANOVA df = 6, F = 3.306, p = 0.003). Conference-related publishing is most common in the technical sciences. More than 70% of the respondents representing the technical sciences had published at least one article in conference proceedings. In the natural sciences too, almost 70% of respondents had given a conference paper. Only 36% of those representing the humanities had published via a conference during the two years.

On average, 40% of respondents had had at least one industrial publication during the two-year span (see Table 30). There are significant differences between disciplines in industrial publishing activity (ANOVA df = 6, F = 16.129, p = 0.000). Producing confidential research reports was significantly (Tamhane p < 0.01) more common in the technical sciences than in all other fields: 74% of respondents representing the technical sciences produced at least one industrial publication. Also, half of the respondents representing the natural sciences had produced a confidential research report.

Table 30: The percentage of respondents producing at least one publication, for various publishing orientations, by discipline

	Professional orientation	Article orientation	Conference orientation	Industrial orientation
Bio and environmental science (N=240-250)*	**88**	**94**	56	28
Natural science (N=131-135)*	79	87	**67**	**51**
Social science (N=102-109)*	**97**	91	54	33
Technical science (N=97-98)*	77	76	**72**	**74**
Health-care science (N=83-85)*	86	**97**	52	29
Multidisciplinary (N=46-48)*	81	**100**	65	35
Humanities (N=20-22)*	82	73	36	5
Total (N=719-747)*	85	90	59	39

*Because of the missing information N varies between variables

6.2.3 Factors influencing publishing orientations

Next, the influence of various cultural and contextual factors on publishing activity with different publishing orientations is examined.

6.2.3.1 The nature of the research

The nature of one's research has a significant influence on publishing practices. In the survey, respondents were asked to indicate the share of empirical and theoretical research and also the share of development/engineering and specialist/consulting work in their activities. The results indicate that different

types of research results are disseminated with different publishing orientations (see Table 31).

Table 31: The percentage of respondents producing at least one publication, by research type

		Professional orientation	Article orientation	Conference orientation	Industrial orientation
Theoretical research	Mainly (N=56)	88	91	**71**	41
	Less (N=579)	85	90	56	39
Empirical research	Mainly (N=393)	86	**93**	58	35
	Less (N=305)	85	86	60	44
Development/ engineering	Mainly (N=143)	82	89	64	42
	Less (N=535)	86	91	59	40
Specialist work/consulting	Mainly (N=133)	**90**	86	56	**47**
	Less (N=576)	85	91	60	38
Total (N=638-709)*		85	90	59	39

*Because of the missing information N varies between variables

Those conducting mainly empirical and theoretical research are the most active publishers of academic articles. The percentage of those producing at least one academic article publication was significantly higher (chi-squared p = 0.004) for those doing mainly empirical research than among those conducting empirical research less frequently. Some academic journals concentrate more on basic research and others on applied research. This often leaves general journals out of the question for those conducting applied research. One of the interviewees described selection of the journal in which a study is to be published:

> The best are the journals with the highest impact factors. […] Some of them [impact factors] are around 30 or even 40. But they are usually only for those working at high ranked universities and for basic research. They are publishing basic research, and because we are working in a more applied field and producing the new basic knowledge is not our core duty, our results are often applied. Because of the applied nature of the research, we are publishing in journals with lower impact factors. (I1)

The applied nature of the research has an effect on researchers' publishing opportunities. Writing an international journal article was seen as a demanding process that takes more time than is often available. One of the interviewees

described the difficulties that the nature of the work brings to writing a journal article:

> [Journal publishing] has greater meaning in theory than in practice. We are encouraged to write journal articles, but it is so demanding and it is hard to find the time for writing. […] When working at the university, I wrote quite a few articles with solid theoretical backgrounds. [Research institute's] research model does not always make it possible to work with theoretical research that you could cultivate into a journal article. (I12)

Those conducting mainly theoretical research were the most active publishers of conference papers. The percentage producing at least one conference-linked publication was higher (chi-squared $p = 0.046$) for those doing mainly theoretical research than those conducting theoretical research less frequently. The proportion of respondents producing at least one conference-related publication is also higher for those doing mainly development/engineering. Research results may also be interesting for those attending conferences, as one of the interviewees explained:

> This subject is quite general. We have published mainly at technical conferences […] technical developers are interested in hearing about our results. (I12)

Producing industrial publications was most common among those conducting mainly specialist work / consulting. The percentage of those producing at least one industrial publication was significantly higher (chi-squared $p = 0.038$) among those doing mainly specialist work / consulting than for those performing such work less frequently. In research assignments, confidentiality agreements may prevent publishing; therefore, results may be published only for the customer, in the form of confidential research reports.

> We don't have permission to publish anything from research assignments if we don't ask for it. (I3)

Even without confidentiality agreements, one problem in working with research assignments is that researchers are often unable to collect research data that could be used for writing academic publications. The data series are too small and specific for cultivation into academic articles.

> There is something we might publish, but it is quite rare because we cannot collect long time series, as on a yearly basis the customers dictate the quantities. […] It is possible for the same control substances to be used for five years, but usually things are developing; they are reducing the quantities and changing the spraying times and so on […] so collecting scientific data is quite hard. (I4)

Conducting specialist work / consulting is also linked to professional publishing orientation. The percentage of respondents producing at least one professional publication is the highest for those performing mainly specialist work / consulting. One of the interviewees saw professional magazines as a more natural publishing channel for his research:

> I like professional publications, because, in my opinion, articles in professional magazines go straight to the customers, those who are using the information. Academic publications are mainly for other scientists. […] I like to hang around more in these industrial circles. (I2)

6.2.3.2 Dependence on other fields

Dependence on knowledge produced in other research fields varies considerably between disciplines (see section 6.1.2). Some disciplines rely more on knowledge produced in other fields than others do. In the survey, dependence on other fields was measured by asking to what extent the respondents use literature from their own and other scientific fields. According to the results, the extent of using literature from other fields has some impact on publishing practices (see Table 32).

Professional publishing is connected to using literature from various fields. Professional publishing activity differs significantly by level of use of literature (ANOVA, df = 2, F = 2.679, p = 0.05). Those using literature from various fields publish significantly more with a professional orientation when compared to those using literature mainly from their own field (Tamhane p = 0.05). There is also some evidence that those using literature from various fields are more active in producing industrial publications than are those who rely mainly on literature produced in their own field. However, differences are not significant between groups (ANOVA df = 2, F = 0.399, p = 0.671).

Those using literature mainly from their own field are the most active publishers of academic articles. However differences between groups in amount of

publishing activity are not significant (ANOVA df = 2, F = 2.497, p = 0.083). One of the interviewees described the problems in multidisciplinary research with recognising novel and significant research results. Sometimes it might be hard to find an appropriate academic publishing forum for multidisciplinary results.

It's the transdisciplinarity that we have and the nature of applied research that makes entities quite large. In the end, what is the new knowledge? (I7)

Those using literature to 'some' extent from their own and other fields publish more conference papers than do those using literature mainly from their own field or various fields. However, differences between groups in conference publishing activity are not significant.

Table 32: The percentage of respondents producing at least one publication, by extent, using literature from their own field and other fields

	Professional orientation	Article orientation	Conference orientation	Industrial orientation
Mainly from my own field (N=269-304)*	84	**93**	58	38
To some extent from other fields (N=291-305)*	85	89	**64**	38
From various fields (N=116-122)*	**89**	89	56	**42**
Total (N=703-731)*	85	91	60	39

*Because of the missing information N varies between variables

6.2.3.3 Dependence between researchers

Dependence between researchers is another cultural factor that varies between disciplines (see section 6.1.3). Dependence between researchers was examined by asking the typical number of co-authors respondents have for their academic publications. Those publishing alone or in a small group of authors are the most active publishers in professional and industrial orientations (see Table 31).

The percentage of respondents producing at least one professional publication and industrial publication is significantly higher (chi-squared $p < 0.05$) for those who typically publish alone or with one or two co-authors as compared to those publishing with more co-authors. On the other hand, the percentage of respondents producing at least one academic publication is higher (chi squared $p = 0.066$) among those who typically publish in a large group than among those who typically publish alone or in a small group.

Table 33: The percentage of respondents who had at least one publication with a given number of co-authors

	Professional orientation	Article orientation	Conference orientation	Industrial orientation
Alone or as a small group (N=341-356)*	**90**	90	61	**43**
Large group (N=344-353)*	82	**94**	62	35
Total (N=685-709)*	86	**92**	61	39

*Because of the missing information N varies between variables

6.2.3.4 Research collaboration

Research is done in different contexts, and the context affects researchers' ability and need to communicate their research results, quite considerably. Collaboration partners are one of the contextual factors examined in this study. Respondents were asked with which organisations and to what extent they engaged in research or publishing collaboration (see Table 34).

Both professional and academic publishing are associated with regular collaboration with Finnish and foreign universities and state research institutes. The percentage of those producing at least one professional publication and at least one academic publication is significantly higher (chi-squared $p < 0.05$) for those respondents engaging in regular collaboration with Finnish and foreign universities and (domestic and foreign) state research institutes than for those who were collaborating less frequently with these organisations. One of the interviewees experienced academic publishing as especially important for universities; academic publishing was an important part of the work when the collaborating involved researchers from universities.

> If the project is very busy, it might be that there is no time to write academic stuff. The emphasis is on what companies want. But usually especially professors from universities require that researchers have time to do some academic writing, because it is important for the departments. Otherwise, it would not be useful for universities to be involved. (I10)

Conference publishing is related, on one hand, to collaborating with academic organisations and, on the other hand, to the private sector. The percentage having produced at least one conference paper is significantly higher (chi-squared p <

0.05) among those engaging in regular collaboration with Finnish universities, Finnish and foreign state research institutes, and private-sector organisations than for those collaborating less frequently with these organisations.

Industrial publishing is associated with collaboration with private-sector organisations. The percentage of respondents with at least one industrial publication is significantly higher (chi squared $p < 0.05$) for those engaging in regular collaboration with private-sector organisations than among those who collaborate with the private sector less frequently. Typically in research assignments paid for by private companies, the researchers do not know how their results are used and for what.

> These days, we just write the report on our study and it is up to the company to decide what to do with it. (I5)

Table 34: The percentage of respondents producing at least one publication, by collaboration activity

		Professional orientation	Article orientation	Conference orientation	Industrial orientation
Finnish university	Regularly (N=301)	**89**	**94**	**64**	37
	Less (N=429)	82	87	57	42
Foreign university	Regularly (N=139)	**93**	**98**	**66**	39
	Less (N=570)	83	89	58	40
Finnish state research institute	Regularly (N=186)	**94**	**98**	**73**	41
	Less (N=528)	82	88	54	39
Foreign state research institute	Regularly (N=127)	**91**	**97**	**72**	45
	Less (N=578)	84	89	57	39
Other government	Regularly (N=78)	**92**	91	63	40
	Less (N=605)	85	90	59	41
Private sector	Regularly (N=85)	86	92	**79**	**67**
	Less (N=597)	85	90	57	34

6.2.3.5 Research funding

Research funding is another important contextual factor affecting publishing practices. Publications have a particularly important role when external research funding is being sought. When competition for research funding gets more intense, publishing becomes more important. Most of the interviewees saw publications as the core means of getting external research funding.

> These days, [publishing] is important because all research funders have started to look at it. So if you don't publish, and if you don't have a credible publishing list, they don't see you as worth granting the funding. (I8)

Respondents were asked to indicate the importance of various types of funding sources in their work. Different funding sources are related to different publishing orientations (see Table 35).

Table 35: The percentage of respondents producing at least one publication, with various orientations, by funding source

		Professional orientation	Article orientation	Conference orientation	Industrial orientation
No external funding	Mainly (N=268)	**89**	**94**	55	32
	Less (N=402)	84	89	64	43
Ministry	Mainly (N=139)	**90**	92	55	37
	Less (N=507)	85	90	61	40
Academy of Finland	Mainly (N=75)	84	**97**	52	23
	Less (N=560)	86	90	60	41
Foundation	Mainly (N=49)	76	86	41	16
	Less (N=597)	86	91	61	40
European union	Mainly (N=86)	86	90	69	**51**
	Less (N=566)	86	91	59	39
Tekes	Mainly (N=88)	73	82	**71**	**66**
	Less (N=531)	87	92	59	38
Private company	Mainly (N=43)	65	61	56	**79**
	Less (N=575)	87	92	61	39

Professional publishing correlates with working without external funding. The percentage producing at least one professional publication was higher among those working mainly without any external research funding (chi-squared $p = 0.059$) than among those working to a lesser extent without external funding. Also those whose main research funding came from the ministries are active professional publishers.

The proportion with at least one professional publication was significantly lower (chi-squared $p = 0.001$) for those working mainly with research funding from Tekes or from private companies than among those for whom these funding sources were less important.

Academic article publishing is related especially strongly to having external funding from academic research funders. The percentage of respondents producing at least one academic article publication was significantly higher (chi-squared $p < 0.05$) for those obtaining their main research funding from the Academy of Finland and working mainly without external funding in comparison to those for whom these funding sources were less important. One of the interviewees stressed the importance of academic publications in application for funding from the Academy of Finland. The opinion of one interviewee was that most researchers are not competent to compete for funding from the Academy of Finland, because of a lack of academic publications. Therefore, another interviewee expressed the conclusion that the research institute in question should try to change its publishing practices such that they allow competition with universities for academic research funding.

> I think we should try to understand better the way universities are producing publications, especially these days as we compete for the same funding. We have to accept that, in the end, academic forums are the ones determining our academic credibility. (I9)

The percentage of those producing at least academic article was significantly lower (chi-squared $p < 0.05$) for those getting their main research funding from private companies or Tekes than those for whom these funding sources were less important. One reason researchers working with private companies' funding are publishing less actively in academic forums is the confidentiality agreements with the companies. There might be also difficulties in arranging the time for writing if it has not been specified in the research contract:

> We make the contract with an external funder for the work we will conduct. There is no money allocated, for example, for two months for writing an academic article. Those two months are assigned to performing the analyses and working with the data. […] It is a problem. I would like there to be the possibility to write, but there isn't. (I2)

Conference publishing is related to working in between the academic and industrial worlds, at least from the research funding point of view. The percentage of those producing at least one conference paper was significantly higher among those whose main research funding came from Tekes (chi squared $p = 0.044$) than those for whom Tekes funding was less important. Usually, both Tekes and EU projects entail collaboration with research partners in the public and private sector both.

The share of production of at least one conference paper was significantly lower (chi-squared $p < 0.05$) for those with their main research funding from foundations or working mainly without external funding as compared to those for whom these funding sources were less important.

Industrial publishing correlates with research funding from the private sector and funders working in collaboration with the private sector. The percentage of respondents producing at least one industrial publication was significantly higher (chi-squared $p < 0.05$), for those with primary research funding from private companies, Tekes, and EU as compared to those for whom these funding sources were less important.

Those interviewees working mainly with research assignments were producing mainly confidential research reports. Researchers saw a contradiction between productivity metrics and customer orientation. If research is done on the customer's terms, results are not always published. Publishing possibilities have an impact also on the career development of individual researchers. Publications are an important part of a researcher's CV, and if one's publications are mainly confidential research reports, CVs stay short.

> We prepare a dozen of these [confidential research reports], which won't bring you any merits. […] You cannot put them on your CV […] we don't have any strong CVs for applying for EU funding. […] There is a conflict. (I4)

6.2.3.6 Research projects

The nature of the research projects was the third contextual factor examined in the study. Respondents were asked about the length of a typical research project and the number of projects they were working on at the same time. Both elements have an impact on publishing practices.

Those working with longer projects are likely to publish more in academic article and professional publishing orientations (see Table 36). The percentage of respondents producing at least one publication in professional and academic article publishing orientations is significantly higher (chi squared $p < 0.05$) among those working in projects lasting three years or more than for those typically working on shorter projects. In short, project-oriented researchers may be unable to collect the comprehensive datasets that academic publications require, as was already pointed out.

Working with shorter projects shows an association with industrial publishing. The percentage producing at least one industrial publication is significantly higher (chi-squared $p = 0.000$) for those working in projects lasting one or two years than for those working in longer projects.

Table 36: The percentage of respondents producing at least one publication, by length of research project

	Professional orientation	Article orientation	Conference orientation	Industrial orientation
Two years or less (N=357-370)*	83	86	57	**47**
More than two years (N=353-368)*	**89**	**95**	**63**	31
Total (N=710-738)*	86	90	60	39

*Because of the missing information N varies between variables

In general, those working with a number of projects at the same time are likely to be more productive in every publishing orientation (see Table 37). The percentage of respondents producing at least one publication in significantly higher (chi-squared $p < 0.05$) in every publishing orientation for those working with three or more projects at the same time as compared to those who work with one or two projects. However, in the interviews, researchers saw a large number of short projects as problematic when it comes to publishing.

> The problem – why people are publishing so little – is that they have too many short projects taking all the time. It's a time management issue, because there are no shortcuts for writing publications: you just have to write, and that requires time. An hour per day is not enough; you need days for it. (I6)

Table 37: The percentage of respondents producing at least one publication, broken down by number of projects in progress simultaneously

	Professional orientation	Article orientation	Conference orientation	Industrial orientation
One or two (N=261-274)*	82	87	55	29
Three or more (N=441-455)*	**88**	**92**	**63**	**45**
Total (N=702-729)*	86	90	60	39

*Because of the missing information N varies between variables

6.2.4 Summary of results

Four publishing orientations were identified on the basis of the amount of publishing activity in distinct types of publishing forums. The results pointed to differences between disciplines in publishing practices. Publishing practices were also related to various cultural and contextual factors. The results are summarised in Table 38.

6.2.4.1 Professional publishing orientation

Professional publishing orientation refers to articles in newspapers and magazines, articles in professional magazines, national academic journals, and public research reports. About 85% of respondents produced at least one publication during the two-year span with a professional publishing orientation. This orientation is most common in the social sciences and biological and environmental sciences.

A distinct type of research is published with professional orientation, especially with specialist work / consulting. Respondents using literature from various fields publish more with a professional orientation than do respondents who use literature mainly from their own field. Also, those publishing alone or in a small group produce more professional publications than do those who work with many colleagues. Therefore, in Becher's and Whitley's terms, the academic culture connected to professional publishing can be defined as divergent and rural and as lacking in mutual dependence and displaying task uncertainty. Respondents who actively produce professional publications are collaborating with multiple academic organisations, so reputational autonomy is relatively high. The research is funded

mainly without external sources or by ministries. Research projects are usually long-term, and the researchers work with many projects at the same time.

6.2.4.2 Academic article publishing orientation

Academic article publishing orientation involves articles in international academic journals, articles in academic edited works, and non-refereed academic publications. More than 90% of respondents had at least one academic publication over the two years. Academic publishing orientation is especially active in the health-care sciences and the biological and environmental sciences.

The research published in the form of academic articles is mainly theoretical and empirical. In Becher's and Whitley's terms, the academic culture can be defined as convergent and urban and as having high mutual dependence and low task uncertainty. Respondents using literature primarily from their own field were publishing academic articles the most actively. Also, a large number of co-authors was connected to active publishing in academic article orientation. This research is done mainly in academic context. Respondents who were collaborating regularly with researchers from other academic institutes published more academic articles. Accordingly, reputational autonomy is high. Resources are focused largely on academic sources of funding, such as the Academy of Finland. The research projects are usually long-term, and the researchers involved work on multiple projects simultaneously.

6.2.4.3 Conference publishing orientation

The conference-related publishing orientation consists of being oriented toward producing articles in international and national refereed conference proceedings. Almost 60% of the respondents had published at least one conference paper during the two-year span. Conference-linked publishing is most common in the technical sciences, the natural sciences, and multidisciplinary biosciences.

A different type of research is published at conferences, especially theoretical research and development/engineering. Academic culture related to conference-based publishing is not stable. For instance, literature is used both from one's own field and from other fields, and papers are written both with sole authorship and jointly with several other authors. Accordingly, the academic culture is difficult to define by means of Becher's or Whitley's concepts. The research is done mainly in an academic and industrial context. Those collaborating regularly with private-sector and other public research institutes produce conference-related publications

actively. Clearly, reputational autonomy is decreased. Research funding is obtained from various sources, such as the European Union, Tekes, and private companies. Research projects are usually long-term. However, also those working in shorter-duration projects publish actively via conferences, and the researchers work with many projects at the same time.

6.2.4.4 Industrial publishing orientation

Industrial orientation is centred on confidential research reports. Almost 40% of the respondents had made at least one industrial publication. Industrial publishing orientation is seen most commonly in the technical and natural sciences.

Specialist work / consulting is related particularly strongly to industrial publishing. If we use Becher's and Whitley's terms, the academic culture can be defined as divergent and rural and as having low mutual dependence and high task uncertainty. Literature is used from various fields. Respondents publishing alone or with only a few co-authors are likely to create more confidential research reports. Research here is done mainly in industrial context. Collaboration with the private sector is very commonplace, and it is often funded by private companies or Tekes. Reputational autonomy is decreased. The research projects are usually short-term in nature, and the researchers work with several projects at the same time.

Table 38: Summary of academic cultures with various publishing orientations

	Professional orientation	Academic article orientation	Conference orientation	Industrial orientation
Main disciplinary group	All disciplines, Most typical in social sciences and bio and environmental sciences	All disciplines, Most typical in health-care sciences and bio and environmental sciences	Technical sciences, natural sciences and multidisciplinary biosciences	Technical and natural sciences
Nature of research	All, Specialist work/ consulting	Theoretical/ empirical research	Theoretical research/ development engineering	Specialist work/ consulting
Dependence on other fields	Increased dependence	Decreased dependence	Not clear	Increased dependence
Dependence between researchers	Decreased dependence	Increased dependence	Not clear	Decreased dependence
Research collaboration	Academic organizations	Academic organizations	Academic organizations and private sector	Private sector
Research funding	Budget funding, ministries	Budget funding, academic funding	Tekes	Private companies, Tekes, EU
Research projects	Many long projects	Many long projects	Many long projects	Many short projects

6.3 Reading

This part of the chapter reports the results pertaining to researchers' reading practices. Firstly, activity in reading materials from distinct types of publishing forums is presented for the various groups of disciplines. Secondly, reading orientations are conceptualised by means of principal component analyses. After this, the impact of diverse cultural and contextual factors on reading practices is examined. This section of the chapter ends with a summary of the results.

6.3.1 Reading as a part of research work

Reading is a vital part of researchers' work. Because the nature of the research is often cumulative, research is usually built upon earlier knowledge about the subject. Therefore, when research is being planned or is about to be published, the researcher has to show awareness of what has been done previously if he or she is to be able to convince the audience of the significance and novelty of the results relative to what has been done previously. However, the importance of grounding research in earlier results and scholars' reading practices varies between disciplines.

In the survey, respondents were asked to what extent reading publications was a part of their job. On average, seven per cent of respondents indicated readings to be the main part of the job. For 55%, reading was a moderate part and for 38% a small part. Discipline-aligned differences are not significant (chi-squared $p = 0.345$). However, reading seems to be taking most of social scientists' work time, with 11% of social scientists indicating reading to be the main part of the job. Respondents representing the humanities and technical sciences used less time for reading than did respondents representing other fields; 48% of respondents representing the humanities and 43% of technical scientists indicated that reading was a small part of the job.

In addition, the respondents were asked the reasons for reading for work. The most common reasons for reading were for writing articles, for primary research, and to keep one's awareness current. Writing articles was the most common reason given for reading in all disciplines: 65% of respondents described reading mostly for writing. Writing was the most common reason for reading in the social science, where 80% of respondents indicated it to be the main reason for their reading.

Also, the interviewees indicated that reading and writing seem to go hand in hand. According to the interview results, the majority of reading happens when one is writing research plans or funding applications and in preparation to publish the research results. All interviewees felt, however, that they did not read as much as they should have. There was not enough time for reading. The majority of reading was done when it was deemed absolutely necessary.

> [W]ell, [writing] is the moment when you have to read them. You have to find out what the current stage of the research is. Of course, I try to do it by looking at the tables of contents of the journals I read, but sometimes I don't even do that. (I1)

The interviews also revealed that reading activity varies between the individual stages of research projects. One of the interviewees described the changes in reading activity in her job thus:

> It changes. If you are planning a test or starting a new project, you have to read quite a lot. But during the project it decreases. Then, again, in the publishing stage, you have to read […] so there are these booms. It never dries up totally. […] I think I read something every day. (I9)

Some interviewees stated that the institute's library helps researchers by offering lists of current publications and assisting with literature searches. However, when reading is not the priority and is done for purposes of maintaining one's awareness, it is easy to forget. One of the interviewees spoke of her experiences with reading in the following terms:

> [W]e have an opportunity to get a list of current publications from the library. I just skim them and skim, skim, and maybe those that are current at that very moment I'll take a look at and put on top of some pile. Then I plan to read it at home and the next morning I'll bring it back without reading it. [...] That is the disadvantage of this job: although it is rich and it's terrific to be able to do many kinds of things, it takes away […] because in the old days we had more time for reading. (I7)

6.3.2 Reading activity for scholarly publications in various disciplines

In the survey, reading activity was measured through items asking how often respondents read various types of publications. Reading was defined as going beyond the table of contents, title, and abstract to the body of the text and reading at least some part of the body. Reading activity was measured with the scale elements 'daily', 'weekly', 'a few times a month', 'once a month', 'less frequently', and 'not at all'.

According to the results, international journals are the most actively read publication type (see Table 39). One in four respondents read international academic journals daily and more than half at least weekly. Differences between discipline groups in the percentage of respondents reading international journals at least weekly are significant (ANOVA df = 6, F = 5.351, p = 0.000). Respondents representing multidisciplinary biosciences were the most active readers of journal

articles, with almost 80% of them reading international journals at least weekly. The difference from the activity in the humanities and technical sciences is significant (Tamhane $p < 0.05$). National academic journals were read less frequently. A fifth of the respondents read domestic journals at least weekly. Most commonly, national academic journals are read monthly. However, one third read journals less frequently. The difference between groups of disciplines is significant (ANOVA $df = 6$, $F = 2.851$, $p = 0.009$). Respondents representing the humanities were the most active readers of national journals. One third of humanists indicated reading them at least weekly. Respondents representing the technical sciences are the least active readers of national academic journals.

The interviews fleshed out this pattern; researchers referred to the greater prestige of international journals as compared to national ones. The reputation of a journal was seen as a guarantee of the quality of the papers within. Also, researchers who have published a paper in the journal have experience of what types of papers are published there and of the editorial policy of the journal.

> A certain journal is in a way a promise of good quality, so if I read a paper from a certain journal, I assume it to be a good one […] because when you write yourself, you'll know the pressure your article will face, how carefully all the details are fine tuned, and the scrutiny in the feedback you usually get. I'd think it has an effect. (I10)

The interviewees followed the core journals of the field mainly by checking the tables of contents of new issues. All the interviewees read or at least searched for articles mainly from electronic journal databases. Only one of the interviewees also subscribed to one core journal of the field in paper form. Information-seeking was seen as quite easy, and researchers used diverse services, such as RSS feeds, for following the core journals. More general journals were seen as more important to have in paper form, which allows browsing them during coffee breaks and so on.

> I've come to the conclusion that the journals I read regularly I read in electronic form. Although it would be very nice, of course, to have our own library, it's not necessary: you cope with the electronic journals. But the general journals such as Science or Nature, you don't read them if you have them only online. They are the ones you want to browse. (I7)

According to the survey, most respondents read academic monographs less frequently than once a month. Only nine per cent of respondents stated that they read academic monographs at least weekly, and 10% did not read them at all.

Differences between discipline groups are significant in the percentage of respondents reading monographs at least weekly (ANOVA df = 6, F = 12.177, p = 0.000). Respondents representing the humanities and social sciences were the most active readers of monographs. More than 40% of respondents representing the humanities and a fifth of the social scientists read academic monographs at least weekly. The difference from the habits in the health care sciences and technical sciences is significant (Tamhane $p < 0.05$). One of the interviewees spoke of her personal library collection, which she used especially for checking basic knowledge about biology:

> I have a collection of books […] it's quite a comprehensive library […] and I use them for looking up basic stuff […] that you'll know is not going to change. […] For example, terms. To be able to define terms, I often look them up in books or dictionaries. (I9)

According to the survey results, 13% of respondents reported reading international conference proceedings at least weekly. Almost half of the respondents read conference proceedings once a month and almost 40% less frequently. The difference between groups of disciplines is significant (ANOVA df = 6, F = 3.036, p = 0.006). Respondents representing the technical and natural sciences read international conference proceedings most actively, with a fifth of the respondents representing these fields indicating that they read them at least weekly. More than half of the respondents representing the humanities, social sciences, and health care sciences read international conference proceedings less frequently than once a month. National conference proceedings are less frequently read than international proceedings materials. Only four per cent read national proceedings at least weekly. Differences between groups of disciplines are not significant.

Table 39: The percentage of respondents reading various academic publications at least weekly, by discipline

	Int. academic journals	Nat. academic journals	Academic monographs	Int. conference proceedings	Nat. conference proceedings
Bio and environmental science (N=236-248)*	**71**	**25**	6	12	6
Natural science (N=126-133)*	59	16	7	**20**	5
Social science (N=105-108)*	**74**	**21**	**22**	9	4
Technical science (N=89-98)*	54	8	1	**21**	4
Health-care science (N=83-85)*	**72**	**24**	2	6	2
Multidisciplinary (N=45-47)*	**81**	18	11	11	2
Humanities (N=21-22)*	32	**32**	**43**	5	5
Total (N=708-741)*	66	20	9	13	4

*Because of the missing information N varies between variables

6.3.3 Reading activity for professional and popular publications in various disciplines

Researchers may also read other than academic literature. In particular, newspapers and popular magazines were actively read for research. More than half of the respondents read these at least weekly (see Table 40). The differences between disciplines in the percentage of respondents reading them at least weekly are significant (ANOVA df = 6, F = 4.339, p = 0.000). The most active reading of newspapers and magazines is in the social sciences and the biological and environmental sciences. The difference from technical sciences and health care sciences is significant (Tamhane $p < 0.05$).

Research reports too are also commonly read. More than a quarter of respondents read research reports at least weekly. Half of the respondents read these once a month. Differences between discipline groups in the proportion of respondents reading research reports at least weekly are significant (ANOVA df = 6, F = 4.942, p = 0.000). Research reports are used most frequently in the social sciences, where 43% read them at least weekly. The difference from the behaviour reported for the humanities and health care sciences is significant (Tamhane $p < 0.01$). Approximately 10% of respondents representing the humanities and health care sciences read research reports weekly.

Also 27% of respondents read professional magazines at least weekly. Differences between groups of disciplines in the proportion of respondents reading them at least weekly are significant (ANOVA df = 6, F = 4.378, p = 0.000). Reading of professional magazines is most active in biological and environmental sciences. There was a significant difference in comparison to the humanities, natural sciences, and health care sciences (Tamhane $p < 0.05$).

Study books and handbooks are also among the materials read for work: 18% read these at least weekly, while one third of respondents read study books and handbooks less frequently. There are some differences by discipline in the number of respondents reading them at least weekly (ANOVA df = 6, F = 2.146, p = 0.046). Respondents representing the humanities are the most active readers of study books and handbooks: 36% of humanists read these at least weekly.

Technical manuals are also used rarely by most of the respondents. Only 10% of respondents read technical manuals at least weekly. There are some significant discipline-aligned differences in the proportion of respondents reading at least weekly (ANOVA df = 6, F = 3.776, p = 0.001). One fifth of the respondents representing multidisciplinary biosciences use a technical manual at least weekly. Also, 15% of respondents representing technical and natural sciences do so at least weekly. The difference from the figures for the humanities and health care sciences is significant (Tamhane $p < 0.05$). None of the respondents representing the humanities use technical manuals weekly.

Table 40: The percentage of respondents reading professional publications at least weekly, by discipline

	Newspapers and magazines	Research reports	Professional magazines	Textbooks and handbooks	Technical manuals
Bio and environmental science (N=241-245)*	**63**	26	**35**	14	10
Natural science (N=127-132)*	**50**	27	15	**22**	**15**
Social science (N=104-108)*	**67**	**43**	25	20	6
Technical science (N=95-98)*	**45**	22	27	13	**15**
Health-care science (N=79-85)*	**41**	13	19	12	2
Multidisciplinary (N=45-47)*	**58**	**36**	27	**21**	**21**
Humanities (N=19-22)*	**55**	11	9	**36**	0
Total (N=714-733)*	**56**	27	26	17	10

*Because of the missing information N varies between variables

Three per cent of respondents indicated reading other publication types too at least weekly. The most common reading of other types of publications was seen in multidisciplinary biosciences, wherein 13% of respondents read other publications at least weekly. In the further information field, most of these respondents indicated reading various types of Internet resources, such as social media, for work. Two respondents read fiction for work. It is likely that the figure, for example, for those doing social media reading for work would have been higher if this had been included in the list in the questionnaire. In the interviews, one researcher in particular spoke of relying on various informal Internet resources:

> I really don't read any books; I'm almost ashamed, but on the Internet I follow stuff on a day-to-day basis. […] All the news sites […] I have that iGoogle, where I get the news, and there I might spot something and also from muropaketti.com or similar nerd sites. (I11)

6.3.4 Reading orientations

Principal component analysis was used to study reading orientations in state research institutes. Variables measuring the reading activity of the individual publication types presented in the previous two sections of the chapter were used in the analyses[17]. Three orientations exceeding eigenvalue 1 were discovered (explaining 65.5% of the variance, Kaiser–Meyer–Olkin value 0.729, Bartlett's test of sphericity p = 0.000). The orientations are referred to as academic, professional, and fact-reading. Core variables of each component were computed to present three reading orientations. Before computing, each variable was coded as a dummy variable to represent those who had read the relevant type of publication at least weekly (1) and for those who had read the publication type less frequently (0). The main results of the principal component analyses are presented in Table 41, below.

Table 41: Factor loadings from principal component analyses

	Academic	Professional	Fact
Domestic journals	,867		
Domestic conference proceedings	,867		
Research reports	,820		
Academic monographs	,759		
International conference proceedings	,582		,375
International journals	,395	-,373	
Other		,823	
Newspapers/magazines		,764	
Professional magazines	,476	,593	
Technical manuals			,840
Study and hand books			,798

Rotation method: Varimax with Kaiser normalisation.

[17] Original scales of the measures were used in the analysis

The first orientation can be called academic reading orientation (33% of variance, Cronbach's alpha 0.771). This orientation consists of use of academic monographs, international and national conference proceedings, international and national refereed journals, and research reports. The second orientation can be referred to as professional reading orientation (15.8% of variance, Cronbach's alpha 0.711). This orientation involves newspapers/magazines, professional magazines, and other sources – such as Web sites. The third orientation, which can be called fact-reading orientation (17% of variance, Cronbach's alpha 0.636), involves technical manuals, study books, and handbooks.

Reading activity with individual orientations varies. There are also differences by discipline in reading activity (see Table 42). The percentage of respondents reading literature in each orientation at least weekly was analysed. Academic literature is most actively read: 76% of respondents read this literature at least weekly. Differences between disciplines are significant (ANOVA df = 6, F = 5.170, p = 0.000). Academic reading was most active in the social sciences and mult¬idisciplinary biosciences, with 90% of respondents representing multidisciplinary biosciences and 84% of respondents representing social sciences reading academic literature at least weekly. The difference from technical sciences and the humanities (Tamhane $p < 0.05$) is significant. Humanists are the most active readers of academic monographs but less active readers of other types of academic literature.

More than half of the respondents read professional literature at least weekly. Differences between disciplines are significant (ANOVA df = 6, F = 4.642, p = 0.000). Professional reading is most active in biosciences and environmental sciences where almost 70 percentages read professional literature weekly. Reading is significantly more active (Tamhane $p < 0.05$) active in biosciences and environmental sciences compared to than in the natural sciences, technical sciences, and health care sciences. One fifth of the respondents read fact-oriented literature at least weekly. Differences between disciplines are not significant.

Overall, reading is most active in multidisciplinary biosciences and the social sciences. More than 90% of respondents working in these fields read something at least weekly.

Table 42: The percentage of respondents reporting at least weekly reading of publications, with various reading orientations, by discipline

	Academic reading	Professional reading	Fact reading
Bio and environmental science (N=223-247)*	**79**	**70**	21
Natural science (N=122-133)*	72	51	24
Social science (N=103-108)*	**84**	**69**	20
Technical science (N=86-98)*	62	50	22
Health-care science (N=79-82)*	73	48	14
Multidisciplinary biosciences (N=44-46)*	**91**	**65**	31
Humanities (N=18-22)*	44	**65**	33
Total (N=685-734)*	76	61	22

*Because of the missing information N varies between variables

6.3.5 Factors influencing reading orientations

Next, the influence of various factors related to academic cultures and research context on reading practices is examined. Firstly, the relationship of reading practices with factors to do with academic culture, such as the nature of the research, dependence on other fields, and dependence between researchers, is studied. Secondly, the impact of contextual factors such as collaboration partners, research funding, and the nature of the research projects is studied.

6.3.5.1 The nature of the research

The nature of the research influences researchers' reading practices. Respondents were asked to indicate the importance of individual types of research, such as theoretical and empirical research and development/engineering and specialist activities / consulting in their work. The nature of the research has an influence on academic and professional reading orientations (see Table 43).

Those who indicated that theoretical or empirical research was their main type of research were the most active readers of academic literature. The percentage of respondents reading at least weekly is significantly higher for those conducting mainly theoretical or empirical research (chi-squared $p < 0.01$) than for those conducting empirical or theoretical research less frequently. More than 90% of those doing mainly theoretical research and over 80% of those who cited empirical

research as their main type of research read academic literature at least weekly. The percentage of those reading academic literature at least weekly is significantly lower for those doing mainly specialist work / consulting (chi-squared $p = 0.000$) than for those performing such work less frequently.

Research reports produced in specialist work / consulting do not necessarily demand literature reviews. Therefore, researchers need not follow academic literature in order to be able to report the results.

> We don't include literature reviews in our reports. We report only the results; we write the reports in English in the form of an academic publication but don't include the discussion part, where we would review earlier research results. Quite often, our results are novel and we could not even find any earlier studies done with the same control substances. (I4)

One interviewee emphasised that the research she conducts does not require building the research settings on earlier knowledge as much as it did when she was working at university:

> Compared to what there was at university, surprisingly little research is built upon earlier knowledge. In a way, [the research] is more practical – we live with the practices […] problems that we face are solved in the moment, although I think it would be smarter to plan ahead and find out what others have done before you try to do it yourself. (I12)

Depending on the subject, basic research may be years ahead of or behind practical or technical developments. Accordingly, the literature published at the moment might not be very useful in practical development, as one of the interviewees explained:

> When I was younger, I read a lot, and I still collect [writings] and follow [them], but for me this has moved to mainly applied research, and the knowledge that is available there is mainly like basic research that is not always applicable in this moment. But I have to follow it because the information that there is might be useful in the practice after 5–10 years. (I2)

Researchers may also use other research groups within their organisation as information sources, allowing them to follow developments in the field. One of the interviewees saw his research community as a critical source of information for development of basic research in his field:

> It's good to have this research community that we have […] there are groups carrying out a sort of basic research, and that way I have a living interface all the time with what is happening in basic research related to my own field […] so it is not necessary for me to look up international publications, because the research [done at this research institute] in relation to my field is done to a high standard. (I2)

The percentage of those reading professional literature at least weekly is significantly higher for those conducting mainly specialist work / consulting or development engineering activities (chi squared $p < 0.05$) than those doing specialist work / consulting or development engineering less frequently. Almost 70% of respondents who cited specialist/consulting or development/engineering work as their main type of research read professional literature at least weekly. Researchers collaborating with industry and the private sector have to be aware of what is happening in the 'real world'. One of the interviewees spoke of keeping his knowledge current by participating in various events meant for industry:

> I participate in seminars meant for industry, I'm taking courses meant for industry, to be aware of what is happening. […] I also go to expositions. I like to go there. There I see all the new equipment and products and meet people from the field. (I2)

Table 43: The percentage of respondents reading publications with various reading orientations at least weekly, by research type

		Academic reading	Professional reading	Fact reading
Theoretical research	Mainly (N=56)	**91**	56	32
	Less (N=571)	74	61	22
Empirical research	Mainly (N=393)	**84**	59	21
	Less (N=303)	67	65	24
Development/ engineering	Mainly (N=143)	69	**68**	27
	Less (N=526)	78	59	21
Specialist work/ consulting	Mainly (N=133)	61	**71**	25
	Less (N=566)	79	60	22
Total (N=626-698)*		76	61	22

*Because of the missing information N varies between variables

6.3.5.2 Dependence on other fields

Also, dependence on other fields has an influence on researchers' reading practices. This dependence was measured by asking to what extent the respondents used literature from their own and other scientific fields. The extent of using literature differs between disciplines (see Table 44).

The extent of using literature from one's own and other scientific fields has an effect (ANOVA df = 2, F = 5.262, p = 0.005) on professional literature reading activity. Those using literature from various fields read professional literature more actively than those using literature from mainly their own field (Tamhane p = 0.002). About 73% of those using literature from various fields read professional literature at least weekly. There is also some evidence that those using literature from various fields are more active readers of academic and fact oriented literature when compared to those using literature mainly or to some extent from their own fields. However, differences between groups are not significant.

Table 44: The percentage of respondents reporting at least weekly reading of publications with various reading orientations, by the scatter of the literature used

	Academic reading	Professional reading	Fact reading
Mainly from my own field (N=284-301)*	74	56	20
To some extent from other fields (N=274-298)*	76	61	24
From various fields (N=115-121)*	**80**	**73**	**24**
Total (N=673-720)*	75	60	22

*Because of the missing information N varies between variables

6.3.5.3 Dependence between researchers

In the survey, dependency relationships between researchers were studied by asking the typical number of co-authors. Number of authors has a significant effect on reading of professional literature (see Table 45). The percentage of respondents reading professional literature at least weekly is significantly higher (chi-squared p = 0.000) for those typically publishing alone or within a small group as compared to those publishing with a larger group. Almost 70% of those publishing alone or in a small group read professional literature weekly. Number of authors does not have an influence on academic or fact reading activity.

Other authors may assist in identifying core literature from various fields. One of the interviewees described the roles of authors in the writing process when literature searches are involved:

> For example, Peter can bring from his speciality references that I don't have access to or I wouldn't know where to look for […] he has a vision of what references we should take and what type of literature. It would take me so much time to do the same, because he already knows the keywords. (I8)

Table 45: The percentage of respondents reporting at least weekly reading of publications with various reading orientations, by number of co-authors

	Academic reading	Professional reading	Fact reading
Alone or as a small group (N=327-351)*	76	**68**	21
Large group (N=328-346)*	78	54	23
Total (N=655-697)*	76	60	22

*Because of the missing information N varies between variables

6.3.5.4 Research collaboration

Researchers engage in research collaboration with diverse organisations. Collaboration has a significant influence on researchers' ability to create research projects and on their publishing opportunities. Respondents were asked with which organisations and to what extent they are involved in research or publishing collaboration. In general, it can be stated that active collaboration is connected to active reading (see Table 46).

The percentage of respondents reading academic literature at least weekly is significantly higher for those collaborating regularly with Finnish and foreign universities and with Finnish and foreign state research institutes (chi-squared $p < 0.01$) as compared to those collaborating less frequently with these organisations. Over 80% of those working in collaboration with Finnish or foreign universities or state research institutes regularly read academic literature at least weekly.

The proportion of respondents reading professional literature at least weekly is significantly (chi squared $p < 0.05$) higher for those collaborating regularly with Finnish universities and Finnish state research institutes than for those collaborating with these organisations less frequently. Also, those collaborating regularly with other government organisations are active readers of professional literature. Almost 70% of those collaborating regularly with Finnish universities and state research institutes and other government institutes read professional literature at least weekly.

The percentage of respondents reading fact-oriented literature at least weekly is significantly (chi squared $p < 0.05$) higher for those collaborating regularly with foreign universities and foreign state research institutes when compared to those collaborating with these organisation less frequently. Approximately one third of respondents collaborating regularly with these organisations read fact-oriented literature weekly.

Interviewees emphasised the meaning of collaboration for gaining information. By collaborating with researchers from other organisations, researchers may gain new ideas and perspectives for research. One of the interviewees emphasised the meaning of collaboration for obtaining up-to-date information about the development of the field:

> From this international network we get the information about the most important issues at the moment. In the end, it is more up to date than what we can get by reading publications. What is really happening? It helps us to be aware what the current state is globally. (I7)

Table 46: The percentage of respondents reporting at least weekly reading of publications with various reading orientations, by collaboration partners

		Academic reading	Professional reading	Fact reading
Finnish university	Regularly (N=301)	**84**	**66**	26
	Less frequently (N=429)	69	57	20
Foreign university	Regularly (N=139)	**89**	58	**30**
	Less frequently (N=570)	72	61	20
Finnish state research institute	Regularly (N=186)	**87**	**67**	24
	Less frequently (N=528)	71	58	21
Foreign state research institute	Regularly (N=127)	**86**	58	**29**
	Less frequently (N=578)	73	61	20
Other government	Regularly (N=78)	77	**69**	22
	Less frequently (N=605)	75	60	22
Private sector	Regularly (N=85)	75	60	25
	Less frequently (N=597)	75	61	21

6.3.5.5 Research funding

Research funding too has an influence on reading practices (see Table 47). Respondents were asked to indicate the importance of various possible funding sources for their work. The proportion of respondents reading academic literature at least weekly is significantly (chi-squared p = 0.009) higher for those whose main research funding came from the Academy of Finland than for those for whom funding from the Academy of Finland is less important (see Table 47). Over 80% of those obtaining their main research funding from the Academy of Finland or from the European Union read academic literature at least weekly. The percentage of respondents reading academic literature at least weekly is significantly lower (chi-squared p = 0.02) for those whose main research funding came from private companies than for those getting less research funding from private companies. More than half of the respondents whose main research funding came from private companies read academic literature weekly.

As has been pointed out above, research reports produced from research assignments need not always include literature reviews looking at earlier research. Therefore, researchers writing these have not read academic literature as actively as those publishing in academic forums. The reason literature reviews are seldom needed in this connection is that companies are not necessarily interested in what others have done or already are aware of the situation, as one of the interviewees pointed out:

> I think that if, for example, Nokia creates a research assignment for comparison of two products, they already know what they have done previously. (I11)

The proportion of respondents reading professional literature weekly is significantly higher for those working mainly without external research funding (chi-squared p = 0.022). There is also evidence that professional reading is especially characteristic of those whose main research funding comes from the ministries (chi-squared p = 0.015). Almost 70% of those obtaining their main research funding from ministries or who are working mainly without external research funding read professional literature weekly. The percentage of respondents reading professional literature weekly is significantly lower (p = 0.006) for those obtaining their main research funding from foundations.

The percentage of respondents reading fact-oriented literature at least weekly is significantly higher (chi-squared p = 0.012) for those working mainly with research funding from the Academy of Finland. One third of respondents whose research

funding came principally from the Academy of Finland read fact-oriented literature at least weekly.

Table 47: The percentage of respondents reporting at least weekly reading of publications with various reading orientations, by type of research funding

		Academic reading	Professional reading	Fact reading
No external funding	Mainly (N=268)	74	**66**	22
	Less (N=402)	76	**57**	19
Ministry	Mainly (N=139)	76	**69**	24
	Less (N=507)	75	59	21
Academy of Finland	Mainly (N=75)	**88**	49	**33**
	Less (N=560)	**74**	**60**	**21**
Foundation	Mainly (N=49)	77	41	27
	Less (N=597)	76	61	21
European union	Mainly (N=86)	81	54	26
	Less (N=566)	75	61	20
Tekes	Mainly (N=88)	68	56	18
	Less (N=531)	77	60	22
Private company	Mainly (N=46)	61	61	23
	Less (N=575)	76	60	20

6.3.5.6 Research projects

Finally, the influence of the nature of the research projects on reading practices was studied. Firstly, respondents were asked about the typical length of their research projects. However, the typical length of the research projects had no significant influence on reading practices. Secondly, respondents were asked the typical number of research projects under work at the same time.

The number of simultaneous research projects has an influence especially on professional reading practices (see Table 48). The percentage of respondents reading professional literature at least weekly is significantly higher (chi-squared $p = 0.02$) for those working with more than two projects at the same time than those working on one or two projects.

There is also some evidence that those working with many projects at the same time read academic literature more actively. Almost 80% of respondents typically working on more than two projects at a time read academic literature at least weekly. On the other hand, there is some evidence that those working with one or two projects at the same time are more active readers of fact-oriented literature. However, the differences are not significant.

Table 48: The percentage of respondents reading at least weekly, by number of research projects

	Academic reading	Professional reading	Fact reading
One or two (N=274)	72	56	**25**
Three or more (N=445)	**78**	**65**	19
Total (N=729)	75	60	21

6.3.6 Summary

Results showed significant differences between disciplines in reading practices. Three reading orientations – academic, professional, and fact-reading orientation – were identified from the principal component analyses, and the influence of various cultural and contextual factors was studied. Next, a summary of results related to each orientation is presented. The results are summarised in Table 49.

6.3.6.1 Academic reading

Academic reading orientation consists of reading academic monographs, international and national conference proceedings, international and national refereed journals, and research reports. About 74% of the respondents read academic literature at least weekly. Academic reading is relatively active in all disciplines. However, the most active reading was associated with the social sciences and multidisciplinary biosciences. The least frequent academic reading was seen in the humanities and technical sciences, and academic reading is connected especially strongly to theoretical and empirical research. There is some evidence that those using literature from various fields are more active readers of academic literature than are those who use literature mainly from their own field. Thus, concepts such as divergent and low mutual dependence and high task uncertainty are connected to active academic reading. Collaborating with other academic organisations is connected with active reading of academic literature. The most active readers of academic literature work primarily with funding from the Academy of Finland, foundations, and the European Union.

6.3.6.2 Professional reading

Professional reading orientation consists of reading newspapers/magazines, professional magazines, and other sources – such as Web sites. More than half of the respondents read professional literature at least weekly. Professional literature was read actively in all disciplines. However, the most active professional reading was seen in the social sciences, multidisciplinary biosciences, and biological and environmental sciences. Professional reading is connected especially to specialist work / consulting and development/engineering. Using literature from various fields and publishing alone or with only a small number of colleagues is connected to active reading of professional literature. Thus, concepts such as divergence, rural nature, and low mutual dependence and high task uncertainty are connected to active reading of professional literature. Most of the active readers of professional literature collaborate regularly with other national academic organisations and government institutes, such as ministries. Research funding is most typically obtained from ministries, or the research is done without external funding. Researchers working with multiple projects simultaneously are the most active readers of professional literature.

6.3.6.3 Reading for facts

Fact-reading orientation involves technical manuals, study texts, and handbooks. One fifth of the respondents read fact-oriented literature weekly. The most active fact reading was found in the humanities, multidisciplinary biosciences, and technical sciences. Fact-reading orientation is not connected to any specific types of research in particular. There is some evidence that those using literature from various fields are more active readers of fact-oriented literature than those using literature situated more within their own field. Accordingly, the culture related to fact reading could be described as divergent and as having low mutual dependence and high task uncertainty. Active readers of fact-oriented literature collaborate most regularly with universities and the private sector. Most typically, the researchers get research funding from private companies and the Academy of Finland. There is also some evidence that working with few projects at the same time is more typical for active readers of fact-oriented literature.

Table 49: The main characteristics of the various reading orientations

	Academic reading	Professional reading	Fact reading
Main discipline	All disciplines, most active in social sciences, multidisciplinary biosciences, and bio and environmental sciences	All disciplines, most active in social sciences, multidisciplinary biosciences, and bio and environmental sciences	Most active in humanities, multidisciplinary biosciences, and technical sciences
Nature of research	Theoretical/ empirical research	Specialist work/consulting, development engineering	Not clear
Dependence on other fields	Decreased dependence	Increased dependence	Decreased dependence
Dependence between researchers	Not clear	Decreased dependence	Not clear
Research collaboration	Academic organizations	Academic and government organizations	Academic organizations
Research funding	Academic and EU funding	Budget funding and ministry funding	Academic funding
Nature of research projects	Many projects	Many projects	A few projects

6.4 The relationship between reading and publishing activity

Reading activity is connected to publishing activity. However, not all types of reading are connected to all types of publishing. Next, the relationships between various reading and publishing orientations are studied. The percentage of respondents producing at least one publication in each publishing orientation is examined in connection with reading activity in various reading orientations.

Academic reading orientation is significantly correlated with academic and conference publishing orientations (see Table 50). The proportion of respondents with at least one academic or conference related publication is significantly higher (chi-squared $p \leq 0.001$) for those reading academic literature at least weekly when compared to those reading academic literature less often.

Professional reading orientation is related to professional publishing orientation. The percentage of respondents producing at least one professional publication is significantly (chi-squared $p = 0.000$) higher for those reading professional literature at least weekly than for those reading professional literature less frequently. Fact reading is not significantly related to any of the publishing orientations. However, those reading fact-oriented literature at least weekly are publishing more with an industrial orientation than are those who read literature of this type less frequently.

Table 50: The percentage of respondents producing at least one publication with the various publishing orientations, by amount of reading activity

Reading orientation		Professional publishing	Article publishing	Conference publishing	Industrial publishing
Academic literature	At least weekly (N=556)	86	**94**	**63**	38
	Less frequently (N=191)	82	79	49	41
Professional literature	At least weekly (N=447)	**90**	89	62	41
	Less frequently (N=300)	79	91	56	36
Fact literature	At least weekly (N=163)	87	92	60	43
	Less frequently (N=584)	85	89	59	38

7 Discussion

In Chapter 5, 20 hypotheses – related to discipline-based differences in communication practices, the influence of academic culture and research context on communication practices, and the relationship between reading and publishing activity – were proposed. In this chapter, these hypotheses are considered and the results are discussed in conjunction with those of earlier studies.

7.1 Discipline-aligned differences in communication practices

Four hypotheses addressing discipline-aligned differences in scholars' publishing and reading practices were formed on the basis of Becher's (1989) taxonomy of discipline groups and previous research on communication practices in various disciplines. Results related to communication practices in hard-pure, hard-applied, soft-pure, and soft-applied fields are presented below.

The natural sciences, health-care sciences, and biological and environmental sciences were categorised as hard-pure fields in line with Becher's taxonomy. The technical sciences were categorised as hard-applied, the humanities as soft-pure, and the social sciences as soft-applied.

7.1.1 Communication practices in hard-pure fields

H1: *In hard-pure fields (the natural sciences, health-care sciences, and biological and environmental sciences), international academic journals are the main communication forums.*

The hypothesis was confirmed. Academic article orientation was the main publishing orientation in hard-pure fields. The atomistic, cumulative, and universal nature of the knowledge produced in hard-pure disciplines supports publishing in

article form. Accordingly, international journal articles were the most commonplace type of academic publication, and respondents representing hard-pure disciplines published more international journal articles than did respondents in other disciplines. In multidisciplinary biosciences and health-care sciences in particular, respondents published significantly more in academic article orientation than did respondents from other disciplines. These findings are similar to those of earlier studies (Piro et al. 2013; Tenopir et al. 2012a; Puuska 2010; Puuska & Miettinen 2008; Kyvik 1991).

However, this study showed that publishing in international journals was not as active in the natural sciences as in other hard-pure fields. In addition to journals, conference-related publishing orientation was common in the natural sciences. These results contradict earlier studies' findings, in work focusing on the natural sciences in a university context (Piro et al. 2013; Puuska & Miettinen 2008). In the natural sciences, industrial publishing orientation too was more common than it was in other hard-pure fields. This points to a more applied nature of research in natural sciences in state research institutes as compared to universities. Publishing practices in the natural sciences in state research institutes may be closer to those in hard-applied fields. The majority of respondents representing the natural sciences (65%) work at the Geological Survey of Finland, the Finnish Meteorological Institute, and VTT. In all of these research institutes, expert services additional to research work are produced; this may explain the applied nature of the work. Especially at VTT, collaboration with private companies is commonplace. Also, the bibliometric review (see section 2.3.3) of publishing practices at these institutes showed that conference-related publishing was active in addition to journal publishing.

In addition to academic publishing, professional publishing orientation was emphasised in the biological and environmental sciences and in health-care sciences. Publishing articles in national academic journals and professional magazines was especially common in these fields. Earlier studies too, in a university context, have shown the importance of professional and national publishing in agriculture and forestry (Late & Puuska 2014; Puuska & Miettinen 2008). Puuska and Miettinen (2008) discovered that national and professional publishing was more important in the health-care sciences as compared to clinical medicine. In state research institutes, research examining health-care sciences has focused on public and occupational health. Finland's largest state research institute conducting research into health-care sciences, THL, has emphasised its function as serving society, actors in the field, and decision-makers in central government and the

municipalities. Thereby, the health-care sciences in state research institutes have a close relationship to the professional, policy, and public audiences. In general, professional publishing seems to be more common in hard-pure fields in state research institutes than it is in a university context (Late & Puuska 2014; Puuska & Miettinen 2008; Kyvik 1991).

As for perspective in reading practices, academic reading orientation was the main orientation in hard-pure fields. International academic journals were read especially actively. Earlier studies too have shown the importance of international journals as information sources in all disciplines (Tenopir et al. 2012a; FinELib 2012). In addition, international conference proceedings were actively read in the natural sciences. Earlier studies (Tenopir et al. 2012a; FinELib 2012) have emphasised the role of conference proceedings in the technical sciences but not in the natural sciences. The results of the present work point to the nature of research in the natural sciences in state research institutes and at universities as differing. In addition to scholarly literature, newspapers and magazines were actively read by researchers representing all hard-pure disciplines. Hicks & Wang (2013) brought up the importance of newspapers and magazines as information sources for scholars. In general, the professional reading orientation takes a more active form in biological and environmental sciences and multidisciplinary biosciences as compared to other hard-pure fields. This finding is in line with results pertaining to publishing practices in biological and environmental sciences. Fact reading is more active in multidisciplinary biosciences than in other hard-pure disciplines.

The findings indicate that in hard-pure fields the academic research market identified by Ylijoki and colleagues (2011) is most typical. Also, the professional market is emphasised in biosciences and environmental sciences and in health-care sciences, and the corporate market in the natural sciences.

7.1.2 Communication practices in hard-applied fields

H2: *In hard-applied fields (technical sciences), researchers communicate in various forums but especially via conferences and by publishing research reports.*

This hypothesis is confirmed. In this study, no single publishing orientation was identified as the most important in the technical sciences. Respondents representing the technical sciences published almost as actively in all publishing

orientations. Research approaches vary in hard-applied sciences, and communication can take place in various forums. Conference publishing orientation is more actively manifested in the technical sciences than in other disciplines. Respondents representing the technical sciences published especially often at international conferences. Publishing via national conferences was considerably less frequent. Earlier studies too have stressed the meaning of conferences in the technical sciences (Late & Puuska 2014; Piro et al. 2013; Tenopir et al. 2012a; Puuska 2010; Puuska & Miettinen 2008; Kyvik 1991).

Academic article publishing orientation was just as active as conference publishing in the technical sciences. Articles in international journals were the main publishing forum in the academic article orientation. However, there was significantly less activity in academic article publishing orientation in the technical sciences than in other disciplines, apart from the humanities. According to Becher and Trowler (2001), publishing in hard-applied disciplines is not as important as it is in pure disciplines because the research is not usually theoretical in nature. Also in earlier studies done in a university context, journal publishing was found to be less active in the technical sciences than in other disciplines (Piro et al. 2013; Puuska & Miettinen 2008). Late and Puuska (2014) showed that journal publishing in the technical sciences at state research institutes is less active than what is seen in the technical sciences at universities.

Use of professional publishing orientation too was active in the technical sciences. As the hypothesis predicted, research reports were the most commonplace professional publications in the technical sciences. In a finding consistent with results from Puuska and Miettinen (2008), professional publishing seems to be more active in state research institutes than at universities. Late and Puuska (2014) echo this conclusion. However, Puuska and Miettinen (2008) showed that there is a great variety within research fields in publishing for national and international audiences in the technical sciences. The results are hard to compare with those of earlier studies, because findings are highly dependent on the research fields selected for study.

Industrial publishing orientation is significantly more actively manifested in the technical sciences than in other disciplines. In comparison to those in other disciplines, the respondents representing the technical sciences had the most patents also[18]. This finding indicates that the corporate research market identified by Ylijoki and colleagues (2011) is stressed in hard-applied fields. When the

[18] It is possible that the under-reprensentativeness of technical sciences may have had decreasing influence to the number of reported patents.

research objective involves commercial benefits, confidential research reports and patents are common outcomes of the research. The majority of respondents representing the technical sciences (68%) were working at VTT, where collaboration with the private sector is very commonplace. Also, the bibliometric study of publishing practices at VTT (see section 2.3.3) showed low academic publishing activity at VTT.

With respect to reading practices, the academic and professional reading orientations are the main orientations in technical sciences. The literature sources used most actively are international journals, newspapers and magazines, and professional magazines. Reading international conference proceedings is more active in the technical sciences than in other disciplines. Previous studies too have shown the importance of conference proceedings as information sources in the technical sciences (FinELib 2012; Tenopir et al. 2012a). In addition, fact-reading orientation is stressed in the technical sciences more than in other disciplines. Fact reading is focused on technical manuals. Overall, reading seems to be frequent in technical sciences in comparison to other disciplines. According to Allen & Cohen (1969, here Tenopir and King 1999), engineers rely more on personal contacts and research reports as information sources than they turn to journal articles.

7.1.3 Communication practices in soft-pure fields

H3: *In soft-pure fields (the humanities), academic monographs and articles in edited works are the main academic communication forums. Research results are also actively popularised for general audiences.*

This hypothesis is confirmed. With respect to the academic article orientation, respondents representing the humanities published mainly articles in edited works. Publishing in journals was less frequent and was focused more on national journals. Relative to other disciplines, the humanities showed less active publishing in academic article orientation. In addition, humanists published more monographs. Earlier studies came to similar conclusions regarding academic publishing practices in the humanities (Piro et al. 2013; Puuska & Miettinen 2008; Kyvik 1991). As Becher and Trowler (2001) argued, the pace of academic publishing is relatively

slow in the humanities because of lack of competition and the comprehensive processing of the problems. Most of the respondents representing the humanities (86%) were working at the Research Institute for the Languages of Finland, from which research work has moved to the universities. Therefore, academic research work in the humanities is limited at state research institutes in Finland.

Professional publishing orientation is applied more actively in the humanities than is academic article and conference publishing. Publishing in newspapers and magazines is especially active in the humanities. These findings are supported by studies by Puuska and Miettinen (2008) and Kyvik (1991), and it is argued that research topics in the humanities are often interesting from the point of view of larger audiences. Accordingly, the public research market is stressed in soft-pure fields (Ylijoki et al. 2011). Industrial publishing orientation is very passive in the humanities. Also, Ylijoki and colleagues (2011) have stated that the corporate research market is almost non-existent in the humanities. The findings for the humanities support the results of the bibliometric review of publishing practices at the Research Institute for the Languages of Finland (see section 2.3.3).

As for reading practices, the professional reading orientation is the most active in the humanities. Newspapers and magazines are the most actively read professional literature. Academic reading is focused on monographs. Humanists read monographs significantly more than do those in all other fields, as has been noted in previous studies (FinELib 2012; Tenopir et al. 2012a). However, overall, academic reading is more passive in the humanities than in all the other disciplines. This may be because research tasks were removed from the Research Institute for the Languages of Finland, where most of the humanist respondents worked. Fact-reading orientation, on the other hand, is more active in the humanities than the other disciplines. However, fact reading in the humanities focuses solely on textbooks and handbooks. It is likely that reading of these books is so active in the humanities because researchers' tasks at the Research Institute for the Languages of Finland include producing dictionaries. The findings are consistent with the study done by the FinELib (2012), which found that humanists were active readers of textbooks and handbooks.

7.1.4 Communication practices in soft-applied fields

H4: *In soft-applied fields (the social sciences), researcher communication takes various forms: reading and publishing monographs, articles in edited works, and articles in national and international journals. Communication in professional forums is active.*

The hypothesis is supported. Respondents in the social sciences published actively in various forums. Academic article orientation has a relatively active manifestation in the social sciences. The most common publication types in this orientation were articles in international academic journals and articles in edited works. Academic monographs were also more actively published than in hard sciences. Conference-linked publications in the social sciences focused on international conferences. Earlier studies have shown the variety of publishing forums in the social sciences (Puuska & Miettinen 2008; Piro et al. 2013). Also, publishing practices in the social sciences have shifted toward international publishing in academic journals (Kyvik 2003; Puuska & Miettinen 2008).

Because of the practical nature of the knowledge produced in soft-applied disciplines (Becher & Trowler 2001), activity in professional publishing orientation was stronger in the social sciences than in other disciplines. In professional publishing orientation, social scientists published mainly research reports and articles in professional magazines. Social scientists produced research reports more actively than those in all other disciplines. Also, articles in national academic journals and in newspapers were produced actively. The results of Puuska and Miettinen (2008) and Kyvik (2005) support the finding as to the active role of social scientists in publishing for professional and also for more general audiences.

As for reading practices, academic reading orientation is the most actively expressed orientation in the social sciences. International academic journals are the most actively read form of academic literature. Also, social scientists read academic monographs more actively than did respondents representing hard sciences. Also, the activity in professional reading orientation is stronger here than in other disciplines. Newspapers and magazines and, at the same time, research reports are the most actively read professional publications. The findings support the argument as to the professional and practical nature of knowledge produced in soft-applied fields. They also are consistent with findings from earlier studies

(FinELib 2012; Tenopir et al. 2012a). In general, social scientists, together with biological and environmental scientists, were the most active readers.

The results can be linked to the findings of Ylijoki and colleagues (2011) about academic, policy, professional, and public research markets. We cannot identify any one research institute where most of the social scientists work; social scientists can be found at almost every institute. This indicates that the social sciences are a discipline that can be applied in (and linked to) many, quite different research contexts and markets. This may also be one factor behind the variety of communication practices seen in the social sciences.

7.2 Academic culture and communication practices

In addition to discipline-aligned differences in communication practices, hypotheses as to the influence of cultural factors on communication practices were formed. Considered next are the hypotheses about the nature of the research, field interdependence, and dependence between researchers.

7.2.1 The nature of the research

In the survey, respondents were asked to indicate the importance of theoretical, empirical, development/engineering, and specialist work / consulting in their activities. The main type of research in every discipline was empirical research. However, relative to other disciplines, theoretical research was most common in multidisciplinary biosciences and the humanities. Development/engineering was more common in the technical sciences than in other fields. Specialist work / consulting was seen most commonly in the humanities and natural sciences.

H5: *Those conducting mainly theoretical or empirical research communicate primarily in academic forums.*

The hypothesis is confirmed. Those conducting mainly empirical or theoretical research did their publishing more in academic article orientation than did those engaged in mainly specialist work / consulting or development/engineering. Also, those conducting mainly theoretical research published most at conferences. Thus,

it becomes clear that the nature of the research affects publishing practices. Results from empirical or theoretical studies can be published in academic forums, while the results of projects described as development/engineering or specialist work / consulting do not necessarily lead to such knowledge as could be published in academic forums. Research described as specialist work / consulting or development/engineering might also be associated with confidentiality agreements that preclude publishing of the results.

As for reading practices, those conducting mainly empirical or theoretical research read more academic literature than do those who perform mainly specialist/consulting or development and engineering work. Researchers conducting development / engineering or specialist work / consulting do not necessarily have to include literature reviews in their publications. Also, basic research may be many years ahead of or, on the other hand, behind practical developments. Therefore, academic reading is more passive in this context than for those conducting theoretical or empirical research.

H6: *Those performing mainly specialist work consulting or development/engineering communicate actively in professional forums.*

This hypothesis is confirmed. Those doing mainly specialist work / consulting published most in professional and industrial publishing orientations. The nature of the knowledge produced in projects described as specialist work / consulting is suitable for publishing in professional forums. Professional audiences may also be interested in the results produced in such projects. In some cases, results may not be published at all, with the findings described only in confidential research reports. Also, those conducting mainly development/engineering work published actively via conferences. This finding is related to the fact that development/engineering was the most common type of research in the technical sciences, where the tradition of publishing via conferences is strong.

Also, those engaged mainly in specialist work / consulting or development/engineering read more professional literature than did those conducting mainly empirical or theoretical research. Interviewees working with specialist work / consulting or development/engineering also emphasised the

importance of following what is happening in the 'real world' – for example, in industry – if one is to be able to collaborate with business actors.

7.2.2 Dependence on other fields

Dependence on other fields was measured by asking to what extent researchers use literature from their own and other scientific fields. In general, researchers in hard sciences such as biological and environmental sciences, health-care sciences, and the natural sciences, rely more on information produced in their own field. In the technical sciences, multidisciplinary biosciences, social sciences, and humanities, researchers rely more on knowledge produced in other fields. In earlier studies, especially involving the social sciences and humanities, researchers have been found to be active in using literature from other disciplines (FinELib 2012).

H7: *Decreased dependence on other fields is connected to active communication in academic forums.*

With respect to publishing practices, the hypothesis is confirmed. There is some evidence that those using literature mainly from their own field are the most active publishers in academic article orientation. Therefore, one can apply Becher's (1989) terms and state that those in convergent fields publish more for academic audiences. In Whitley's (1984) terms, fields exhibiting high mutual dependence and low task uncertainty produce more in academic forums than do those exhibiting low mutual dependence and high task uncertainty. For reading practices, the hypothesis is not confirmed. The extent of use of literature from one's own and other scientific fields does not have a significant correlation with academic reading activity.

H8: *Increased dependence on other fields is connected to active communication in professional forums.*

The hypothesis is supported. Those using literature from various fields show the most active professional orientation in publishing and reading of literature. Therefore, in using Becher's (1989) terms, researchers in divergent fields communicated more with a professional audience than did those in convergent fields. In Whitley's (1984) terms, fields having low mutual dependence and high task uncertainty rely more on professional communication when compared to fields exhibiting high mutual dependence and low task uncertainty. The results confirm Fry and Talja's (2004) hypothesis as to the spread within literature and publishing practices.

7.2.3 Dependence between researchers

Dependence between researchers was measured through items asking the typical number of co-authors that the researchers have when publishing. In general, the number of co-authors is highest in hard-pure fields such as health-care sciences, biological and environmental sciences, multidisciplinary biosciences, and the natural sciences. In the technical sciences, social sciences, and humanities, the majority of the respondents publish alone or with one or two co-authors. These results are consistent with findings from earlier studies (e.g., Puuska & Miettinen 2008).

H9: *Respondents who are highly dependent on other researchers communicate more in academic forums than do those who have been less dependent.*

With respect to publishing practices, the hypothesis is confirmed. Number of co-authors has a significant influence on academic article publishing orientation. Those publishing with more co-authors are more active publishers of academic articles than are those who publish alone or as a member of a small group. In Becher's (1989) terms, publishing in academic forums is more active in 'urban' as opposed to 'rural' fields. On the other hand, Whitley's (1984) concept of high

mutual dependence with low task uncertainty is linked to active publishing in academic forums. The hypothesis is not correct in relation to reading practices. Dependence between researchers has no relationship to academic reading activity.

H10: *Those who have been less dependent on other researchers communicate more in professional forums than those who have been more dependent.*

This hypothesis is confirmed. The number of co-authors has a significant relationship with professional and industrial publishing activity and with professional reading activity. Those publishing alone or with only a small group communicate more actively with professional and industrial audiences. In Becher's (1989) terms, rural fields are more dependent on professional audiences than are urban fields. Also, Whitley's (1984) low mutual dependence and high task uncertainty are related to reliance on professional communication.

7.3 Communication practices in different research contexts

Nine hypotheses addressing the relationship between communication practices and research context were set. Next, these are responded to and discussed in light of the research and earlier findings.

7.3.1 Collaboration

Collaborative activity involving various types of organisations was studied in the survey. In general, collaborating with academic organisations such as universities and state research institutes is most common in hard-pure fields and in the social sciences. In the technical sciences, collaboration with private-sector organisations is very common. In multidisciplinary biosciences, the social sciences, and biological and environmental sciences, researchers collaborate regularly with other government organisations such as ministries. In all, collaboration is less frequent in the humanities.

Results indicate that different types of research are done in collaboration with different types of organisations. Those conducting mainly empirical and theoretical research collaborated most regularly with academic organisations. Specialist work / consulting was connected to collaborating with other government organisations. Development/engineering, on the other hand, was linked to collaboration with the private sector.

H11: *Regular collaboration with academic organisations is related to active communication in academic forums.*

The hypothesis is confirmed. Those collaborating regularly with academic organisations publish more in academic article orientation and read more academic literature than do those collaborating regularly with other types of organisations. These findings are linked to the academic research market identified by Ylijoki and colleagues (2011). In the academic research market, research is strongly associated with the international academic community. The results also support earlier findings, by Bozeman and Corley (2004) and Shin and Cummins (2009), with respect to research collaboration and publishing productivity. Additionally, Hollingsworth (2004) has discussed the importance of collaboration with other organisations across discipline and theme boundaries as a factor of creativity.

H12: *Regular collaboration with other than academic organisations is related to active communication in professional forums.*

This hypothesis is supported. Those collaborating regularly with government organisations such as ministries publish more in professional publishing orientation and are the most active readers of professional literature. However, also those engaging in regular collaboration with academic organisations publish actively in professional forums. Those collaborating regularly with the private sector publish most in industrial orientation.

Ylijoki and her colleagues (2011) have defined characteristics of the policy, professional, corporate, and public market. Collaborating with ministries and municipalities and communicating with professional audiences are related to the policy and professional research markets. Collaborating with private-sector organisations and producing industrial publications are related to the corporate market, wherein the basic objective is to achieve commercial benefit. The public

market does not necessarily include collaboration with other organisations, because it is often linked to researchers' personal motivation.

H13: *Collaboration with other academic organisations is linked to increased dependence between researchers and decreased dependence on other fields.*

The hypothesis is confirmed. Publishing with more co-authors and using literature mainly from one's own field are associated with regular collaboration with Finnish and foreign universities and Finnish state research institutes. The findings confirm Whitley's (1984) argument about the connection of reputational autonomy to mutual dependence and task uncertainty; also, the influence of collaboration partners on communication practices can be explained in terms of reputational autonomy.

7.3.2 Research funding

Most of the respondents worked mainly without external research funding. Beyond this, in the technical sciences, the main research funders were Tekes and private companies. The Academy of Finland was the most important funder of research in the natural sciences and health-care sciences. In biological and environmental sciences and the social sciences, the main external research funders were government ministries. The European Union was the main external research funder in multidisciplinary biosciences. Finally, most humanists work without external research funding. Researchers receive different types of research funding for different types of projects. Empirical- and theoretical-type research were connected to having research funding from academic funders such as the Academy of Finland and foundations. Those conducting specialist work / consulting activities typically worked without external research funding. Development/engineering was connected to having research funding from private companies.

H14: *Those working mainly with external research funding are publishing more in academic and professional forums than are those who work without external research funding.*

The hypothesis was not confirmed. Both publishing and reading practices are highly dependent on the source of external research funding. Not every type of external research funding is linked to increased publishing activity. In this, the results contradict those of earlier studies by Gulbrandsen and Smeby (2005) and by Kyvik (1991), who found that any type of external research funding was linked to increased academic publishing. Late and Puuska (2014) revealed different publishing profiles between universities and state research institutes and that universities and state research institutes obtain external research funding from different types of sources. Therefore, one could argue that Gulbrandsen and Smeby's and Kyvik's results may apply only to universities. In state research institutes, the goal of the research does not encompass production of academic publications. Other types of publications may be more important in, for example, projects funded by ministries or private companies.

H15: *Those whose main external research funding comes from funding bodies for academic research communicate actively in academic forums.*

The hypothesis was confirmed. Having research funding from academic sources such as the Academy of Finland, the EU, and foundations is significantly correlated with active academic article publishing orientation and academic reading orientation. To be able to obtain research funding from academic funders such as the Academy of Finland, researchers must have a record of academic publications and compete with other applicants thereby. Also, research projects supported by external research funders have to produce publications so as to show the funders the results of the study. Such results are related to the academic research market defined by Ylijoki and colleagues (2011). In the academic research market, research funding is obtained from sources intended for academic research and is most clearly evident in the natural sciences.

H16: *Those working with other types of external research funding communicate actively in professional forums.*

The hypothesis is partly supported. Professional publishing orientation and professional reading orientation has a significant relationship to working without

external research funding. Industrial publishing orientation, on the other hand, is related to having private companies, Tekes, and the EU as one's main sources of research funding. Those whose main research funding came from private companies or Tekes published less in academic article orientation. Competition for research funding from these sources is based not so much on academic merits as it is on academic funding sources such as Academy of Finland. The results are in contradiction with findings from Kyvik (2005), who found a correlation between industry funding and academic publications. In state research institutes, research assignments often produce only confidential research reports, on account of the nature of the research. These research assignments do not produce such knowledge as could be published in academic forums. Furthermore, the assignments often involve confidentiality agreements that preclude publishing.

7.3.3 Research projects

Most often, the respondents worked on projects lasting three to four years and one to two years. The percentage of them working with shorter projects was highest in the social and technical sciences, while the humanities and health-care sciences showed the highest proportion of respondents working with longer projects. The researchers worked most typically with three to four projects at the same time. The number of ongoing projects was highest in multidisciplinary biosciences and the technical sciences and lowest in the humanities.

H17: *Those working with shorter projects communicate actively with professional audiences.*

For industrial publishing practices, the hypothesis is confirmed. Those working with shorter projects are producing more publications in industrial orientation than are those working with shorter projects. This finding is related to discipline-aligned differences. In the technical sciences, where working on short projects is commonplace, industrial publishing is active. However, those working with longer projects are publishing more in professional orientation than are those working on shorter projects. According to the findings, the shortest projects are usually research assignments for private companies.

H18: *Those working with longer projects communicate actively with an academic audience.*

The hypothesis is confirmed. Those working with longer projects publish more in academic article orientation and conference orientation and read professional and academic literature more actively than those working with shorter projects do. Overall, longer projects are related to active communicating. In projects lasting three years or more, researchers have more time to communicate, while those working with shorter projects publish significantly less in academic article orientation. Working with short research projects does not leave researchers time to write academic publications. Also, short projects do not necessarily produce such research data or materials as could be cultivated into academic articles. In addition, short research assignments are not necessarily intended to lead to any publications if the assignment is carried out for the purposes of the client only. Hemlin and colleagues (2008) have stated that limited time for research is one of the factors decreasing creativity in the workplace.

H19: *Those working with many projects at the same time publish more than those who work with one project at a time.*

This hypothesis is confirmed. Researchers working with three or more projects at the same time are more active publishers in all publishing orientations and more active readers of professional and academic literature than are those working with one or two projects at a time. As for findings related to differences between disciplines, in the humanities, where publishing is less active, working with one or two projects is much more common than in other disciplines. The results confirm those of Fox and Mohapatra (2007), who found a connection between number of projects and publishing activity.

7.4 Publishing and reading

H20: *Active reading is associated with active publishing.*

The hypothesis is confirmed. However, not all reading is linked to active publishing. Academic reading orientation is related to academic article and conference publishing. Earlier studies too have shown a link between active

reading and active academic publishing (Tenopir et al. 2012a; King & Tenopir 1999). In addition, this study showed that reading professional literature is connected to active publishing in professional publishing orientation. There is also some evidence of a relationship between fact reading and industrial publishing. The findings indicate that certain types of publishing require reading a certain type of literature. For instance, scholars publishing for professional audiences must be aware of the current state of professional development in the field. The importance of citing earlier academic research in academic publications is evident.

8 Conclusions

The overall aim with this thesis was to study publishing and reading practices in state research institutes in Finland. Communication practices in various disciplines were studied in relation to academic cultures and research context. In this chapter, the contributions of this research are evaluated, with this discussion followed by evaluation of the power of Becher's (1989) and Whitley's (1984) theories to explain differences in communication practices in state research institutes. Research evaluation in the context of state research institutes is discussed in light of the findings. Finally, the limitations of this research are discussed and suggestions for future research are given.

8.1 Areas of contribution

The study yielded both quantitative and qualitative knowledge about communication practices in state research institutes and gave comprehensive account of the research context in the Finnish state research institutes. To the knowledge of the researcher, the present work was the first empirical study done in Finland that covers a broad range of research institutes. The qualitative enquiry in this study gave examples of various types of research projects and their relationship to publishing practices. Qualitative data also gave explanations for the difficulties researchers face in connection with, for example, publishing and reading. The quantitative enquiry gave broader insight into the work in state research institutes.

This study offered knowledge about the nature of the work (including research) and research context in state research institutes. It is evident that research practices and, for example, collaboration partners and research funders vary to a considerable extent between disciplines. For instance, researchers in the technical sciences and natural sciences work between the academic and industrial worlds while in other disciplines the focus is more or less on academic and professional research projects. There is also great variety among research institutes in research

practices. The tasks given to the institutes determine what type of research is conducted. For example, research in the humanities is in the minority in state research institutes because research in this field has been moved to the university context. Research in the humanities in state research institutes is focused on specialist work / consulting such as compilation of dictionaries.

Another central contribution of this thesis lies in identification of four publishing and three reading orientations that are typical with state research institutes. These orientations cover a broad range of publication types. The study also showed relationships between publishing and reading orientations. The findings indicate that, although researchers working in state research institutes conduct academic research, they offer knowledge for various other audiences also. It may be argued, therefore, that studying scholarly communication only from the perspective of academic journals or academic publications may yield a biased interpretation of communication practices. Also, use of only bibliometric methods for studying publishing practices leaves work outcomes that are not published publicly, such as confidential research reports, outside the data examined. Confidential research reports may be the only work output of some researchers working on research assignments.

The study offered knowledge about communication practices in various disciplines at state research institutes. Most of the findings were similar to the results from studies conducted earlier in the university sector. Therefore, it may be said that the various disciplines' publishing and reading practices are quite stable across research site boundaries. However, some differences were found. The research produced in state research institutes is often of a more applied nature, and the results may not always be published in forums intended for academic research. In particular, the communication practices in the natural sciences were similar to those in the technical sciences in state research institutes. In the university sector, communication practices in the natural sciences are similar to corresponding practices in other hard-pure disciplines, such as medical sciences. Also, in particular, academic publishing in state research institutes in the humanities is more limited than that at universities, because of the nature of the work. However, it must be remembered that comparing findings from separate studies may be misleading because of the different disciplinary groupings used in the studies and the research fields selected for the studies.

Another important aim of the present study was to offer knowledge about the relations between communication practices and various cultural and contextual factors. To this end, metrics for both cultural and contextual factors were created

for the survey. Becher's (1989) and Whitley's (1984) theories were taken as a point of departure for examination of cultural factors. However, creating metrics for the concepts used by Becher and Whitley is challenging. In the survey, many ways of measuring the concepts were experimented with. Most of them did not show any relationship to publishing and reading practices, so the metrics for academic culture were restricted to only three: one referred to the research type, the second to dependence on other disciplines, and the third the dependence between researchers. These metrics proved to be very useful for explaining differences, especially in publishing practices. Cultural factors, in contrast, showed less power to explain differences in reading practices. However, academic publishing and reading was related to theoretical and empirical research and to low dependence on other disciplines and high dependence between researchers. Communicating with other audiences was linked to specialist work / consulting and to high dependence on other disciplines and low dependence between researchers. Qualitative data and earlier empirical research were taken as a point of departure for creation of metrics for contextual factors. The influence of research collaboration, research funding, and the nature of the research projects on publishing and reading practices was studied. The associated measurements are useful and have power to explain differences in publishing and reading practices. Academic publishing and reading was related to engaging in collaboration with academic organisations and having external research funding from academic sources. Professional publishing and reading was linked to collaborating also with other than academic organisations and to having external research funding from ministries, Tekes, and private companies.

8.2 Extending Becher's and Whitley's theories

Becher's (1989) and Whitley's (1984) theories about academic cultures were used as the theoretical background in this study. These theories were used as a jumping-off point for formation of hypotheses pertaining to the relationships between academic cultures and communication practices. Becher's taxonomy for grouping disciplines was used in the development of hypotheses as to the differences between discipline groups in communication practices.

When one considers state research institutes, Becher's taxonomy for cognitive categorisation of disciplines is in some cases hard to apply because of the applied nature of the research at state research institutes. Disciplines are hard to divide

along the lines of pure and applied knowledge. For example, disciplines that, according to Becher's taxonomy, should be categorised as pure may exhibit applied research too and show communication behaviour that is typical in applied disciplines. Also, applied research may take various forms, such as development work or research assignments. Changes in academic knowledge production toward mode 2 or a triple-helix model, whatever name one wishes to use, create pressure to revise Becher's taxonomy. When most of the research is defined as applied and as multidisciplinary Becher's taxonomy is no longer useful, because it does not allow placing disciplines in different opposing dimensions of the taxonomy at the same time. Fry (2003) too has argued that Becher's concepts are harder to apply for multidisciplinary fields than for monodisciplinary fields. Accordingly, situating discipline in polar positions is a clear limitation also in her opinion (Fry 2003, 208).

It may be argued that applying such taxonomies is going to grow even more difficult in the near future because of the complexity and changing nature of disciplinary structures. In a solution to the problem of the dichotomy of pure and applied research, the nature of research was studied in the survey by asking about the share of empirical, theoretical, development / engineering, and specialist work / consulting in respondents' work. The idea here was to broaden the scale beyond pure and applied and attempt to identify distinct research types. The findings showed that publishing practices differ between, for example, those conducting mainly development/engineering work and researchers engaged in specialist work / consulting. However, this topic needs more research, and this type of categorisation should be further developed and used in future studies.

In addition to cognitive dimensions, both Becher and Whitley offer concepts for social dimensions of academic cultures. Both theories provide interesting insights into academic culture. Analyses of concepts developed by Becher and Whitley revealed similarity between the theories. In the end, the theories discuss the same phenomena, only with different names. In accordance with the synthesis of the theories performed in the present work, two concepts were operationalised in the survey for examination of their relationships with researchers' communication practices. Social dimensions exposed differences in disciplines grouped into the same category in cognitive categorisations. For example, multidisciplinary biosciences differed from other disciplines categorised as hard-pure in their social dimensions. There were also difficulties in describing technical sciences by Becher's and Whitley's concepts. However, as is mentioned above, creating metrics for the concepts defined by Becher and Whitley proved very challenging because of the abstract nature of the concepts. Since one clear

limitation of both theories is that their components are hard to measure, it would have been very useful if both Becher and Whitley had suggested more practical measurements for their concepts. That said, others (e.g., Krampen et al. 2011) have made intriguing attempts to measure especially Whitley's concepts, and it will be interesting to see how this line of study will develop.

The advantage of Whitley's theory when compared to Becher's is that it takes into account also contextual factors. However, it is difficult to synthesise Whitley's cultural and contextual factors. According to Whitley, contextual factors influence cultural factors, which makes it even more difficult to measure cultural factors and renders the theory quite complex. Findings from the present study showed that contextual factors have an influence on communication practices. Hence, it seems important for contextual factors to be taken into account. For instance, the study by Ylijoki and colleagues (2011) about different research markets is fresh and interesting. Such frameworks do not take discipline-linked cultures into account but can be applied simultaneously with consideration of cultural factors.

8.3 Evaluation of research done at state research institutes

The study showed that different types of research, conducted in different disciplines, with different research funding, in collaboration with different types of organisations and in different types of research projects, produce different research outcomes. Therefore, it is reasonable to argue that not all research can be evaluated with the same criteria. Especially in state research institutes, where the common aim is to produce knowledge for decision-making and for society, the research cannot always be evaluated with the same criteria as that conducted at, for example, universities.

In the evaluation, the aim of the research should be taken as a starting point (Rossi et al. 2004). For example, if the aim of the research is to produce academic knowledge for an international audience, the number of international publications is probably the right evaluation criterion. However, if the aim of the research is, for example, to develop professional practices, the number of academic publications produced in the course of the project does not say anything about the actual impact of the study. Most state research institutes in Finland have additional, other than purely academic tasks – for example, to support decision-making or offer

information for society and citizens. For instance, the National Institute for Health and Welfare issues new national nutritional recommendations, including changes to the food plate model applied in contexts such as planning of school lunches. Therefore, the goal of the research and how impact is determined form the central question in solid evaluation.

The ongoing process of reorganisation of state research institutes may have its own effect on research evaluation. Firstly, the new funding instrument associated with strategically targeted research may increase the mode 2 type of research by funding research projects that aid in political decision-making and solving of societal problems. Therefore, there is a need to specify clearly what type of research and research outcomes will be produced by research funded under the new model and to take it into account in research evaluation.

Secondly, the future will see those research institutes to be merged into universities evaluated with the same criteria as universities. This should be acknowledged before the mergers and taken into account in the development of new strategies for institutes[19]. For example in Finland the merger of three distinct university organisations to form Aalto University has resulted conflicting signals to researchers about the kind of research they are expected to conduct (Luukkonen & Thomas 2013).

Thirdly, with the merging of research institutes working in closely related research fields to form new research centres, the variety among the types of research undertaken within a single organisation will increase. Accordingly, the various types of research projects should be identified within organisations before the criteria are set for evaluation of the research. Research evaluation at the organisation-wide level is a difficult task because of the variety among research projects. Consequently, it would be better to evaluate research at project level, with project aims as a point of departure. However, doing this is not easy without an accompanying increase in bureaucracy.

8.4 Limitations of the study

In terms of reliability and validity, this study has some limitations. Firstly, problems exist with the representativeness of both the qualitative and quantitative data. The qualitative data collected in the first phase of the study have limited

[19] The National Consumer Research Centre and the National Research Institute of Legal Policy will be merged into the University of Helsinki in 2015.

scope. The interview data cover interviews with only 12 researchers, representing three research fields and two research institutes; therefore, the qualitative data give information only from the perspective of these interviewees. It is likely that different kinds of research projects and of practices could be identified with a broader set of interview data. The interview data are particularly lacking in the perspective of smaller state research institutes and researchers working in soft research fields. The initial aim in the collection of the interview data was to give information about work practices that are typical in state research institutes, to inform designing the survey questionnaire, stating the hypotheses, and illustratin researchers work and communication practices. For first two aims collected interview data seemed to be broad enough. For the latter aim, perspective of soft research fields such as humanities and social sciences would have given a richer view. However, the use of the interview data and selection of citations strive for giving examples of the work in state research institutes in general not specific to certain disciplines. Also, this was the first time similar qualitative data collection in Finnish state research institute environment was conducted. Thus, qualitative data (even with limited scope) gives valuable knowledge about work in state research institutes.

The quantitative data are biased toward biological and environmental sciences. The technical sciences are under-represented in the data because of a general lack of responses from VTT. Consequently, the quantitative data may lead to incorrect interpretation of the publishing and reading practices in the technical sciences. This factor may have decreased such figures as the number of patents reported in the study; in reality, differences in publishing practices between state research institutes and universities may be greater than shown here. Also, only three per cent of the respondents (N = 22) represent the humanities. While the humanities are not under-represented in the data (because research focusing on the humanities is in the clear minority in state research institutes), conducting statistical analyses for such a small group may be problematic. Another limitation in the quantitative data has to do with the acknowledged problems with self-reporting methods such as surveys. It has been argued that publishing and reading activity are symbols of virility and that, accordingly, exaggeration is likely (Nicholas & Clark 2012). The data may also be biased toward active and experienced researchers. However, collection of similar research data covering a broad range of publication types and independent factors would not be possible with other methods, such as bibliometrics.

Secondly, some limitations can be seen in the design of the questionnaire. Certain scales used in the study (for example, to measure publishing activity) caused problems in the analyses. Using ratio scales would have enabled exploiting different types of statistical methods for analyses. Using ordinal scales also forced us to use dichotomies of publishing and reading orientations. This use of dichotomies decreased the variance within variables. Therefore, correlations with cultural and contextual factors, especially in the case of reading orientations, were low.

Another reason for cultural factors not always influencing communication practices lay in the orientations themselves. Different types of publication forums were grouped together for the calculations, to present the publishing and reading orientations. For example, the academic article publishing orientation and academic reading orientation cover publication types typical of different disciplines, such as journals and monographs. Accordingly, using orientations in the analyses masked differences between disciplines in publishing and reading practices.

Also, the scales used for questions related to research type, research collaboration, and research funding caused problems in the analyses. In the questionnaire, research type was addressed with four variables, research collaboration organisations with six, and research funding with seven. This decision made comparison between variables difficult. If respondents had been asked to select only one main research type, one main research collaboration organisation, and one main source of research funding, comparing communication practices across main research types, main collaboration partners, and main funders would have been possible. However, forcing respondents to select only one option does not reflect real life, in which multiple, equal options would be appropriate. The use of multiple variables increased the reliability of the measurements.

Also, measurements related to the concepts defined by Becher and Whitley turned out to be difficult, as is explained above. The metrics employed do not cover all aspects of the theoretical concepts. For example, number of co-authors was used as a proxy for mutual dependence, yet the number of co-authors refers more to micro mutual dependence between researchers than mutual dependence within a field.

8.5 Suggestions for future research

The findings of this study suggest several interesting topics for future research. First of all, comparing publishing practices in different disciplines between universities and state research institutes would be of interest. Especially if research institutes were able to offer reliable and comparable publication records covering a broad range of publications, publishing practices could be studied with more reliable research data. Because the nature of research varies between types of research projects and also owing to the diversity of work tasks between individual researchers, it is recommended that publication records contain background information about the research projects and the nature of the work the researchers are conducting. Because publishing practices differ between disciplines, records should also include information about the researchers' research field.

Also, the influence of various contextual factors on communication practices needs more research. One way to study publishing practices and take into account research context would be by taking research projects as a point of departure. Some of the state research institutes keep public records of ongoing and completed research projects that include information about research funding, collaboration partners, and publications. With this information, it would be possible to study publishing practices in different types of research projects and in different types of collaborations via quantitative methods.

The nature of the research, such as pure vs. applied and different research types, merits further work. It would be interesting to know more about the nature of applied research in various disciplines, especially in soft sciences such as the humanities. Among the interesting research questions are what types of research projects and research assignments there are in the humanities and how applied projects differ from traditional research conducted in these fields.

Compared to publishing practices, scholarly reading practices have been studied less. In particular, scholars' reading practices related to professional publications may point to interesting future research topics. For example, Hicks & Wang (2013) documented an increasing number of citations to newspapers in scholarly publications. Others have shown that scholarly publications are cited increasingly for example in government reports (Lewison 2004). Also, discussion has led to the idea of using, for example, altmetrics (see section 3.1) for research evaluation. Accordingly, interesting questions include how professional and general

information is retrieved and used in academic research and whether the boundary between academic and other publications is vanishing or, instead, the two are used for different purposes and in a different way.

In addition, the reorganisation process that state research institutes in Finland are going through offers interesting topics for future research. In 2015, there will be only 12 state research institutes in Finland. It would be very interesting to follow how the reorganisation works out and what consequences it may have for research and communication practices. It remains to be seen also how the process of reorganising is going to affect the roles of universities and state research institutes. The future will show whether there will be clearer boundaries in the distribution of work among research sectors.

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Appendix 1. List of interview questions

1. Work tasks in general

- Describe your work briefly in your own words?
- What is your research field?
- How is your research field related to other fields? What are the neighboring fields?
- What are the main research topics in your field?
- How national/international are the topics?
- Can you tell me more about one of your ongoing or finished research project?

2. Research practices

- How did the project started?
- What was the aim of the project?
- Why this topic was studied?
- How long was the project?
- What research methods were used in the project?
- What type of data was collected?
- Does project demand of using specific research infrastructure (e.g. laboratory)?
- Are you working alone or with a group?
- What is the size of the group?
- How does the group work in practice?
- How researchers were selected to the group?
- Do you have national/international collaboration?
- Where research funding is gained?
- What is the principal audience for the study?

3. Scholarly communication

- Do you participate regularly in some specific conference?
- Why do you participate on conferences?
- Is it important to publish research results? Why?
- Do confidentiality agreements have effect on your publishing practices?
- What publications were/are produced during the project?
- What are the most important publishing forums in your field?

4. Reading

- How much do your read for work? Why?
- What journals do you follow regularly?
- Is it easy to found core literature?
- From which disciplines do you read?
- How do you select cited publications?

5. Work environment

- Can you describe your research institute as work environment?
- How many projects do you have under work at the same time?
- Have there been changes is your work in last years?
- Have you worked in university? What are the main differences compared to state research institute?
- Have you worked in private company? What are the main differences compared to state research institute?
- What type of services research institute offer for researchers?

Appendix 2. Questionnaire for state research institutes in Finland

1. Background information

1.1 Research institute

1.2 Department or unit

1.3 Gender

- Female
- Male

1.4 Age (in full years)

1.5 Please indicate highest degree earned?
- Vocational education
- BA or BS
- MS or MA
- Licentiate or equivalent
- Ph.D. or equivalent
- Other, please specify?

1.6 In what year did you received your highest degree?

1.7 What is your professional position?
- Director/manager of the institute or unit
- Professor or equivalent
- Project manager/ team leader
- Senior research scientist
- Research scientist
- Other expert (e.g. medical doctor, designer)
- Research technician (e.g. secretary, laboratorian)
- PhD student
- Other, please specify?

1.8 Previous work experience after graduation
- Finnish university

- Foreign university
- Other state research institute in Finland
- Foreign state research institute
- Other research institute
- Other private sector
- No earlier work experiences from other organizations
- Other, please specify?

1.9 What is your scientific discipline? Choose one option from the following categories:

- Biosciences and environmental sciences
    - Agronomy
    - Biochemistry
    - Ecology
    - Environmental sciences
    - Food science
    - Forestry
    - Geography/Regional studies
    - Microbiology
    - Neuroscience
    - Plant sciences
- Health-care sciences,
    - Biomedicine
    - Clinical medicine
    - Dentistry
    - Nutrition
    - Nursing science
    - Pharmacy

    - Physical education, sport sciences
    - Public, educational and occupational health
    - Veterinary medicine
- Humanities
    - Archaeology
    - Arts and literature
    - Cultural studies
    - History
    - Linguistics
    - Philosophy
    - Theology
- Natural sciences
    - Astronomy and astrophysics
    - Chemistry
    - Earth sciences, meteorology
    - Mathematics
    - Physics
- Social sciences,
    - Business economics
    - Economics
    - Education
    - Communication and information sciences
    - Law
    - Political science and administrative Sciences
    - Psychology
    - Social research

- Statistics

- Technical sciences
  - Architecture
  - Chemical engineering (metallurgy, mining, minerals etc.)
  - Computer science
  - Construction & building technology
  - Electrical and electronic engineering
  - Energy and environmental engineering
  - Industrial engineering (operations research & management science)
  - Materials science
  - Mechanical and manufacturing engineering
  - Paper and wood science

- Other please specify

1.10 What is your research field (e.g educational sociology, history of ideas, geriatrics, information systems science):

2. Nature of research

2.1 How large part does the following tasks cover of your work?
Scale: Main part, Moderate part, Small part, Not a part of my job, I don't know

2.1.1 Primary research (collecting data, analyses etc.)
2.1.2 Writing publications/reports
2.1.3 Reading
2.1.4 Applying funding
2.1.5 Teaching
2.1.6 Administration
2.1.7 Service work (e.g. working as referee, committee work)
2.1.8 Other, please specify?

2.2 Does your work include assignments from external companies?
- Yes, they are important part of my work
- Yes, to some extent
- Yes, but cover only a minor part
- No, they are not a part of my work

- I don't know

2.3 What type of research/expert work do you do?
Scale: Mainly, To some extent, Rarely, Not at all, I don't know

2.3.1 Theoretical research
2.3.2 Empirical research
2.3.3 Development/engineering
2.3.4 Specialist work/consulting
2.3.5 Other, please specify?

2.4 What type of research methods do you use in your work?
Scale: Mainly, To some extent, Rarely, Not at all, I don't know

2.4.1 Quantitative methods
2.4.2 Qualitative methods
2.4.3 Other, please specify?

2.5 Does your research field have commonly shared agreement about choosing and applying research methods?

- There is a clear agreement
- There is a quite clear agreement
- There is some disagreement
- There is no agreement
- I don't know

2.6 What type are the research results from your studies?
Scale: Mainly, To some extent, Rarely, Not at all, I don't know

2.6.1 Discovery/explanation
2.6.2 Understanding/interpretation
2.6.3 New product/technique
2.6.4 Protocol/procedure
2.6.5 Other, please specify?

2.7 Does your research field have a commonly shared agreement about the hierarchy and significance of research problems?

- Yes
- To some extent
- Not so clearly
- Not at all
- I don't know

3. Work practices

3.1 How long does a typical research project you have been working with last?

- Less than one year
- 1-2 years

- 3-4 years
- More than four years
- I don't know

3.2 With how many research projects do you usually work at the same time?
- One
- Two
- Three or four
- Five or more
- I don't know

3.3 Do you work with researchers in other disciplines than your own?
- Yes, on regular basis
- Yes, sometimes
- Rarely
- Not at all
- I don't know

3.4 I am carrying out research:
- Primarily on my own
- In a loose research group
- In a close-knit research group

3.5 If you work in a research group, is your group:
- Project based, temporary research group
- Permanent research group
- Other, please specify?

3.6 Is your research group multidisciplinary?
- Yes
- No
- I don't know

3.7 How important do you consider your research group for your work?
- Absolutely critical. I could not do this work alone
- Quite important. I could do this work alone but less effectively
- Not so important. Working with a research group is mainly a formality
- I don't know
- I don't work in a research group

4. Collaboration

4.1 Do you have research or publishing cooperation with researchers from other organizations than your own?
Scale: On regular basis, Sometimes, Rarely, Not at all, I don't know

4.1.1 Finnish universities
4.1.2 Foreign universities
4.1.3 Finnish research institutes
4.1.4 Foreign research institutes
4.1.5 Other public sector organizations
4.1.6 Private sector organizations
4.1.7 Other, please specify

4.2 From which sources the funding of the research projects you are involved consist?
Scale: Mainly, To some extent, Rarely, Not at all, I don't know

4.2.1 Scholarship from foundation
4.2.2 European union research funding
4.2.3 Research funding from the ministry
4.2.4 Funding from the Academy of Finland
4.2.5 TEKES funding
4.2.6 As a part of your work/no external funding
4.2.7 Private company funding
4.2.8 Other, please specify

4.3 How important do you see the following audiences for your work?
Scale: Very important, Important, Not so important, Not important at all, I don't know

4.3.1 Finnish scientific audience
4.3.2 International scientific audience
4.3.3 Finnish professional audience
4.3.4 International professional audience
4.3.5 Partner companies
4.3.6 Public administration
4.3.7 General public
4.3.8 Other, please specify

5. Reading practices

5.1 To what extent are the following types of publications valued in your field as publication forums?
Scale: Much, To some extent, Little, Not at all, I don't know

5.1.1 National scientific journals
5.1.2 International scientific journals
5.1.3 National conference proceedings
5.1.4 International conference proceedings
5.1.5 Research reports
5.1.6 Scientific monographs
5.1.7 Textbooks or handbooks
5.1.8 Technical manuals
5.1.9 Professional magazines
5.1.10 Newspapers/magazines
5.1.11 Other, please specify

5.2 How regularly do you read for your work:
Reading means going beyond the table of contents, title and abstract to the body of the text and reading at least some part of the text
Scale: Daily, Weekly, A few times a month, Once a month, Less frequently, Not at all, I don't know

5.2.1 National scientific journals
5.2.2 International scientific journals
5.2.3 National conference proceedings
5.2.4 International conference proceedings
5.2.5 Research reports
5.2.6 Scientific monographs
5.2.7 Textbooks or handbooks
5.2.8 Technical manuals
5.2.9 Professional magazines
5.2.10 Newspapers/magazines
5.2.11 Other, please specify

5.3 How old are the publications you use in your work?
Scale: Mainly, Sometimes, Rarely, Not at all, I don't know

5.3.1 1 year or less
5.3.2 2-5 years
5.3.3 6-10 years
5.3.4 Older than 10 years
5.3.5 Older than 20 years

5.4 For what purpose do you read?
Scale: Much, To some extent, Rarely, Not at all, I don't know

5.4.1 Primary research (designing settings etc.)
5.4.2 Writing articles, reports etc.
5.4.3 Writing funding applications
5.4.4 Preparing presentations
5.4.5 Current awareness/keeping up
5.4.6 Administration
5.4.7 Teaching
5.4.8 Consulting
5.4.9 Other, please specify

5.5 Does the literature you cite have influence on publishing possibilities?

- Yes
- To some extent
- Rarely
- No, not at all
- I don't know

5.6 To what extend do you use scientific literature from your own and other scientific fields?

- Mainly from my own scientific discipline

- To some extend from other disciplines
- From various disciplines
- I don't know

6. Publishing practices

6.1 How many authors there are typically in your scientific publications?
- I write alone
- 2-3
- 4-5
- 6-9
- 10 or more
- I don't know

6.2 In your field, how important is rapid publishing of research results?
- Very important
- Important
- Not so important
- Not important at all
- I don't know

6.3 In what language do you write publications?
Scale: Mainly, Sometimes, Rarely, Not at all

6.3.1 Finnish
6.3.2 Swedish
6.3.3 English
6.3.4 Other, please specify

6.4 How often do you participate on the one hand national and international conferences and on the other hand conferences in your own field and other fields?
Scale: More than twice a year, Once or twice a year, Every other year, Less frequently, I don't participate, I don't know

6.4.1 National conferences
6.4.2 International conferences
6.4.3 Conferences in my own field
6.4.4 Conferences in other fields

6.5 Why do you participate on conferences?
Scale: Very important, Important, Not so important, Not important at all, I don't know

6.5.1 To publish
6.5.2 To discuss about your own research
6.5.3 To keep track on the development in my own field
6.5.4 To gain information about the development in other fields
6.5.5 To make new and sustain old contacts
6.5.6 Learn about new applications

6.5.7 Other, please specify

6.6 To what extent do you have to persuade your colleagues of the significance of your problem definitions and approach?

- Very much
- To some extent
- Not so much
- Not at all
- I don't know

7. Publishing activity

7.1 How many publications have you made during **last two years** from following categories?
Scale: 0, 1-2, 3-5, 6-10, more than 10

7.1.1 Scientific monograph
7.1.2 Chapter in edited work
7.1.3 Article in international refereed journal
7.1.4 Article in Finnish refereed journal
7.1.5 Article in international refereed conference proceedings
7.1.6 Article in Finnish refereed conference proceedings
7.1.7 Unrefereed publications (editorial, poster etc.) in scientific forum
7.1.8 Presentation in scientific seminar/workshop

7.2 How many publications have you made during **last two years** from following categories?
Scale: 0, 1-2, 3-5, 6-10, more than 10

7.2.1 Public research report
7.2.2 Unpublished research report (confidential)
7.2.3 Article in professional journal/publication
7.2.4 Patents
7.2.5 Presentation in professional workshop, meeting, exposition etc.

7.3 How many publications have you made during **last two years** from the following categories?
Scale: 0, 1-2, 3-5, 6-10, more than 10

7.3.1 Study book
7.3.2 Other popular book
7.3.3 Article in newspaper or magazine
7.3.4 Presentation in popular event
7.3.5 Contribution to the public discussion (e.g. interview in a media)

7.4 Other publications?

8. Feedback

8.1 Your feedback for the questionnaire?

Appendix 3. Disciplinary groupings used in the study

Disciplinary group	Disciplines	Share (%)
Bio and environmental sciences	Ecology	23
	Forestry	18
	Environmental research	16
	Agronomy	16
	Microbiology	9
	Biochemistry	6
	Food sciences	5
	Plant sciences	4
	Geography/regional studies	3
	Total (N=250)	100
Natural sciences	Earth sciences/meteorology	56
	Physics	21
	Chemistry	14
	Astronomy and astrophysics	5
	Mathematics	4
	Total (N=135)	100

Social sciences	Social research	33
	Economics	25
	Political and administrative sciences	12
	Psychology	9
	Business economics	8
	Law	6
	Pedagogy	4
	Statistics	2
	Communication and information sciences	1
	Total (N=109)	100
Technical sciences	Computer science	19
	Electrical and electronic engineering	16
	Energy and environmental engineering	15
	Construction and building technology	12
	Material science	11
	Mechanical and manufacturing engineering	10
	Industrial engineering	10
	Chemical engineering	4
	Paper and wood science	3
	Total (N=98)	100
Health-care sciences	Public, educational and occupational health	54
	Biomedicine	18
	Veterinary medicine	11
	Nutrition research	8
	Physical education and sport sciences	3
	Nursing sciences	3
	Clinical medicine	3
	Total (N=85)	100

Multidisciplinary biosciences	Bio and environmental sciences and health-care sciences	33
	Bio and environmental sciences and natural sciences	29
	Bio and environmental sciences and technical sciences	11
	Bio and environmental sciences and social sciences	11
	Other[20]	16
	Total (N=48)	100
Humanities	Linguistics	73
	Philosophy	4
	History	4
	Cultural studies	19
	Total (N=22)	100

[20] Combinations of more than two disciplinary groups