OTTO AURANEN

University Research Performance

Influence of funding competition, policy steering
and micro-level factors

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UNIVERSITY OF TAMPERE

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Preface and acknowledgements

There is a strong tradition in both sociology of science and higher education research of studying the social and cultural factors which shape the academic research work. A much studied phenomenon in this tradition is scientific productivity: what are the productivity differentials among scientists and which individual and social factors make scientists productive? The question is relevant not only for researchers themselves who presumably want to work in an environment that makes them more productive, but also for decision makers in science policy who consider the productivity of the science system to be an important objective.

The existing research has largely concluded that collaboration and networks are among the most important factors that promote scientific productivity. This finding was my starting point when I started working on my dissertation in 2006. I intended to analyze the role of research networks as promoters of high research performance in various scientific disciplines and in relation to several other individual and social factors. But as it often happens with research projects, my study took a somewhat different direction.

In the summer of 2009 it was time to acknowledge that I was not conducting a study about networks and research performance. Instead, I had mainly studied the influence of competitive funding on research performance. The original research setting is still partly present in the final dissertation, but the majority of its articles are the results of the several official and unofficial research projects which I participated in from 2005 to 2010.

In retrospect, the final version of my dissertation may contribute more to the understanding of the conditions of scientific productivity than the study I undertook in the first place. Given the popularity of funding incentives as the instruments of science policy, it has been rather surprising for me to find out how scarce are the studies that analyze the effectiveness of these incentives in terms of research performance. I hope my work increases the understanding of this phenomenon, leads to more advanced research in the future and perhaps even affects the formulation of science and higher education policy.

My dissertation has been accomplished with a contribution by several colleagues and friends, and I wish to thank them on the following pages.

First I would like to warmly thank the supervisors of my dissertation, Professor Ilkka Arminen, Principal Scientist Mika Nieminen and Academy Research Fellow Oili-Helena Ylijoki. I'm especially grateful to Ilkka for frequently reminding me about the importance of focusing on manageable research tasks, as everything cannot be studied in one dissertation. I extend special thanks to Mika for making me realize the benefits of compiling the already published articles into a dissertation. Thank you, Oili-Helena, for your skillful and supportive supervision during the later stages of my work.

My dissertation literally would not exist without the intellectual contributions of my co-authors, who were the researchers in those above mentioned official and unofficial research projects. Thank you Inari Aaltojärvi, Ilkka Arminen, Laura Himanen, Reetta Muhonen, Mika Nieminen, Hanna-Mari Puuska and Nina Talola for your ideas, insights and hard work. I also want to acknowledge Riikka Homanen for gathering the data for the fourth article in my dissertation.

For most of my academic career, I have been a member of the academic community called the Centre for Knowledge, Science, Technology and Innovation Studies (TaSTI) at the University of Tampere. This community started as a group, then became a research unit and finally transformed into a research centre. I have enjoyed the seminars, coffee room discussions, corridor chats and social events of TaSTI for about ten years. I thank Research Director Erkki Kaukonen of TaSTI for hiring me as a research assistant to the research project entitled "Dynamics and Innovativeness of Research Communities", which was to become the starting point of my dissertation project. Later Erkki supported my work with his expertise on research funding and science policy. Johanna Hakala, Marita Miettinen and Pia Vuolanto were my closest colleagues during the early days of TaSTI, and I'm grateful for their support and friendship. I am especially indebted to Johanna for her constructive and rigorous comments on a variety of my academic texts, including the earlier versions of this dissertation. I also want to thank all the current and former members of TaSTI, Mika Kautonen, Nina Suvinen, Liisa Marttila, Mika Raunio and Marjaana Rautalin in particular.

The students and supervisors of the Finnish Post-Graduate School in Science and Technology Studies (TITEKO) in 2006-2010 deserve my gratitude for their constructive and critical comments on my ongoing work and for familiarizing me with the various areas of science and technology studies. Special thanks go to the

Abstract

This dissertation explores the influence of science and higher education policy and the micro-level factors of research environment on university research performance. The main objective is to analyze university research in a context where high research performance is regarded as an important goal in science and higher education policies and to ask if this performance-oriented science and higher education policy is beneficial for universities' research performance. To achieve this objective, I first study universities' research funding both at national and university level. I then analyze the policy models which governments have used to steer university sector. Finally, I present an analysis of university research performance at national and university level, and scrutinize the influences of competition for funding and steering models on research performance. These analyses are longitudinal, ranging from the 1980s or the early 1990s to the mid-2000s, and include comparisons of several, mainly European, countries and comparisons of Finnish universities.

The second objective of the dissertation is to study research performance at the micro-level of university systems. This part of the dissertation focuses on the field of sociology at the Nordic universities and asks: what are the patterns of research performance among Nordic sociologists and factors which influence it? The analysis of Nordic sociology is also aimed at testing an alternative data source for the analyses of research performance, namely the Google Scholar web search engine.

My study relates to the discussions about trends in science and higher education policies during the past 20-30 years in several developed Western countries. The nature and effects of these trends has been debated in higher education research and science policy studies. Many studies have shown that improving universities' research performance has become a significant policy goal in the post-industrial societies. The ideology of New Public Management, emphasizing accountability, cost-effectiveness and competition in the public sector, has influenced policy-making so that universities are expected to be accountable for the large (financial) investments on them. Another point of reference for my study is the discussion on the position of universities and scientific research in the so called knowledge-based

economy. Many scholars in innovation studies, science studies and higher education research argue that after the 1980s, knowledge-creating institutions such as universities and science have been of strategic importance for the post-industrial societies. Third, the dissertation stems from the research traditions of sociology of science and bibliometrics, where the patterns of research performance among scientists and factors affecting these patterns have been studied.

The major contribution of my dissertation to existing research is the analysis of connections between performance oriented policy and research performance, at both national and university level. With a few exceptions, previous research has largely concentrated on studying either policy trends and instruments (such as funding) or research performance. Furthermore, it has been customary to focus on a particular level of university system. Another contribution comes from the use of Google Scholar for analyzing publication productivity and citation visibility in sociology. The majority of studies on research performance focus on natural sciences and medicine and use citation databases such as the Web of Science as data sources. Google Scholar provides a more comprehensive perspective on scientific publishing and citation patterns than citation databases. Results of the analysis of the Nordic sociologists' research performance also enable me to reflect upon the relationship between performance-oriented policy solutions and the norms and values of scientific communities.

I employ several conceptual resources in my study. The funding environment of university research is analyzed using an analytical framework that indicates the level of competition in the funding environment. The framework was developed in collaboration with Mika Nieminen. Gornitzka and Maassen's idea of the four state steering models for higher education is applied for studying the governmental steering of universities. The principal-agent theory, which originates from economics, has later been used, for instance, to study the relationships between the state (principal) and universities (agents). I utilize the theory to frame the development of science and higher education policies from the 1980s to the 2000s. I approach the patterns of research performance and scientific publishing among the Nordic sociologists by using the concepts of disciplinary publication practices and cumulative advantage in science.

The comparisons of national level funding systems and research performance include a total of eight countries: Australia, Denmark, Finland, Germany, the Netherlands, Norway, Sweden and the United Kingdom. The state steering models have been analyzed in the cases of five countries: Australia, Finland, the Netherlands, Norway and the United Kingdom. University level analysis on

research funding and performance includes three Finnish universities: the University of Helsinki, the University of Jyväskylä and the University of Kuopio. The data on research funding consists of statistics and documentary material from the OECD and from the national sources. Analysis of the state steering models is based on documents and accounts in research literature. The data for the national and university level studies of research performance is drawn from the Web of Science citation database and from the Finnish higher education database. The analysis of Nordic sociologists is based on the data from the Google Scholar and from the websites of the sociology departments.

I employ multiple indicators on publications, citations and doctoral degrees for analyzing the research performance at national and university level. The framework of funding environments is used for the analyses of research funding. In the case of the state steering models, the analysis is based on interpretation of documents and research literature. A multi-level regression model is used to study Nordic sociologists' research performance in order to isolate the effects of individual and departmental factors on productivity and visibility.

The results of the dissertation indicate that, at the level of national university systems, improvements of research performance are not an automatic and direct result of the competitive funding environment or of a state steering model that relies on market mechanisms. Furthermore, the national level data shows that university systems like those in Sweden, Denmark and the Netherlands can be high-performing and/or improve their performance in conditions of a relatively low level of competition for funding or when the state steering is not based on a market-type steering model. However, short-term improvements in research performance can follow from increasing competition for funding, as happened in Norway and in the United Kingdom. The university-level analysis also points to the relative ineffectiveness of a competitive funding environment in improving research performance, except for the University of Jyväskylä. However, even in Jyväskylä the effect of competition was not very long-term.

The analysis of the patterns of publication productivity and citation visibility among Nordic sociologists shows the persistence of disciplinary cultures. The English-language, international scientific publications understandably attract more citations than the publications in Scandinavian languages, because of the larger audience of the English-language publications. Still, sociologists continue to publish and cite monographs and articles in books. In a similar vein, the differences of research performance among individual researchers persist. The

minority of researchers are much more productive in publishing and are cited disproportionally more often than the majority.

The main conclusion of my dissertation is that policy measures based on competition for funding and market-type steering appear to be relatively ineffective instruments for improving research performance in universities in the long term. A related major conclusion from the findings of the micro-level analysis is that the reward and value system of science is potentially able to check the influence of policy instruments. I conclude the study by presenting potential explanations for the mixed success of performance oriented policy solutions, reflect some of the limitations of my analysis, and suggest themes and directions for further research on research performance.

Tiivistelmä

Väitöskirja käsittelee tiede- ja korkeakoulupolitiikan sekä tutkimusympäristön mikrotason tekijöiden vaikutuksia yliopistotutkimuksen tuloksellisuuteen. Päätavoitteena on analysoida yliopistollista tutkimustoimintaa tilanteessa, jossa tutkimuksen tuloksellisuutta pidetään tärkeänä tiede- ja korkeakoulupolitiikan tavoitteena, ja selvittää, parantavatko tuloksellisuusorientoituneen politiikan välineet yliopistojen tutkimustoiminnan tuloksellisuutta. Voidakseni vastata tähän kysymykseen analysoin ensin yliopistojen tutkimusrahoitusta sekä kansallisella että yliopistojen tasolla. Tämän jälkeen tutkin ohjausmalleja, joita eri maissa on käytetty yliopistosektorin ohjaamiseen. Lopuksi tutkin yliopistotutkimuksen tuloksellisuutta kansallisella ja yliopistotasolla sekä sitä, miten rahoituskilpailu ja valtiolliset ohjausmallit vaikuttavat tutkimustoiminnan tuloksellisuuteen. Analyysit ovat pitkittäisanalyysejä 1980-luvulta tai 1990-luvun alusta 2000-luvun puoliväliin. Niissä vertaillaan useita, pääosin eurooppalaisia maita ja suomalaisia yliopistoja.

Väitöskirjani toinen tavoite on analysoida tutkimuksen tuloksellisuutta yliopistojen mikroympäristössä eli tutkijoiden ja yliopistojen laitosten tasolla. Tässä osassa väitöskirjaa keskityn sosiologian alaan pohjoismaisissa yliopistoissa ja kysyn, miten tutkimustuloksellisuus jakautuu tutkijoiden keskuudessa ja mitkä tekijät vaikuttavat tuloksellisuuteen. Tämän analyysin tavoitteena on myös testata Google Scholar -hakukonetta vaihtoehtoisena aineistolähteenä tutkittaessa tutkimustoiminnan tuloksellisuutta.

Tutkimukseni liittyy korkeakoulu- ja tiedepolitiikan tutkimuksessa käytyihin keskusteluihin yliopistoja ja tiedettä ohjaavista politiikkasuuntauksista viimeisten 20-30 vuoden aikana useissa kehittyneissä länsimaissa. Useissa tutkimuksissa on osoitettu, että yliopistojen tutkimustuloksellisuus on yksi monien jälkiteollisten maiden politiikkaprioriteeteista. Tilivelvollisuutta, tehokkuutta ja kilpailua korostava uuden julkishallinnon (New Public Management) ideologia on vaikuttanut yliopistoja ja tiedettä koskeviin politiikkalinjauksiin. Yliopistoilta edellytetään tilivelvollisuutta niihin tehdyistä merkittävistä (taloudellisesta) investoinneista. Tutkimukseni toinen lähtökohta on keskustelu yliopistojen ja tieteellisen tutkimuksen asemasta niin kutsutussa tietoperustaisessa taloudessa. Monet tutkijat innovaatiotutkimuksen, tieteentutkimuksen ja korkeakoulututkimuksen alueilla ovat

argumentoineet, että 1980-luvulta lähtien yliopistojen ja tieteen kaltaisilla tietoa luovilla instituutioilla on ollut strategisesti tärkeä asema jälkiteollisissa yhteiskunnissa. Kolmas lähtökohta väitöskirjalleni ovat tieteensosiologiset ja bibliometriset tutkimusperinteet, joissa on tutkittu tutkimustuloksellisuuden jakautumista tutkijoiden keskuudessa sekä tekijöitä, jotka vaikuttavat tutkimustuloksellisuuteen.

Väitöskirjani merkittävin kontribuutio nykyiseen tutkimukseen on tuloksellisuutta korostavan politiikan ja tutkimustuloksellisuuden yhteyksien analyysi, joka on toteutettu sekä kansallisella että yliopistojen tasolla. Muutamia poikkeuksia lukuun ottamatta aiemmassa tutkimuksessa on keskitytty analysoimaan joko politiikkasuuntauksia ja -välineitä (esimerkiksi rahoitusta) tai tutkimuksen tuloksellisuutta. Lisäksi aiemmalle tutkimukselle on ollut tyypillistä keskittyä yhteen yliopistojärjestelmän tasoon. Työn toinen tutkimuksellinen kontribuutio on Google Scholar -hakukoneen testaaminen sosiologien julkaisutuottavuuden ja viittausnäkyvyyden analyysissä. Suurimmassa osassa tutkimustuloksellisuuden analyyseistä kohteiksi on otettu luonnontieteiden tai lääketieteiden aloja, ja aineistolähteenä on käytetty Web of Sciencea tai vastaavaa viittaustietokantaa. Google Scholar antaa viittaustietokantoja laajemman kuvan tieteellisestä julkaisemisesta ja viittaamisesta. Pohjoismaisia sosiologeja koskevan analyysin tulokset mahdollistavat myös tuloksellisuutta painottavan politiikan ja tiedeyhteisöjen normien ja arvojen suhteen tarkastelun.

Tutkimuksessani hyödynnetään useita käsitteellisiä resursseja. Yliopistotutkimuksen rahoitusympäristön analyysissä käytetään analyyttistä kehikkoa, joka kuvaa rahoitusympäristön kilpailullisuuden astetta. Kehikko on luotu yhdessä Mika Niemisen kanssa. Valtion politiikkaohjausta tutkittaessani hyödynnän Gornitzkan ja Maassenin ideaa korkeakoulutuksen neljästä ohjausmallista. Taloustieteistä lähtöisin olevaa päämies-agentti-teoriaa on sovellettu muun muassa valtion (päämies) ja yliopistojen (agentit) suhteen analyysiin. Käytän päämies-agentti-teoriaa 1980-2000-lukujen tiede- ja korkeakoulupoliittisten ratkaisujen kehystämiseen. Pohjoismaisten sosiologien tutkimustuloksellisuutta ja julkaisutoimintaa lähestytään tieteenalojen julkaisukäytäntöjen ja tieteen kumulatiivisen edun käsitteiden avulla.

Maatason rahoitusjärjestelmien ja tutkimustuloksellisuuden vertailu käsittää kahdeksan maata: Alankomaat, Australia, Iso-Britannia, Norja, Ruotsi, Saksa, Suomi ja Tanska. Valtion ohjausmalleja on analysoitu viiden maan kohdalla (Alankomaat, Australia, Iso-Britannia, Norja ja Suomi). Yliopistotason analyysit tutkimusrahoituksesta ja -tuloksellisuudesta kattavat kolme suomalaista yliopistoa:

Helsingin, Jyväskylän ja Kuopion yliopistot. Tutkimusrahoitusta koskeva aineisto koostuu tilasto- ja dokumenttimateriaalista, joka on kerätty OECD:n tietokannoista ja kansallisista lähteistä. Valtion ohjausmallien analyysi perustuu dokumenttimateriaaliin ja tutkimuskirjallisuuteen. Kansallisen ja yliopistotason tutkimustuloksellisuuden analyysissä aineistolähteinä ovat Web of Science -viittaustietokanta ja Suomen korkeakoulutietokanta KOTA. Pohjoismaisten sosiologien tuloksellisuusanalyysissä aineisto on kerätty Google Scholarilla ja sosiologian laitosten verkkosivuilta.

Kansallisen ja yliopistotason tuloksellisuutta analysoidaan väitöskirjassani useilla julkaisu-, viittaus- ja tohtorintutkintoindikaattoreilla. Tutkimusrahoitusympäristöjen analyysissä hyödynnetään edellä mainittua analyyttistä kehikkoa. Valtion ohjausmallien analyysi perustuu dokumenttien ja tutkimuskirjallisuuden tulkintaan. Pohjoismaisten sosiologien tuloksellisuuden analyysissä käytetään monitasoista regressiomallia, jonka avulla voidaan tutkia sekä yksilö- että laitostason tekijöiden vaikutusta tutkijoiden julkaisutuottavuuteen ja näkyvyyteen.

Väitöskirjan tulokset osoittavat, että kansallisten yliopistojärjestelmien tasolla kilpailullinen rahoitusympäristö tai markkinamekanismeja painottava valtiollinen ohjausmalli eivät yksiselitteisesti johda yliopistojen tutkimustuloksellisuuden paranemiseen. Kansallisen tason analyysi osoittaa lisäksi, että yliopistojärjestelmien tuloksellisuus voi olla korkealla tasolla ja/tai parantua vaikka rahoitusympäristö ei ole erityisen kilpailullinen tai valtion ohjaus ei perustu markkinamekanismeihin. Ruotsi, Tanska ja Alankomaat ovat esimerkkejä tällaisista maista. Norjan ja Iso-Britannian tapaukset kuitenkin osoittavat, että kasvava rahoituskilpailu voi parantaa tuloksellisuutta lyhyellä aikavälillä. Yliopistotason analyysi viittaa myös siihen, että kilpailullinen rahoitusympäristö on verrattain tehoton keino parantaa tutkimustuloksellisuutta. Poikkeuksena on Jyväskylän yliopisto, mutta myös Jyväskylän yliopiston tapauksessa rahoituskilpailun vaikutus on lyhytaikainen.

Pohjoismaisten sosiologien julkaisutuottavuuden ja viittausnäkyvyyden analyysi osoittaa, että tieteenalojen julkaisukäytännöt ovat varsin pysyviä. Kansainväliset, englanninkieliset julkaisut saavat ymmärrettävästi enemmän viittauksia kuin skandinaavisilla kielillä julkaistut artikkelit ja kirjat, koska englanninkielisillä julkaisuilla on laajempi yleisö. Tästä huolimatta sosiologit edelleen julkaisevat tieteellisiä monografioita ja kirja-artikkeleita ja viittaavat niihin. Yksilöiden tutkimustuloksellisuuseroihin liittyvät säännönmukaisuudet osoittavat samanlaista pysyvyyttä kuin julkaisukäytännöt. Vähemmistö sosiologian tutkijoista on selvästi muita tuottavampi julkaisutoiminnassa, ja heidän julkaisuihinsa viitataan suhteessa merkittävästi enemmän kuin tutkijoiden enemmistön julkaisuihin.

Väitöskirjani pääasiallinen johtopäätös on, että rahoituskilpailuun ja markkinaperustaiseen ohjaukseen perustuvat politiikkatoimet vaikuttavan olevan verrattain tehottomia keinoja parantaa yliopistojen tutkimustuloksellisuutta pitkällä aikavälillä. Edelliseen liittyvä, mikrotason tuloksellisuusanalyysiin perustuva johtopäätös on, että tiedeyhteisöjen arvo- ja palkkiojärjestelmä voi torjua tiede- ja korkeakoulupoliittisten toimien vaikutusta. Tutkimuksen lopussa pohdin selityksiä tuloksellisuutta korostavan politiikan vaihtelevalle menestykselle, käsittelen työssäni esitettyjen analyysien rajoituksia ja ehdotan suuntia tuleville tutkimustuloksellisuutta koskeville analyyseille.

List of original articles

This dissertation is based on the following original articles.

Article I

Auranen, Otto & Nieminen, Mika (2010) University research funding and publication performance—An international comparison. *Research Policy* 39: 6, 822-834.

Article II

Himanen, Laura & Auranen, Otto & Puuska, Hanna-Mari & Nieminen, Mika (2009) Influence of research funding and science policy on university research performance: a comparison of five countries. *Science and Public Policy* 36: 6, 419-430.

Article III

Auranen, Otto & Muhonen, Reetta & Talola, Nina (forthcoming) Connections between competition for funding and research performance in three Finnish universities. Manuscript, submitted to *Minerva. A Review of Science, Learning and Policy.*

Article IV

Aaltojärvi, Inari & Arminen, Ilkka & Auranen, Otto & Pasanen, Hanna-Mari (2008) Scientific Productivity, Web Visibility and Citation Patterns in Sixteen Nordic Sociology Departments. *Acta Sociologica* 51: 1, 5-22.

Articles I, II and IV are published with the permission of the original publishers. Article II is published as a postprint manuscript PDF.

Contents

1   Introduction

Improving universities' research performance has become a significant goal in science and higher education policy over the past 20-30 years in several post-industrial societies. Governments want universities to be accountable for the large amounts of funding that have been allocated to them. Universities are expected to produce more publications and degrees, publish highly-cited research, gain more competitive research funding, and rank higher in international university rankings. At the same time, universities have been facing expectations to benefit society by, for example, modifying the research and teaching to suit economic and societal goals more directly. (Elzinga & Jameson 1995; Nieminen 2005.)

These policy trends stem from two interconnected developments in developed market economies since the 1970s: the rise of knowledge as a production factor, and the international policy currency of New Public Management (NPM) and similar ideologies. In the eyes of politicians and state officials, universities and other knowledge producing institutions have become highly relevant players with regard to the competitiveness of national economies (Etzkowitz & Leydesdorff 1997, 2000; Gibbons et al. 1994; Slaughter & Leslie 1997). New Public Management, in turn, has marked the ideological shift in organizing public administration. It emphasizes accountability, cost-effectiveness and competition, and private sector-type management of public sector activities. (Hood 1991; Ferlie et al. 1996.)

In science and higher education policy, the accountability demands have been manifested as increased use of evaluations, funding allocations based on results and competition, indicators for steering universities, etc. Funding is a much used policy instrument since it is assumed to have a strong impact on the behaviour of universities that are largely dependent on public funding for their research and teaching activities (Slaughter & Leslie 1997; Nieminen 2005, 124-125). These developments and their effects on universities and academic work have been analyzed in many studies, both in the context of single countries and in international comparisons (e.g. Neave 1988, 1998; Bleiklie 1998; Whitley & Gläser 2007; Henkel 1997; Ylijoki 2003).

Irrespective of the growing interest among policy-makers towards making university research more productive, there is a research branch of science studies that is focused on analyzing the productivity and quality of the scientific research, as well as factors affecting them. Classical studies of this tradition include Price (1963), Pelz and Andrews (1966), and Andrews (1979a). This tradition often concentrates on finding factors that affect research performance on the micro level of science (individual and research group level). Bibliometrics, the quantitative study of science, has also contributed to studies on research performance. For example, bibliometricians have analyzed growth of scientific publishing, publication productivity, and distribution and networks of citations. Bibliometric studies range from the individual to the national level of science systems. (van Raan 2005; Moed 2005, 16-17.)

Despite the large amount of literature on performance oriented science and higher education policies of the past 20-30 years, only a few studies address the question of influence of policy solutions on research performance. Much of the existing research concerns the rise and impact of increasing demand for applicability, such as the influence of increased industry funding on the outputs of university research (e.g. van Looy et al. 2004; Gulbrandsen & Smeby 2005; Kyvik 2007; Ylijoki et al. 2011, 2012). Secondly, the analyses of research performance at national or institutional level typically ignore the policy environment. There are studies that address the effects of policy and funding on the social and organizational context of research activity that is a precondition of good research performance, but the research performance itself is not often viewed in its policy context (for exceptions, see Butler 2003, 2005; Sivertsen 2008; Tammi 2009; Vanecek 2014). Relatively little is known about the success of performance-oriented policies: does an increase in performance monitoring, competitive funding and use of evaluations actually enhance the research performance of the universities?

In addition, studies on research performance tend to concentrate on the natural sciences and medicine, and use international, commercial publication and citation databases such as the ISI Web of Science (WoS) and SCOPUS as data sources. The weaknesses of these databases are well known, such as poor coverage of research publications on technology, social sciences and humanities, and bias for English language journal articles, but few other data sources have been available, especially for international comparisons and citation analyses.

The main goal of this dissertation is to view university research performance in its policy context, mainly from the perspective of research funding systems. The

analysis of research funding, governmental policy steering and research performance operates on two levels, presenting comparisons of national university systems and comparisons of individual universities. The analysis is longitudinal, ranging from the 1980s or the early 1990s to the mid-2000s. National and university level analysis is supplemented by a study of research performance at the micro-level of the university system: individual researchers and university departments. This contributes to the tradition of research on micro-level performance analyses by taking sociology as a case example of the less studied fields of science and testing the Google Scholar (GS) search engine as an alternative data source for citation databases. The micro-level study is also set to analyze whether the law-like regularities of research performance (e.g. Lotka 1926; Price 1963) apply when using wider data sets than WoS or SCOPUS can offer. Based on the empirical results of the dissertation, I will also to discuss how the national and organizational policies and financial incentives are connected to the logic of research work and academic communities. Do policy choices, especially funding instruments, converge with the logic and rationalities of the grass-roots level of academic communities, and what are the chances of a policy changing the cultural logic of academia?

The empirical work in the dissertation consists of four journal articles. Article I: *University research funding and publication performance—An international comparison* analyses the development of university research funding and publication performance (number of publications compared with research expenditure) from the early 1980s to the mid-2000s in eight countries: Australia, Denmark, Finland, Germany, the Netherlands, Norway, Sweden and the United Kingdom. The main questions of the article are: has the funding environment of university research become more competitive in these countries, and have the countries with more competitive funding environments been more efficient in producing scientific publications?

Article II: *Influence of research funding and science policy on university research performance: a comparison of five countries* takes a similar approach to Article I, but besides the analysis of research funding, it also includes an analysis of state steering models towards universities and their influence on the research performance of university systems. Numbers of publications and citations are included as indicators of research performance. Five countries (Australia, Finland, the Netherlands, Norway and the UK) are compared.

Article III: *Connections between competition for funding and research performance in three Finnish universities* shifts the question about the relationship between competitive research funding and research performance to the level of universities. The

development of research funding and research performance from the early 1990s to the mid-2000s is analyzed in three Finnish universities (University of Helsinki, University of Jyväskylä and University of Kuopio). The analysis of research performance includes publications, doctoral degrees and citations, and the academic elements of research funding are included: government basic funding, research council funding and funding for doctoral schools.

Article IV: *Scientific Productivity, Web Visibility and Citation Patterns in Sixteen Nordic Sociology Departments* is an analysis of the research performance of academic staff in departments of sociology of the universities in the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden). Distributions of publication productivity, citation impact and Internet visibility among these sociologists are analyzed, as well as individual and departmental-level factors that explain the variation in research performance.

This introductory essay is organized as follows. Following the introduction (Section 1), Section 2 reviews previous research that is relevant for my conceptual approach and research questions. It introduces research on macro-level trends in science and higher education policies, highlighting the changing relationship between state and science and universities in developed countries since World War II and particularly since the early 1980s. Since Article III concerns Finnish universities, the Finnish policy phases are introduced separately. The literature review also includes studies and concepts that describe the changes in the market economy during the past couple of decades, the growing relevance of (university) research for post-industrial societies, and the high expectations towards the universities. Next, Section 2 presents analyses of the research funding, and, finally, existing literature on research performance at different levels of the science system.

The research questions of the dissertation are formulated in Section 3. Section 3 also describes the conceptual background for the dissertation: framework for the analysis of the competitive intensity of research funding, state steering models for the higher education system, principal-agent theory, and disciplinary publication practices and cumulative advantage in science. Section 4 presents the data and methods of the four articles, and discusses the methodological choices in relation to previous research. Section 5 includes the main empirical results and seeks connections among them. Section 6 reflects on the results and discusses their academic and policy relevance. Particular attention is paid to connecting the findings from the macro- and meso-level analyses (Articles I-III) to the results of the micro-level analysis (Article IV).

2 Review of existing research

2.1 Phases of science and higher education policy

In addition to factors that are internal to universities and scientific research, such as academic cultures and traditions and evolution of research fields, the research conducted in universities is shaped by external factors. Since the Second World War, major external forces influencing university research have been governmental policies, especially in the developed countries. While science policy also covers research institutions other than universities, the universities are major players in publicly funded research. In post-war science policies, high financial investments have been coupled with high expectations from governments towards universities and other research institutions. These expectations have manifested themselves as varying goals and instruments in science policy (Salomon 1977; Elzinga & Jameson 1995; Ruivo 1994). Because of their teaching function, universities are typically steered also by another policy area, that of higher education policy. In this review of the post-war policy phases, both science and higher education policy are taken into account to the extent that they are relevant for the research function of universities.

Students of science policy have timed the birth of systematic science policy of the developed countries to the years of the Second World War and the years immediately after it. State-funded scientific research was extensively and successfully used for military purposes during the war. The success of scientific research as a source of inventions and applications made many governments in Europe and North America understand the potential of scientific research for civil purposes as well. As the significance of science for societal and economic development, and the large investments in science became accepted among government officials and politicians, the need to govern science was also understood. (Salomon 1977).

Governmental intervention in the goal-setting, coordination and financing of science had a model in the Soviet Union, and several influential Western scientists supported the idea of a systematic governmental science policy in the 1920s and the 1930s (Elzinga & Jameson 1995). Similarly, right after WWII, many politicians

in the US emphasized the necessity for democratic, public steering and goal-setting of science. On the other hand, many scientists, such as Vannevar Bush with his influential report (1945), welcomed government intervention in the form of growing public resources but wanted to retain the autonomy of the scientific community in deciding the goals and norms of scientific activity, e.g. through a process of scientific peer review. Both sides of the debate disliked the idea of scientific research being under the control of a totalitarian government, but they both argued that their method for organizing the goal-setting and steering of science would make the scientific research most beneficial for the democratic society. (Kevles 1977; Elzinga & Jameson 1995.) The model advocated by Bush was to become the dominant way of organizing science policy-making in many Western countries immediately after WWII (Salomon 1977; Elzinga & Jameson 1995).

In the post-WWII era, national science and higher education policies have converged due to several reasons, most important of which are perhaps the connections and communication between the governmental officials of different countries. International collaboration and coordination of policy making have also followed from the growing costs of research and requirements for large-scale research facilities, the importance of science-based inventions for societies with similar social and economic structures, and the globalization of science. (Elzinga and Jameson 1995; Ruivo 1994.) International organizations such as the Organisation for Economic Co-operation and Development (OECD) and the European Union (EU) have been the sources and platforms of policy convergence. They have produced information, created policy recommendations or binding guidelines and offered possibilities for discussion among the policy-makers. The OECD, which was established in 1961, has provided its member states with models for science policy making, as well as framed and synchronised the policy making in the member states by a regular production of reviews, studies and indicators on science and (higher) education. The OECD has also been able to introduce new concepts and catchwords into the national policy discourses. (Henriques & Larédo 2013; Kallo 2009, 362-368; Rautalin 2013, 53-55.) In Europe, the EU has had an increasingly important role in integrating policies among its Member States. The EU has attempted to harmonise the national policy-making in science and higher education, for instance, by setting EU-wide targets for R&D investments in the Lisbon Strategy and in the Europe 2020 Strategy. The EU has also established institutions like the European Research Council and the European

Science Foundation for the allocation of research funding and collaboration among the policy-makers. (Young 2012.)

Ruivo (1994) argues that there are systematic and shared views among key science policy-makers of different countries. She calls these views "paradigms of science policies". The paradigms have been manifested as similar historical policy phases after the World War II. While the timing of phases somewhat differs, both Salomon (1977) and Elzinga and Jameson (1995) divide post-war science policy from the 1940s to the late 1970s into three phases. Elzinga and Jameson's account extends to the 1980s, including four phases in total. The development of Finnish higher education and science policy has very much followed the international phases, while including some national characteristics (Kivinen et al. 1993; Nieminen 2005).

Despite international convergence, there are of course national variation in formulating the science and higher education policies, variation which is due to more general differences in national politics and governance: modes of organizing public administration, balances of power among societal actors, political situations and possibilities, and institutional arrangements of knowledge production (Elzinga & Jameson 1995; Kauko 2013). In fact, much of the empirical work of this dissertation is concentrated on analysing the national variation in governmental steering of university research since the 1980s, especially in terms of funding.

To give a historical background to the trends in science and higher policy since the 1980s, I describe below the phases of the post-WWII science and higher education policies using the accounts by Salomon (1977), Elzinga and Jameson (1995), Kivinen et al. (1993) and Nieminen (2005). When reading this account, one must bear in mind that while there are dominant policy trends, all of these phases have also included much societal debate and conflicts over the course of policy in different countries (see e.g. Välimaa 2005 on Finnish higher education policy).

Early era of science policy (from the mid-1940s to the late 1950s): Institutions were set up to prepare policy guidelines and steer research, to allocate resources, and to produce information about the science system. Many countries set up discipline-based research councils to allocate research funding. They were small in comparison with later times, but many mission-oriented research organizations also conducted basic research at that time. Funding for research was generously increased compared with earlier decades, and both governments and the scientific community saw investments in research through the science-push model; (basic) scientific research was expected to eventually cause positive societal effects. In line with this, the control of funding and governance of science was very

much left to the scientists, although administrative and managerial staff were recruited in research organizations.

Although the value of scientific research for the development of society began to be understood in Finland immediately after the war, the government was unable to make large public investments in science. During the 1950s, the rapid increase in secondary school graduates and the eagerness of various regions of the country to establish higher education institutions were forcing the state to expand the university system outside the old university cities of Helsinki and Turku. The first research councils and a few new higher education institutions were established, and at the end of the 1950s a government committee made plans for modernizing the Finnish science system, the relationship between the state and the science system, and research funding.

Science as a strategic and economic factor (from the late 1950s to the late 1960s): The first part of the period was influenced by military competition between the two super-powers, the United States and the Soviet Union. Huge investments in military research and development were made, especially in the United States. During the latter part of the period governments were more devoted to creating economic well-being through science. Investments in science grew rapidly. The rising costs of research caused the need for countries to collaborate internationally, which also meant policy collaboration - for example, via the newly established OECD. The OECD made recommendations for its Member States in resourcing R&D systems, and the OECD statistics became a tool with which to follow the progress. A division between basic and applied research and their different funding streams (research councils and other funding agencies) began to take shape. During this time, government officials became increasingly sceptical of the science-push model and the continuously increasing, unbound research funding. In Finland, the previous policy phase continued until the 1960s to some extent, but the expansion of the university system was getting underway in the latter part of the 1960s.

Science as a source of solutions to (social) problems (from the late 1960s to the end of the 1970s): Right-wing policy-makers in many countries criticized large investments in natural sciences and technology, which they saw as too costly, and left-wing policy-makers and civic movements brought social and environmental problems (partially caused by science) to the agenda. Attention was drawn more into solving social problems and increasing the overall usefulness of science, which raised the status of applied research in policy-making. With new research programmes oriented towards providing solutions to societal questions, the control of research was partially taken away from researchers and given to

policy-makers and citizens through participatory bodies. However, targeting social problems was more difficult than conducting the previous, clearly-defined scientific and technological development projects, and the usefulness of research in solving social questions was more difficult to prove and legitimate. Increased external control of the research was followed by criticism of the scientific quality of the type of research, which was aimed at solving social problems. At the end of the 1970s, several Western governments were facing fiscal problems and challenges from rapidly developing Asian countries. Socially useful research didn't appear worth the investment any more.

Finnish policy-making from the 1960s to the end of the 1970s was marked by an expansion of university system, statutory development and societal relevance. During the 1960s, the government laid plans to expand university research and education because their activities were seen as vital for society and the economy. Four new universities were established in the 1960s and two in the 1970s. Another strong motive for the establishment of universities was the social and economic development of the regions where the new universities were being established. The state planned to increase research funding considerably, but failed to meet the targets, especially with regard to universities' resources. The planning and steering of the university policy was centred on the Ministry of Education. All universities were taken under state ownership at the turn of 1970s and 1980s at the latest. A new Academy of Finland, comprising six research councils under the regulative power of the Ministry of Education was established (see also Eskola 2003). The 1970s were a time of emphasizing the societal relevance of research. Government coordination on research priorities was increased and specific priority areas were selected. Programmes for socially relevant research proved difficult to conduct and legitimize, largely due to the political atmosphere of Finland in the 1970s.

Science as a source of technological inventions and economic success (from the 1980s to the 1990s (and beyond)): Many Western countries attempted to respond to what they saw as a challenge from the Asian, especially Japanese, economies. Creating technological inventions from research and bringing them onto the market became an important policy goal. Governments created national programmes in different fields of natural and medical sciences and technology to enhance collaboration between industry and research organizations. Another policy instrument was technology forecasting, in which actors from the public and private sectors constructed possible technological development trajectories and ways to accomplish them. Researchers called for a lessening of the bureaucratic control of science, which was a legacy of the 1970s policy. Despite the bureaucratic control,

the scientific community had enjoyed relatively large autonomy until the end of the 1970s, operating at arm's length from other institutions of society. In the 1980s, university research was brought to closer interaction with firms and the state, which led to new organizational forms between science and business. To safeguard the public expenditure on research, governments were interested in more selective resource allocations, "picking the winners" that could deliver something usable for the resources they were getting (see also Martin 2003). This was the period of the new social contract for science. In the 1990s, global economic competition made science and higher education ever more important priorities in developing the competitiveness of national economies. The science policies of the developed countries reflect the situation of their economies in a multi-polar world with several competing regions (Europe, North America, Asia, and South America).

In the case of Finland, the development of information technology (IT) in the 1980s raised fears about IT having negative influence on the Finnish job market. However, the governmental working group of the time concluded that technology is a possibility rather than a threat. As a result, the technology policy was strengthened, while the role of basic research (conducted in universities) was also a high priority. Various fields of science and technology were identified as key areas where benefits for the economy and society were expected, mainly in the form of new technologies. Another strong policy trend was the increase in research evaluations and general accountability demands from the state. The government wanted to give universities more legal and financial autonomy, but the proper use of the growing public funding had to be ensured somehow. Funding and steering universities based on their performance provided solutions to this question. Internationalization of research and researchers was the third Finnish policy priority of the 1980s. Finland joined the European R&D funding and coordination organization (EUREKA) and European research programmes, which gave researchers better access to international collaboration networks.

In the 1990s, the Finnish government was still aiming at using technological and natural scientific research to enhance the country's economic competitiveness, increasing R&D investments, developing researcher training and encouraging firms to engage in R&D activity. The National Innovation System (NIS) was introduced as a new overall policy concept. The government's view was that Finland was a knowledge-based, post-industrial society whose success and welfare depended on the production and (economic) utilization of high-standard knowledge. Universities, public research institutes and firms were seen as important actors in the NIS. The government wanted university research to be of higher quality, more

efficiently produced and closer to firms' product development and innovative activity.

The post-war phases of the science and higher education policy in the developed countries are a combination of change and continuity (Nieminen 2005, 54-56). For example, the idea that scientific research needs to be socially and economically usable is something that has been a policy target since the early days of the science policy in the 1950s. Similarly, the need for governments to somehow ensure the proper use of large scientific resources is not new (Elzinga & Jameson 1995). However, certain developments in capitalist production and social and political changes in many Western countries in the late 1970s brought about particular forms of policy targets and instruments towards universities and the institution of science in general.

2.2   Universities in global knowledge-intensive economies

During the 1970s, the so-called Keynesian Welfare National State (KWNS) as a predominant way of organizing and controlling market economy societies located mainly in Western Europe and North America drifted into crisis. According to Jessop (2002, 80-84), this was due to changes in the way in which the capitalist economy was organized, as well as political and social shifts in the KWNS countries. In the late phase of Fordist production, accumulation of profits and increase in productivity became more difficult than before. The paradigm of production shifted from economies of scale and mass production to emphasize economies of scope, innovation and flexible production, oriented more according to changing demand from the markets than according to standard supply. Larger multinational companies were able to move production and capital internationally to seek cheaper labour and lower taxes. In this new phase of capitalism, KWNS was no longer seen as the best political and social solution for securing the accumulation of capital and social welfare.

As the capitalist economy of the KWNS countries began to transform from the earlier Fordist model towards a post-Fordist mode of economies of scope and the use of innovations in production, universities and other knowledge producing organizations became more important to firms and national economies in general. The reason for the pronounced role of the universities was their position as both producers of scientific knowledge and as providers of educated, highly skilled people. Together with the societal and political changes in KWNS countries, the

changed role of the universities furthered the change in the social contract for universities and the entire science system from the 1980s, a change that was also visible in science and higher education policies (Martin 2003).

The position of universities and scientific research in knowledge-based economies and societies is described in many accounts, of which the best known are the concepts of Triple Helix (Etzkowitz & Leydesdorff 1997, 2000; Leydesdorff & Etzkowitz 1997), Mode 2 (Gibbons et al. 1994), and academic capitalism (Slaughter & Leslie 1997). The developers of the Triple Helix and Mode 2 concepts concentrate on the transition of academic/scientific values, practices and institutions from the mode emphasizing scientific research defined by the goals of scientific communities to the application-oriented mode defined in wider societal and economic contexts. The academic capitalism concept by Slaughter and Leslie was developed for the same purpose, but it is also relevant for understanding the science and higher education policy that promotes performance and competition.

The Triple Helix thesis argues that organizational boundaries between universities, industry and government are in a state of flux compared with the previous social contracts between the universities and other societal actors. The argument takes as its starting points the institutional differentiation between the public and private sectors, and the functional differentiation of the markets and science in the late 19th century. Industry, the state and the universities have kept an arm's length distance from each other. The breakdown of this differentiation started in the 1970s as a result of the increasing pace of technological development, tighter global competition in industry, and many firms' growing dependence on R&D-based innovations. As the older science-push and market-pull innovation models have proved obsolete, firms have sought continuous interaction and collaboration with external sources of knowledge and innovation (e.g. universities) instead of supporting in-house R&D departments. Governments have an interest in facilitating the collaboration between firms and science because it's seen as a critical element of the knowledge-based economy that benefits societies. The facilitation happens through policy initiatives and organizational mixing of academia and industry. As a consequence, new hybrid organizations are being born, and knowledge is produced and transferred in networks between university, industry and government. (Etzkowitz & Leydesdorff 1997, 2000; Leydesdorff & Etzkowitz 1997.) Leydesdorff and Etzkowitz (1997) argue for the enhanced role of universities in Triple Helix because the academic institution is no

longer just a site of research and education but also has increased economic relevance.

Gibbons et al. (1994) describe the ways in which the values, norms, practices, and structures of scientific knowledge production are changing from the mode they call Mode 1 to Mode 2, dating the shift to have begun in the 1980s. These two modes have come to co-exist (Gibbons et al. 1994, 14). Mode 1 was dominant during the era after the Second World War. Typical features of Mode 1 include knowledge production in the scientific context, mono-disciplinarity or sometimes multi-disciplinarity, demand for accountability to peers (other researchers), and evaluation of quality within the (academic) scientific community. The organizational forms in Mode 1 are stable, homogenous and hierarchical. Mode 2, in contrast, is characterized by knowledge production in the context of application or applicability, trans-disciplinarity (going over disciplinary borders to create new approaches and concepts), a demand for broader societal accountability, and socially determined criteria of quality. The organizations are heterogeneous, non-hierarchical and dynamic. (Gibbons et al. 1994, 3-8.)

In line with the accounts by Etzkowitz and Leydesdorff, as well as Jessop, Gibbons and his colleagues suggest that the sources for the Mode 2 knowledge production are in the increasing global economic competition and the changes in the market economy since the 1970s. Many developing countries and their businesses have been able to challenge the developed countries' economies in mass production (economies of scale). This has led firms - especially in the developed countries - to rely on rapidly changing and flexible production (economies of scope) that is based on (technological) innovations and knowledge in order to gain advantage in the competition. The earlier model of firms' in-house R&D work and product development has proven insufficient, too costly and outdated. Firms have sought access to different kinds of knowledge, but they can't produce all the knowledge themselves. Thus they have sought collaboration with, e.g., universities to get new knowledge sources for innovations. From the perspective of knowledge producing organizations, firms' funding for research has been a new resource in the face of rising costs in research. Governments have also been encouraging university-industry collaboration and have been funding application-oriented research. This is the governments' reaction to the post-Fordist situation, where they must safeguard the wealth creation for society by new means. Increasing collaboration with firms and changed demands for knowledge production change the mode of scientific research. However, Gibbons and others argue that knowledge produced under Mode 1 conditions is also in demand. (Gibbons et al.

1994, 46-61, 111-125.) Like the Triple Helix thesis, the Mode 2 argument points to the increased significance of research organizations (e.g. universities) for economy and, eventually, for society.

Slaughter and Leslie's (1997) concept of academic capitalism is also rooted in the global economic changes since the 1970s and their implications for national higher education systems' operating environments. They refer to several descriptions of the global economic changes during the 1970s and the 1980s and note that these descriptions argue for the increased significance of knowledge (for example, as a basis for innovations), information and communication technology, and highly skilled labour in business and production. While this development is by no means pervasive, firms have become more dependent on (scientific) knowledge and a more highly educated workforce. Thus Slaughter and Leslie suggest that the universities have become more important, not only as knowledge producers but also as providers of educated people. (Slaughter & Leslie 1997, 25-31, 36-40.)

In addition to analyzing changes in global capitalism and the role of universities in the new economy, Slaughter and Leslie refer to the same changes in the funding of science that have been noted by science policy analysts (e.g. Salomon 1977; Elzinga & Jameson 1995; Ziman 1994; Martin 2003). During the 1960s and the 1970s, the welfare state was expanded to include more and diverse social groups, functions and services. Eventually, many KWNS countries' tax income began to weaken due to companies avoiding taxes by moving internationally, and because of growth in unemployment and retirement. In the late 1970s this resulted in a fiscal crisis in many KWNS countries and a need to re-organize the public sector and its services (see also Jessop 2002, 84-90). At the same time, the post-Fordist phase of capitalism required selective public investments in research and development to advance nations' economic competitiveness. The attention to financing science shifted more towards the fields of science that were expected to deliver for the creation of (technological) innovations. Governments also wanted to monitor the use of funding to ensure the productivity and efficiency of the universities. This meant reducing the share of the block grant type of higher education funding and increasing project funding, increasingly directed to applied research. (Slaughter & Leslie 1997, 31-40, 54-63, 66-72.)

Following Pfeffer and Salancik (1978), Slaughter and Leslie see universities as resource-dependent organizations, meaning that universities can be at least partially controlled by external actors who allocate resources to universities. Thus the universities' activities are a balance between autonomy and resource providers' expectations and demands. The larger the share of resources that come from a

single resource provider, the larger is the influence of that provider on the activity of a university. Also, if a resource provider can provide a university with critical resources, it has a strong influence on the activity of that university. Block grant funding from governments has been very important for universities in the post-war era because of its share and criticality for the universities' basic operations: teaching and research. With the reduction in block grants, the universities have sought public and private alternatives. Based on resource dependence theory, Slaughter and Leslie argue that since these alternative funding sources often include conditions for getting and using the money (such as funding applications and various ways of commercializing), university employees have turned towards academic capitalism, which includes market and market-like behaviour. Market behaviours are actions that are taken to gain profit from academic work, such as patenting or establishing spin-off companies. Market-like behaviour refers to competition for funding, whether public or private. (Slaughter & Leslie 1997, 11, 64-76.)

For my study, the consequences of market-like behaviour and the funding conditions that induce market-like behaviour are of interest: have the changes in the goals of science and higher education policies since the early 1980s caused behavioural changes that have led to more efficient and better quality research activity? Slaughter and Leslie's own empirical results (1997, 121-134) from Australia, Canada, the United Kingdom and the United States in the 1980s and the early 1990s indicate that academic capitalism was usually seen to increase the academic prestige of successful academics, units and universities, but increased project funding was considered to burden the support infrastructure of universities and create extra costs, thereby possibly reducing efficiency.

2.3 Performance orientation in science and higher education policies

The economic, fiscal and political crises of KWNS were factors that also influenced the rise of a new mode of organizing public sector activities in many developed Western countries at the turn of the 1970s and the 1980s (Jessop 2002, 80-90; Hood 1991). This mode has often been called New Public Management (NPM). Some scholars have also used the term New Managerialism or new governance to refer to similar phenomena (a shift from administration to

management, or from old government to new governance) (e.g. Flynn 1999; Rhodes 1996; Fredrickson 2005).

According to Hood (1991), New Public Management has seven doctrines: 1) named management professionals that are free to actively and visibly lead public sector organizations (instead of promoting regular civil servants to leading positions), 2) explicitly defined goals and (usually quantifiable) measures and indicators of performance, 3) resource allocation based on measured performance, 4) organizing larger organizational units into smaller ones which have separate budgets and which offer clearly defined, product-type public services, 5) more competition amongst public sector organizations, fixed-term contracts and public tendering, 6) more private sector style of management, more flexibility in hiring and rewarding employees, use of PR techniques, and 7) aim for more efficient resource use, cutting direct costs and greater labour discipline.

Ferlie et al. (1996) present four models of New Public Management. The first model stressed the efficiency of the public sector and orientation to users of the public sector services. NPM Model 2 was characterized by decentralization and downsizing of public sector activities and organizations. Also, management styles moved away from management by hierarchy towards management by contracts and influence. NPM Model 3 was oriented towards a search for excellence and innovative ways of operating via changes in the organizational cultures of the public sector. Finally, NPM Model 4 was about public service orientation, which meant responsiveness and accountability to users of services, participation of users in service provision, and stress on the quality of activities. (Ferlie et al. 1996, 10-20.) Early in the 1980s, NPM gained more support in some of the Anglo-American countries and Sweden than in other developed countries, but since then at least some of the principles of NPM have been adopted elsewhere too (Hood 1995; Pollitt 1999; Pollitt & Bouckaert 2000, 62-96; Proeller & Schedler 2005).

Science and higher education policies have not been immune to the rise in policy demands for high performance, efficient resource use, professional management and user value. In the following I concentrate on reviewing the research literature on NPM style, performance-oriented science and higher education policies since the 1980s from the perspective of the national level steering of universities and (research) funding. I pay less attention to other features of this policy trend, e.g. increasing professionalism in managing research and universities, or the demands for economic and societal usefulness of research results.

Analyses of the New Public Management principles in science and higher education policy often relate to the governance of universities and/or university research rather than to the entire science system, but see, however, Cartner and Bollinger's (1997) account of New Zealand's science policy reforms in the 1980s and the 1990s, and Braun's (2003) theoretical description of the modes of science policy. The policy goals and instruments that, for some authors, go under the rubric of NPM (e.g. Bleiklie 1998; Ferlie et al. 2008, 2009; Schimank 2005; Schmoch & Schubert 2010) are described by others as signs of new managerialism (e.g. Deem & Brehony 2005; Neumann & Guthrie 2002), of the rise of the Evaluative State (Neave 1988, 1998), or of changes in governance (e.g. Whitley 2007, 2011; de Boer et al. 2007). These analyses often refer to similar policy features, and some authors use these concepts interchangeably to refer to the same phenomena (see e.g. Paradeise et al. 2009b). In addition to macro-level policy analyses, there are analyses of the grass-roots influence of NPM or similar trends on academics, and analyses of the responses of academic communities and universities towards these policies (e.g. Chandler et al. 2002; Henkel 1997; Schimank 2005; Thomas & Davies 2002).

Ferlie et al. (2009) list eight signs and symptoms of the application of New Public Management ideas in higher education policy, five of which are related to funding principles and/or state-university relationship. These five signs include using market mechanisms (for example for the allocation of funding among higher education institutions), tight budget control and demand for efficient resource use, stress on performance measured by evaluations and indicators, concentration of funding to "winners", and state steering by target setting and performance contracts. Ferlie et al. see the United Kingdom as a prime example of the NPM style of public administration and as an importer of NPM principles that have also covered the higher education policy of the UK.

According to Bleiklie (1998), the NPM principles in higher education policy are visible as the organizational ideal of corporate enterprise. The key issue is the efficiency in achieving the targets, which, in the case of universities, are typically scientific publications and degrees. Increasing use of performance indicators is the consequence of the efficiency demand, since the achievement of targets needs to be monitored. Performance indicators are part of the larger phenomenon of evaluation as the core activity of the NPM-influenced higher education policy. Governments have been abandoning the governance by pre-decided rules and regulations (ex ante regulation) and have been moving towards the ex post evaluation of activity. With regard to the Norwegian higher education policy,

Bleiklie sees signs of NPM or New Managerialism in the late 1980s in the way the government set explicit targets for universities.

Cartner and Bollinger (1997) refer to similar policy solutions as Ferlie, Musselin and Andresani (2009) and Bleiklie (1998) when describing the reforms of the New Zealand science policy since the mid-1980s. Among other things, public research funding was increasingly allocated as project funding based on applications and less as institutional block grants. The use of research funding was also monitored more closely than before. In general, the government exercised tighter control of public expenditure on research although investment in R&D was also seen as a key element in the economic growth of the country. Research evaluation was developed towards the assessment of pre-defined research targets and priorities.

Deem and Brehony (2005) and Neumann and Guthrie (2002) use the term new managerialism to describe the recent UK and Australian higher education policies. Despite the different analytical focus and intellectual roots of the NPM and new managerialism concepts, they largely refer to the same phenomena. Neave (1988) talks about the rise of the Evaluative State, which largely means the same phenomenon that Bleiklie (1998) refers to: substituting pre-defined regulations (process control) with subsequent evaluation of activity (product control). Product control includes basing resource allocations on output (products). Neave sees the signs of the Evaluative State in several countries' higher education policies since the late 1980s, though the technical implementation of the main principle has varied from country to country. The Evaluative State also means creating a state-university relationship where universities are no longer in the service of the state but where universities provide services that are funded and supported by the state – among other actors. Steering of universities has become a business for various public agencies that influence universities by conducting evaluations and the choice of the evaluation criteria. (Neave 1998.)

Whitley (2011) suggests that the changing governance of science in several countries over recent decades has three main features: increasing state steering and evaluation, competitive funding allocation and performance monitoring, and enhanced management in universities and public research institutes. For Whitley (2007), the important components of the governance of science systems during recent decades have been the research evaluation systems (RES), and especially the strong RES where the formal criteria and indicators are established and the results are connected to the funding allocations and quality rankings of the research organizations, departments, etc.

Comparative international studies on the post-1970s science and higher education policies indicate that the emphasis on performance, accountability, competition, goal setting and strong management affect many, if not all, science and higher education systems of the developed countries. Yet there is considerable variation in the extent and pace to which these policy goals and instruments have been implemented in different countries. (Paradeise et al. 2009b; Whitley & Gläser 2007; Neave & van Vught 1991; Locke et al. 2011.) For example, Paradeise et al. (2009a) conclude that among the West European countries, the UK has been an early adopter of many performance-oriented policy solutions, followed by the Netherlands with regard to certain policy issues, whereas Germany, France, Italy, and the Nordic countries have been more cautious and adopted NPM-type policies much later.

2.4   Analyzing research funding of universities

Research funding is a strong steering instrument with regard to universities because universities are dependent on resources coming from sources external to them. Most universities in the developed countries have received most of their funding in the post-war decades from different governmental sources (Slaughter & Leslie 1997, 68-71; Nieminen 2005, 124-125). A typical structure of public research funding to universities since the 1960s has been the so-called dual support of basic funding or block grants via the ministry responsible for higher education and science on the one hand, and the project funding from other governmental agencies, such as research councils, on the other hand. International funding sources such as the EU research funding in Europe have become more important over recent decades. In addition, the universities have usually received some private funding for research. The total funding income of the universities in many countries has also included tuition fees, donations and the income from selling products and services. (see e.g. Irvine et al. 1990; Lepori et al. 2007.)

The preparation of statistics on R&D expenditure in the OECD countries has followed the funding landscape described above. Since 1964, the Frascati Manual of the OECD (OECD 2002) has given the OECD Member States guidelines on collecting and reporting the statistical and survey data on different elements of the national research systems, among which is the expenditure on research and development. Regarding the universities' R&D expenditure, the manual differentiates between 1) the general university funds from national government to

universities "in support of overall research/teaching activities", 2) the contract and earmarked funding from public and private, national and international sources, and 3) income from e.g. donations, sales of products and services, and other property (OECD 2002, 116-117). Similar divisions are often used when studying funding of university research and/or teaching at the national or institutional level (Geuna 1999, 21-22; Lepori et. al. 2007). Some studies on university research funding concentrate on making divisions among public funding sources, typically between the general university funds and funding from research funding agencies (Irvine et al. 1990, 6; Jongbloed & Vossensteyn 2001; Lepori 2006). A somewhat more distinctive division is to use three categories of research funding: general university funds from the government, funding from public research funding agencies, and other project and contract funding from public and private sources (Hackmann & Klemperer 2000, 4-5; Jongbloed 2007).

When studying the funding environment for university research, funding sources can be combined for analytical clarity. Project or contract funding from different sources may be put together as external funding in contrast to general university funds, which mainly consist of an annually recurrent funding block to universities called basic funding, block grants, budget funding, etc., and of universities' own funds. Besides their own funds, governmental basic funding can be considered internal for universities because of its recurrent nature and because universities in many countries are allowed to determine the allocation and use of basic funding within their organizations (OECD 2002, 168-169; Estermann & Nokkala 2009, 19-21).

Since universities' research funds in most developed countries predominantly consist of governmental basic funding and funding from public research funding agencies (such as research councils) (Geuna 1999, 66-68), the allocation criteria for basic funding, as well as the proportions among basic (internal) funding and external public funding, are major national level steering instruments for policy-makers. Policy choices in these two issues form the national funding environment for university research. It's important to note that public research funding agencies are intermediaries whose science policy goals are not necessarily at one with the central government, which is usually represented by the ministry responsible for higher education and science (Braun 1998). However, funding from agencies forms a part of the funding environment, where the relevant question for universities is: what do they have to do in order to secure the financial resources for research that they depend upon? Other external funding from private or international sources is also part of this funding environment. The government may even influence the

role of the third parties in the funding environment by increasing or decreasing its own funding (Slaughter & Leslie 1997).

At the level of individual universities, the management of the universities have similar steering power over the units of universities, especially via basic funding allocations, if the universities are autonomous in allocating the basic funding originating from the state. The universities' autonomy to decide on their basic funding varies from country to country (Estermann & Nokkala 2009, 19-21), but recent science and higher education policy solutions – in line with NPM principles – of many countries have favoured loosening the direct state control of universities (for example, in funding) and replacing it with other forms of steering. On the other hand, university management often has little or no power over the amount of public research funding originating from the government, or over how much the university staff will apply for or receive external project funding from public or private sources. Still, the situation among university units and academic staff of universities is analogous to the situation among universities at the national level: they face a funding environment with a certain allocation criteria for basic funding, and a certain proportion of external funding.

Jongbloed and Vossensteyn (2001) suggest that the policy interests towards universities are articulated - among other things - through the ways in which public funding is allocated for universities. If governments emphasize the value for money and accountability of universities' activities, they are more likely to use performance-based funding mechanisms instead of allocating funding based on, for example, the staff or student numbers of the universities. In their own comparison of 11 OECD countries Jongbloed and Vossensteyn assumed that performance-based funding mechanisms would be common in the late 1990s, which is when their data was collected. This is because they also assumed the science and higher education policies of these countries to be largely influenced by the New Public Management.

Jongbloed and Vossensteyn differentiate between two dimensions of public university funding. The mechanisms of basic funding for universities form the first dimension, and the other is the share of research council funding. They use both dimensions to mirror the performance orientation of university funding. With regard to basic funding for universities, the central question is the choice of funding criteria, while the actual methods for allocating basic funding can vary. Some countries use a specific formula for allocations, others rely on negotiations between the government and the universities, or a combination of the two, and sometimes funding is incremental, meaning that it's based on the universities'

historical resource levels. The criteria for basic funding are of the input type, if they refer to the universities' resources. The main concern is to secure a sufficient level of resources for the universities with regard to the volume of their teaching and research activities. When the funding criteria refer to the performance and results of the activity, they are of the output type. In this approach, the attention of the financier (the state) is on rewarding the high-performing universities via funding and creating incentives for all universities to develop teaching and research. (Jongbloed & Vossensteyn 2001.)

The second dimension of public university funding is the share of research council funding. Councils allocate funding based on proposals from researchers, and funding decisions are usually based on peer-reviewed evaluations of then expected (and past) performance of the applicants. The evaluators judge the quality of the research plans and the applicants' ability to conduct the planned research projects. Since this funding has to be applied for separately and competed for, it increases the general performance orientation of university funding. The more universities get their total public funding via research councils, the more performance oriented the public funding system is. The same applies to the input-output criteria of basic funding: the more output-type of criteria are used, the higher the performance orientation of the funding system. (Jongbloed and Vossensteyn 2001.)

Based on the two dimensions, countries can be placed on a two-axis field, where the vertical axis describes the performance orientation of funding for university research and the horizontal axis describes the orientation of funding for teaching In the case of Jongbloed and Vossensteyn's (2001) own empirical analysis, a major finding was that for most of the countries, the degree of performance orientation was low in funding related to teaching. In research funding, the performance orientation was higher due to the competition-based research council funding. The UK, Japan, the US and Denmark were the employing the most output-oriented research funding systems at the end of the 1990s, while Germany, New Zealand and the Netherlands had the most input-oriented systems. In general, the use of input criteria for allocations of basic funding was more common than the use of output criteria.

On the extent of performance orientation of university (research) funding, studies have focused on several levels of university systems. There are international comparisons of national funding systems as well as national and university level analyses. Frölich et al. (2010) use a two-axis analytical framework that resembles the one introduced by Jongbloed and Vossensteyn. The first axis denotes

centralised and decentralised funding mechanisms and the second axis input and outcome orientation. Centralisation refers to the level to which funding is dependent upon a single funding source (such as the Ministry of Education or similar governmental body). Input and outcome orientation refers to the funding criteria: is the funding of universities based on securing the resources of universities (input), or their performance (outcome).

Other scholars have approached the performance orientation of funding by categorising different types of funding mechanisms. Orr (2004) presents four categories of funding for analysis of state funding for universities in various countries and in the federal states (Länder) of Germany. In his typology, formula-based funding and project-based funding systems include more direct competition and hence are more performance oriented than mission-based funding and discretionary incremental funding where centralised budget planning is amplified. Schmidt (2012) approaches the university funding reforms in the Nordic countries by dividing the funding mechanisms into four categories: negotiation, incremental funding, formula and contracts. Hicks (2012) focuses on performance-based funding systems, dividing them into systems which emphasize indicators, peer review or a combination of the two. In a report by the European Commission (2008, 96-97) the university funding models in the EU countries are divided into four categories. In practice, this typology is based on the funding sources of universities. Koelman (1998) uses a simpler distinction between input and output oriented funding models.

Geuna (1999, 21-26; 2001) suggests that there are two rationales of state funding for universities, especially in the case of research funding. The first rationale, dominant in many countries after the World War II, is based on the assumption that the staff of the universities is in the best position to judge the academic and societal value of research and education before they are carried out (ex ante evaluation) and that academic staff should be able to manage the university activities free from the control of the state and other stakeholders. The implication for funding in this rationale is that universities are mainly funded on the basis of input-oriented allocations of basic funding and the allocations of project funding are based on academic peer review. The second rationale (since the 1970s) emphasizes direct societal benefits from research and education and more efficient resource use than previously. This rationale assumes that it is possible to evaluate and measure the quality of research and education accurately using also other methods than academic peer review. In terms of funding, the second rationale leads to ex post evaluation where universities are funded based on output

and impact after research or education are carried out. It also leads to a decrease in basic funding and an increase in project funding as accountability and efficiency become important goals for policy-makers. Later, Geuna and Martin (2003) have used the distinction of ex ante and ex post evaluation in an international comparison of university research funding.

In the analysis of Finnish universities' research funding in the 1990s, Nieminen (2005, 218-224, 84-97) applies the structuration theory of Anthony Giddens and argues that changes took place in rules and resources that form the operational environment of universities. Normative rules (laws and state regulation) that govern the universities' activities shifted towards decreasing regulation, universities gained more political resources in deciding their activities (e.g. use of funding) and interpretative schemes (ideologies, beliefs about science and society) changed to emphasize the forces of globalization and information society development that made NPM-influenced changes appear unavoidable at the university sector. And "in terms of economic resources, these changes meant above all the introduction of market-like mechanisms".

In some of the studies the question of performance orientation of university funding is approached more descriptively, without employing explicitly defined frameworks or categorisations. Typically, the decreasing share of state basic funding of the total research funding, an increase in competitive project funding, and basic funding allocations based on performance indicators and evaluations are taken to mark performance oriented funding. Examples include Butler (2003), Jongbloed (2007), Kyvik (2007), Lepori et al. (2007), OECD (1998, 33-40) and Tammi (2009).

Generally, studies on university (research) funding suggest that the performance orientation of funding has increased over the last few decades. However, as in the case of the NPM principles, the diffusion of performance-based funding systems has not been pervasive. Some countries and universities have been more moderate in changing their funding systems than others. Research also indicates that funding systems typically consist of a mixture of different funding mechanisms.

2.5   Studies on university research performance: levels of analysis

Research on university research performance has addressed many levels of the academic research system. There are international comparisons of entire countries'

scientific production (often including all sectors of the science system), as well as analyses of single countries and university-level comparisons. Several studies have also covered the micro level: research performance of academic units, research groups and individual researchers. The latter body of literature often concerns the individual and the social factors that influence research performance.

Definitions of research performance are not always explicit in previous research. In fact, it is quite typical to assume that the concept of research performance is obvious and concentrate on discussing the best ways to analyze and measure it. There are, however, some authors that have pondered the concept of research performance and related concepts. On the basis of these definitions, it can be said that research performance includes both a quantitative and a qualitative dimension, both of which can be measured with several criteria.

In a large UNESCO study of the performance of research units in several countries, Andrews (1979b) sees research performance (which he calls research effectiveness) as a multi-dimensional phenomenon with both quantitative and qualitative aspects. While not defining research performance formally, he presents several measures for the analysis of research performance. Some of them indicate the volume of different forms of research output (such as publications, patents, computer software, audiovisual material), while other measures indicate the quality of research in a unit: contribution to science and technology, recognition by others, societal value and applicability of research, training effectiveness, and productivity and innovativeness. Martin and Irvine (1983) separate scientific production and progress. Production refers to the creation of scientific results, which mainly manifest as scientific publications, and progress refers to the contributions to scientific knowledge that the scientific activity results in. They also reflect upon the concepts of quality, impact and importance of publications. For them, quality is a property of the publication and the research the publication is based on. Quality describes how well the research was done and how original the results are. Importance is the potential influence a publication has on scientific progress, and impact is the actual influence of a publication on scientific progress.

Kaukonen (1997) and Gulbrandsen (2000) have presented several dimensions for the concept of research quality. Kaukonen reports that, for researchers from different fields of science, good research is related to at least eight dimensions: practical utility, novelty and originality, methodological level, theoretical contribution, research design, versatility and scope, verisimilitude ("likeness to truth" of results), and international visibility. These dimensions are very differently valued among researchers from different fields. Based on Kaukonen (1997) and

other authors, Gulbrandsen (2000, 27-29) has formulated four dimensions of research quality: solidity (particularly related to methodology), originality, scholarly relevance (related to cumulativity and generality of research), and utility value. Gulbrandsen (2000, 114-117) also found disciplinary differences with regard to dimensions of quality, mainly in the case of solidity.

Despite the multi-dimensional nature of research performance, most studies do not use as many measures for analyzing it as the above-mentioned UNESCO study did (Andrews 1979a). Much used quantitative measures of research performance are the numbers of scientific publications and citations. The use of publications is based on the underlying assumption that the creation of new knowledge is (the most) important task of research and that new knowledge is mainly disseminated through scientific publications (van Raan 2005). But as Martin and Irvine (1983) state, publications are a valid measure of scientific production (quantity), but because not all publications are equal contributions to scientific knowledge (progress), it is debatable whether publications are but a partial measure of the qualitative dimension of research performance.

Citations are often seen as a good measure of the quality of research since there are studies that have found a connection between high citation rates and the quality of research judged by peers (see Kyvik 1991; Gulbrandsen 2000 for reviews). The argument is that researchers cite colleagues' publications if they see that these publications are of high quality and make significant contributions to scientific knowledge. More precisely though, citations to publications indicate that these publications have some kind of impact on the scientific community, and that they have become a part of the accepted knowledge base of a scientific field. Furthermore, because researchers also have many motives for citing the work of others, citations are inevitably a partial measure of research quality. (Martin & Irvine 1983; van Raan 2005; Glänzel 2008.)

Doctoral degrees are a relatively common measure of research performance, although in some countries the work done by junior researchers is considered to be more related to education than to research activity. In some studies, the amount of received competitive research funding has been an indicator of research performance, but it is debatable whether competitive funding actually indicates high level research or is to be regarded as a form of research input (Laudel 2005). Studies based on a peer-review assessment of research quality have also been conducted, mainly when analyzing research performance at the micro-level. A peer-review assessment can be combined with quantitative analysis. Commercial and social outputs such as patents, popular publications and spin-off companies

have sometimes been regarded as part of research performance, particularly when the influence of research on economy and society, and changes of knowledge production are studied.

Quantitative studies of research performance can be conducted by measuring the absolute numbers of different research outputs. However, it is also typical to use some kind of relative measures. The number of publications and other types of output is often analyzed in relation to the volume of research funding or scientific workforce in order to compare the performance of units of analysis that are of different sizes. The research outputs may also be scrutinized in a certain time window to make the analysis time-independent, for example when analyzing the performance of both senior and junior researchers. A third way to create relative indicators of research performance is to proportion the research output of units of analysis to the output of larger entities. There are, for instance, comparisons of countries' or universities' publication or citation numbers as percentage shares of the national or world total. Citations received by publications of a country or a university are often normalized against the average number of citations in the world or different fields of science (normalized citation score).

Analyses that use relative measures, especially input-output indicators, tend to draw attention to the efficient use of resources. One could argue that excellence in research or high visibility in terms of absolute publication or citation volumes is not revealed when focusing on efficiency. Absolute measures, in turn, may be considered biased against younger researchers with shorter careers than seniors, or against small research units, organizations or countries that have smaller resources than larger ones. Using absolute volumes in analyses of research performance also makes comparisons difficult. Some much-used university rankings have been criticized for not taking the differences in size, resources or disciplinary specialization of the ranked universities into account.

As the typicality of co-authoring publications differs among scientific disciplines, it is usual to fractionalize the numbers of co-authored publications, especially when conducting analyses that include researchers from different disciplines. Without fractionalization, researchers from fields where co-authoring is a standard appear much more productive than others. There are several methods for fractionalizing publication numbers. For example, a co-authored publication can be simply divided by the number of authors, or the first author can be given more weight than the others. (Kyvik 1991, 40-42; Gaffriau et al. 2008). Another issue related to disciplinary publication practices is the weighting of different types of publications. Should, for example, scientific monographs be given more weight

than journal articles or articles in books when analyzing research performance, and what should the different weights be? Different weights have been given in performance analyses, but there appears to be no consensus on the issue. (Kyvik 1991, 39-40; Puuska & Miettinen 2008, 60-61.)

A large proportion of studies on research performance are conducted in bibliometrics, a research field of the quantitative study of science, although the typical bibliometric data sources and methods have well-known limitations regarding the publication activity in social sciences and humanities (van Raan 2005; Nederhof 2006; Moed 2005). Input-output studies on universities' and countries' research performance that take the available resources into account are often influenced by methods and approaches from economics. Econometric efficiency analyses may seek the average production function between inputs and outputs of a given group of universities or countries, or search for the production frontier: a university or a country that uses its resources the most efficiently among a given group of universities or countries. These methods have been used to analyze both the research and teaching activities in universities. (Bonaccorsi & Daraio 2005; Johnes 2006.) Some of these studies combine the efficiency analysis with the analysis of factors that potentially influence (research) performance (e.g. Bonaccorsi et al. 2006; Wolszczak-Derlacz & Parteka 2011; Worthington & Lee 2008). Input-output analyses of universities' research performance can naturally be conducted without an econometric approach (see e.g. Kivinen & Hedman 2008; Kivinen et al. 2013).

As a result of these disciplinary and methodological roots, many studies - especially the macro-level analyses - focus on creating more precise measures of scientific research and research performance and not on developing concepts for understanding research performance. More theory-driven research can be found among the micro-level studies of research performance. In addition to academic studies, statistical offices or other government agencies in several countries regularly produce statistics, indicators and reports on the performance of national R&D systems. A similar kind of data collection and indicator production is done in the OECD, the EU and similar inter- or supranational organizations. An important purpose of this type of knowledge production is to inform and aid policy making, but indicators and statistical data are also used for example as criteria for funding allocations. (see e.g. Grupp & Mogee 2005; Moed 2005, 271-272.)

2.5.1   National level research performance

Studies on research performance at the country level have used both absolute and relative measures. Sometimes, both types are used in the same study. As mentioned above, typical measures for research output have been the numbers of publications or citations, and the amount of R&D expenditure and numbers of R&D personnel (either headcount or full-time equivalent) for research inputs, while the precise use and indicators based on these measures have varied.

Absolute measures are used to scrutinize the sheer volume of research output of one or more countries. According to several studies, the United States has been the largest producer of scientific publications in the world in the post-WW2 era, followed by other large, developed science systems such as Japan, the UK, Germany, France, China, Italy, and Canada (see e.g. May 1997; King 2004; Cole & Phelan 1999; Karlsson & Wadskog 2007, 6). China has recently increased her scientific output considerably and is predicted to pass the United States as the world's largest producer of scientific publications in the near future (Zhou & Leydesdorff 2006; Shelton 2008a). Not surprisingly, the global distribution of citations among countries has been very similar to distribution of publications (e.g. May 1997; King 2004). These types of analyses can tell us which countries make the largest contributions to the global scientific knowledge base, but they are not very helpful in international comparisons of research performance that include countries of very different sizes. It is rather self-evident that, at least among the developed national science systems, larger systems produce more publications and receive more citations than smaller ones.

Number of scientific publications per R&D expenditure and normalized citation scores are much used relative measures. They provide a partially different picture to measures of total numbers of publications and citations. While larger countries don't lose their top positions completely, some smaller countries have higher publication productivity and/or a higher relative citation score than larger countries. Switzerland often emerges as the leading country of the world, and some of the Nordic countries, the Netherlands and Israel also rank highly (May 1997; Veugelers et al. 2009; Karlsson & Wadskog 2007, 5-6). If the population or gross domestic product of a country is used as an input and publications or citations as an output, smaller countries that heavily invest in R&D appear to the best performers (Switzerland, Israel, the Nordic countries, the Netherlands) (May 1997; King 2004; Prathap 2010). Rousseau and Rousseau (1998) have shown that a similar pattern exists when a Data Envelopment Analysis is conducted to study

countries' efficiency in science. Switzerland is at the so-called production frontier, using her resources most efficiently among the European countries to produce publications and patents. The Netherlands, Sweden, Denmark and Germany are also among the most efficient countries. (Rousseau & Rousseau 1998.) However, the results from Chen et al. (2013) suggest that the science systems of the developed countries may experience difficulties in increasing their efficiency after a certain level has been reached, and that most of the gains in R&D efficiency occur in the developing countries.

While the differences in the total research performance of (developed) countries are rather easy to explain by reference to the size of the science systems, it's more difficult to understand why the research performance of countries is different when analyzed by relative measures. Researchers have pointed to several reasons, such as the proportion of higher educated population and degree of English skills in a country (Wang & Huang 2007) or structural differences in national science systems (Leydesdorff & Wagner 2009). Publication language also has an influence if the data source for publications and citations is ISI Web of Science; Germany and France in particular would have higher relative citation scores if their researchers did not publish in German and French language journals that are cited less in the global science communication dominated by the English language (van Raan et al. 2011). Furthermore, the disciplinary profiles of countries (Schulz & Manganote 2012; Yang et al. 2012) may explain differences in relative research performance if research outputs are proportioned to inputs without field-normalization. This is because average publication and, particularly, citation rates vary across fields of science (van Raan 2005).

Despite the large amount of literature on national-level research performance, only a few studies address the question of policy influences on research performance. Analyses of research performance are often made for policy-makers, but the benefits and drawbacks of practised national policies are not analyzed from the perspective of national research performance. There is also a lack of studies on the research performance of different institutional sectors of science systems (higher education institutions, public research institutes and firms). There are some exceptions to both cases, however. For example, Butler (2003, 2005) has studied the influence of government funding models on Australian universities in the 1990s and 2000s and concluded that the model's emphasis on publication quantities led to the weakened citation visibility of Australian university research. Sivertsen (2008) has suggested that the level of Norwegian university research has risen since the mid-2000s when the government implemented a basic funding

model that includes incentives to publish in high-level journals and publishers. Tammi's (2009) study indicates a weakening of the research performance of the Finnish university sector in 1994-2005, which happened in the policy environment of increasing funding competition and increasing the legal autonomy of universities. Vanecek (2014) has observed that the recently implemented funding model in which a large proportion of public institutional funding is allocated based on volume of research output has done little to improve the research performance of the higher education institutions and public research institutes in the Czech Republic. Articles I and II of this dissertation improve the situation by looking at the effects of research funding and state steering of the higher education sector at the national level. Both are international comparisons of national university systems, Article I (*University research funding and publication performance—An international comparison*) comparing eight countries and Article II (*Influence of research funding and science policy on university research performance: a comparison of five countries*) comparing five countries.

2.5.2   University-level research performance

Studies of research performance at the university level are often conducted without reference to explanatory factors or the resources available. Typically, numbers of publications, PhD degrees and citations are used as measures of research performance. While these studies don't proportion the performance (output) to resources (input), they can still employ other relative measures, such as publications per number of staff or normalized citation scores. The motivation for these studies may stem from the need to benchmark universities or to find out which universities are the highest performers in a particular context (e.g. a country, a continent, or the world). (Braun 1999; Gorraiz et al. 2008; Halffman & Leydesdorff 2010; Li et al. 2012; Persson et al. 2000, 28-30; Sandström & Sandström 2007.)

There are several studies that take the various internal factors of universities to explain universities' research performance. A study of Italian universities by Bonaccorsi, Daraio and Simar (2006) shows that size does not have an impact on universities' research performance, and that a both very diversified and undiversified range of curricula can negatively affect research performance. Their results also suggest that applied research funding and teaching tend to complement good performance in basic research, not substitute it. However, when studying several universities in Europe, Wolszczak-Derlacz and Parteka (2011) found that

the diversified nature of a university (large number of faculties) has a positive influence on research, as has the share of women among the academic staff. Younger universities had lower research performance, as had those universities that received a higher share of their total income as basic funding from the state. The results from López-Illescas, de Moya-Anegón and Moed (2011) also indicate that the degree of disciplinary specialization in Spanish universities influences their research performance. Kyvik and Olsen (2008) found that the aging of tenured staff in Norwegian universities used to have a negative impact on research performance but that this pattern has disappeared among the younger cohorts, indicating a change in research practices, career patterns and funding incentives. Abramo, D'Angelo and Di Costa (2008) studied the correlation of collaboration and research performance in Italian universities and concluded that the influence of collaboration on performance is very disciplinary-specific, and also dependent on the type of collaboration.

In addition to academic studies on universities' research performance, there are several university rankings available, such as The Academic Ranking of World Universities, commonly known as the Shanghai ranking, published by Shanghai Jiao Tong University, The World University Rankings compiled by The Times Higher Education, and The Leiden Ranking developed by Leiden University's Centre for Science and Technology Studies. Their ranking criteria vary; some concentrate on stricter quantitative data on research (e.g. The Leiden Ranking), others include more subjective assessments by academics (e.g. The World University Rankings). Some of the indicators in rankings emphasize research performance by absolute measures, while other rankings use relative measures, proportioned to the size of a university or normalized for a field of science or the world level. Rankings have received not only a lot of attention in the scientific community as well as among academic managers and policy-makers but also some criticism for having methodological deficiencies, especially the well-known and much-used Shanghai ranking (Billaut et al. 2010; Florian 2007; van Raan et al. 2011). Rankings have also been criticized for not taking the different resource levels and disciplinary structures of universities into account (Kivinen & Hedman 2008; López-Illescas et al. 2011).

As with the research performance analyses at the national level, there are only a few studies that scrutinize universities' research performance in relation to their policy environment. For example, Jongbloed (2007) has analyzed changes in Dutch universities' research performance under the conditions of monitoring and increasing competitive research funding, but he does not make the connection

between research inputs and outputs. Frølich et al. (2010) have done similar work on Norwegian higher education institutions. Tammi's (2009) study of the Finnish university sector extends to the level of three clusters of Finnish universities. Liefner (2003) has studied the influence of research funding mechanisms on the activities and performance of universities in both Europe and the United States, basing his analysis of influence on estimates given by the interviewed research staff. In a study of a Turkish university, Baskurt (2011) refers to national and intra-university policies of recruitment and rewarding as potential explanatory factors for the development of research performance.

Most of the existing studies and university rankings focus on comparing universities and making temporally cross-sectional analyses of their research performance. Longitudinal analyses are rarer. If the policy environment is taken into account, there is usually no connection between inputs and outputs, or the university sector is analyzed as a whole. Article III (*Connections between competition for funding and research performance in three Finnish universities*) contributes to the few studies that have analyzed the research performance of universities with regard to the policy environment.

2.5.3   Research performance at the micro-level of science

Studies on research performance at the micro-level of the science system (individuals, research groups and academic units such as university departments) often operationalize research performance as a number of scientific publications, but amounts of citations, patents, PhDs or competitive research funding have also been used as measures of research performance, as well as dimensions of perceived research quality (see e.g. Andrews 1979b; Martin & Irvine 1983; Kyvik 1991, 20-24; Gulbrandsen 2000, 32-37). A persistent pattern of research performance among scientists is a very uneven distribution of publication productivity. During any given period of time, a small fraction of the researchers publish a great deal and the large majority publish very little. This regularity was observed very early on in science studies and bibliometrics (e.g. Lotka 1926; Price 1963; Reskin 1977). More recent studies confirm the finding (e.g. Kyvik 1991, 91-94; Fox & Mohapatra 2007; Puuska 2010). Another regular pattern is the low average publication productivity among scientists (Fox 1983, Ramsden 1994), while there are differences in average productivity among disciplines (Kyvik 1991, 45-48; Prpić & Vuković 2009; Puuska 2010).

Productivity distributions are not as skewed as the original Lotka's Law (1926) predicts, and the "Price's Law" (1963) is also considered to be exaggerated with regard to the most productive researchers. Despite this, distributions of publication productivity are not even close to normal distribution. An uneven pattern of publication productivity remains even if one takes the different publication types and co-authored publications into account (Kyvik 1991, 90-94, 101; Puuska 2010). According to Kyvik (1991, 95), differences in publication productivity are somewhat larger in natural and medical sciences than in social sciences and humanities. Some studies indicate that other types of research output, such as patents, also tend to accumulate on those who have high productivity in scientific publications (Gulbrandsen & Smeby 2005; van Looy et al. 2004).

Regarding citations, a similar skew distribution exists. In any given period of time, most of the publications receive only a few or no citations after their publication, and a few receive a lot of citations. This means that a few authors receive the major proportion of citations. The same skew distribution exists among the publications from individuals. (Seglen 1992; Cronin & Overfelt 1994; Aksnes & Sivertsen 2004.) As disciplines differ in average publication productivity, they also differ in average citation rate. Typically articles in life sciences and medicine receive more citations on average than articles in other fields, including many fields of natural sciences and engineering. The average citation rate in social sciences and especially in humanities is far lower than citation rate in other fields. (van Raan 2005; Moed 2005, 91-105; Times Higher Education 2011.)

The reasons underlying the differences of research performance have been sought from the psychological characteristics of the researchers, but the age, gender and position of the researchers, as well as different environmental and organizational factors, have also been studied as possible promoters of research performance (e.g. Fox 1983; Pelz & Andrews 1976; Andrews 1979a, Kyvik 1991; Gulbrandsen 2000). Organizational and environmental factors that have been studied include things such as funding, collaboration and communication, size and prestige of research group or other academic unit, leadership, and freedom of activity. While the results from various studies are not conclusive, some factors have been observed to have a positive influence on research performance. Usually, men have higher research performance than women, although recent studies indicate that the difference between men and women is narrowing or even disappearing (van Arensbergen et al. 2012). Some studies have shown that research performance increases up to a certain age but then levels off or declines. However, there are also indications that research performance has two peaks along

researchers' careers, or that productivity continues to grow with age. (Stephan & Levin 1997; Kyvik & Olsen 2008.) Researchers in higher positions usually perform better than others, but it may be difficult to separate cause from effect: do people in higher academic positions perform better because of their position or are they in higher positions because of their better performance (Kyvik 1991, 172-180; Puuska 2010)? With regard to psychological factors, studies refer to characteristics such as high motivation and determination, willingness to work hard and pursue particular goals, and autonomy. Motivation is particularly emphasized. (see Fox 1983 and Gulbrandsen 2000, 124-127 for reviews of literature.)

Regarding environmental and organizational factors at the group or unit level, research clearly indicates that links between communication and collaboration both within the group/unit and outside it enhance research performance. Collaboration has its costs though, because it takes time and requires certain technical facilities. (Lee & Bozeman 2005; Katz & Martin 1997.) Freedom of work is also important but needs to be balanced with coordination of research activity (Pelz & Andrews 1976; Gulbrandsen 2000, 178-179). Size of research group has a positive effect on the research performance of groups up to a point, meaning that groups with a certain critical mass are better than smaller ones. This connection is, however, dependent on the field of science. (Knorr et al. 1979; Stankiewicz 1979; Gulbrandsen 2000, 198-201.) Secondly, there is no clear support for the idea of larger university departments being better than smaller ones (Kyvik 1995; Gulbrandsen 2000, 201-203). Somewhat counter-intuitively, funding and other kinds of material resources of a research group or a unit are not very significant for research performance. After a certain level of resources has been achieved, adding resources does not enhance research performance. It may be that the type and continuity of funding is more decisive than the amount of funding. (Stolte-Heiskanen 1979; Kyvik 1991, 129; Gulbrandsen 2000, 205-206.) Some studies suggest that regardless of individual researchers' abilities and personal characteristics, their research performance conforms to their organizational setting (Zuckerman 1967; Long & McGinnis 1981).

Studies on micro-level research performance have had some shortcomings with regard to data. They are often based on publication and citation data that has been retrieved from ISI Web of Science or, more recently, from SCOPUS. It is well known that social scientists and humanities scholars publish much of their research as monographs and articles in edited books, and in languages other than English. In engineering, papers at conference proceedings have traditionally been a valued form of publishing. Several bibliometric studies indicate that WoS and SCOPUS

mainly cover scientific journals that publish in English. This is a major form of publishing in natural sciences and medicine. As a result, WoS and SCOPUS give a comprehensive picture of the publication activity of only these disciplines. (Hicks 1999; Nederhof 2006; Pölönen et al. 2011.)

Some studies have overcome this problem by using questionnaires and national publication databases to gather data on researchers' publication activity. However, citation data has mainly been accessible via WoS and SCOPUS. Since the mid-2000s, the Google Scholar web search engine has provided an alternative for gathering more comprehensive publication and citation data than WoS and SCOPUS can offer. Some researchers have already employed Google Scholar for the analyses of research activity and performance (Amara & Landry 2012; Harzing 2013; Kousha & Thelwall 2007). Article IV (*Scientific Productivity, Web Visibility and Citation Patterns in Sixteen Nordic Sociology Department*s) joins the studies that use Google Scholar to give a more comprehensive picture of publication productivity and citation impact than studies based on citation databases.

3 Research questions and conceptual resources

In accordance with the goals of the dissertation, I present two research questions. Both questions have been operationalized using three more detailed questions.

Based on the earlier research, science and higher education policies in many countries have become more performance-oriented during recent decades. The first research question and its operationalization concerns university research in this policy environment: **Is performance-oriented science and higher education policy beneficial for universities' research performance?**

Have the systems of university research funding become more performance-based from the 1980s to the 2000s? Are there differences between country and university-level developments?

What kind of steering models have governments used to steer university research from the 1980s to the 2000s?

How has the universities' research performance developed from the 1980s to the 2000s? Are there differences between country and university-level developments?

The second research question and its operationalization relate to research performance in its micro-level environment, with a specific reference to a particular field of science and a particular data source: **What are the patterns of research performance and factors which influence it in the sociology departments of Nordic universities?**

What are the patterns of publication productivity and visibility of sociology scholars, and which individual and departmental factors influence the research performance?

Is the publication behaviour in sociology changing to resemble the publication patterns of natural sciences and medicine?

Does the analysis based on Google Scholar provide similar results to the analysis based on citation databases, especially the Web of Science?

Based on previous literature on research performance and research quality (see Section 2.5), I define research performance in my dissertation in terms of both quantity and quality:

Research performance as quantity is the ability of a unit of analysis (such as a country, an institution, an organizational unit, a group or an individual) to produce different forms of scientific output (such as publications, patents, prototypes and algorithms);

Research performance as quality is the ability to conduct research that contributes to the progress of science (e.g. by being solid, original, scholarly relevant, and societally useful).

As will become evident in Section 4, I have only used quantitative data and measures to analyze research performance. This choice is motivated by the fact that qualitative data on research performance is not readily available and it is beyond the resources of a single researcher to gather it for the types of analyses that I have conducted.

Articles I-III of the dissertation analyze the university research performance in its policy context, which is mainly indicated by the structure of and changes to research funding (first research question). They scrutinize the connection between research funding and other policy steering (steering models) and research performance at two levels of the university system. Article IV looks at the research performance through micro-level factors in university departments and with a data source that has not often been used in the analyses of research performance (second research question).

Accordingly, the conceptual approaches employed in Articles I-III are similar to each other, whereas the theoretical perspectives of Article IV differ from Articles I-III (see Table 1). The analytical framework based on the concept of different funding environments (introduced in Section 3.1) has been developed for analyzing the level of competition and use of financial incentives in university research funding. State steering models (Section 3.2) are used to clarify the relationship between governments and national university systems. The principal-agent theory (Section 3.3), explicitly used in Article I but also underlying the research setting of Articles II-III, presents a perspective on the relationship between universities and governments or between a university and its units, and the so-called task delegation problem between the two. The concept of disciplinary publication practices (Section 3.4) helps to understand why fields of science differ in regard to publication behaviour. The Matthew effect and cumulative advantage in science (Section 3.5) are concepts for explaining the variation of research performance.

Table 1. Conceptual resources used in dissertation.

	Funding environments of university research (Section 3.1)	State steering models (Section 3.2)	Principal-agent theory (Section 3.3)	Disciplinary publication practices (Section 3.4)	Cumulative advantage in science (Section 3.5)
Article I: Comparison of university systems in 8 countries	X		X		
Article II: Comparison of university systems in 5 countries	X	X	(X)		
Article III: Comparison of 3 Finnish universities	X		(X)		
Article IV: Academic staff in 16 sociology departments of Nordic universities				X	X

3.1 Funding environments of university research

Together with Nieminen, I have developed a four-field framework (Figure 1) for analysis of the funding environments of university research (Auranen & Nieminen 2010). The framework is based on the work by Jongbloed and Vossensteyn (2001). The two-axis field by Jongbloed and Vossensteyn is not able to differentiate the dual nature of the research funding in universities (government basic funding and external funding) because the funding for teaching is included in their model. The four-field framework has been developed for closer analysis of the national systems of university research funding. It can also be employed in the analysis of individual universities in a country.

The basic idea in the framework is relatively simple: there are country-specific and institution-specific funding environments that vary due to different funding sources, their shares of the total funding and the involved incentives. Depending on the internal-external funding ratio and input-output orientation of the basic funding allocation, the overall systemic dynamics caused by funding vary. These dynamics, in turn, may have varying impacts on the outputs. The continuums are cross-tabulated in order to form a two-dimensional framework for estimating country-specific and institution-specific systemic characteristics. The position each country or university has in this two-dimensional framework mirrors the potential susceptibility of the national university systems or universities for different steering impulses and activity paths in research.

Figure 1. Framework for positioning the funding environments of university research. University systems or universities can be positioned in the framework according to the orientation of basic funding and the share of external funding. Modified from Auranen & Nieminen (2010) by the author.
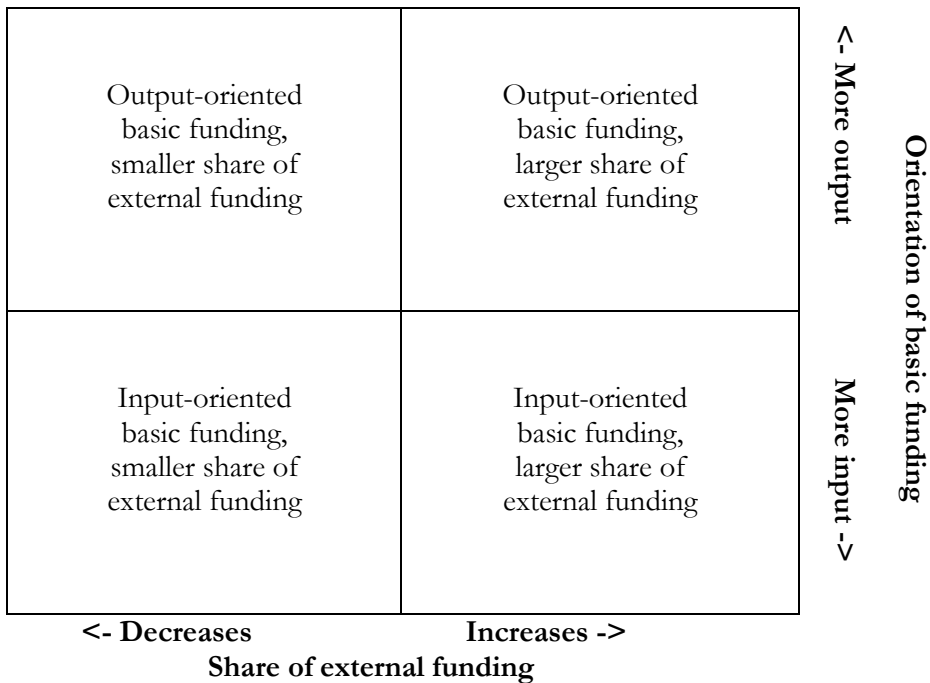
If the framework is considered at the level of national university systems, the left side of the field represents funding environments where state basic funding dominates. Universities are mainly dependent on it and are affected by political steering. On the right side of the field, universities have more funding sources and

part of the governmental steering occurs through funding agencies. The role of the government is not necessarily weaker compared with the situation on the left side but it is more indirect. However, in this case there are also other actors (e.g. industry) that may directly affect the orientation of the research while in the previous case these interests are mainly represented indirectly through government steering. The lower part of the field describes input-oriented systems and the upper part systems with an output orientation in government basic funding. In an input-oriented system the governmental steering is usually weaker than in output-oriented systems. In input-oriented systems the government is more concerned about the sufficiency of resources, while in output-oriented systems it explicitly expects efficiency and definable results from the universities. (Geuna & Martin 2003; Jongbloed & Vossensteyn 2001.) To put it another way, the more output-oriented the basic funding and the larger the share of external research funding, the more competitive the funding environment.

The same logic of funding environments can be transferred to the level of individual universities. If the basic funding covers the majority of the university units' research costs, the units are dependent on the steering by the university management. In the case of a larger share of external funding, the steering possibilities for the university management are smaller or more indirect. Regarding the input-output orientation of basic funding, the logic at the university level is similar to the national level. However, the financial steering possibilities for the university management depend on the universities' autonomy in allocating the government's basic funding and/or having a significant amount of own funding.

Systems and universities in which governmental basic funding dominates are sensitive to changes in the allocation mechanisms and incentives for basic funding employed by the government or university management. However, basic funding may also increase stability as it covers the salaries of permanent research and teaching staff, as well as basic infrastructure expenditure. It is not normally possible to use external project funding for these purposes. Therefore, university systems and universities in which external funding dominates can be seen as volatile from the perspective of permanent basic structures. On the other hand, external funding and its availability can also be seen as an opportunity for new initiatives and the extension of activities. Input-oriented basic funding systems are potentially less dynamic than output-oriented systems (Geuna & Martin 2003).

Regarding the international advance of the NPM principles, one would expect several countries and universities to move from the lower left corner of the framework towards the right side (large share of external funding) and/or up

(output-oriented basic funding system). This shift would be visible in empirical analysis of research funding and science policy from the 1980s to the 2000s. In addition, if the NPM-influenced policy is correct, the university systems and universities that operate in the most competitive funding environments and can be positioned to the upper right corner of the framework should also be the ones with the highest research performance. This is because the funding incentives are assumed to bring dynamics to university systems and institutions. Similarly, the systems and universities in the lower left corner of the framework should be the weakest performers in research. In general, movement to the right and/or upwards in the framework should be visible as improving research performance, if there is a positive connection between competition and performance. However, one could also argue that while competitive funding environments are dynamic, their volatility may at the same time have a negative effect on research performance.

When the entire external research funding for universities is regarded as an indicator of competition in the funding environment, one must bear in mind that enhancing the research performance is not the only motive for the allocation of external funding. Some sources of external funding – both public and private – may be targeted for societal needs instead of basic research which typically leads to scientific publications. One could argue that the more applied sources of funding should be excluded when using the framework to analyze the influence of the competitive funding environment on performance in basic research.

However, the purpose of the framework is to illustrate the competition as a general systemic character. The allocation of external funding is typically based on competition in one way or another. Universities, their units as well as individual researchers and research groups, have to prove themselves and become competitive in order to be funded. Previous research indicates that success in applied research usually goes hand in hand with success in basic research (van Looy et al. 2004; Gulbrandsen & Smeby 2005). This means that competitiveness in the funding environment requires high performance in terms of basic research. Furthermore, while there has been an increase in public and private funding, which is at least partly targeted for applied research, the funding environment of university research has in many countries been largely dominated by government basic funding and funding from research councils, both of which are typically used for basic research (see e.g. Auranen & Nieminen 2010; Kyvik 2007). Researchers have also shown an ability to adapt to their funding conditions, for example by combining their own goals of conducting basic research to the goals of the sponsors of applied research (Laudel 2006; Kyvik 2007; Nieminen 2005, 144-155).

Thus it is logical to include all external funding when the relationship between the funding environment and performance in basic research is studied, although the indicators that describe the performance in applied research would undoubtedly complement the performance analysis.

3.2   State steering models for higher education

One of the major interests of higher education research has been to understand the national governance and steering of universities and other higher education institutions, as well as the level of autonomy higher education institutions have with regard to the state. Burton Clark's triangle of coordination is one of the best known models with which to understand national university systems and their governance. The model separates three forces - academic oligarchy, state and market - according to whose power relations the steering of universities is organized in different countries (Clark 1983, 136-145). Neave and van Vught (1991) have suggested making a similar division between centralized state steering (rational planning and control) and market-style steering (self-regulation). Other authors have also used this type of basic continuum with state-oriented university systems and their governance structures at one end and market-oriented systems at other (see Liefner 2003 and Gornitzka & Maassen 2000 for reviews on these studies). However, state steering of universities may take many forms and change over time, and steering solutions do not normally form clear, ideal-type models of state control versus deregulation.

Instead of the dichotomy of centralized state steering and market steering, Gornitzka and Maassen (2000) suggest using four state steering models developed by Olsen (1988). They find the four models more suitable for analyzing changes in the steering relationship between governments and higher education. The models are the sovereign state, the institutional state, the corporate-pluralist state and the classical liberal state, also referred to as the state supermarket model. The four models provide a framework for answering the question of why and on what conditions governments should give agencies more autonomy. Autonomy is an important issue, especially in the conditions of the New Public Management since NPM is likely to strengthen management and steering solutions based on performance monitoring and evaluations while implying deregulation of financing and personnel management. Besides approaching the question of autonomy, the models also encompass other issues of interest to my analysis: for example, what is

the role of the higher education sector in society and how this role is best upheld, what are the tenets underlying the assessment of functionality of the higher education sector and how and where does decision-making about higher education take place.

In the sovereign steering model, higher education is seen as a governmental instrument for reaching political, economic or social goals. The role of the higher education sector is to implement whatever political objectives are on the higher education policy agenda. The universities are under tight control and strong emphasis is put on the fact that they are accountable to the political authorities. In the sovereign model, the assessment of functionality in the universities is based on their political effectiveness. The decision-making process is centralized and top-down. The mode of steering is hierarchical. University autonomy is based on the notion that the government is overloaded and technical decisions can therefore be left to the universities themselves. Changes in higher education follow changes in political leadership, either via elections or via changes in political coalitions.

In the institutional steering model, the universities have a special responsibility to protect academic values and traditions against the whims of shifting political regimes and coalitions and the short-term agendas of interest groups. The role of the higher education sector is to uphold its traditions and socio-economic and cultural role, as well as to protect academic freedom. This model can best be exemplified by the relationship between the state and the old elitist universities. In the institutional model, the functionality of universities is assessed based on their effects on the structure of meanings and norms. Decision-making is specialized and traditionalist. University autonomy is based upon shared norms of non-interference – the government does not interfere directly with higher education. Changes in the higher education system take place through historical processes and evolution rather than as a result of reforms.

The corporate-pluralist steering model assumes that there are several competing and legitimate centres of authority and control with regard to higher education. The role of the higher education system reflects the constellation of interests voiced by different organized interest groups in the sector, such as student unions, staff unions, professional associations, industry or regional authorities. The Ministry of Education is just one of the many stakeholders. The functionality of the university is therefore assessed based on the criteria of multiple stakeholders. Decision-making is also segmented and dominated by interest groups with a recognized right to participate. University autonomy is negotiated and is the result

of a distribution of interests and power. Changes in the higher education system depend on changes in power, interests and alliances.

In the supermarket steering model, the role of the state is minimal and the role of the universities is to deliver services, such as teaching and research. The criteria for assessing universities include efficiency, economy, flexibility and survival. As a result of extreme decentralization, there is no dominant arena of policy making. University autonomy depends on the ability to survive while changes in the higher education system depend on the rate of stability or change in the environment.

Of the four state steering models (see Table 2) that are used in this dissertation to conceptualize the state-university relationship in different countries, NPM doctrines and models are most keenly in line with the supermarket model. When a government uses supermarket steering, it relies on market-like mechanisms such as competition and strives for efficiency and flexibility. These types of policy instruments are very typical for NPM and similar ideologies. This does not mean that the use of NPM-influenced policy instruments would be completely absent in other steering models. For example, such instruments could very well be used in the sovereign steering model as it has an emphasis on higher education sector's accountability to policy-makers.

Table 2. Four state steering models for higher education (based on Himanen et al. 2011).

Sovereign state model	**Corporate-pluralist model**
Strong state steering of universities Autonomy: tight control of universities, strong emphasis of accountability to policy-makers Role: government instrument for achieving political, economic, and social goals Assessment of activities: based on political efficiency Decision making: centralized, top-down, hierarchical	Universities steered by multiple stakeholders Autonomy: negotiable, based on division of interests and power Role: reflected through the goals of organized interest groups (e.g. student organizations, labour unions, industry, and local decision makers) Assessment of activities: based on the ability to respond to interests of various groups Decision making: divided
Institutional model	**Supermarket model**
Universities are highly independent actors Autonomy: no direct government intervention to universities' activities Role: protection of academic values and traditions Assessment of activities: based on academic impact Decision making: based on expertise and traditions	Universities are like private sector organizations Autonomy: minimal role for state Role: universities provide services (e.g. teaching and research) Assessment of activities: based on efficiency, economy, flexibility, and survival Decision making: extremely decentralized, no dominant arena of decision making

3.3   Principal-agent theory

The principal-agent theory has been applied in science policy studies and higher education research to explain 1) the relationship between the government and the universities or other research organizations, or 2) the relationship between other public agencies (such as research councils) and researchers (Kivistö 2007, 2008; Gornitzka et al. 2004; McLendon 2003; van der Meulen 1998; Shove 2003; Caswill 2003; Morris 2003). The principal-agent theory is an abstract and fundamental way for understanding the relationships between different actors in science and/or higher education systems, but other theories and conceptualizations like those employed in this introductory essay (funding environments and steering models) may be used to explain particular ways of organizing these relationships or changes in them.

The principal-agent theory, or agency theory, originates from economics, where it originally depicted a relationship between two parties, one of which gives the other party a task to perform. The party setting the task is called the principal, the party performing the task is called the agent. The principal also gives the agent resources for performing the task (see e.g. Ross 1973; Jensen & Meckling 1976). The theory assumes that the relationship has certain characteristics:

Informational asymmetry: the principal knows less about the task than the agent, and may not be aware of the agent's abilities in performing the task, and

Goal conflicts: the agent may have different goals to those of the principal, and a wish to use the resources for purposes other than doing the task the principal has set.

As a consequence, the principal faces two problems: how to choose the most capable agent(s) to do the task, and how to make sure that the selected agent(s) do the task. In the agency theory, these problems are called adverse selection and moral hazard. The principal can try to lessen the risk of adverse selection by obtaining information about the abilities of the agent and the task itself. Both cause costs for the principal. The main solutions to the moral hazard problem for the principal are to trust or monitor the agent. According to the theory, trust includes a high risk of shirking - that is, the use of resources for the agent's own purposes. On the other hand, monitoring creates costs for the principal. (Petersen 1993; Waterman & Meier 1998; Kivistö 2008; Braun & Guston 2003.)

In higher education research and science policy studies, governments or public agencies are seen as principals that have tasks to conduct, in this case scientific research or higher education. As governments or agencies do not have the appropriate know-how and human resources to conduct the mission on their own, they need to delegate the actual implementation of the tasks to universities or individual researchers. Delegation includes allocating resources (funding, buildings, labour force, etc.). The principals also have an interest in governing the accomplishment of the tasks. Governance can take place through monitoring the activities before, during or after conducting the tasks, or just by blind delegation - that is, by trusting the agents (Braun 2003). In the context of university research, principal's trust towards the agents refers to solution where financiers (such as the state or research councils) choose to believe that even without incentives set by the financiers, researchers, research groups, universities will conduct research it, and that the research conducted is in line with the financiers' goals.

Government or agencies usually don't know beforehand which universities or researchers they should allocate the resources to: who will be best able to conduct

the research and education. Funding allocations by research councils are a typical example of this adverse selection problem in science policy. Selection of agents has usually been less pronounced in the government-university relationship because governments have typically delegated the tasks of education and research, as well as resources for the tasks, to all universities. However, governments may want to give better resources to the universities they rate higher than others.

With regard to goal conflicts between the universities (and their employees) and government, Kivistö (2007) suggests that the classic goal conflict between the universities and government is one between cultural and utilitarian. The universities and their employees emphasize that universities should create knowledge for its own sake and teach students in an atmosphere of academic freedom, which also includes universities' institutional autonomy from the state. Governments see that universities exist to serve society, produce skilled labour and provide useful knowledge. In addition, academics have goals that relate to the advancement of their personal careers and working conditions. Researchers need the prestige, both for themselves and their units, to be attractive in the eyes of peers, but governments usually don't want to reward prestige seeking in itself. University employees may also have an interest in securing comfortable working conditions using public resources, which is not a legitimate goal from the government's perspective. (Kivistö 2007, 67-78.) From the wider science policy perspective, Braun (2003) sees the tension between the autonomy of researchers and research organizations and the goals of governments as a basic paradox of the science policy making.

Various historical ways of organizing the relationships between the state and the universities or the entire science system can be understood as national level solutions to the delegation problem embedded in the principal-agent setting. The same applies at university level in the relationship between the university management and university units or employees. Transferring the framework of funding environments (Section 3.1) to represent different solutions to the delegation problem of the principal-agent setting, the general upper right corner represents a low level of trust and high level of monitoring, and lower left corner represents a high level of trust and low level of monitoring.

The international trends in science and higher education policy since the 1970s indicate governments' distrust towards researchers and research organizations. Governments in many countries have abandoned trust as the main policy solution to the delegation problem. From distrust follows the need to monitor the universities and their employees with instruments that are typical of NPM-

influenced policy: competition for resources, performance indicators and evaluations. However, as international comparisons of science and higher education policy show, it is not self-evident that distrust and monitoring dominate policy making in all countries.

3.4   Disciplinary publication practices

The differences in values, working practices and organization of research activities of scientific disciplines are well known. Becher's (1989, 1994) work on academic tribes is one of the best-known studies on the disciplinary cultures in science. Before him, Snow (1959), Kuhn (1962) and Whitley (1984) had outlined some of the variations among the scientific disciplines. Becher (1994) connects the differences among scientific disciplines to the subject matter and knowledge forms of research. The so-called hard-pure fields (e.g. physics) are concerned with universal questions, and knowledge is cumulative and atomistic, leading to discoveries and explanation of phenomena. The soft-pure fields (e.g. history or anthropology) operate on particular phenomena, knowledge is holistic and reiterative and results in understanding or interpretation. The hard-applied fields (e.g. clinical medicine or engineering) produce purposive and pragmatic knowledge aimed at mastering the physical environment and resulting techniques or products. The soft-applied fields (e.g. education or law) produce functional and utilitarian knowledge aimed at enhancing professional practices, leading to development of practices and procedures. However, the categories are not to be seen as simple boxes with clear boundaries. Many disciplines, let alone sub-disciplines or fields of study, are on a boundary between two categories or close to the boundaries rather than fitting nicely into a single category.

Whitley (2000) argues that different fields of science collectively control the processes of the research work and their outcomes to ensure sufficient coherence in the knowledge production. Collective control over the correct way of conducting research and communicating the results varies among the disciplines, and this variation is dependent upon 1) the degree of mutual dependency between the researchers, and 2) the degree of task uncertainty in research work.

Mutual dependency "refers to scientists' dependence upon particular groups of colleagues to make relevant contributions to collective intellectual goals and acquire prestigious reputations" (Whitley 2000, 87). If the dependence is high, the researchers face special and clearly defined requirements for the relevant and

significant contributions in their field, and need to rely more on the results, methods and perspectives used by others in the same field. Task uncertainty refers to the uncertain nature of scientific work. Scientific disciplines differ with regard to the level of coherence in the existing knowledge base. If the existing knowledge base is precise and shared by the researchers in a field of science, there is more consensus on the tasks that should be performed (low task uncertainty) than in a field with a less coherent knowledge base (high task uncertainty). Degree of task uncertainty also applies to the procedures in conducting research. Task uncertainty is low if the researchers in a discipline or research field have a high consensus on the proper research procedures and techniques.

Kyvik (1991) suggests that cognitive and social differences among disciplines have implications for publication practices. According to him, six dimensions determine the nature of publication practices: 1) Paradigmatic status: hard fields follow a single paradigm at a time, which leads to consensus on concepts and methods, while soft fields include a number of competing paradigms and have a lower consensus on concepts and methods; 2) Nature of scientific language: the language of hard fields is codified and uniform, and arguments can be presented briefly. Soft fields use a more literary, persuasive style of language that requires more length; 3) Level of mutual dependency: researchers in hard fields are more dependent on each other as they aim to make relevant contributions, which means that high-quality research requires more collaboration than in soft fields where mutual dependency is lower; 4) Audience structure: typical audiences of publications in all fields consist of scientific colleagues, but in some fields, publications for lay people or professionals also give merit to researchers; 5) Level of universality of subject matter: hard fields typically have universal subject matter that is not affected by a particular cultural, historical or geographical context, as opposed to soft fields, which usually study phenomena that are limited to a particular context; 6) Level of competition for priority in research: competition for priority in conducting research and publishing is higher in areas where the knowledge form is universal and cumulative, because researchers are given merit for discovering something has not been discovered by others. Such breakthroughs and discoveries are more typical in hard fields.

In line with these cognitive and social differences, some typical patterns of publishing among disciplines can be outlined. The results from Puuska and Miettinen (2008) on the publication behaviour in Finnish universities show that researchers in natural sciences and medicine publish most of the work as journal articles. A similar pattern is partially present in engineering, although papers in

conference proceedings are another dominant form of publishing in engineering. In social sciences and humanities, much of the research is published as articles in edited books and as monographs. Disciplines also differ with regard to publication language and co-authoring. In hard fields, most publications are published in English (the post-war lingua franca of science) in international journals or conference proceedings, whereas in social sciences and humanities a considerable proportion of publications are written in the national languages of the authors. In the same vein, the majority of publications in hard fields are co-authored. In soft fields, co-authorship is rarer and even marginal in some fields of humanities. Publishing for lay audiences is more common in humanities and social sciences than in other disciplines, and social scientists and humanities scholars also direct their publishing at various groups of professionals. Publishing for professionals in industry is also typical in some fields of engineering. (Puuska & Miettinen 2008, 27-51.) Kyvik's earlier study (1991, 45-62) using data from the Norwegian universities in the 1980s shows very similar patterns.

Although different publication practices can be distinguished along the lines of the disciplinary groups, there is also variation within the groups. For example, in social sciences, sociology and education are relatively national fields with regard to publication language, whilst in economics and psychology most of the research is published in English. Engineering also includes fields such as traffic and transport engineering, in which a relatively large proportion of publishing occurs in national languages. Co-authorship is clearly less common in mathematics and philosophy than in other fields of the same disciplinary groups. (Kyvik 1991, 68-86; Puuska & Miettinen 2008, 23-51.)

Disciplinary cultures and publication practices tend to cross national borders, are resistant to change and are able to filter the pressures which are external to the scientific community, such as the claims of science policy-makers (Ylijoki 2003). However, the social and political conditions of scientific work may have an effect on disciplinary practices. These conditions include the available sources of funding, and policy guidelines or local operating environment of the research organization (e.g. university, university department). Kyvik (2003) has shown that the publication behaviour of Norwegian academics changed between the early 1980s and the early 2000s. The percentage of articles among all publications increased and the share of reports decreased. Researchers also started to publish more in non-Scandinavian languages, mainly English. Co-authored publications became more common. The largest changes in publication practices occurred in social sciences and humanities, which more resembled the hard disciplines in the early

2000s than the early 1980s. Kyvik refers to the increase in research programmes initiated by the national and international financiers of research, reduction in the cost of travel and general trend of internationalization in science as reasons for increasing co-authoring and publishing in English. Puuska and Miettinen (2008, 101-103) report the growth of co-authoring and decrease in Finnish language publishing in Finnish social sciences between 1998 and 2004. An increase in co-authoring has also been demonstrated in other studies (e.g. Persson et al. 2004; Glänzel & Schubert 2005).

3.5   Matthew effect and the cumulative advantage in science

A standard result of bibliometric studies on individual researchers is the skew distribution of research performance, indicated by, for example, publication productivity and citation visibility. Besides the psychological characteristics of the researchers or micro-level social and organizational contexts of research, sociologists of science have also referred to wider social processes in the scientific community that work to renew the accumulation of scientific achievements (e.g. Cole & Cole 1973; Merton 1973; Zuckerman 1977).

Merton (1973) presented a famous argument on the so-called Matthew effect of science, meaning the self-reinforcing circle of achievements and recognition that helps the few productive and visible researchers to maintain and strengthen their positions. Merton's starting point is the reward system of science, which is based on the different forms of recognition of researchers' work by their peers. Recognition can be manifested as citations, scientific awards, professional positions, allocation of resources and invitations for collaboration. As the achievements among researchers are unevenly distributed, so is the recognition. Merton argues that recognition is even more unevenly distributed than could be expected based on achievements. Researchers tend to give more credit to a colleague who is eminent or high-performing than to a colleague who is less known, even if the contributions from these two are equal. This is the misallocation of scientific recognition or the Matthew effect, which can be described by referring to a passage in the Gospel according to St. Matthew in the Bible: "For unto every one that hath shall be given, and he shall have abundance, but from him that hath not shall be taken away even that which he hath". (Merton 1973, 439-446.)

Merton goes on to describe the social and psychological bases of the Matthew effect. He argues that eminent researchers tend to have an ability to focus on relevant and ground-breaking problems, and work on their research and publications longer to make them better than average. Other researchers learn to expect higher quality work from the eminent researchers, and this works for the logic of the Matthew effect. High expectations towards the eminent ones also further encourage and pressure them to maintain their level of work and standing among their peers. (Merton 1973, 452-456, 442-443.)

The Matthew effect is connected to the cumulative advantage in science, a phenomenon where some researchers gain access to better material and immaterial resources than others in the early stages of their careers. Resources can be encouragement and attention from senior colleagues, research funding, opportunities for publishing and access to networks. Usually, these researchers are the ones who have more talent for research work than the others because they are selected as junior researchers by the leading research groups and departments in their field. Once some researchers gain this early advantage, they have better opportunities to become eminent researchers. As eminent researchers, they gain disproportionately more recognition than the others, which leads to more and better opportunities for conducting research. These opportunities will, in all likelihood, lead to more achievements, such as highly-cited publications. (Cole & Cole 1973, 72-75; Merton 1973, 457-458, 1988.) The circle of opportunities, achievements and recognition will further strengthen the accumulation of achievements for a small number of researchers. At the same time, those who have fewer achievements, less recognition and opportunities face difficulties in acquiring them because rewards and recognition in the scientific community are largely based on past achievements.

Although the results are not conclusive, empirical research indicates that the Matthew effect and the cumulative advantage do exist. Resources and achievements tend to concentrate on the established and eminent researchers, and the division between them and the rest grows over time and within age cohorts (e.g. Allison & Stewart 1974; Allison et al. 1982; Larivière et al. 2010; Puuska 2010). Kyvik (1991, 221-222) suggests that cumulative advantage in publication productivity works for male researchers in a particular career stage, when a large share of female researchers have children and use more of their time for parenting responsibilities than men. He suspects that changes in the gender system in modern societies may lessen the influence of cumulative advantage. However, the results from recent studies are ambiguous on whether the cumulative advantage for

men has disappeared among younger generations of researchers (van Arensbergen et al. 2012; Danell & Hjerm 2013).

New forms of research funding from industry and policy requirements to produce applied research output such as patents, prototypes and policy-relevant publications do not appear to have changed the logic of the Matthew effect and cumulative advantage. The resources for and outputs from applied research largely accumulate for the researchers who are also the most successful in basic research (Gulbrandsen & Smeby 2005; van Looy et al. 2004).

4 Data and methods

The two research questions and perspectives on research performance that are set in Articles I-III on the one hand and in Article IV on the other hand have different implications, not only for conceptual tools but also for the use of data and methods. The choices regarding data and methods go very much hand in hand in Articles I-III, while the methodological choices and questions in Article IV are different. Table 3 includes an overview of the data.

Table 3. Data used in dissertation.

	Research funding	State steering models	Research performance	Background data on Nordic sociologists and sociology departments
Article I: Comparison of university systems in 8 countries	OECD and national R&D statistics, national policy documents, research reports		Publication data from WoS database	
Article II: Comparison of university systems in 5 countries	OECD and national R&D statistics, national policy documents	Research literature and documents on policy development in compared countries	Publication and citation data from WoS database	
Article III: Comparison of 3 Finnish universities	National R&D statistics, national and universities' policy documents, research reports		Publication data from WoS and KOTA database, citation data from WoS database	

Article IV: Academic staff in 16 sociology departments of Nordic universities			Publication and citation data from Google Scholar	Information on departments' websites

4.1 Sources and gathering of data

4.1.1 Research funding and state steering models

The two country-level comparisons (Articles I and II) include developed industrialized countries with established and well-funded science and university systems. The compared countries have been selected on the basis that the comparisons would include both big and small countries as measured by total R&D expenditures and output of scientific publications. Another basis for selection was the assumed differences in policy choices among countries, particularly regarding research funding. Australia, Denmark, Finland, Germany, the Netherlands, Norway, Sweden and the UK were chosen for the first analysis (research funding and publication performance). Since the second analysis (research funding, state steering models and research performance) included more data, only five countries were included: Australia, Finland, the Netherlands, Norway and the UK. Data availability was another reason for limiting the number of countries. Germany proved to be a difficult research subject in this kind of study since document and statistical data on Germany was very hard to find.

The university-level analysis (Article III) is a comparison of three Finnish universities: University of Helsinki (UoH), University of Jyväskylä (UoJ) and University of Kuopio (UoK). These universities were chosen because they differ from each other in size, disciplinary structure, research intensity and structure of research funding (Kaukonen et al. 2011, 118-123; Muhonen & Talola 2011). The selection was also partially motivated by the availability of data.

Two types of funding data was collected for each country: documentary data on the mechanisms of state basic funding, and statistical data on the development of level and sources of research funding. Data was collected from various national sources and OECD databases. To analyze state steering models, Meek and Wood's (1997) presentation of Australia and Gornitzka and Maassen's (2000) presentation

of the other countries were principal data sources. Other published research as well as documentary data was also used. In the case of the three Finnish universities, the data on allocation mechanisms for basic funding mainly consisted of documents provided by the case universities. Statistical data on the universities' R&D expenditure and shares of basic and external funding were provided by Statistics Finland.

A typical issue in international comparisons of higher education and science systems is that the quantity and quality of the available data varies if readily available statistics and documents are used as data. These were issues regarding the international comparisons of my dissertation, especially with regard to the allocation mechanisms of basic funding in the compared countries. This data was mainly documentary data collected from national sources, not from OECD statistics or other standardized international data sources. In some countries, governmental organizations such as ministries publish detailed and comprehensive documents on university funding, while in other countries information on university funding is scarcer and dispersed in various documents. Somewhat surprisingly, similar difficulties were encountered when gathering data for the analysis of the Finnish universities' basic funding mechanisms. Older documentary data on the universities' basic funding was difficult to find, and the data gathering sometimes required personal contact with employees of the case universities. In both the country and the university-level analysis, some of the data had to be collected from a number of sources in order to have satisfactory information. Research literature was also used to supplement the documentary data.

The OECD statistics on volume and structure of R&D expenditure also have certain limitations for the purposes of international comparisons, even though the OECD and the EU have made recommendations in order to standardize the statistical definitions and data collection practices (OECD 2002). One must bear in mind that the OECD data on higher education sector R&D expenditure (HERD) often includes all higher education institutions carrying out research, not just universities, and that the higher education sector can be defined differently across the different countries. For example in Finland the higher education sector covers two groups, universities ("yliopisto" in Finnish) and polytechnics ("ammattikorkeakoulu" in Finnish), of which universities conduct most of the research in higher education sector. In the UK the separation of universities and polytechnics was abolished in 1992. Some countries have also included university hospitals or some elements of public research institutes as part of the higher education sector.

Definitions and calculations of the general university funds may differ from country to country, and the OECD statistics report the structure of research funding on a high level of aggregation (Irvine et al. 1990, 3-5; Lepori 2006). Hence some measures had to be taken to clean and supplement the OECD statistics. In the comparison of five countries (Article II), the university hospitals were excluded from the R&D expenditure figures of the Finnish universities after 1997. This issue remained unnoticed in the first article. To present more precise figures on the role of public funding agencies in the funding environment of the eight countries' universities (Article I), national data sources and research reports were used instead of OECD statistics.

4.1.2   Research performance at national and university level

The ISI Web of Science databases (the Science Citation Index Expanded, the Social Sciences Citation Index and the Arts & Humanities Citation Index) were used as data sources in the international comparisons (Articles I-II). The WoS databases were also the sources for the Finnish universities' international publication activity (Article III). The citation data for the five-country comparison and for the Finnish universities (Articles II-III) was derived from WoS. In the analysis of the Finnish universities, the data source for national publications and doctoral degrees was the Finnish higher education database (KOTA).

The Web of Science is usually considered methodologically problematic for comparisons across countries, academic institutions and fields of science. The databases have a bias towards journals in natural and medical sciences and engineering, favour English language publications, and mainly cover journal articles, excluding much of the other research output. Therefore, they can give misleading information on total performance due to the differing scientific profiles in different countries and universities (Bordons et al. 2002).

Despite their limitations, the citation databases such as the Web of Science and SCOPUS remain the only available sources for publication measures in practice since there are no other databases that can provide a wide international coverage of publications. Over the past few decades, international publishing has become increasingly valued and more common in the social sciences and humanities as well (Kyvik 2003; Puuska & Miettinen 2008, 101). Since international publishing is considered a necessary target for high-standard research and emphasized in science policy agendas, the Web of Science can be considered to reflect the high-standard

international performance of a university system or a university. One also needs to note that the majority of scientific publishing across fields of science actually takes place in natural sciences, medicine and engineering, where the publication activity is relatively well covered by the Web of Science. Furthermore, as the main purpose of Articles I-III is not to compare university systems or universities with each other but to follow the historical development of their research performance, the limitations of the WoS data do not compromise the analyses.

4.1.3   Nordic sociologists' publications and citations

The data on the scholars of the 16 sociology departments in the Nordic universities and their research performance was gathered in 2005, when Google Scholar was in the beta testing phase (the GS search engine has since been partially remodelled). Every individual faculty member's first name and surname in quotation marks was used as a search phrase. The names and positions in the faculty were drawn from each department's web pages. In some cases the various search results differed a little from each other. This inconsistency is a known technical problem in search engines and databases, which was resolved by using the best search result for the researcher. The various academic positions were classified under three categories: 'Professor', referring to the highest faculty position in the department; 'Emeritus professor', referring to retired staff with continuing ties to the home department; 'other teaching position', referring to a large class containing researchers at PhD level, i.e. with a PhD, and other staff with a teaching responsibility. A lack of data reliability prevented the use of the category of 'affiliated faculty'; the departments seemed to have different definitions of 'affiliated faculty', which did not enable the composition of a stable category.

Because of the sorting techniques of the GS search engine, there is enough data to study the most relevant and influential publications - i.e., publications that receive the most citations are put in the highest places on the search results list. Working papers, abstracts of conference papers and master's theses were not considered publications. The age of the most cited publication was limited to a range of 0–25 years; hence, the oldest publication in the data is 23 years old. The number of citations was drawn from the researcher's most cited publication because of the research interest in the most visible work of these scholars. The first 10 hits from every scholar were subjected to closer study, thus limiting the maximum for an individual researcher to 10.

A notable feature of Google Scholar at the time of the data collection was that the individual search results (hits) do not necessarily represent publication. Among the researchers with 10 hits at most, 37 per cent of the hits were publications. This proportion of publications was estimated to apply in the case of more than 10 hits as well. In all, 47 per cent of the hits were some form of research output produced by the sociologists in question. However, the analysis concentrated on the published research output and its impact, and other forms of output were excluded.

4.2   Methods of analysis

Table 4 presents an overview of the methods that were used to analyze the data of the dissertation.

Table 4.   Methods used in dissertation.

	Research funding	State steering models	Research performance
Article I: Comparison of university systems in 8 countries	Interpretation of policy documents, calculation of funding structure according to analytical framework (Section 3.1)		Performance indicator: R&D expenditure per scientific publications (6-year moving averages, 6-year time lags)
Article II: Comparison of university systems in 5 countries	Interpretation of policy documents, calculation of funding structure according to analytical framework (Section 3.1)	Interpretation of research literature in relation to features of steering models (Section 3.2)	Performance indicators: Scientific publications per R&D expenditure (2-year time lags), shares of OECD14 publications and citations
Article III: Comparison of 3 Finnish universities	Interpretation of policy documents, calculation of funding structure		Performance indicators: National and international

	according to analytical framework (Section 3.1)		scientific publications and PhD degrees per academic R&D expenditure (3-year moving averages, 3-year time lags), citation impact relative to OECD14 countries (3-year citation window, 3-year moving averages)
Article IV: Academic staff in 16 sociology departments of Nordic universities			Descriptive: Distributions of publications, citations and web search hits among sociology staff and departments Explanatory: Two-level regression analysis (author level, department level)

4.2.1   Research funding and state steering models

In both international comparisons (Articles I-II) and in the comparison of Finnish universities, (Article III) the main focus in the analysis of research funding was a) to analyze the allocation mechanisms of basic funding and b) to analyze the structure of research funding - that is, shares of basic and external funding. In other words, the focus was on the dimensions of the analytical framework that was described in section 3.1.

The analysis of the basic funding was based on describing the allocation method(s), funding components and their shares of the total basic funding, and the funding criteria. As the funding criteria determine the input-output orientation of basic funding in the framework, most attention was paid to them. The distinction

between input and output criteria was made according to the following guideline: when the financier (government or university) focuses on the sufficiency of resources, it uses input criteria, and when it focuses on the performance and results of the activity, it uses output criteria. Typical input criteria include, for example, the existing funding level, the number of staff and students, and the strategic and political considerations. Typical output criteria include, for example, the number of produced publications, degrees and study points, the amount of (external) research income earned, and the results of quality assessments. As mentioned earlier, several policy documents and research publications were used to retrieve the necessary information for describing the funding mechanisms and making the distinctions between the funding criteria. For the second dimension of the funding environment - the ratio of basic research funding to external funding - a more straightforward method was used: the ratio was calculated using the OECD or national statistics on R&D expenditure of national university systems (Articles I-II) or of individual universities (Article III).

While the main guidelines in analyzing research funding were similar in Articles I-III, some choices differed from each other. Different time spans were used in all three articles: Article I looked at funding and its changes from 1981 to 2000, Article II from 1987 to 2006, and Article III from 1991 to 2003. Changes in the structure of research funding were presented at a more aggregate level in Articles II-III, whereas Article I included a more detailed analysis of funding structures. The analytical framework was also employed in different ways. In Article I it was used to illustrate the final situation of the competitive intensity of the national funding environments at the end of the analyzed time period. In Article III, the case universities were depicted as having different positions in the framework depending on the temporary changes in the funding environment. The framework itself was not used in Article II but its idea was employed in analyzing and describing the changes in the funding environment of the five compared countries.

In the analysis of state steering models (Article II), the countries were compared in terms of their position relative to four steering models described by Gorniztka and Maassen (2000). The countries were placed on a continuum (weak-strong) based on how strongly the policy developments in a given country fitted the description of a given model. The historical development of each country with regard to steering models was described, and the final situation at the mid-2000s was presented in a figure. This analysis was mainly based on the interpretation of research literature on the policy developments in the five countries.

A relevant technical issue in longitudinal international comparisons of research funding is to remember to use the inflation adjusted figures of R&D expenditure. Equally important is to adjust the purchasing power of different currencies by using the so-called purchasing power parity (PPP) rates of HERD from the compared countries. If these measures are not taken, the analysis gives a misleading picture of the compared countries' R&D expenditures. The above-mentioned data is readily available in the OECD databases, and the HERD figures were presented in the year 2000 as US dollars PPP in Articles I-II. For Article III, R&D expenditure was indexed to the year 2000 prices in euro to correct for inflation. No purchasing power adjustments were needed because the funding data was from a single country.

4.2.2 Research performance at national and university level

Analyses of the research performance of university systems and universities (Articles I-III) have certain similarities. All use relative performance indicators that proportion the volumes of output to the resources (input) available for the university systems and universities or present the output in relation to a reference point, for example as a country's share of publications among the OECD countries. Another common feature is the longitudinal perspective: research performance is analyzed in around 15 to 20-year time periods. There are, however, some differences in indicator choices, which are related to the goals of each of the articles or to data availability.

For the analysis of the eight countries' university research performance (Article I), six-year moving averages of publications and funding were calculated for each country, and a funding per publications ratio for each six-year period for each country was calculated. A six-year time lag between funding and publications was used, so that, for example, the six-year average of HERD in 1981-1986 was divided by the six-year average of publications in 1987-1992. The total time-span for publication activity was from 1987 to 2006. The funding per publications ratio indicates the efficiency of universities in producing one scientific publication in each country. While the publications indexed in WoS - mainly articles in scientific journals - are the major form of research output in many fields of science, they are still a relatively narrow indicator of research performance.

As a continuation for the performance analysis in Article I, two indicators were added to the analysis of research performance in the comparison of the five

countries (Article II). A total of three indicators were formed: international scientific publications (articles, reviews and letters) per country's higher education sector R&D expenditure, the share of the country's higher education sector of OECD14[1] publications, and the share of the country's higher education sector of OECD14 citations. With the last indicator it was possible to follow not only the basic output of scientific research (publications) but also its impact on other scientific research (citations).

The time period 1991-2006 was used in the case of publications per HERD ratio and 1987-2006 in the case of share of OECD14 publications. For the calculation of the share of OECD14 citations, citations to publications in the period 1987-2006 were included, starting from 1988. Publications per HERD ratio was calculated using a two-year time lag: e.g. the 1993 ratio is the number of publications in 1993 divided by the amount of HERD in 1991. All performance figures for each country were also indexed according to their starting level. For example, in the case of the citation indicator, the share of citations in 1988 was given the value 100, and changes in the share of citations in 1989-2006 were proportioned to the start year. This emphasized the point of following the development of the five countries' university systems on a case-by-case basis.

In analyzing the three Finnish universities (Article III), national scientific publishing and doctoral education were taken into the analysis in addition to international publications. A lack of data had prevented this in the international comparisons, but the situation was different when analyzing universities in a single country. The numbers of national scientific publications (articles in refereed journals, articles in edited volumes and articles in conference proceedings), international scientific publications (articles, reviews and letters), doctoral degrees and citations were included as output of research. This gave a wider perspective on the universities' research activities. The time period for degrees and publications was 1994-2006. It was also possible to use R&D statistics from Statistics Finland, which provides more detailed categorization of the sources of R&D expenditure than the OECD data. In Article III, only the so-called academic R&D expenditure was taken into account as an input of research. This included basic funding

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[1] OECD14 refers to the OECD15 countries (Austria, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Korea, Portugal, Spain, Sweden, United Kingdom and United States) excluding the United States. Citation counts are unfractionalized. Self-citations are included. All the R&D sectors of OECD14 countries are included. As citation data for the OECD14 countries was not readily available, a stratified search of the Web of Science databases was conducted for each member country.

invested in research, funding from research councils (The Academy of Finland), and funding for doctoral schools. Academic R&D expenditure was used because it better reflects the resources that are directed more to doing basic research and to basic types of research outputs, such as journal articles and doctoral degrees.

Four performance indicators were formed in Article III: national publications per academic R&D expenditure, international publications per academic R&D expenditure, doctoral degrees per academic R&D expenditure, and citation impact relative to the OECD14 countries. Three-year moving averages of publications, degrees and funding were calculated for each university. A time lag of three years between funding and publications and degrees was used. For example, the average number of international publications in 1994-1996 was proportioned to the average volume of academic R&D expenditure in 1991-1993 to get the performance figure for 1994-1996. Publication and degree-based indicators were indexed to the level of the average of 1994-1996. Separate indicators for national and international publications were used in order to see the development of the two sides of scientific publishing. Citation data included citations to international publications that were published in 1994-2006, the citations starting from 1994 and ending in 2008. Three-year citation windows were used, meaning that for each year's publications, the citations of the publication year and the citations of the next two years were taken into account. Each university's citation scores for publications in 1994-2006 were proportioned to the citation scores of the OECD14 countries in the respective years. The citation score of the OECD14 countries was given a value of 1; values over 1 are above the OECD14 average and values under 1 are below the OECD14 average. The citation scores are presented as three-year moving averages.

An optimum time lag between input and output is a relevant issue when conducting input-output analyses of research performance. Time lags are necessary because the available resources are not immediately realized as publications, degrees or citations. This is intuitively clear when one thinks of a typical research process. But how long should the time lags be? Earlier research indicates that publication output becomes visible after two years of investment in R&D, but that after six years there is no significant impact on publication activity (Adams & Griliches 1996; Crespi & Geuna 2008). For citations, the time lags between input and output are even longer, appearing after three years from investment and becoming insignificant after seven years (Crespi & Geuna 2008). In light of these results, shorter time lags can be used in order to see the most rapid changes resulting from investments in research. On the other hand, six-year time lags

indicate more solid trends between input and output. Both approaches have been employed in my study.

Moving averages of input (funding) and output (publications, degrees and citations) were used in Articles I and III. Average numbers reduce the year-to-year fluctuations in volumes of input and output. This allows for a better understanding of the trends in research performance in a time-series analysis. Reducing the contingent fluctuations was particularly important for the analysis in Article III as the output volumes varied a great deal, especially in the case of the University of Jyväskylä. However, the use of long-term averages may even out the fluctuations so much that it makes changes in performance difficult to detect.

4.2.3   Influence of funding environments and state steering models

There are no established methods for analyzing the connection between the degree of competition in the funding environment of university research and the research performance of university systems or universities. A statistical approach would require giving numerical values to the degree of competition in funding environments and changes in research performance, and then calculating correlations between the variables indicating funding environment and research performance (or its changes). This would entail a risk of oversimplifying the connection between funding environment and research performance.

It is possible to approximate the degree of competition in a two-dimensional framework on the basis of qualitative evidence (documents on basic funding) and funding statistics, but it is fully another issue to give them relative numerical values: how far is the country/university x from the country/university y regarding the degree of competition? Also, the two dimensions of framework pose problems for this approach: how does the country/university z relate to these values as it is close to country/university x on the basic funding dimension and far from the country/university y on the external funding dimension? The values would be rather speculative and difficult to interpret since they would be based on a two-dimensional estimation. The longitudinal approach to funding and research performance sets another problem for using correlation analysis. Calculating the correlation between two values would be a cross-section analysis depicting one point in time: degree of competition vs. research performance in a country/university x in time t. A number of points in time with more or less

speculative variables should be included to study the change over time. This would be possible in principle, but hardly plausible in practice.

The analysis of the influence of steering models would include similar problems. It would be possible to give numerical values to each country in Article II based on how strongly they employ each of the models at different points in time, but, of course, several values depicting different points in time would have to be given, and it would be necessary to decide how far the countries are from each other in terms of certain policy solutions. This kind of operation would provide an overly simplified picture of the connections between policy steering and research performance rather than making the connection clearer.

Since the statistical approach has its problems, a qualitative, interpretative approach was chosen to analyze the connections between funding environments, steering models and research performance. The basic idea was simple: to follow the changes in the funding environments at the level of university systems and universities and to see whether the possible changes to a more competitive direction result in higher research performance measured by any of the indicators. In a similar fashion, the development of performance indicators for each compared country in Article II was interpreted with regard to the employed steering models: under which models – if any – can improvement of performance be seen?

There were, however, certain differences in interpreting the possible influences of competitive funding environments. In Article I, the focus was on the long-term influences of competitive funding and comparing the publication performance of university systems. Article II concentrated on finding more rapid influences of competitive funding, while the university-level analysis in Article III was again focused on the longer, trend-like impact of competitive funding.

The countries and universities where there were no radical changes in research funding also formed an important point of comparison for the other countries or universities. If the analysis were to show that countries and universities with less competitive funding environments were able to improve their research performance and/or be as efficient as those with a higher degree of funding competition, the benefits of the competitive funding for research performance would also be doubtful.

4.2.4   Nordic sociologists' research performance

For the analysis of the Nordic sociologists' research performance, distributions and averages of publications, citations and hits in the Google Scholar search (indicating web visibility) were presented at the level of departments of sociology as well as at the level of individual factors (sex and position of faculty members). A relevant step in this analysis was to separate the researchers without publications from those with at least one publication. Because the analysis focused on a single discipline and publication culture, the publication counts were not fractionalized. Based on this idea, it was assumed that counting non-fractional publication numbers would give comparable numbers on publication productivity among scholars of sociology. All publication types were equally weighted for the same reason, and because the share of monographs of all publications is so small, it was assumed not to have a relevant effect on the results (Puuska & Miettinen 2008, 28).

A multilevel regression analysis was used to trace the potential factors that could affect the citation frequency and web visibility of individual members of the faculty: the position and sex of the author, publication productivity, the age and type of the most influential publication and the effect of the departmental level. This analysis included only those faculty members with at least one publication. Multilevel analysis takes the nested structure of the data into account and allows any variation to be examined at two levels. The multilevel linear regression model was fitted separately for the citations and the web hits. The separate models made it possible to determine whether similar factors influence citations and web visibility. The relationship between web visibility and citation impact was also examined.

A multilevel Poisson regression model was also used because of the skewed distribution of the explanatory variables, but since the findings did not differ markedly from the multilevel linear regression model, the results are based on the normal linear models. The skewness of the dependent variables was corrected by limiting the high end of hits and citations to 100. This affected the two most cited publications, with 198 and 1328 citations, and the four authors with most hits, ranging from 121 to 378.

5   Summary of results

5.1   University research funding

5.1.1   Different trajectories of funding environments of university research at national level

The compared countries in Article I (Australia, Denmark, Finland, Germany, the Netherlands, Norway, Sweden and the UK) can be roughly clustered into three groups according to their input-output orientation in government basic funding in the early or mid-2000s. To start with the output-oriented basic funding systems, the UK and Australia were clearly the most output oriented. In Australia the system was to some extent more focused on measurable performance (e.g. the amount of research income and number of publications) than in the UK. In the UK, the emphasis has been on the outcomes of the Research Assessment Exercise (RAE), while some input-oriented funding components can be found in the system. The second group includes Norway, Finland and the Netherlands. All these countries used a formula, evaluation and quantified criteria, but the extent of the existing activities, number of students and circumstantial considerations played a bigger role in the allocation than in the UK and Australia. The least output-oriented countries in this comparison were Sweden, Germany and Denmark. The significance of the formula-based allocation decreases in these countries compared to the two previous groups. The extent of the activities (historical basis) and political considerations have played a more prominent role. They have been rather input oriented in the allocation of basic funds, even though some indicators have been used. Denmark was an exception to some extent as performance indicators were used in the allocation of new research grants.

At the beginning of the 2000s, the UK, Finland and Sweden were the most competitive funding environments for universities when looking at the shares of internal and external funding. The role of basic funding and university assets in research was more significant in the rest of the countries, with the Netherlands emerging as the least competitive funding environment. Longitudinal data shows

that the funding environments have become more competitive in all the compared countries as the share of internal funding decreased in all of them between 1981 and 2000. The extent of this development has varied, the largest changes having occurred in the UK and Finland.

Looking more closely at research funding in the university sector in the five compared countries in Article II (Australia, Finland, the Netherlands, Norway and the UK), it is possible to observe the following developments in 1987-2006. In the UK, the share of internal funding was already rather low at the beginning of the period and did not decline very much from that level. Output orientation has been high in government basic funding for the whole period of the analysis. Shifts towards more selective basic funding since the early 1990s have made the system even more output oriented. In Australia, the relative funding model marked the beginning of a performance-based approach in research funding. External income was used as a basis for funding allocations. A new funding formula was introduced in 1995, including other output measures such as publication counts and higher degree loads and completions. In 2001, formula funding was expanded to account for more than half of the funding specifically targeted at research and research training. In Finland, the increase in external research funding has been remarkable. The basic funding model was very input oriented before the mid-1990s, after which the weight of output criteria has increased. However the funding model was still relatively input oriented in the mid-2000s. In Norway, the share of basic research funding has remained rather high. The system of basic funding was heavily input oriented until the turn of the millennium, after which some output criteria have been added to the system. Input orientation is still quite strong. In the Netherlands, the share of basic funding has remained relatively high, although it has decreased considerably since the early 1990s. The basic funding model was more output oriented than in most of the other compared countries at the end of the 1980s, but more input criteria were introduced at the beginning of the 1990s. At the end of the 1990s, the funding system was again altered towards a more output-oriented direction.

In countries where the relationship between target setting and funding of research is less pronounced, government basic funding does not steer research activity significantly, or steering takes place indirectly via funding agencies (Sweden, Denmark, the Netherlands and Norway). If at the same time the proportion of external funding is low (Germany), the influence of external steering and competition incentives on research is limited. In these countries, the degree of systems' built-in competition is also low or moderate.

Input-oriented basic funding systems may balance the competitive effects of external funding. This holds true for Sweden and, to a lesser extent, for Finland. The situation is clearly different in the UK and Australia, where the basic funding systems emphasize funding through performance, giving a lot of weight to steering incentives and competition. Furthermore, as research is to a large extent externally funded, especially in British but also in Australian universities, these university systems include cumulative competitive elements.

The increase in the share of external, competitive funding and the growing use of output-based criteria in basic funding in the compared countries from the 1980s to the 2000s shows that several countries have moved away from trust as a solution to the delegation problem of the principal-agent setting between the state and the university system and transferred to monitoring. The increasing share of external funding is the more general trend as the change in basic funding criteria. At the same time, the analysis shows that the pace and extent of this shift varies among countries.

5.1.2 Intensification of competition for funding in Finnish universities

With regard to developments in research funding at the university level in the three Finnish universities (Article III), the early 1990s was mainly a time of the incremental mode of basic funding in the case universities. The universities allocated funding to their units (faculties or departments) according to same general principle as the state allocated basic funding to universities - i.e., based on the existing levels of funding. This practice of funding allocations continued for a longer period of time in the Universities of Helsinki and Jyväskylä than in the University of Kuopio. The share of external research funding grew in all the case universities in 1991–2003. This means that towards the turn of the millennium, all of the case universities had become clearly more competitive environments in both dimensions. The University of Kuopio was ahead of the other universities.

The development of the three universities as funding environments appears to follow the national development of the funding landscape of university research in Finland in the 1990s. The reason for this may lie in the Finnish universities' general dependence on state funding in both research and teaching. At the end of the 1990s, as the state changed its university funding policy, it also created new incentives for the universities. Because of the slowly growing basic funding and increasing costs, it was possible for the universities to increase their research

activity mainly through the rapidly growing external funding (Nieminen 2005, 92-94). At the same time, the new basic funding model used by the state meant that some kind of performance-based funding allocation became a viable option for the universities' own basic funding models. Similarly, the strong role of the state in external funding meant that the competition for external funding throughout the whole university sector also had an impact within individual universities.

5.2   State steering models

In the UK, the government made a notable reduction in higher education expenditure and moved away from the institutional steering model towards the supermarket model in the early 1980s. The effects of the cutbacks and the changes in the government approach sensitized the universities to money as a policy instrument of the government. Research funding was heavily connected to the research assessment exercise, which took place in 1986, 1992, 1996 and 2001. During the period of analysis, the UK universities as private sector institutions have had a considerable amount of autonomy to define their priorities and plan their activities. As private sector institutions, they have also been dependent on customers, that is, research financiers and students. But even with a high level of autonomy, the government has been able to use public funding in an effort to steer the universities to act according to national science policies.

Since the late 1980s, the Australian higher education policy has placed substantial trust in market mechanisms, and the concept of the market has helped regulate the relationship between higher education institutions and the government. The government was not totally disinterested in the regulation of higher education. There was an increasing emphasis on quality control and other accountability measures. The end of the dual system of universities and colleges of advanced education in 1987 created pressures for efficiency, elimination of apparent duplication and consolidation into more economic units. A consequence was mergers of higher education institutions to larger units. In addition, a new funding system designed to give the institutions a fair degree of autonomy and flexibility in the management of their resources was introduced. The motivation for giving institutions more autonomy was to facilitate the achievement of the goals officially set out for higher education.

In Finland, the relationship between the state and the universities has moved away from the classic sovereign state model of the 1960s and 1970s for the past 20

or so years. Since 1994, the universities and the Ministry of Education have negotiated performance agreements, which have become the single most important steering device of the Ministry of Education. In the second half of the 1990s, the universities have been given the freedom to decide on a number of issues. The result-orientation and market-based co-ordination of the funding and management system reflect the change towards the supermarket model of state steering. In association with the political rhetoric of decentralization and the delegation of responsibility from the state to the higher education institutions, a national evaluation system was developed. The increase in organizational independence from the central government is balanced by an increase in accountability. However, the evaluation has not yet been linked to the performance agreements or government funding allocations.

In the Netherlands, government introduced a new steering model in 1985. It was based on the notion that the higher education sector would become more effective and efficient if the universities had more autonomy and the government were to step back. Until the late 1980s and early 1990s, the formal regulations for the university sector fit the sovereign state model. Elements of the institutional model could also be found. In 1993, university regulatory autonomy was further strengthened in the Higher Education and Research Act. In many ways, the governmental steering of higher education moved away from setting the conditions to focusing on the performance of the institutions and students. The change in the steering focus is visible in the quality assurance system, which, instead of controlling beforehand, evaluates afterwards. Since 1993, university research programmes have been assessed through a system of peer review. The assessment is conducted by the institutions themselves and the results are used for developing their internal policies, not as inputs for the government funding decisions.

In Norway, university student enrolment doubled between 1987 and 1994, and more resources were channelled into teaching. As a response to the state interest in teaching, the universities started to develop their own research policies at the end of the 1980s. This development was also encouraged by the state, but governmental steering had little influence. Since the early 1990s, the universities have prepared strategic research plans and established administrative units for research policy matters. During the 1990s, the government's role in controlling the higher education sector has changed from the earlier, relatively strongly centralized steering towards giving HE institutions more autonomy and making them more accountable. The state has played a significant role in the Norwegian university sector as it allocates most of the funding for research. The universities, therefore,

cannot ignore its goals. None of the four steering models have dominated in Norway, but the Norwegian steering approach has consisted of a mixture of elements of the sovereign model, the institutional model and the supermarket model. Besides the Ministry of Education, a number of other stakeholders have been involved in decision-making and planning, which means that the elements of the corporate-pluralist steering model can also be found.

To sum up, all the five countries studied in Article II have a mixture of elements from at least two different models, with Norway having a mixture of elements of all the models. In the UK, the supermarket model dominates, and it is also strong in Australia. Australia has also heavily relied on the sovereign steering model. Finland has a scattered orientation to all the models. The corporate-pluralist model is strong in Norway, while the elements of the institutional model can also be found. The Netherlands has employed the institutional model more than the other compared countries. Common trends in the state steering in the compared countries have been an increase in the regulatory autonomy of universities, and an increase in the accountability of universities via market mechanisms.

5.3   University research performance

5.3.1   Questionable influence of performance-oriented policy solutions on research performance at national level

The results of the national level comparisons differ somewhat regarding the development of research performance and the possible effects of competitive funding environments. If the performance indicator of Article I is used (higher education sector R&D expenditure per scientific publications, 6-year averages, 6-year time lags), countries can be divided into two groups based on their performance in 1987-2006: the UK, Finland, Australia and Denmark form the group of more efficient systems, while the Netherlands, Sweden, Norway and Germany are less efficient. The latter group is less coherent than the former. The countries in the latter group come closer to each other towards the end of the period of analysis while starting relatively far away from each other. Since the UK, Australia and Finland have become more competitive funding environments for universities than the other countries, the result appears to support the idea that

operating in a more competitive funding environment is beneficial for university research performance, at least if one looks at the national level.

However, it can also be observed that the performance indicator remains relatively unchanged in nearly all the countries throughout the entire period. The countries that have used more competitive funding systems (the UK, Australia and Finland) since the mid-1980s or the mid-1990s to fund universities were not able to raise their publication efficiency in the long term. Finland's performance even went down at the end of the period. Furthermore, Denmark is in the group of more efficient countries while the funding environment for Danish universities was one of the least competitive ones. The same partly applies to the Netherlands, although it must be noted that the efficiency of the Dutch university system is clearly lower than that of the top four countries. Sweden and Germany also demonstrated a substantial increase in efficiency even though they were relatively non-competitive funding environments for university research.

There is also a methodological reason why one should be cautious in interpreting the results of Article I in favour of the competitive funding environments. The UK and Australia may have a relative advantage as English-speaking countries in producing articles for mainly English-language international journals. When the Web of Science database is used as a data source, English-language countries easily appear more productive than non-English-speaking countries. The language factor may partially explain why Germany, as a big science system, does not get higher values in this comparison: her scientific community is oriented towards producing publications for both English and German speaking audiences. German language publications are less extensively covered by the Web of Science databases. As noted in Section 2.5, a similar problem exists when studying countries' citation impact (van Raan et al. 2011). The effects of national policy instruments (such as research funding) on research performance are perhaps best analyzed on a case-case basis by looking at the countries' developments with regard to their own history.

Closer examination of the university systems' research performance in the five countries (Article II) also gives reason to doubt the benefits of the competitive funding environment in improving research performance. However, one can also see some differences when different publication indicators are employed (scientific publications per HERD, 2-year time lags, share of OECD14 scientific publications). In the UK there was a moderate increase in the share of OECD14 publications between 1987 and 2006. The effects of the Research Assessment Exercises can be seen as visible jumps in publication performance (especially when

looking at the scientific publications per HERD ratio) in 1995 and 2001. However, both indicators only show a short-term improvement in publication performance. Australia's share of OECD14 publications has constantly increased since the beginning of the 1990s, but the publications per HERD ratio have stagnated since the late-1990s. This indicates a weakening efficiency in the use of resources despite an increasingly competitive funding environment, but also gains from the funding competition in the form of publication output. Finland has increased her share of the OECD14 publications, but this development halted in 2001. After a clear growth in the 1990s, the ratio of publications per HERD started to plummet around 1997 and declined below the 1993 level. This result suggests that the competitive funding environment may even have negative consequences for research performance, at least in the short term. In the Netherlands, the university sector has been able to increase its publication efficiency almost constantly from the early 1990s to the mid-2000s, while the share of OECD14 publications started to grow after the end of the 1990s. This finding supports the above claim that the enhancement of national research performance can happen without using incentives and competition in research funding. Norway's share of OECD14 publications has gone hand in hand with the publications per expenditure ratio. The former increased considerably after 2003. The implementation of a basic funding model with publication-related criteria happened at the same time as publication performance improved. The result suggests that a rather moderate incentive can be also have positive consequences for research performance.

The citation-based performance indicator (share of OECD14 citations) goes hand in hand with similar publication-based indicators (share of OECD14 publications) in all of the five countries in Article II. The implication is that when a country is able to increase its output of international publications more than other countries, it also gains more visibility for those publications among the international scientific community.

With regard to the effects of the four steering models, the Netherlands is a sort of success story of a more traditional university system and steering relationship because the institutional steering model emphasizing university independence from the state has dominated the Dutch system, and all the performance indicators in Article II show improvement. Norway's strong orientation towards the corporate-pluralist steering model has been seen as a considerable strength in the successful implementation of reforms that have improved Norway's scientific productivity in recent years. A strong orientation towards the sovereign steering model, as can be found in Australia, does not have a positive influence on publication productivity

(publications per HERD). In the case of the UK and Finland, the publications per HERD ratio actually declined at the turn of the millennium. This suggests that Britain's strong orientation towards the supermarket steering model and Finland's scattered orientation to all of the four models have not been successful with regard to publication productivity.

To sum up, the benefits of a performance-oriented policy appear to be doubtful at the national level, especially in the long term. All indicators employed in analyzing the research performance of university systems show that a long-term improvement in research performance does not automatically follow from using output-based funding allocations, external funding or a market-type policy steering. The examples of the UK, Australia and Finland are indications of this. The developments in research funding and state steering also indicate that research performance can be improved without extensive use of performance-oriented policy instruments. This is particularly clear in the cases of the Netherlands, Sweden and Germany. However, there are some short-term improvements resulting from moving to a more competitive funding environment (the UK, also Norway).

5.3.2 Mixed consequences of competitive funding environment on research performance at university level

To a large extent, the university-level analysis of research performance among the three Finnish universities (Article III) points towards similar conclusions to those of the national level analyses. The funding environment of research in all three universities became more competitive between 1991 and 2003. If competing for money does improve research performance, one should see an improvement in all of the case universities, but, according to the performance indicators used (national and international scientific publications and PhD degrees per academic R&D, citation impact relative to OECD14 countries), this did not happen. However, there is no reason to completely abandon the idea of a performance-oriented policy when looking at the university level.

The shift towards more competitive funding environments appears to have had mixed consequences with regard to the universities' research performance. The increase in the share of external funding has occurred hand in hand with the rising productivity of international publications and degrees, and, with a delay, with the rise of citation impact in the University of Jyväskylä. However, this development

halted at the turn of the millennium. In contrast to Jyväskylä, the improvement of performance in terms of publications and degrees in Helsinki and Kuopio was very modest. In Helsinki there was also a decline in publication and degree productivity after the turn of the millennium, and in Kuopio a remarkable drop in productivity of national publications in the mid-1990s. There was a visible improvement in the citation impact that occurred in as the share of external research funding was increasing in the 1990s, but, as in Jyväskylä, the citation impact in Helsinki and Kuopio declined in the early 2000s. The case of Jyväskylä provides more grounds to support the policy argument for funding incentives than the cases of Helsinki and Kuopio.

At the university level, creating a more competitive funding environment may make university research more effective in terms of publications and degrees. Increasing external funding appears to be more effective than creating output-oriented basic funding models. However, efficient use of resources may be difficult to improve once a certain level has been reached. Regarding citation impact, competition can also have a positive influence. However, since the competitive funding environment doesn't seem to have very long-term and comprehensive positive effects on research performance, it is likely that other factors are more decisive than funding incentives for research performance in the long run.

5.4   Patterns of research performance among Nordic sociologists

5.4.1   Individual and departmental factors promoting the productivity and visibility

Analysis of Nordic sociologists' research performance based on Google Scholar shows that the distribution of publications and citations among individual scholars is very skewed. A third of all researchers did not have publications (excluding conference papers, working papers, etc.). Of those scholars with publications, 67% have at most 5, and only 10% have at least 10 publications. The average was 4.3 when the maximum was limited to 10 publications. Twenty-three% of the scholars had at least 10 citations, while 10% with at least one publication were left without citations. An average value for citations was 9, where the maximum was limited to

100 citations. In terms of web hits, the average visibility was 17 hits per scholar, with the maximum limited to 100 hits.

Several author-level explanatory factors were statistically related to the web visibility of the sociologists - that is, the number of hits based on a Google Scholar search. The hits were scientific publications, but other types of publications, as well as acknowledgements and other references to persons were also searched for (see Section 4.1.3). Female scholars had far fewer hits than men. Position was closely linked to hits: senior researchers had more hits. The type, in particular the place of publication, predicted the number of hits. Authors whose most influential publication was international also gained more hits than those whose top publication was a national one. The age of the most cited publication was also positively associated with the number of hits.

The variation in the number of web hits was not only between individual researchers but also between departments to some extent. Since the departmental level explained 4.1% of the variance in the web hits, some activities seem to be departmentally bound, so that particular departments are slightly preferred in activities visible as web hits. The variation between these departments was partly explained by the department's number of staff, with bigger departments producing significantly more hits than smaller ones, even when the effects of the author-level factors were taken into account. The countries did not differ significantly from each other.

The differences in web visibility between females and males were rather similar in all departments, but the effect of position varied significantly across the departments. A more detailed examination showed that individual top scholars tend to increase the difference in visibility between professors and other staff members. The top performers' achievements did not impact equally on other researchers' performance in the department. This suggests that individual top performers do not necessarily enhance the level of the whole department (Smeby & Try 2005).

The influence of author-level factors on citation rates was similar to the influence on web visibility. First, women were cited significantly less than men. Professors and emeritus professors were cited significantly more than other staff. International monographs drew far more citations than any other kind of publication. The international refereed journal articles were to some degree more cited than other international articles or national publications. Not surprisingly, the age of the publication correlated strongly with the number of citations, each year adding one citation on average.

The effects of sex, position and age of publication on citations largely vanished when the effect of individual visibility on the web (number of hits based on a Google Scholar search) was taken into account. Although female scholars seemed to attract far fewer citations, this difference turned out to be mostly an outcome of the individual differences in visibility. Both the individual web visibility and publication productivity were strongly associated with the citation impact. Each new publication added more than two new citations to the most cited publication. Similarly, web visibility and citations went almost hand in hand: the greater the web visibility, the more citations the author drew. An active publishing history increased the probability of citations. In the multivariate model, only individual web visibility and the type of the most cited publication remained significant predictors of the probability of citations. Controlling for the effect of web visibility diminished the impact of international publication types compared with national ones.

Unlike in the case of web hits, the departmental level explained only a small proportion of the variation (0.3%) in the number of citations. In other words, compared with the variation across individual authors, the variation between departments in terms of citations was almost non-existent. The differences between countries were not statistically significant. The average number of hits was the only departmental factor that is significantly related to the number of citations, which indicates that the productive and otherwise visible departments attract significantly more citations. However, this was only due to the author-level relationship between web hits and citations since the departmental-level effect disappeared when the author-level effect was taken into account.

The correlation between hits and citations varied significantly across departments. In some departments (Göteborg, Lund, Turku and Åbo), the most cited authors were among the least web visible authors within the department. Citations appear to be more closely tied to individuals, while hits are more related to positions and departments.

The importance of position for web visibility in the form of publications and other types of scientific output refers to existence of the Matthew effect and resulting cumulative advantage among Nordic sociologists. The link between web visibility (e.g. publications) and citations points towards a similar conclusion: publication productivity brings recognition in the form of citations. Recognition, in turn, gives further possibilities for publishing. In all, a mutually reinforcing configuration between web visibility, citations and position seems to prevail. However, with this cross-sectional data it was not possible to analyze whether the cumulative advantage is present within age cohorts of Nordic sociologists.

5.4.2 Publication behaviour in Nordic sociology

If publication behaviour is approached from the perspective of shares of most cited publication types rather than the perspective of shares of different publication types with regard to total publication output, one finds that monographs and articles in edited volumes seem to have maintained their standing as relevant and influential publications in sociology. Around 60% of the most cited publications by the Nordic sociology departments' staff were other than international journal articles. On average, international monographs and articles in edited volumes attract more citations than other types of publications. As far as the number of citations per publication goes, international journal articles have not become the dominant type of publication in sociology. However, they are the *most cited individual publication type*. The remaining salience of books in sociology suggests that the practices and functions of sociology have remained different from the hard fields of science.

The finding that international publications draw much of the highest citation impact suggests a growing international publication behaviour in Nordic sociology. From the perspective of citation visibility, it's profitable for sociologists to publish internationally as the international audience is usually much larger than the national one.

5.4.3 Analysis of research performance based on Google Scholar data

Regarding scholars' publication productivity and citation impact, Google Scholar and citation databases seem to amount to largely similar findings. The same skew pattern among sociologists is found in Article IV as in previous studies, which are often based on data from citation databases. For example, a study of sociologists in Nordic university departments (Bjarnason & Sigfusdottir 2002) based on data from the WoS Social Science Citation Index and Sociological Abstracts shows that the proportion of faculties with no publications was 31%, a result very similar to that of Article IV.

There are also some systematic differences. The high citation impact of international monographs and articles in edited volumes indicated by the Google Scholar data is an evident difference. This phenomenon is hidden when the analysis of research performance is based on citation databases that poorly cover forms of publishing other than journal articles.

The success of individual authors may vary significantly depending on whether Google Scholar or citation databases are used. Individual journals or publishers may be completely absent, amounting to systematic differences between GS and citation databases (Jacsó 2005). The inclusion criteria for what is considered a reportable scientific publication vary between citation databases and GS. Studies on the coverage of databases show that WoS is particularly selective in indexing journals (see e.g. Gavel & Iselid 2007; López-Illescas et al. 2008). Because the providers of citation databases are selective and cautious in accepting new journals, the new and less conventional fields of research may be better represented if the data is gathered using Google Scholar. Citation databases give a more stable picture of academic work.

Google Scholar provides data that requires much more cleaning than data acquired from citation databases. In the case of the Nordic sociologists, the majority of hits resulting from the Google Scholar search were not scientific publications but acknowledgments and other references to the sociologist in question. Other studies on Google Scholar point to similar conclusions. Jacsó (2010, 2012) has been particularly critical of the ability of GS to provide data that is stable enough for research assessments and analyses of research performance.

6   Discussion

The results of my dissertation indicate that at the level of national university systems, improvements of research performance are not an automatic and direct result of the competitive funding environment or of a state steering model that relies on market mechanisms. Short-term improvements in research performance can follow from increasing competition for funding, as the cases of Norway and the UK show. But it's not evident that the short-term improvements are worth employing national-scale policies. Furthermore, the cases of Sweden, Denmark and the Netherlands suggest that university systems can be high-performing and/or improve their performance in conditions of a relatively low level of competition for funding or when the state steering is not based on a market-type steering model. The university-level analysis also points to relative ineffectiveness of a competitive funding environment in improving research performance. The University of Jyväskylä is a positive example of the effect of competition, but even in Jyväskylä the effect is not very long-term. Policy measures based on competition for funding and market-type steering appear to be relatively ineffective instruments for improving research performance in universities, at least in light of the performance indicators that were used here.

Below I discuss some possible explanations for the mixed success of a competitive funding environment and market-oriented steering. The explanations relate to 1) changes in the operational environment of the universities, 2) consequences of the use of different funding instruments, 3) limits of performance improvements and 4) the interplay between the cultures of scientific communities and policy goals and instruments. At the end of this section, I reflect some of the limitations of my analysis, and suggest themes and directions for further research on research performance.

Increased use of funding incentives for steering university research during the past 20-30 years indicates that national policy-makers and (Finnish) university management have moved away from using trust as a solution to the principal-agent dilemma (Braun 2003; van der Meulen 1998). Monitoring has replaced trust. Selection of agents (universities, units or researchers) to conduct tasks (research) has also intensified as an increasing share of research funding is allocated as

competitive project funding. Somewhat paradoxically, this can lead to worse possibilities for national governments or university management to implement their policies. The increase in funding from sources that are not directly governed by the Ministry of Education or an equivalent policy body has brought new principals to the national funding landscape of university research (e.g. research councils, government organizations, international research funding agencies and firms). As a result, researchers, university departments and universities orient themselves towards principal-agent relationships other than with the state (Shove 2003; Morris 2003; Kivistö 2007, 189-191). In this kind of situation it's more difficult for the government to enforce its goals than in a situation where most of the research funding consists of state basic funding. At the university level, the ability of the university management to exercise power over units and researchers via financial incentives is also limited because of multiple principals. This is because agents are less dependent on a single funding source (state at the national level and university administration at the university level). The situation with multiple principals allows freedom for agents, be they universities, university units or individual researchers.

Furthermore, while research funding is allocated based on competition, the research activity based on competitive funding may not be intensively monitored. Studies on principal-agent relationships among representatives of research councils and researchers suggest that the researchers' autonomy to follow their own interests, goals and values is high (Shove 2003; Morris 2003). Caswill (2003) has found a similar higher level of autonomy for agents in a study of relationships among researchers, public research funding organizations and state institutions. These findings further indicate that the control over university research by central national principal, such as the Ministry of Education, is limited by an increase in competitive external research funding.

The question of stakeholders in universities is closely related to the principal-agent dilemma. Universities have many stakeholders that demand their missions be performed by the universities, and the number of stakeholders has grown over recent decades along with the growing number of sources for research funding (Jongbloed et al. 2008). As a result, the interests and mission demands from other stakeholders intervene in the relationship between universities and central governments and make it more difficult for governments to implement performance-oriented policies. While this provides more autonomy for the universities and their staff in the relationship with the state, it may also lead to mission overload and mission confusion, especially if a single stakeholder (such as

the government) presents several, possibly conflicting, goals. (Jongbloed et al. 2008.)

A possible source of mission confusion is the demand for both high performance in basic research and the societal relevance of the research. A strengthening trend in the science and higher education policies of several countries since the 1980s has been the demand for usability of research results. Several studies show that the influence of increased research funding for applied research has not led to a decrease in basic research but rather to a multiplicity of research tasks and audiences of research at the aggregate level of the university system. The extent of the change has also been called into question (Gulbrandsen & Smeby 2005; van Looy et al. 2004; Kyvik 2007; Gulbrandsen & Langfelt 2004). However, individual universities and units may receive significant amounts of funding that is targeted for applied research or cannot compete successfully on different types of funding. This may lead to a trade-off situation between conducting basic or applied research, where working time and funding is increasingly used for conducting applied research and the productivity of basic research output, such as scientific publications and doctoral degrees, decreases (Nieminen 2005, 139-155; Ylijoki et al. 2012; Tammi 2009).

The continuous worldwide growth in the number of scientific journals and publishers is increasing the potential avenues for publishing. With the simultaneous growth in resources, both in terms of funding and number of staff, it is likely that the number of scientific publications will grow, despite the policy measures. In general, the number of publications published in science is positively connected to the number of researchers (and the volume of financial resources), although there are national and institutional differences and fluctuations in publication efficiency (e.g. Abt 2007; Shelton 2008b; Kivinen & Hedman 2008). A large influx of resources can cause short-term inefficiency, as the results from the Finnish university sector at the turn of the millennium indicate (Articles I-III). As the state of Finland made an additional appropriation of research funding in 1997-1999, the efficiency of Finnish university research declined despite the growing number of academic staff. The opposite example, growth of publications that exceeds the growth of resources (and staff) in relatively non-competitive funding environments, as the cases of Sweden (Article I) and the Netherlands (Articles I-II) show, can be partially explained by changes in publication behaviour. The overall increase in English-language journal publishing in non-English-speaking countries becomes visible in performance indicators that are based on the Web of Science

data. The analysis of the Finnish universities (Article III) shows the shift of resources towards publishing in the international arena.

Increasing external, competitive research funding can have unintended negative consequences (e.g. Geuna 2001). While external research funding provides incentives for researchers and makes it possible for the financiers of the research to select the best applicants, it may have a negative impact on the researchers' possibilities to do sustainable, long-term research. A large share of project funding makes short fixed-term work contracts more common in universities, increasing the insecurity of the working conditions. In some countries, functional tenure-track systems can counterbalance this problem, but the Finnish university system, for example, has suffered from poorly organized personnel policies. Competing for funding may also have a demoralizing effect on unsuccessful applicants. The third risk is the loss of time and energy resulting from laborious funding applications and reporting. Fourth, a pervasive evaluation culture goes hand in hand with the increase in competitive funding. Together with the overall increase in evaluations of the universities' (research) activities, there is a risk of overburdening the academic staff with administrative work related to the evaluations. This can have a negative impact on the universities' primary activities. (see Bleiklie & Kogan 2007; Ziman 1994, 102-106; Treuthardt et al. 2006.)

In the atmosphere of an increasing amount and share of external funding, the intertwined phenomena of the Matthew effect and cumulative advantage probably cause a concentration of research resources on those researchers who are more visible and successful than others (Larivière et al. 2010). The question arises as to whether this elite group of researchers are able to use their resources efficiently or whether there is a risk of decreasing marginal productivity in the overflow of resources to those few. From the perspective of the entire university system and larger researcher population, a more equal allocation of resources might produce better efficiency and larger diversity of research as the less eminent researchers, groups and units would also be able to contribute to the scientific knowledge base (Whitley 2011). The concentration of resources can be seen as a form of misallocation of resources.

Despite the fact that basic funding is a significant element of the funding environment of university research, its effect as a funding incentive can be questioned. Governments often use basic funding as a balancing factor in the funding environment of universities and are cautious to use a lot of output criteria in the allocation of basic funding. The results of my analyses do indeed show that it is much more common to increase the share of external, competitive research

funding than allocate a significant share of basic funding based on output criteria. Basic funding is also typically allocated to all universities or university units to secure the basic preconditions of research and teaching. Allocation of basic funding to universities is not a "winner takes all" type of competition like external project funding. The UK, with its very selective model of allocating state basic funding for research, has been an exception to this rule.

All the analyzed countries are developed post-industrial societies that have established and well-funded university systems. The same applies to a large extent to the three Finnish universities analyzed in Article III. Are significant improvements in research performance possible in this context? In an analysis of Australian universities, Worthington and Lee (2008) suggest that scientific research is a labour-intensive activity where the most efficient way of using the resources (production frontier) among units of analysis is unlikely to change very much after the best practices are implemented. In their study, efficiency gains in research were visible in the newer Australian universities, which were catching up with the established, older ones and moving up to the production frontier. The results from Chen, Hu and Yang (2013) show a similar pattern at the country level. In line with these findings, an explanation for the clearest improvement in research performance in the University of Jyväskylä among the Finnish universities (Article III) may lie in the different levels of research culture. In the teaching-oriented University of Jyväskylä there may have been potential for improving performance by using funding competition as an incentive among other measures. However, the levelling off of the performance improvements in Jyväskylä at the turn of the millennium suggests that it too had reached the limits of efficiency in the use of research funding. Based on these findings, the assumption that the research performance of universities can be boosted virtually endlessly by using more and more funding incentives is unrealistic, particularly on a national scale.

The analysis of patterns of productivity and visibility among Nordic academic sociologists shows the persistence of the practices of disciplinary cultures as well as persistent differences of research performance among individual researchers. Sociologists continue to publish and cite monographs and articles in books. The English-language, international scientific publications (articles and monographs) understandably attract more citations than the national publications, because the audience of the English-language publications is larger than that of the publications in Scandinavian languages. In a similar vein, the minority of researchers are much more productive in publishing and are cited disproportionally more often than the

majority. These findings point to the reward and value system of science that is potentially able to check the influence of policy instruments.

Academics are strongly socialized to the disciplinary cultures that carry within them the wider values and reward system of the scientific communities. Academics continue to renew the disciplinary cultures and traditional values of the scientific community because this culture makes sense to them and provides a cultural model story on the meaning of academic work (Ylijoki 2009). From the perspective of the reward system of scientific communities, it is also necessary for the university staff to renew the traditional values and shared practices of the scientific community because their career advancement and credibility as full members of the community depends on it (Latour & Woolgar 1986, 200-201).

Policy goals and instruments are rational in their own sphere, among government officials and top university management, but because of the competing rationalities of the scientific community, policy rationalities may encounter resistance from the unofficial organization of universities. Academics continue to follow and renew the values, norms and practices into which they have been socialized, despite economic incentives to act otherwise. Clearly, there isn't a positive model story among academics for a high performing university of world class that is a typical goal in the policy discourse in many countries (Ylijoki 2009). Academic management, particularly at the lower levels of university organizations, is typically socialized into the same culture as the rest of the academic staff, and may be reluctant to implement policies that are external to the scientific community (Schmoch & Schubert 2010; Välimaa & Jalkanen 2001). As a result, administrative inertia may play a part in the implementation of policies, such as new funding models. Furthermore, different disciplinary cultures in universities include different goals and operational practices for research and teaching, not to mention various stakeholders, which have interests to influence on universities' actions. The multiplicity of goals and practices hinders the possibility for successful top-down management of new policies and reforms in universities. (Välimaa 2013.)

A classical goal conflict between knowledge creation for its own sake promoted by academics and accountability and effectiveness promoted by policy-makers appears indeed to exist (Kivistö 2007, 68-76), but the gap between the goals and rationalities of the scientific community and the policy-makers needs not to be exaggerated. Academics tend to welcome the policy goals that accord with their values (Kyvik 2007). Koski (2002) suggests that the scientific communities value achievements that are also targets of recent science and higher education policies, such as high publication productivity, citation impact and success in funding

competition. She argues that this accordance was one of the main reasons for wide approval of performance-based policy goals in Finnish universities in the 1990s.

The resistance from the scientific communities towards policy goals and instruments is perhaps not so much due to the goals themselves but due to fears of loss of autonomy and external intervention. As academics see themselves as experts in scientific work and are socialized into the idea of autonomous science and universities, they want the freedom to decide on the core issues of academic (scientific) work: what are the important tasks in universities and in scientific work in general, how should research performance be defined and assessed, and how should recognition, rewards and resources be allocated. (Schimank 2005; Mollis & Marginson 2002.)

While the academics probably experience an increased sense of hurry and pressure resulting from the performance oriented policy, it seems that the instruments of performance oriented science and higher education policy have not induced such behavioural changes on the grass-root level of academic communities that would be visible as increased research performance on the macro levels of university systems (Slaughter & Leslie 1997). Scientific research seems to be an activity where certain individual and environmental factors are simply needed for researchers to reach good performance, and it appears that this logic is difficult to change by using funding incentives. This is partly because the amount of funding is not among the most important factors that promote good research performance, although a certain amount of funding is naturally needed to conduct research in the first place.

At worst, the various instruments and practices of NPM-influenced policies may actually exacerbate the research performance by having a negative effect on the above mentioned factors. Research collaboration has often been shown to be a factor that makes researchers more productive and increases their citation impact, but competition for funding increases the risk of not collaborating because potential collaborators also become competitors. Furthermore, a recent study among Finnish academics indicates that performance measurements can have a negative influence on motivation which is one of the key factors that promote high research performance (Kallio 2014, 161-165, 200-208).

My study has made extensive use of input-output-type indicators (Articles I-III). Although it is sensible to take account of the resources of university systems and universities of a different size when analyzing their performance, the input-output analyses tend to emphasize efficiency of resource use and the quantitative aspect of research performance. Another perspective is to concentrate on the qualitative

aspect and use measures that emphasize the impact of a university system or a university on (worldwide) scientific progress. The use of citation impact relative to OEDC14 countries (Articles II-III) is a step towards that. More rigorous indicators would be the top 5% or 10% citation indicator (indicating the share of publications from a unit of analysis that belong to the most cited 5 or 10% of publications in the world), or the field-normalized citation indicator (van Raan 2005) customarily used to position units of analysis in terms of their scientific impact in relation to the world average.

Inevitably, however, citation indicators are also partial measures of research quality. The persistent limitation of large-scale performance analyses is that they are bound to use quantitative measures for analyzing the quality of the research, since qualitative data is very difficult to collect when analyzing entire countries and universities. Especially in international comparisons, researchers are also often forced to draw their data from readily available sources, such as the Web of Science or statistics databases of the OECD. Lepori (2006) and Bonaccorsi, Daraio, Lepori and Slipersæter (2007) have suggested relying more on national sources for gathering input and output data for international comparisons of countries and universities, but this kind of data collection is of course more laborious and requires more resources than the use of ready-made databases. Moed (2007) and Butler (2007) have called for a combination of quantitative measures and qualitative peer review in large-scale research evaluations. However, their advice is hardly usable by researchers and research groups that have no resources with which to organize peer review evaluations on a national or even an institutional scale.

Google Scholar has the potential to provide a more versatile image than citation databases for analyses of research performance in the social sciences and humanities. The fact that the data GS provides is of poorer quality than that of the citation databases hinders its wider use. A further complication is that users of Google Scholar have no way of knowing where the data comes from, as Google does not reveal the data sources of the search engine. Also, as GS is obviously designed for searching for publications by individual researchers, it does not provide a standard feature of citation databases, the possibility to search for publications by particular institutions, such as universities, or entire countries. This makes the use of GS virtually impossible for large-scale analyses of research performance.

It is naturally not possible to control all the possible factors that may have a positive or negative effect on research performance in an analysis of funding

environments, steering models and their possible effects. There is no doubt that research activity at the level of university systems is affected by several other contextual elements, from varying structures of science and technology systems or funding patterns to cultural practices. For example, a study by Horlings and van den Besselaar (2011) on the scientific output of 205 countries in 1993-2008 shows that countries can be grouped into eight clubs according to disciplinary specialisation. This specialisation may have an influence on the countries' scientific output and citation impact. Another example is the rapid increase in recruitment of PhD students in the Finnish universities in the 1990s that has possibly had a negative impact on research performance at the national level, as junior researchers are typically less productive than their more senior colleagues (Hakala 2009, 48-52; Puuska 2010). The internal features of universities, the organizational and cultural factors of the micro-level research environments and, moreover, the general logic of the scientific communities are also potentially highly relevant to the universities' research performance as shown by previous research (see Sections 2.5, 3.4 and 3.5). While this analysis cannot positively confirm which factors are decisive, it has illustrated the role and limitations of funding competition and macro-level state steering of universities.

Since the competitive funding environment or market-type steering do not seem to have long-term and comprehensive positive effects on research performance, it is likely that other factors are actually more decisive than funding incentives in the long run. Still, in some cases, the performance-based funding does appear to have an effect, as the example of the University of Jyväskylä suggests. The effect of funding incentives may be a highly contextual phenomenon. I propose that in future research the analysis of internal meso-level (university) factors and micro-level (researchers, university units, research groups) factors should be combined with the analysis of external, policy-related factors (such as funding environment) to explain the research performance of universities more comprehensively.

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Original articles

University research funding and publication performance—An international comparison

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ARTICLE INFO

ABSTRACT

In current science policies, competition and output incentives are emphasized as a means of making university systems efficient and productive. By comparing eight countries, this article analyzes how funding environments of university research vary across countries and whether more competitive funding systems are more efficient in producing scientific publications. The article shows that there are significant differences in the competitiveness of funding systems, but no straightforward connection between financial incentives and the efficiency of university systems exists. Our results provoke questions about whether financial incentives boost publication productivity, and whether policy-makers should place greater emphasis on other factors relevant to high productivity.

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1. Introduction

Hand in hand with the rise of the New Public Management and expanding global techno-economic competition, an increasing prominence has been given to the idea that university systems employing output incentives and competition mechanisms are more efficient and productive than systems in which such incentives and mechanisms are employed less or not at all. While there is some evidence of the short-term usefulness of incentives and competition, country-specific comparative information on research performance in relation to the scope and scale of competition seems to be largely missing (Geuna and Martin, 2003; Liefner, 2003). In this article we study this relationship by comparing the funding environments of university research in eight countries. We scrutinize allocation mechanisms for direct government research funding, shares of external funding and compare these systemic characteristics with university publication outputs of countries. Do university research systems that operate in competitive funding environments perform better than others? The question has high policy relevance and we suggest a critical re-examination of the idea that competition and incentives boost the productivity of university research.

In recent decades, university sector research funding has changed in many countries. The share of direct government funding has gradually decreased, while the share of external and industrial funding has increased. At the same time, public funding has faced transformations. Government core funds have been increasingly allocated on the basis of performance, and funding agencies have adopted mission-oriented and contract-based strategic allocation procedures (e.g. OECD, 1998, 2004; Skoie, 1996; Slaughter and Leslie, 1997). Nonetheless, public funding is still the predominant source of funding for university research. For instance, the mean for industry funding of university research in OECD countries in 2003 was only 6% (OECD, 2005, p. 41). Recent studies have also pointed out country-specific differences in universities' public funding. There are, for instance, differences as to the allocation mechanisms of the core university funds. Even though utilized extensively, result-based mechanisms do not fully dominate. In a comparison of 11 OECD countries by Jongbloed and Vossensteyn (2001), it was pointed out that the orientation to output is used to a varying extent as an allocation model. Similarly, one of the conclusions of the broad cross-country comparison by Geuna and Martin (2003) was that there is great variation as to the extent and way of using evaluation for resource allocation.

Funding shifts have not taken place without receiving attention. Some observers have been convinced that changes in resource allocation may lead to unintended negative consequences especially in terms of basic research outputs (e.g. Geuna, 1999; Ziman, 1996). Others have argued that the whole way of science-society interaction is changing in the global knowledge economy, lead-

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ing the science system to produce more socially relevant and applicable knowledge (e.g. Etzkowitz and Leydesdorff, 2000; Jacob and Hellström, 2000; Nowotny et al., 2001). Some other studies have claimed, in contrast, that while researchers utilize new funding opportunities, they succeed in balancing scientific and extra-scientific interests. Therefore, funding shifts do not strongly affect the actual practices of research, for example, publication behaviour (Albert, 2003; Behrens and Gray, 2001; Van Looy et al., 2004).

In this article we focus on the idea that financial incentives either form a macro-level imperative or an opportunity in the development of university-based research. More precisely our research questions are:

1. How do the funding environments of university research vary across countries?
2. Are there differences among countries in their publication performance according to the degree of competitiveness of the funding environment?

The structure of the article is as follows. The conceptual background is introduced in Section 2, including the analytical framework for comparing the funding environments. Data and methods are described in Section 3, followed by the analysis of the allocation mechanisms for government core funding and level and sources of university research funding (Section 4.1). Based on the analysis, the compared countries are placed into the analytical framework (Section 4.2). We then connect the analysis of funding environments with the analysis of publication performance (Section 4.3). Results and their implications are discussed in Section 5.

2. Conceptual background

2.1. Principal-agent dilemma and New Public Management

The major rationale for the shift of public policies towards increasing output orientation and the use of external competitive funding mechanisms relates to the principal-agent dilemma, as well as to the ideas of the New Public Management (NPM) that market-like mechanisms create an incentive towards enhanced performance. The principal-agent dilemma (Van der Meulen, 1998) reflects a situation in which the government or a governmental agency is attempting to enhance its own or wider societal targets, for instance, via public research funding programs. As it does not have the appropriate know-how and human resources to conduct the mission, it needs to "delegate" the actual implementation of tasks (research) to specialized organizations such as universities. It faces at least two problems in the implementation of programs. First, it needs to screen out the best possible actors to conduct the mission and second, it cannot control all the activities of relatively independent actors. If it does not choose to trust the actors, it needs both appropriate selection and control mechanisms, which ensure that the principal's targets are fulfilled.

Ideas rooted in the New Public Management have provided some practical answers to these problems (e.g. Pollitt, 1993). In general, in the science and technology policy the NPM has meant the increasing use of results as a screening mechanism and the use of targeted external funding with related evaluation practices as a control mechanism. The general idea behind competitive mechanisms has been twofold. First, it has included the idea that if money is given to the best performers, it will most likely produce better results. Therefore, the allocation should be based on earlier results. Second, if the allocation is based on results, it creates a general incentive for all the actors to achieve better results in order to

become more competitive. Furthermore, the shift of focus to results enables a detailed assessment of activities, which, in turn, means enhanced control possibilities.

In many studies concerning the impact of funding to research activity, the implicit or explicit theoretical assumption is that dependence on external resources (resource dependence theory: Pfeffer and Salancik, 1978) forces research organizations and researchers to alter their activity as conditions for funding change. Our starting point here is that there is no straightforward mechanism from funding incentives to research activity, but rather that it is the complex mix of different allocation mechanisms, funding sources and their varying criteria of funding which creates incentives for change or stability in the system. At times these incentives balance each other and at other times they reinforce each other (cf. Benner and Sandström, 2000; Geuna, 1999).

There is no doubt that research activity is affected by several other contextual elements from cultural practices to the political legitimization of a system. For example, research assessments and the overall science policy "climate"—while not being directly connected to funding—may have consequences on an institutional level (Jongbloed, 2007). On the other hand, researchers and universities are highly able to adapt their behaviour and organization to new external requirements in ways that do not affect their pattern of activity too much if requirements do not match their interests (Calvert, 2000; Krücken, 2003). Furthermore, external policy pressures and incentives are mediated by existing disciplinary cultures (Hakala and Ylijoki, 2001).

2.2. Typology of funding environments

Funding models for university research can be classified on the basis of the degree to which they are based on internal or external funding (Irvine et al., 1990). In general, internal funding can be defined as consisting of governmental core funding and a university assets. While, strictly speaking, from the universities' perspective, governmental core funding is also external funding by nature, it is usually justified to see it as internal funding so far as universities are capable of determining its allocation and use within their organizations. In reality this view is complicated by various earmarked and strategic funds, which can be subsumed into block grants as well as by steering exercised by the state via various funding methods.

External funding, in turn, can be defined as public and private research funding which is not part of the core funds. Public external funding is composed of public project funding or grants by public funding agencies and contracts with public administration. While contracts with public administration correspond with contracts with the private sector, funding agencies with varying aims also carry out a science policy steering function (Braun, 1998). The state can use both the allocation of core funds and funding agencies as steering instruments. Because universities' research funds usually consist predominantly of governmental core and agency funding, the targets and criteria of public funding play a major role in the university-system-level steering.

The basic idea in the analytical framework (Fig. 1) is relatively simple: there are country-specific funding environments,[1] which vary due to different funding sources, their shares of total funding and involved incentives. Depending on the internal–external funding ratio and input–output orientation of the core funding allocation, the overall systemic dynamics caused by funding vary. These dynamics, in turn, may have varying impacts on system

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[1] There are correspondingly meso- and micro-level funding environments at the university/faculty/department level, which differ significantly across universities and fields of science (Nieminen, 2005). This analysis concerns, however, only macro-level incentives and system-level aggregate performance.
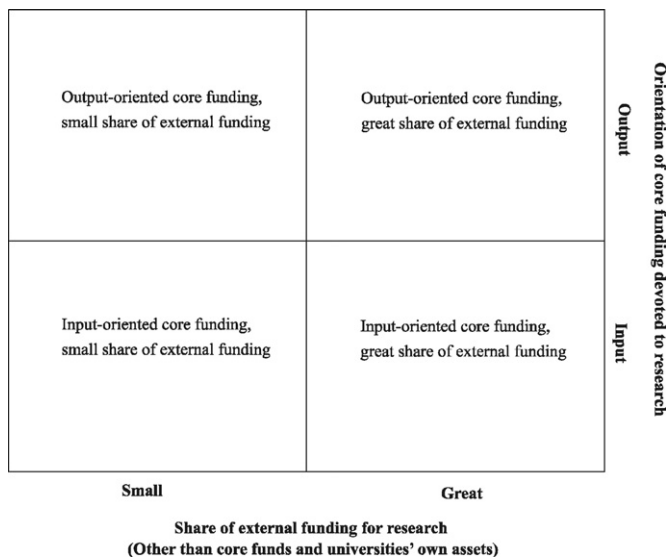
Fig. 1. Framework for positioning university research funding systems. Funding systems (countries) can be positioned in the framework according to their orientation of core funding and share of external funding.

outputs. The continuums are cross-tabulated in order to form a two-dimensional framework for estimating country-specific systemic characteristics (cf. Jongbloed and Vossensteyn, 2001). The position each country has in this two-dimensional framework mirrors the potential susceptibility of the universities in a given country to different steering impulses and activity paths in research.

On the left side of the field, state funding dominates in the form of core funds. The role of the state is important in the steering of the system. Universities are mainly dependent on the state core resources and affected by political steering. On the right side of the field, universities have more funding sources and, part of the governmental steering occurs through funding agencies. The role of the state is not necessarily weaker compared to the situation on the left side but it is more indirect. However, in this case there are also other actors (e.g. industry), which may directly affect the orientation of research while in the previous case these interests are mainly represented indirectly through state steering.[2] The lower part of the field describes input-oriented systems and the upper part systems with an output orientation in government core funding. In an input-oriented system the governmental steering is usually weaker than in output-oriented systems. In input-oriented systems the state is more concerned about the sufficiency of resources, while in output-oriented systems it explicitly expects efficiency and definable results from the universities (Geuna and Martin, 2003, p. 296; Jongbloed and Vossensteyn, 2001, p. 128).

In general, systems in which governmental core funding dominates are sensitive to changes in the allocation mechanisms and incentives of public funding. However, core funding may also increase stability in the system as it covers the salaries of permanent research and teaching personnel as well as basic infrastructure expenditures. Usually it is not possible to use external project funding for these purposes. Therefore, systems in which external funding dominates can be seen as volatile from the perspective of permanent basic structures. On the other hand, external funding and its availability can also be seen as an opportunity for new initiatives and the extension of activities. Input-oriented core funding

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[2] There are differences among countries as to the degree researchers and other actors such as industry can affect the formulation of science policy agendas (Rip and van der Meulen, 1996).

systems are potentially less dynamic than output-oriented systems (Geuna and Martin, 2003, pp. 297–299).

3. Data and methods

3.1. Data

The compared countries have been selected on the basis that the comparison would include both big and small countries as measured by total R&D expenditures and output of scientific publications. The compared countries are: Australia, Denmark, Finland, Germany, the Netherlands, Norway, Sweden, and the UK. For each country, we collected three types of data: document data on the mechanisms of government core funding, statistical data on the development of level and sources of research funding, and data on publication volumes. Data were collected from various national sources, OECD databases and Thomson Reuters Web of Science databases (the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index).

One problem in the data on funding mechanisms was that the quantity of available information as well as its quality varied across countries. In some cases the data had to be collected from a number of different sources in order to have satisfactory information (see Appendix A for more details). Regarding the structure of research funding in Germany and the Netherlands, we had to rely on a research report (Hackmann and Klemperer, 2000). These figures are therefore older than in the other countries studied.

The data mainly cover the situations in the countries from the beginning of the 2000s to the mid-2000s. There have been and are transformation processes going on in the compared countries' university funding systems. Hence the situation in some of these countries has changed to a certain extent since we gathered the data. Recently transformed or transforming funding systems include at least those of Australia, Finland and Norway. However, as the main aim is to compare the systems and performance of the countries over a certain historical period of time, this does not compromise the analysis.

Even though the OECD and the EU have made recommendations in order to standardize statistical definitions and data collection practices, a number of possible sources of error can be found in the R&D statistics. The most noteworthy is that the data collection methods can differ. This is mirrored, for instance, in the fact that the university sector is defined differently across countries (Irvine et al., 1990, pp. 3–5; cf. Lepori, 2006). One must bear in mind that OECD data often include all higher education institutions carrying out research, not only "research-led" universities.

Web of Science databases are also usually considered methodologically problematic for comparative purposes. They have, for instance, a bias towards journals in the natural and medical sciences and engineering, they favour English-language publications, and cover mainly journal articles excluding much of other research output. Therefore they cover each country's scientific publications only partially and can give misleading information of total performance due to differing scientific profiles (e.g. Bordons et al., 2002; van Raan, 2005; Weingart, 2005).

Despite their limitations, Web of Science databases remain in practice the only available sources for publication measures, since there are no other databases that can provide a wide international coverage of publications. Over the past few decades, international publishing has become increasingly valued and more common also in the social sciences and humanities (Kyvik, 2003; Puuska and Miettinen, 2008, p. 101). Since international publishing is both considered a necessary target for high-standard research and emphasized in science policy agendas, Web of Science can be regarded as reflecting the high-standard international performance

of a university system. Still, the number of international publications is not synonymous with scientific quality. In a strict sense, our measurement concerns only country-level publication productivity.

One might also be suspicious whether scientific publications form an adequate indicator of overall research performance. In many countries statistics related to the "third mission" of universities are, however, missing or still in the development phase.[3] While this information would provide, together with domestic publication information, a more profound picture of countries' research-related university performance, we believe that the data are as robust as possible concerning the relations between resources and high-standard scientific performance defined as international publications. In addition, the existing empirical evidence indicates that there is necessarily no decline in academic outputs even though universities receive substantial amounts of industrial funding (Gulbrandsen and Smeby, 2005; Van Looy et al., 2004).

3.2. Methods of analysis

Our analysis consisted of three phases. The first step was to describe the allocation mechanisms of core research funding as well as the level and sources of research funding for universities. The analysis of the allocation mechanisms was based on allocation method(s), funding components and their shares of total core funding, and funding criteria. As funding criteria form the dimension that determines the input–output orientation of core funding in our model, they are described in more detail. As we were interested in university research, descriptions of funding mechanisms focus on research funding components and the associated criteria. Components of funding clearly related to education were excluded. Here we also present data on the "age" (year of implementation) of the respective allocation mechanisms to see how long they have been affecting the university research system in the compared countries. We distinguished between input and output criteria according to the following guideline: when the financier (state) focuses on the sufficiency of resources, it uses input criteria, and when it focuses on the performance and results of the activity, it uses output criteria. Typical input criteria include, for example, the existing funding level of universities ("historical basis"), the number of staff and students, and the strategic and political considerations. Typical output criteria include, for example, the number of produced publications and degrees, the amount of (external) research income earned, and the results of quality assessments.

When analyzing the level and sources of university research funding, we present statistical data on the development of R&D expenditure and recent R&D intensity in the university sector of the compared countries. We also analyze the structure of R&D expenditure at the beginning of the 2000s and show how the share of internal funding (government core funding and university assets) has developed in relation to external funding in 1981–2000.

Second, we positioned the countries in the analytical framework described in Section 2.2. This positioning was based on the results of step 1 of the analysis. Countries with the most competitive funding environments for university research are positioned on the upper right corner of the framework, countries with least competitive environments to the lower left corner.

Third, we analyzed the efficiency of university systems in the compared countries. For this we (a) retrieved from the Science Citation Index Expanded, the Social Sciences Citation Index and the Arts & Humanities Citation Index all the publications attributable to the compared countries' universities in 1987–2006, (b) searched the OECD science and technology database for higher education R&D expenditures (HERD) in the compared countries in 1981–2000, (c) calculated the means of publications and funding for six-year periods for each country, and (d) calculated the funding per publications ratio for each six-year period for each country. We used a six-year time lag between funding and publications, e.g. the six-year mean of HERD in 1981–1986 was divided by the mean of publications in 1987–1992. This funding per publications ratio indicates the efficiency of universities in producing one scientific publication in each country.

By using six-year means of funding and publications we were able to eliminate possible year-to-year fluctuations, thus giving a simple and more solid figure for general trends. We used six-year time lags because the available resources are not immediately realized as publications. Usually there is lag between the change in R&D investments and the change in the number of publications. As funding makes research activities possible, the studies have to be conducted before publishing. In choosing the time lag we followed the results of an econometric approach by Crespi and Geuna (2008), who concluded that there are no significant effects from past R&D (expenditure) on publication output after six years.

We are not able to control all the possible affecting factors in employing the HERD per publications calculation, such as the varying structures of science and technology systems or funding patterns in the compared countries. While the analysis cannot positively confirm which factors are decisive in publication performance, it can, however, illustrate the role of competition.

4. Results

4.1. University research funding in the compared countries

4.1.1. Allocation mechanisms for core funding

One of the crucial elements in the analysis of funding environments is time. When following the changes in publication productivity one must bear in mind that changes in funding systems have been implemented at different times in the compared countries. The countries where there are no radical changes also form an important point of comparison for the other countries. If there are no remarkable differences in publication productivity between the compared countries over the time, also the effect of the competition mechanisms is doubtful. Another issue is the time lag between implementation of the funding system and its possible consequences. While there is no definitive answer on this question, it might be sensible to assume that the lag is the same as in the case of the change of resources, i.e. maximum six years.

In order to find out the length of influence of incentives used in core funding systems that are described here, we ascertained when these systems were implemented in the compared countries. Most of the systems are rather new but there is more variation if we also include the changes in the more distant past (Table 1). The UK, Netherlands and Denmark have older systems while Finland, Australia and Sweden have more recent systems, and Norway the newest. Table 1 also shows that when governments change the principles of allocating core funding to universities, it often happens by changing some elements of the existing system, not by reforming the entire system at once.

We can conclude that possible long-term effects of performance incentives on core funding are to be expected especially in the UK but to a lesser extent also in Denmark and the Netherlands.

The compared countries can be clustered roughly into three groups according to their input–output orientation in government core funding. To start with the output-oriented systems, the UK and Australia were clearly the most output-oriented systems in

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[3] Perhaps the most developed follow-up statistics on the third mission can be found in the UK.

Table 1
Year of implementation of the described core funding systems in the compared countries.

Country	Year
Australia	2002 (some features of the system implemented in 1996)
Denmark	1993 (a more output-oriented system adopted at the beginning of the 2000s)
Finland	2004 (some features of the system implemented in 1998)
Germany	1990s or before that (each state (Land) has its own funding system)
Netherlands	2006 (most of the features of the system implemented in 1993)
Norway	2002
Sweden	2000 (most of the features of the system implemented in 1997)
UK	2002 (most of the features of the system implemented in 1986)

Source: Various national sources, see Appendix A.

the early or mid-2000s (Table 2). Unlike in some other countries, the formula was used plainly as an allocation method and the criteria emphasized performance. In Australia the system was to some extent more focused on measurable performance (e.g. the amount of research income and number of publications) than

in the UK. In the UK the emphasis has been on the outcomes of the Research Assessment Exercise (RAE) while some input-oriented funding components can be found in the system. The RAE emphasizes qualitative evaluation of university research while using quantitative indicators as part of the evaluation. Both countries, however, devoted a separate segment of their core funding to research and used predefined performance criteria to allocate it. This makes competition an integral component of obtaining core research funding from the government budget. In addition, the core funds have included several subsumed programs or earmarked allocations for certain purposes, i.e. steering has taken place both through specified targets and performance monitoring.

The second group includes Norway, Finland, and the Netherlands (Table 3). All these countries used a formula, evaluation and quantified criteria, but the extent of existing activities, number of students and circumstantial considerations played a bigger role in the allocation than in the UK and Australia: competition-based incentives were used, but not as exhaustively. The funding component, usually called the basic component or basic allocation, covered a significant proportion of core funding and it was largely based on the extent of existing activities. It also has to be noted that the utilization of formula as such does not make a system output-oriented. In many countries the elements of the formula consisted of input information or one element was the current resource situation (e.g. the Netherlands and Norway). In addition, it seems that

Table 2
Dimensions of allocation mechanisms of government core funding for university research in Australia and the UK.

Australia
  Method: Formula

  Components: Teaching and learning allocations (81% in 2004) and research and research training allocations (19% in 2004): research and research training allocations include block funding for research (Institutional Grants Scheme, Research Infrastructure Block Grants Scheme, Regional and Rural Assistance) and block funding for research training (Research Training Scheme, Australian Postgraduate Awards, International Postgraduate Research Scholarships Scheme)

  Criteria: Institutional Grants Scheme: amount of research income (60%), number of publications (10%), and number of higher degree research student places (30%). Research Infrastructure Block Grants Scheme: university's share of Australian Competitive Grants income. Regional and Rural Assistance: targeted to regional universities for avoiding deterioration in research funding in the first three years of the new funding system. Research Training Scheme, Australian Postgraduate Awards, International Postgraduate Research Scholarships Scheme: number of successful research degree completions (50%), amount of research income (40%), number of research publications (10%)

UK (information not available on Northern Ireland)
  Method: Formula

  Components: *England*: Funds for teaching (76%) and funds for research (24%): funds for research include Quality-related research funding (Mainstream QR, Research-degree programme supervision fund, Charity support element, London weighting, 'Best 5*' allocation, Transitional special funding for research libraries) and Research Capability Fund

  Scotland: Grants for teaching, research and knowledge transfer: Grants for research and knowledge transfer include the Main Quality Research Grant, Research Development Foundation Grant, Research Postgraduate Grant, Strategic Research Development Grant, Science Research Investment Fund, Knowledge Transfer Funding (Knowledge Transfer Grant, Promotion of Knowledge Transfer), The Scottish Institute for Enterprise, Research Support Libraries Programme

  Wales: Funds for teaching, postgraduate research training and research: funds for research include quality research funding, the Research Investment Fund, and the Science Research Investment Fund.

  Criteria: *England*: Mainstream QR: RAE rating (only ratings 4–5* (scale 1–5*) attract funding) proportioned to number of research staff and relative costs of subject area. Research-degree programme supervision fund: cost-weighted UK and EC postgraduate research student numbers in departments rated 4 or above in RAE. Charity support element: amount of charity research income, to universities with departments rated 4 and above in RAE, or rated 3b or 3a and receiving grant from the Research Capability Fund. London weighting: 12% (for inner London) or 8% (for outer London) of the total of mainstream QR funding to universities in the London area. 'Best 5*' allocation: to universities with departments rated 5* in RAE of 1996 and 2001. Transitional special funding for research libraries: to heavily used libraries of national importance. Research Capability Fund: to subject areas with low proportions of staff in departments rated 4–5* in the 2001 RAE, and relatively high proportions of QR funding in 2002–2003 attributable to 3b or 3a-rated departments, proportioned to the number of research staff and the relative costs of the subject area

  Scotland: Main Quality Research Grant: RAE rating (only ratings 3a–5* (scale 1–5*) attract funding) proportioned to the number of research staff and students, the amount of research income and the relative costs of the subject area. Research Development Foundation Grant: average amount of research income of the previous two years, to universities with departments not funded through the Main Quality Research Grant. Research Postgraduate Grant: number of full-time equivalent student places, proportioned to the costs of the subject area. Research Development Grant: strategic considerations, based on Scotland's strategic priority areas in research. Science Research Investment Fund: strategic considerations, based on the research infrastructure needs of universities. Knowledge Transfer Grant: amount of income from various "outreach" activities. Promotion of Knowledge Transfer: strategic considerations, funding intended to promote research expertise, commercialisation and knowledge transfer. The Scottish Institute for Enterprise: support for teaching management and business skills to students and researchers. Research Support Libraries Programme: strategic considerations

  Wales: Postgraduate research training: number of previous year's student enrolments proportioned to the costs of the subject area, only to departments rated 3b or above in RAE or departments rated 2 whose RAE return included Research Council income. Quality research funding: RAE rating (only ratings 4–5* (scale 1–5*) attract funding) proportioned to the number of research staff and students, amount of charitable income, the relative costs of the subject area and the average ratings of the subject areas in RAE. Research Investment Fund: volume of research staff in 3a and rising/new 3b departments. Science Research Investment Fund: amount of a university's QR funding and combined total amount of a university's external research income and QR funding

Table 3
Dimensions of allocation mechanisms of government core funding for university research in Finland, the Netherlands and Norway.

Finland
  Method: Negotiation and formula
  Components: Core funding, including the extent factor (19%, including the basic component, new students, facilities), education appropriation (44%), research appropriation (30%, including graduate schools, doctorates), and societal services appropriation (7%, including open university activities and other societal services), project funding and performance-based funding. Funding for teaching and research are not separated.
  Criteria: Basic component: university's operational expenditure in the last year of the previous performance agreement period. New students: target numbers set in performance agreements. Facilities: university's realised budgetary expenditure in the middle year of the previous performance agreement period. Graduate schools: decision based on assessment. Doctorates: target number of PhD degrees (2/3), number of completed PhD degrees (1/3). Open University: target number of FTE student places (2/3), number of realised FTE student places (1/3). Other societal services: intended to support equipment-intensive activities and university's regional impact, partly R&D expenditure and research personnel. Project funding: strategic priorities. Performance-based funding: number of centres of excellence in research in the university, amount of funding from the Academy of Finland, amount of other external research funding.

Netherlands
  Method: Formula
  Components: Teaching component and research component: research component includes basic allocation (17%), allocation for PhDs and designer certificates (12%), allocation for research schools (3%), allocation for top research schools (3%), strategic considerations allocation (60%), Smart Mix (4%)
  Criteria: Basic allocation: extent of existing activities. Allocation for PhDs and designer certificates: two-year average number of completed degrees. Allocation for research schools: university's share of basic allocation, allocation for PhDs and designer certificates and strategic considerations allocation. Allocation for top research schools: strategic choice based on assessment. Strategic considerations allocation: extent of existing activities. Smart Mix: amount of competitive research funding

Norway
  Method: Formula
  Components: Basic component (57%), teaching component (21%), and research component (23%, including result-based funding and strategic funding)
  Criteria: Basic component: extent of existing activities. Result-based funding: completed PhD degrees (30%), amount of EU research income (20%), amount of research council research income (20%), number and level of scientific publications (30%). Strategic funding: number of PhD student places, decisions on special funding for scientific equipment, strategic considerations

Table 4
Dimensions of allocation mechanisms of government core funding for university research in Denmark, Germany and Sweden.

Denmark
  Method: History and formula
  Components: Appropriation for education (activity-based), appropriation for research (performance-based, including basic research grants and new research grants), and building and rent grants (including building taximeter grant related to education, research overheads and basic grant).
  Criteria: Basic research grants: extent of existing activities. New research grants: amount of educational grants (50%), amount of external research income (40%), and number of awarded PhD degrees (10%). Research overheads: total research turnover of a university. Basic grant: rent of special university buildings.

Germany
  Method: History, formula
  Components: Most of the states (Länder): core funding budget. Funding for teaching and research are not separated.
  Criteria: Most of the states (Länder): extent of existing activities.

Sweden
  Method: History
  Components: Core teaching funding and core research funding: core research funding includes four funding areas: the humanities/social sciences, medicine, the natural sciences, technology.
  Criteria: Extent of existing activities, strategic considerations.

these countries used less specific programs or earmarking in the allocation, giving more leeway for universities' own considerations in their internal allocation of funding.

The least output-oriented countries in this comparison were Sweden, Germany and Denmark (Table 4). The significance of the formula-based allocation decreases in these countries compared to the two previous groups. The extent of the activities (historical basis) and political considerations have played a more prominent role. They have been rather input-oriented in the allocation of core funds, even though some indicators have been used. If an evaluation of activities was carried out, it was usually linked to the development of activities. Denmark was to some extent an exception, as performance indicators were used in the allocation of new research grants. Allocations based on the previous expenditure of resources are not etched in stone, however: they can be changed by political decisions. For instance, in Sweden, which is one of the clearest examples of input-oriented systems, most of the increase in direct government research funding in the period of 1997-2002 was allocated to three "new" universities (Högskoleverket, 2004, pp. 51–52). What is also of interest is the fact that these countries have used less strategic allocations or earmarked funds for spe-

cific science and technology policy goals than the other compared countries have done. Earmarked or strategic funding components appear to have been especially typical in the UK, but also Finland, and to a lesser extent Australia, the Netherlands and Norway have used them (Tables 2 and 3).[4]

4.1.2. Level and sources of research funding

The volume of university R&D expenditures has increased between 1981 and 2001 in all the countries compared (Table 5). There are some country-specific trends. Especially Australia and Finland have increased their research volume during this period. The volume of university research funding per capita was rather low in these countries at the beginning of the 1980s, which partially explains the growth rate. At first glance, the relative position

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[4] Examples of earmarked or strategic funding components: UK: London weighting, 'Best 5*' allocation, Strategic Research Development Grant, Promotion of Knowledge Transfer; Finland: Open University, Other societal services, Project funding; Australia: Regional and Rural Assistance; Netherlands: Strategic considerations allocation; Norway: Strategic funding in research funding component.

Table 5
Higher education R&D expenditure (HERD, million constant US dollar 2000 prices and PPPs), HERD of gross domestic R&D expenditure (GERD, %) in 1981, 1991 and 2001, and change of HERD in 1981–2001 (%) in the compared countries.

Country	HERD 1981	HERD of GERD 1981 (%)	HERD 1991	HERD of GERD 1991 (%)	HERD 2001	HERD of GERD 2001 (%)	Change of HERD 1981–2001 (%)
Finland	218	22	465	22	826	18	279
Australia	740	29	1202 (1)	26	2124 (2)	27	187
Denmark	277	27	439	23	700	19	153
Norway	310	29	461	27	673	26	117
UK	2910	14	4036	17	6243	22	115
Netherlands	1080	23	1955	30	2245	27	108
Sweden	1050	30	1447	27	2053	20	96
Germany	5096	17	7185	16	8584	16	69

Source: OECD (2006).
Notes: (1) 1990. (2) 2000.

of universities in science and technology systems seems to have weakened to some extent over the same period of time. The share of universities in the compared countries' research and development expenditures has increased clearly only in the UK, while in other countries the share has decreased to some extent. This can be explained, however, by industrial research and development, which has grown strongly during the past ten years. While at the same time the share of public research institutes has decreased, it can be claimed that the relative position of universities has actually strengthened, not weakened (see e.g. OECD, 2004, pp. 195–196). There is also cross-country variation in this respect, which can be explained by differences in system structures. For instance in Sweden, universities have a very strong position due to the fact that universities carry out tasks which in some other countries are the responsibility of public research institutes. In contrast, in Germany, the role of public research institutes is strong.

A somewhat better estimation of the relative university sector research investments can be obtained by comparing the proportion of expenditures with the population (Table 6). Big countries rather self-evidently dominate the scene when looking at the volume of university research expenditures, but when these figures are proportioned to the population, it turns out that the Nordic countries invest relatively more in university research than does, for instance, the UK or Germany. The Nordic countries have the biggest university sector research investments per capita among the compared countries, Sweden being well ahead of the other Nordic countries. The Netherlands is in the middle ground, while the UK, Germany and Australia invest the least. Again, when we look at these figures, we have to remember systemic differences among the compared countries. On the other hand, Finland, for instance, has both rather extensive university and public research institute networks, indicating that systemic characteristics do not exhaustively explain differences in research investments.

These differences can also be due to the structure of funding. The more additional or external funding there is, the higher are total expenditures. The comparison of countries indicates, however, that

Table 6
Higher education R&D expenditure (HERD, million current PPP US dollars) and HERD per capita (current PPP US dollars) in 2003 in the compared countries.

Country	HERD	HERD per capita
Sweden	2293	256
Finland	952	183
Denmark	982	182
Norway	823	180
Netherlands	2543	157
Australia	2566 (1)	130
UK	7358	125
Germany	10,037	122

Source: OECD (2007b).
Notes: (1) 2002.

high research expenditures per capita do not necessarily go hand in hand with large amounts of external funding (Figs. 2 and 3). The share of external funding is high in Sweden and Finland, which also rank high in per capita research expenditure, but the same does not apply to the UK. Also, Norway and Denmark invest a great deal in university research in relation to population size, but rely more on governmental core funding. In addition, the structure of external funding varies. Research funding agencies are rather clearly more significant financiers in Finland and the UK than, for instance in Sweden or Australia. The varying shares of funding agencies vs. other external funding sources, however, do not seem to affect the publication productivity among countries, as we will see later.

At the beginning of the 2000s the UK, Finland and Sweden were the most competitive funding environments for universities when looking at the shares of internal and external funding. In the rest of the countries the role of core funding and university assets in research was more significant, the Netherlands emerging as the least competitive funding environment. Longitudinal data (Fig. 3) show that the funding environments have become more competitive in all the compared countries as the share of internal funding has decreased in all of them in 1981–2000. The extent of this development has varied, the largest changes having happened in the UK and Finland.

It could be argued that variation in funding structures mirrors, in addition to differences in science and technology policy agendas, also wider political and economic differences. The strong position of governmental core funding in some of the Nordic countries may reflect the traditionally strong position of the state and the maintenance of the welfare policy tradition. Also economic structures and potential vary. Large industrialized countries usually have more accumulated capital and large-scale industry, thus having more leeway to finance university research than their smaller counterparts. On the other hand, Norway has a wealthy national economy due to its oil industry, which gives Norway greater potential to finance universities directly through the state budget.

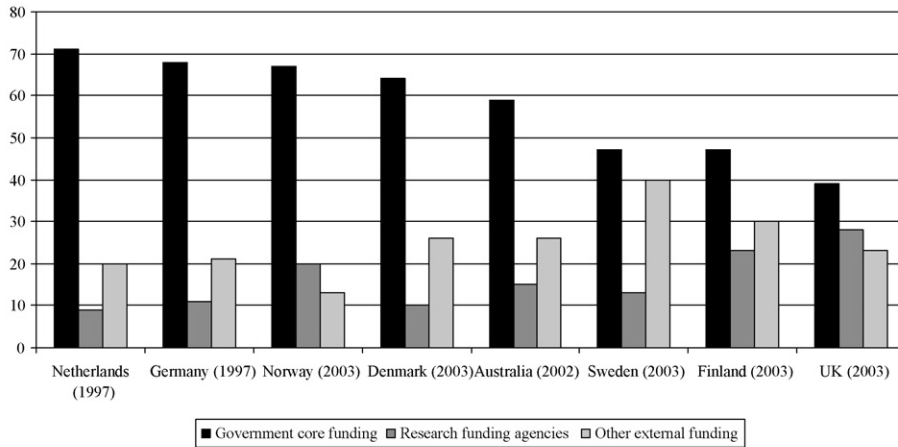### 4.2. Funding system characteristics in the analytical framework

By using allocation mechanisms of core funding and the proportion of external funding as rough indicators, the overall conclusion of the comparison is that there are country-specific differences among national university systems in relation to steering impulses and competition incentives (Fig. 4). In countries where the relationship between target-setting and funding of research is less pronounced, governmental core funding does not steer research activity significantly, or steering takes place indirectly via funding agencies (Sweden, Denmark, the Netherlands, Norway). If at the same time the proportion of external funding is low (Germany), the influence of external steering and competition incentives over research is limited. In these countries the degree of systems' built-

Sources: Various national sources, see Appendix A.

Notes: Based on the OECD recommendations, the share of core funding devoted to research is a calculation. It is based on time-use coefficients usually derived from national university personnel surveys, in which the allocation of time resources to research, education and other activities is studied. Funding from research funding agencies includes Deutsche Forschungsgemeinschaft (DFG) in the case of Germany and Australian Competitive Research Grants and Commonwealth schemes in the case of Australia.

Fig. 2. Shares of government core funding, funding from research funding agencies and other external funding of universities' total research expenditures (%) in the compared countries.

in competition is also low or moderate. Input-oriented core funding systems may balance the competitive effects of external funding. This holds true for Sweden and to a lesser extent for Finland.

The situation is clearly different in the UK and Australia, where the core funding systems emphasize funding through performance, giving a lot of weight to steering incentives and competition. Furthermore, as research is to a large extent externally funded especially in British, but also in Australian universities, these university systems include cumulative competitive elements.

Despite the fact that policy influences are internationally mobile and countries imitate each other's policy solutions rather effectively (Ruivo, 1994), the dispersion of countries within these two dimensions also suggests that funding transformations do not take place in a uniform manner (cf. Geuna and Martin, 2003; Jongbloed and Vossensteyn, 2001). There may be a number of interconnected reasons for this (Hood, 1995; Kivinen et al., 1993; Rip and van der Meulen, 1996; Van der Meulen, 1998; Senker et al., 1999):

- Economic, structural and cultural elements slow down the pace of reforms.
- The adaptation of new ideas to local conditions takes time.

- Not enough political will or leverage exists to change the system.
- Political affiliations or participation structures in policy-making resist changes.
- Rhetoric and policy targets usually change faster than actual practices.
- Policy-makers wait to learn from the experiences of path-breaking countries and avoid possible problems.
- Past decisions and actions restrict the scale of possible policy actions (path dependency).
- Actors (universities, their units, researchers) may react to changes in a way that slows down changes.

Germany is an example of a country in which structural and cultural elements have apparently delayed reforms. It is a federation in which states (Länder) have relatively broad autonomy in university issues. Federation-wide reforms in universities are therefore relatively difficult to implement. Furthermore, as the Humboldtian tradition of closely linking teaching and research has been strong, core funding does not separate teaching and research. A funding system in which teaching and research would have separate performance-based portions would undoubtedly go against
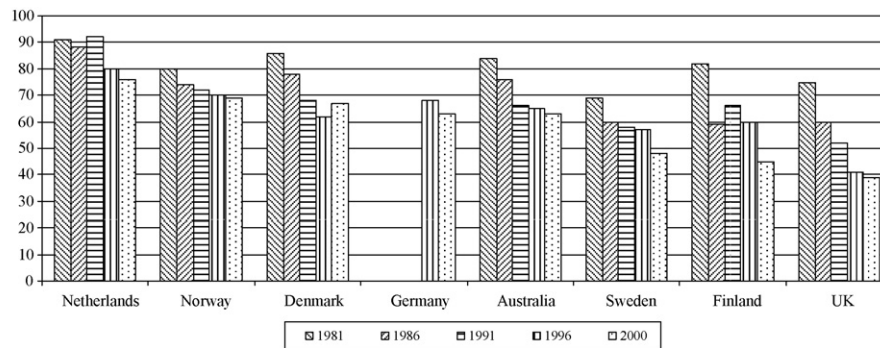
Source: OECD, 2007a.

Note: Missing values in original data have been replaced by the means of closest possible years.

Fig. 3. Share of internal funding (government core funds and university assets) of the higher education R&D expenditure in 1981, 1986, 1991, 1996 and 2000 (%) in the compared countries.
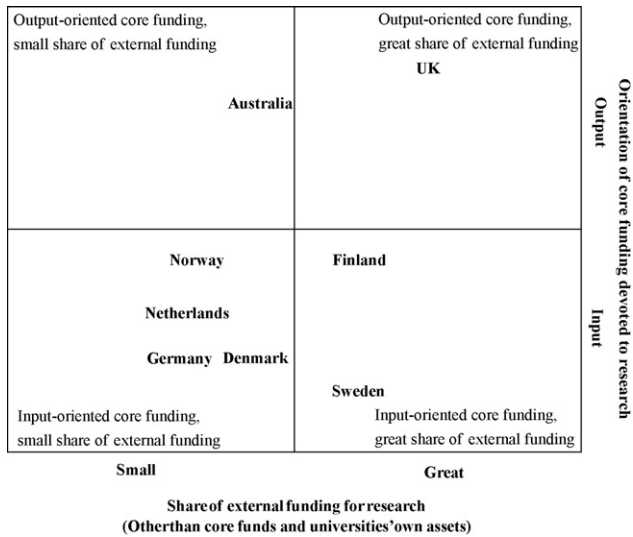
Fig. 4. University research funding systems according to orientation of core funding and share of external funding in the compared countries. Situation at the beginning of the 2000s.

the idea of a close teaching–research nexus. However, as in practice the funding needs of universities have been defined primarily on the basis of educational needs, research staff have been increasingly forced to seek external funding sources. There are, however, clear indications that Germany is moving towards a more output-oriented system (Orr, 2004; Schimank and Winnes, 2000; Senker et al., 1999). The Netherlands seems to be an example of a country where policy-makers have not had enough leverage to change the system. Even though there have been continuous debates on changing the Netherlandic funding system to a more output-oriented one, universities have successfully resisted these plans (Jongbloed, 2005).

4.3. Publication performance and efficiency

Fig. 5 presents the answer to the second research question: are there differences among countries in their publication performance according to the degree of competition in the funding environment? As we can see from the figure, the compared countries are divided into two groups based on their efficiency: UK, Finland, Australia and Denmark form the group of more efficient systems, while the Netherlands, Sweden, Norway and Germany are less efficient. The latter group is less coherent than the former. Countries in the latter group come closer to each other towards the end of the period of analysis while starting relatively far from each other. Since the UK, Australia and also Finland are more competitive funding environments for universities than the rest of the countries, the result appears to support the idea that competition for money makes universities more productive in research.

However, the relationship between competition for money and publication performance is more complex than that. Several observations support this conclusion. First we can note that the efficiency ratios remain unchanged in nearly all the countries during the entire period. The most competitive countries have introduced their funding systems at different times during the period of analysis. The UK was the first to increase competition, using the RAE-based core funding since the mid-1980s while Australia and Finland started to use more competitive funding instruments from the mid-1990s. Despite these efforts, there is no rise in efficiency ratios in these countries. Finland even goes down at the end of the period. Second, Denmark is in the group of more efficient countries while the funding environment for Danish universities has been one of the least competitive ones. The same partly applies to the Netherlands, although we must note that the efficiency of the Dutch university system is clearly lower than of the top four countries. Third, Sweden demonstrates a substantial increase in efficiency although it has been a quite non-competitive environment. Similarly, the efficiency of German university research increases, although Germany has been an even less competitive
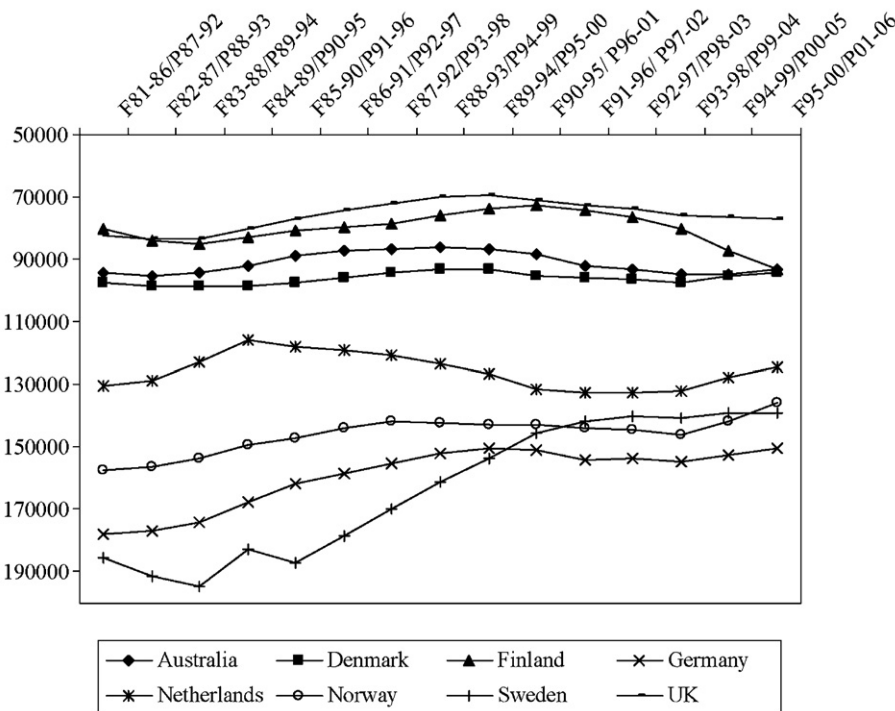

Fig. 5. Higher education sector R&D expenditure (HERD) per publications ratio in constant US dollars 2000 prices and PPPs in the compared countries (six-year means of HERD (F) 1981–2000, six-year means of publications (P) 1987–2006 and six-year time lags).

funding environment than Sweden. One must remember that external research funding has clearly increased in Swedish universities in 1981–2000, which has tightened the competition for funding. On the other hand, the government core funding system in Sweden has remained input-oriented.

Furthermore, some cultural and system-related reservations with respect to university sectors in the compared countries are in place. The UK and Australia may have a relative advantage as English-speaking countries in producing articles for mainly English-language international journals. The language factor may partially explain why especially Germany as a "big" science system does not get higher values in this comparison: its scientific community is oriented to producing publications also for the Germanic language area. These publications are less extensively covered by the Web of Science databases. Also some country-specific reasons for differences in publication performance most likely exist. For example, Swedish universities perform activities, which in some other countries are carried out by public research laboratories and institutes. This might result in a situation where relatively more resources devoted to universities are spent on research and development activities that do not lead to international scientific publications.

Our results suggest that output and competition incentives have a positive effect on publication productivity, at least to a certain degree. But if we take into account the "deviant" cases of Denmark, Sweden and Germany, as well as the aforementioned language-related, cultural and systemic intervening factors, we may conclude that the idea of competition for funding as a promoter of productivity in university research is not a straightforward issue. In any case, efficiency ratios tend to stay on the same level with some fluctuations or increase over the years.

5. Conclusion and discussion

Our aim in this article has been twofold: first, to see how the funding environments of university research vary across countries. The theoretical idea behind this analysis was that financial incentives form a macro-level imperative in the development of university-based research. There is, however, no straightforward mechanism from funding incentives to research activity. Incentives sometimes balance and sometimes enforce each other. Thus, one needs to study both the allocation mechanisms of core funds and the share of external competitive funding in order to assess the overall degree of competition in the system of university funding. The second aim of the article was to analyze the compared countries' scientific productivity in terms of international publications. The overall rationale behind funding incentives is usually that if money is given to the best performers, it will most likely produce better results and give an overall incentive for better performance. From this logic it follows that the most competitive systems should also be the most productive systems when resources are taken into account.

Our results indicate that there are significant country-specific differences among university systems in relation to steering impulses and competition incentives. Despite the fact that often countries effectively emulate each other's policy solutions, such as the NPM principles, transformations do not take place in a uniform manner. Governments adapt policy solutions to their own systems and have to take into account the political and systemic conditions under which changes can be implemented. Thus, university research is conducted in rather different country-specific funding environments.

The efficiency calculations suggest, in turn, that the idea of output and competition-based incentives promoting productivity in science is more complex than policy-makers seem to believe. Even though the countries with a competitive funding environment for university research (the UK, Australia and Finland) appear more efficient than the rest, they have not been able to increase their efficiency in publication output. At the same time, some university systems with a less competitive funding environment are either almost as efficient as the more competitive systems (Denmark) or have been able to increase their efficiency despite the relatively low level of competition for funding (Sweden and Germany).

This result raises a crucial question in terms of policy-making. While there is an evident need to find ways to enhance a country's research activity, is it possible that funding incentives and competition can be used too excessively and that they do not after all significantly affect research productivity? Too much competition may even be dysfunctional from the perspective of productivity since competition for funding takes time and energy away from research and writing. Might it be that incentives that have traditionally been part of the institution of science (e.g. researcher's reputation, mission to produce new knowledge, competition for tenure) are more decisive than recent funding-related incentives? Research processes and productivity can also be enhanced by other means, which relate to the conditions under which research is conducted. The literature on the quality and creativity of science suggests that, among others, multi-level communication, continuity in funding, and peace and quiet in working environments, are factors which support creativity and productivity (Amabile, 1994; Gulbrandsen, 2000; Hurley, 1997).

Our results cast doubts over the widespread and self-evident use of funding incentives in research policy and management. More detailed country-specific studies on the relations between funding incentives and the dynamics of research activity are needed (cf. Cherchye and Abeele, 2005). There is some evidence that, at the grass-root level of research, researchers are able to adapt to increased competition for funding. Adaptation can happen through careful selection of funding sources, "creative" use of funding or through shaping the research content (Laudel, 2006). Our macro-level approach is not able to reveal these kinds of processes. Strong funding incentives may have unintended and negative system-level consequences, such as the emphasis on quantity instead of quality, orientation to less innovative, mainstream research and weaker societal impacts in the long run (Butler, 2003; Langford et al., 2006; Laudel, 2006). Policy-makers should take these risks into account.

Appendix A. Data sources

A.1. General sources

OECD, 2006. Research & Development Statistics—Gross Domestic Expenditure on Research and Development by Sector of Performance and Source of Funds (Table 1), vol. 2006 release 01. URL http://oberon.sourceoecd.org/vl=1404917/cl=78/nw=1/rpsv/~3954/v209n1/s1/p1.

OECD, 2007a. Research & Development Statistics—Gross Domestic Expenditure on Research and Development by Sector of Performance and Source of Funds (Table 1), vol. 2007 release 1. URL http://titania.sourceoecd.org/vl=5960719/cl=15/nw=1/rpsv/ij/oecdstats/16081242/v209n1/s42/p1.

OECD, 2007b. Main Science and Technology Indicators, vol. 2007 release 02. URL http://titania.sourceoecd.org/vl=8087228/cl=20/nw=1/rpsv/ij/oecdstats/16081242/v207n1/s1/p1.

Thomson Reuters, 2008. ISI Web of Knowledge, Web of Science: Arts & Humanities Citation Index, Science Citation Index Expanded, Social Sciences Citation Index.

A.2. Country-specific sources

A.2.1. Australia

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Department of Education, Science and Training, 2002. Higher Education Report for the 2002–2004 Triennium.

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A.2.2. Denmark

Ladefoged, S., Mortensen, P.S., 2005. Forskning og udviklingsarbejde i den offentlige sektor—forskningsstatistik 2003 (Research and development in the public sector—research statistics 2003). Dansk Center for Forskningsanalyse.

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Tilastokeskus, 2004. Tutkimus-ja kehittämistoiminta 2003 (Research and development statistics 2003). Tiede, teknologia ja tutkimus, 2004:4.

A.2.4. Germany

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Hackmann, H., Klemperer, A., 2000. University Research Funding: An International Comparison. Report for the Dutch Organization for Scientific Research. University of Twente.

Huisman, J., 2003. Higher education in Germany. CHEPS higher education monitor—country report.

Orr, D., 2004. More competition in German higher education: expectations, developments, outcomes. A paper presented at the 17th CHER conference, University of Twente, 17–19 September.

A.2.5. The Netherlands

Boezerooy, P., 2003. Higher Education in the Netherlands. CHEPS higher education monitor—country report.

Hackmann, H., Klemperer, A., 2000. University Research Funding: An International Comparison. Report for the Dutch Organization for Scientific Research. University of Twente.

Jongbloed, B., 2007. Steering the Dutch academic research enterprise: Universities' responses to project funding and performance monitoring. A paper presented at the 20th CHER conference, Dublin, 30 August–1 September 2007.

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A.2.6. Norway

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The Research Council of Norway, 2006. Report on Science and Technology Indicators for Norway 2005. The Research Council of Norway, Oslo.

A.2.7. Sweden

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Swedish Institute, 2004. The Swedish Research System. Fact Sheets on Sweden.

A.2.8. The UK

Higher Education Funding Council for England, 2006. Funding Higher Education in England. How HEFCE allocates its funds. 2006/17. Higher Education Funding Council for England, Bristol.

Higher Education Funding Council for Wales, 2005. PGR Funding Method. URL http://194.81.48.132/Research/funding_method.htm.

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Appendix B. Data used in the calculation of efficiency ratios

See Tables B.1 and B.2 for details.

Table B.1
Higher education R&D expenditure in 1981–2000 in the compared countries (million constant US dollars 2000 prices and PPPs).

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Australia	747	827	827	908	970	1033	1062	1058	1130	1203	1342	1481	1523	1565	1705	1904	1992	2081	2102	2123
Denmark	267	274	288	303	320	354	377	407	430	434	438	459	483	539	596	546	604	594	628	685
Finland	212	237	262	279	298	319	348	369	374	377	452	456	428	435	466	497	623	684	788	792
Germany	5114	4981	4942	5038	5147	5337	5561	5732	5858	6072	7282	7462	7419	7504	7699	7945	7947	7997	8142	8414
Netherlands	1106	1323	1304	1280	1325	1369	1420	1382	1426	1984	2043	2040	2078	2096	2174	2253	2249	2211	2310	2372
Norway	303	299	306	311	332	337	342	369	395	423	452	478	504	510	516	548	580	621	662	663
Sweden	1059	1141	1224	1277	1330	1432	1534	1608	1681	1571	1460	1503	1545	1522	1500	1558	1616	1708	1800	1931
UK	2895	2932	2969	3139	3310	3523	3793	3847	3838	3954	4001	4054	4287	4787	4793	4798	4831	4944	5288	5728

Source: OECD (2007a).
Note: Missing values have been replaced by the means of closest possible years.

Table B.2
University publications in 1987–2006 in the compared countries.

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Australia	8900	9105	8842	9251	9686	10,639	11,459	12,162	13,797	14,772	15,381	16,434	17,252	17,596	18,563	17,999	21,208	20,793	23,651	25,886
Denmark	2953	2891	2893	3046	3142	3651	3812	4197	4396	4539	4872	5190	5281	5467	5546	5533	6334	6390	7406	7403
Finland	3306	3193	2997	3293	3378	3799	4049	4551	4762	5234	5666	5921	6142	6361	6508	6209	6869	6871	7299	7631
Germany	29,308	27,686	25,656	28,747	28,774	31,583	32,652	34,774	38,536	42,061	46,696	49,811	49,798	49,335	50,296	47,530	52,079	51,203	59,494	60,117
Netherlands	9023	9288	9220	9950	10,173	11,361	12,308	12,828	14,114	14,583	15,584	15,996	15,783	16,002	16,282	15,916	17,317	17,401	20963	21,298
Norway	1996	1926	1825	1934	2019	2267	2369	2538	2829	2928	3144	3522	3430	3447	3712	3598	3976	4292	5208	5605
Sweden	6601	6628	6225	6679	6813	7311	7820	8321	9044	9566	9909	10,515	10,770	10,588	11,241	10,990	11,962	11,528	13,413	13,505
UK	38,373	36,948	34,976	36,946	37,958	42,973	45,092	48,829	55,269	58,199	58,005	60,588	62,317	63,652	62,279	60,070	63,472	63,764	72,364	73,921

Source: Thomson Reuters (2008).
Notes: Advanced search; search phrase OG = (Univ SAME CU = country name) AND PY = XXXX. For each search, timespan was defined as the same as publication year in the search phrase. UK includes England, Northern Ireland, Scotland and Wales. A search was also conducted using the search terms UK and United Kingdom, but the result in these cases was zero. Both Germany and Fed Rep Ger were used for country name in the case of Germany in 1987–1991 and results added together.

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Influence of research funding and science policy on university research performance: a comparison of five countries

Abstract: The ability of universities to efficiently produce high-standard knowledge has become an important goal in science policies of many developed countries. Thus, many countries nowadays steer universities based on performance monitoring and competition. This article analyzes the connection between the competitiveness of the university funding environment and research performance in five OECD countries in 1987-2006. Besides funding, other science policy factors are analyzed using the framework of four state steering models. Results indicate that the university funding environment has become more competitive in all the compared countries, but the extent and pace of this development varies. Countries also differ in relation to steering models but all have employed policy elements typical of at least two models. In terms of

competitive funding environment and research performance, there is no straightforward relationship between the two. With reference to the state steering models, the most traditional model which emphasizes university independence from the state seems to be the most beneficial to research performance.

Introduction

Knowledge has become an important resource for industry both as an element of products and production processes over the last couple of decades. This development is associated with the globalization of economy. The developed, industrialized countries have faced a challenge of maintaining their position in global economic competition. Universities have become key components of the economies of developed countries because they create knowledge and disseminate it to industry and wider society and provide the highest education to people. Because of the strategic significance of universities, their performance and cost-effectiveness have become highly relevant issues to policy makers. (Slaughter and Leslie, 1997: 36-40)

As a result, there is a strong science policy trend that emphasizes the research performance of the university sector. Competition for money and other financial incentives are often used as steering instruments, since funding is regarded to have a strong impact on the behaviour of universities which are dependent on resources from other organizations such as the state agencies (Hackett, 1990; Nieminen, 2005: 124-125). However, this development is not uniform across countries. Also the long-term usefulness for and impacts of funding incentives and competition on university research are still unclear.

In this article, we analyze the connection between the funding and research performance of universities. In addition, we scrutinize the role of other science policy factors and instruments in explaining university research performance. Our analysis is longitudinal and comparative: we compare five OECD countries (Australia, Finland, the Netherlands, Norway, and the UK) during 1987-2006. More precisely, our research questions are:

1. How has university research funding developed in the compared countries?

2. How competitive are the funding environments of university research and how has competitiveness of funding developed?

3. How have science policies developed in the compared countries with regard to the relationship between the state and the university sector?

4. Has the university sector become more efficient in producing scientific publications and gaining citations in countries where the funding environment is competitive?

5. Can other policy factors explain the differences in research performance?

Research framework

From the 1980s onwards, progressive public administration (PPA) as the main principle of organizing public administration was gradually replaced with New Public Management (NPM) in many OECD countries. Unlike PPA, this new mode of government included lessening the boundaries between the public and private sectors of society and shifting the attention from controlling the process to controlling the results. (Hood, 1995) In the NPM mode, policy makers rely on market-like mechanisms to enhance the cost-effectiveness and quality of public organizations' activities. The same trend has also occurred in higher education and science policy. The governments have lessened the regulation of universities and created incentives in order to make universities more productive in terms of degrees, publications and other forms of output. In the allocation of research funding, the share of "free" basic funding has been decreased and various systems for allocating targeted funding have been established. (Nieminen, 2005: 13-16)

Bearing in mind the science policy trend towards controlling the results and cost-effectiveness, and the argument that funding allocations can be regarded as the most effective science policy instruments available (Nieminen, 2005: 85), our analysis focuses mainly on the developments in university research funding and their connection to university research performance (measured by publications and citations) in the five above-mentioned countries. However, the shifts in university funding policy occur in country-specific circumstances and in relation to other science

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policy factors, which may also have an affect on university research performance. Science policy being such an extensive concept, we have decided to focus on the following issues.

According to van Vught (1989; ref. Gornitzka and Maassen, 2000: 269) there are two basic models of state steering, which in the context of higher education have been referred to as the state control and the state-supervising model (Neave and van Vught, 1991; ref. Gornitzka and Maassen, 2000: 269). This typology focuses on the links between central political authorities and higher education organisations and on how tight or loose those links are. Instead of this dichotomy, however, Gornitzka and Maassen suggest using Olsen's (1988) four state steering models as they find them more suitable for analysing changes in the steering relationship between governments and higher education. The models are: the sovereign state, the institutional state, the corporate-pluralist state and the classical liberal state, also referred to as the state supermarket model. (Gornitzka and Maassen, 2000: 269) Olsen's four models provide a framework for answering the question of why and on what condition governments should give agencies more autonomy. Autonomy is an important issue especially with reference to NPM as, according to Schimank (2005, 365), NPM strengthens hierarchical management by rectors and deans as well as by state authorities and external stakeholders while implying deregulation on budgeting and personnel management. Besides approaching the question of autonomy, the models also encompass other issues of interest to our analysis: for example, what is the role of the higher education sector in society and how this role is best upheld, what are the tenets underlying the assessment of functionality of the higher education sector and how and where does decision-making about higher education take place.

In the sovereign steering model, higher education is seen as a governmental instrument for reaching political, economic or social goals. The role of the higher education sector is to implement whatever political objectives are on the higher education policy agenda. Universities are under tight control and strong emphasis is put on the fact that universities are accountable to political authorities. In the sovereign model, assessment of functionality in universities is based on their political effectiveness. The decision-making process is centralised and 'top-down'; the mode of steering is hierarchical. University autonomy is based on the notion that government is

overloaded and technical decisions can therefore be left to the universities themselves. Changes in higher education follow changes in political leadership either via elections or via changes in political coalitions.

In the institutional steering model, universities have a special responsibility to protect academic values and traditions against the whims of shifting political regimes and coalitions and short-term agendas of interest groups. The role of the higher education sector is to uphold its traditions and socio-economic and cultural role as well as to protect academic freedom. This model can best be exemplified by the relationship between the state and the old elitist universities. In the institutional model, functionality of universities is assessed based on their effects on the structure of meanings and norms. Decision-making is specialised and traditionalist. University autonomy is based upon shared norms of non-interference – the government does not interfere directly with higher education. Changes in the higher education system take place through historical processes and evolution rather than as a result of reforms.

The corporate-pluralist steering model assumes that there are several competing and legitimate centres of authority and control with respect to higher education. The role of the higher education system reflects the constellation of interests voiced by different organised interest groups in the sector, such as student unions, staff unions, professional associations, industry or regional authorities. The Ministry of Education is just one of the many stakeholders. Functionality of the university is therefore assessed based on the criteria of multiple stakeholders. Decision-making is also segmented and dominated by interest groups with a recognised right to participate. University autonomy is negotiated and is the result of a distribution of interests and power. Changes in the higher education system depend on changes in power, interests and alliances.

In the supermarket steering model, the role of the state is minimal and the role of the universities is to deliver services, such as teaching and research. Criteria for assessing universities include efficiency, economy, flexibility and survival. As a result of extreme decentralisation, there is no dominant arena of policy making. University autonomy depends on the ability to survive while

changes in the higher education system depend on the rate of stability or change in the environment.

Data and methods

The development in the volume of university research funding is described through data on higher education sector R&D expenditure (HERD), drawn from the OECD science and technology database. The data cover the years 1991-2006. Competitiveness of the university funding environment in the compared countries is analysed using two indicators: 1. the input-output orientation of direct government funding for research, and 2. the shares of internal research funding (direct government funding and universities' own funds) and external research funding (all other funding sources). Direct government funding for research is usually mainly composed of so-called basic or core funding that states allocate to universities for maintaining the basic infrastructure of research activities (e.g. staff salaries, buildings and equipment). The orientation of direct funding is dependent on the allocation criteria. Input criteria include, for example, historical level of funding and staff and student numbers, while output criteria include, for instance, results of assessments as well as publication and degree numbers. The more output-oriented the direct government funding and the larger the share of external research funding are, the more competitive the university funding environment is. The analysis of the input-output orientation of direct funding is based on the interpretation of document data, gathered from national sources. Research literature was also used. The data cover the years 1987-2006. In the case of the distribution between internal and external funding, we derived data from the OECD science and technology database. These data cover the years 1991-2006.

We have compared the countries in terms of their position relative to Olsen's (1988) four steering models. The countries are placed based on how they "score" with regard to the models - in other words, how strongly the science policy developments in a given country fit the description of a given model. To do this, we have primarily used Meek and Wood's (1997) presentation of Australia and Gornitzka and Maassen's (2000) presentation of the rest of the countries. We have also gathered and analyzed other document data that cover the years 1987-

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2006. In the analysis of each country, we have described the development with regard to the steering models. In the results we have placed the countries on the four dimensions based on their recent situation.

As for university research performance in the compared countries, we formed three indicators for the analysis: 1. publications per the country's higher education sector R&D expenditure, 2. the share of the country's higher education sector of OECD14 publications, and 3. the share of the country's higher education sector of OECD14 citations[1]. Publication and citation data were gathered from the Web of Science databases provided by Thomson Reuters (Arts and Humanities Citation Index, Science Citation Index Expanded and Social Science Citation Index). The data cover the years 1991-2006 in the case of publications per HERD ratio and 1987-2006 in the cases of the share of the country's higher education sector of OECD14 publications and citations. Publications per HERD ratio has been calculated using a two year time lag: e.g. the 1993 ratio is the number of publications in 1993 divided by the amount of HERD in 1991. Time lag is used because there is a lag between the investment in research and publication of research results.

Results

Australia

In Australia, higher education R&D expenditure has increased constantly, but there has been a steady state in the late 1990s. The share of internal funding has decreased moderately. The system of direct government funding became more competitive in the early 1990s, and competitiveness of the funding system has since remained quite high. Australia's share of OECD14 publications and citations has increased since the beginning or mid-1990s, but the publications per HERD ratio has stagnated since the late 1990s.

Figure 1. Relative change in higher education sector R&D expenditure (million constant US dollars 2000 prices and PPPs) and in the share of direct government funding and universities' own funds of HERD in 1991-2004 in Australia.
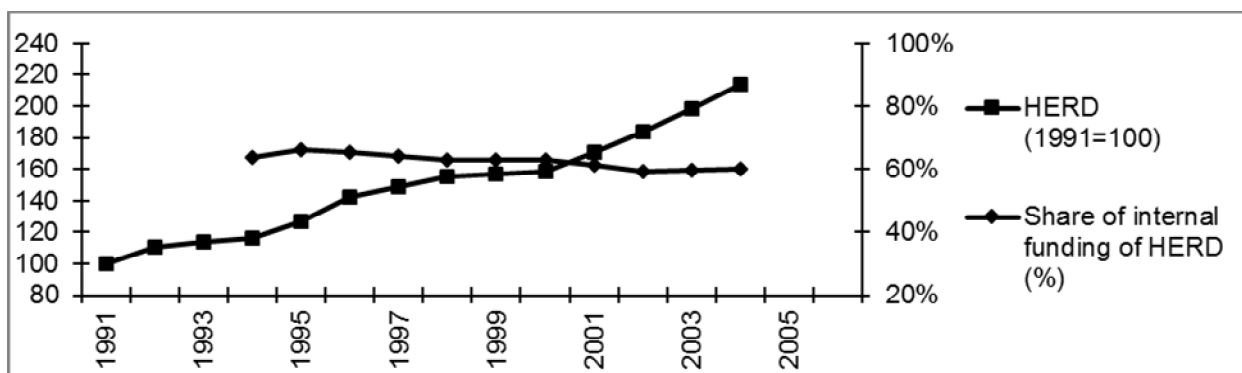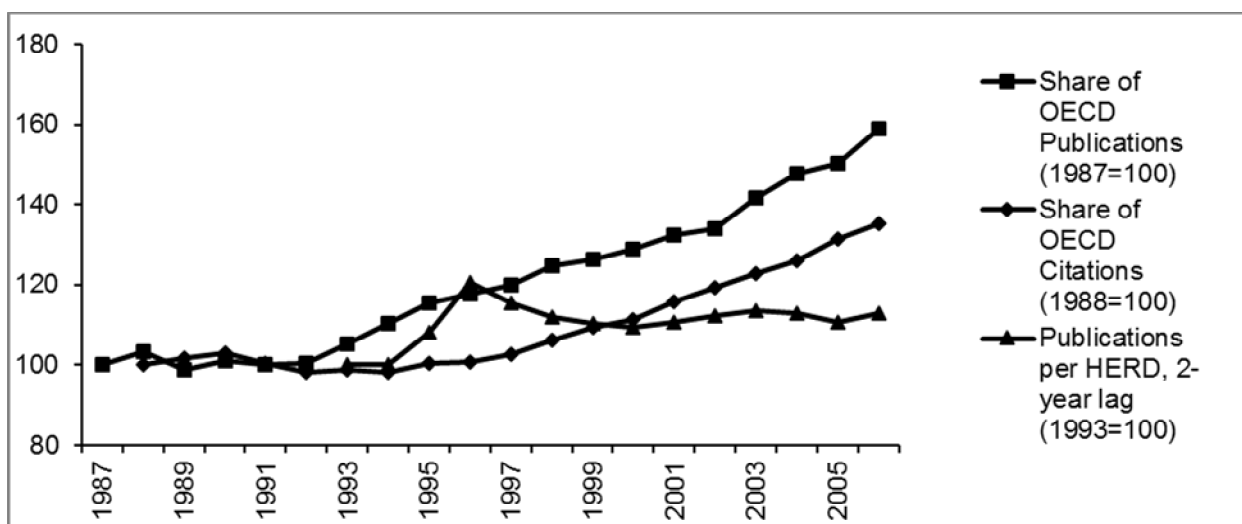

Figure 2. Relative change in Australian universities' share of OECD14 publications in 1987-2006, share of OECD14 citations (to papers published in 1987-2006) in 1988-2006 and publications per higher education R&D expenditure (million constant US dollars 2000 prices and PPPs) in 1993-2006.

Profound changes took place in the Australian higher education system at the end of the 1980s. One such change was the end of the dual system of universities and colleges of advanced education in 1987. Moving towards a mass system of higher education created pressures for

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efficiency, elimination of apparent duplication and consolidation into more economic units. The rationale behind institutional amalgamations was partly the desire to improve management efficiency and lower unit costs. This led to a much smaller number of significantly larger institutions, all called universities. (Meek and Wood, 1997) In the light of our data, creating bigger units, however, does not seem to have a positive influence on publication performance.

In addition to the above-mentioned reforms, a new funding system, designed to give the institutions a fair degree of autonomy and flexibility in the management of their resources, was introduced (Gamage, 1992). According to Mahony (1994), the motivation for giving institutions more autonomy was to facilitate achievement of goals, officially set out for higher education. In his view, university autonomy is therefore a paradox – autonomy to be free to conform.

Ever since the late 1980s, Australian science policy has placed substantial trust in market mechanisms, and the concept of the market has helped regulate the relationship between higher education institutions and the government. The government is not totally disinterested in the regulation of higher education, however, as is evidenced by an increasing emphasis on quality control and other accountability measures. (Meek and Wood, 1997) In international comparison, the state is more than on average in control of universities and their research activities even though the relative funding model, which was designed to lessen the control, was introduced in 1990. (Anderson and Johnson, 1998; ref. Neumann and Guthrie, 2002)

The relative funding model marked the beginning of a performance-based approach in research funding. To begin with, only external earnings were used as a basis for allocation and that favoured the pre-1987 universities, and the research funding becoming more competitive presented a particular challenge to many of the new universities. However, after the year 1990 the share of OECD14 publications took a turn for the better, and after a few years' delay, the share of OECD14 citations followed the same positive trend.

The research capacity of the new universities began to improve after a new funding formula was introduced in 1995. This new formula also included other output measures, such as publication

counts and higher degree loads and completions. In 2001, formula funding was expanded to account for more than half of the funding specifically targeted for research and research training.

Finland

In Finland, the increase of HERD as well as the decrease in internal funding has been remarkable. Growth of total spending started later, in the mid-1990s. Direct government funding was very input-oriented before the mid-1990s, after which the weight of output criteria has increased. The system is still input-oriented. Finland has grown its share of OECD14 publications and citations, but this development has halted in 2001. After a clear growth in the 1990s, the ratio of publications per HERD has declined below the 1993 level.

Figure 3. Relative change in higher education sector R&D expenditure (million constant US dollars 2000 prices and PPPs) in 1991-2004 and in the share of direct government funding and universities' own funds of HERD in 1991-2006 in Finland.
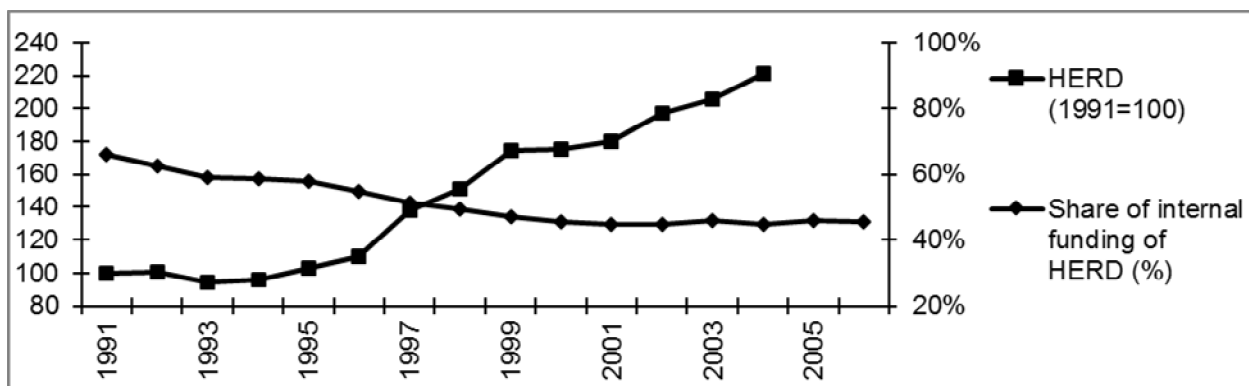
Figure 4. Relative change in Finnish universities' share of OECD14 publications in 1987-2006, share of OECD14 citations (to papers published in 1987-2006) in 1988-2006 and publications per higher education R&D expenditure (million constant US dollars 2000 prices and PPPs) in 1993-2006. (Note: Data on higher education R&D expenditure includes central university hospitals since 1997. Central university hospitals are included in the publication data since 1999 for the publications per HERD ratio.)
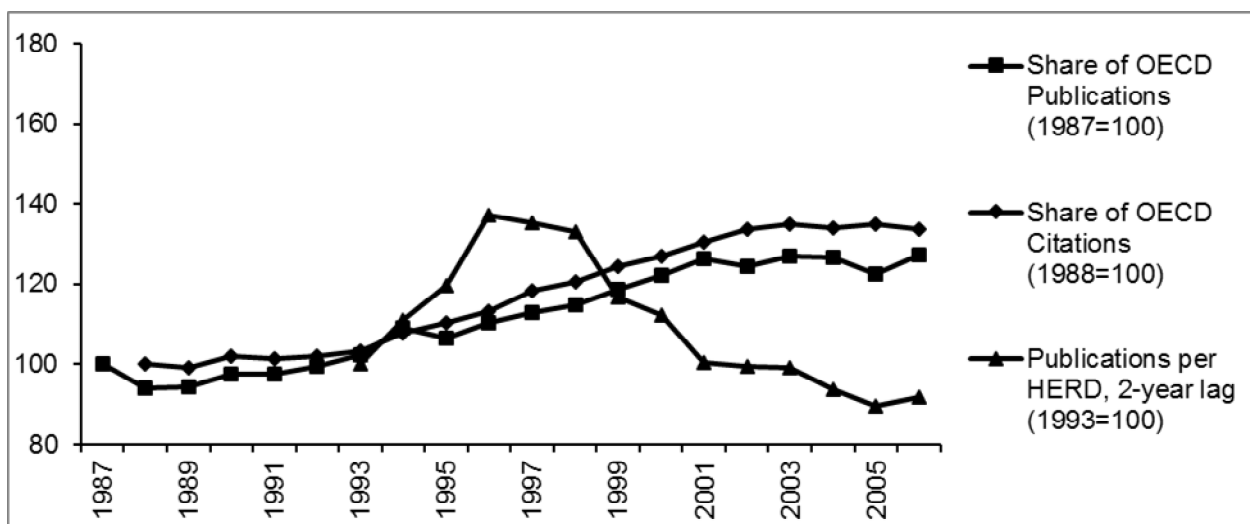
In Finland the direction of the relationship between the state and the universities has moved away from a classic sovereign state model of the 1960s and 1970s for the past 20 or so years. At the end of the 1980s, visible changes took place in higher education policies and government steering of universities as a result of the introduction of a market and internationalization oriented ideology in Finnish society in general. (Gornitzka and Maassen, 2000) The national innovation system took over in 1991 as an overall concept around which the functioning of the science and technology system was studied and assessed. The national innovation system managed to create a consensus on focal development priorities and it can be said that university functions were defined from the perspective of this system.

Since 1994, universities and the Ministry of Education have negotiated performance agreements, which have become the single most important steering device of the Ministry of Education. The agreements include, for example, targeted numbers of completed master's and doctoral degrees.

In the second half of the 1990s, the increase in university autonomy has been distinct and real; universities have been given the freedom to decide on a number of issues. The result-orientation and market based co-ordination of the new budget and management system reflect the change towards the supermarket model of state steering. (Gornitzka and Maassen, 2000) In 1997, the unit-cost formula was introduced into core funding and has been in full use since 2003. Since the formula includes completed degrees, measurable results have increasingly affected basic funding of universities.

In association with the political rhetoric of decentralization and the delegation of responsibility from the state to the higher education institutions, a national evaluation system was developed. The increase in organizational independence from the central government is balanced by an increase in accountability. Moreover, an ideology of evaluation is developing as part of the new steering ideology. However, the evaluation has not yet been linked to the performance agreements or public budget allocations for the institutions. Rather, in the view of Gornitzka and Maassen (2000), evaluation and quality issues represent a strengthening of the role and impact of the academic profession instead of the role and impact of market forces or ministerial influence.

Finland's share of both OECD14 publications and citations has increased during the study period, but publications per higher education R&D expenditure started to plummet around 1997. We suggest that this is partly due to the core funding formula's incentive for universities to produce more doctors. This inevitably leads to the increased admittance of doctoral students. As is generally acknowledged, doctoral students do not publish as much as, say professors, and also because of the same incentive, professors have to do more teaching which can affect their publishing because they have less time for research.

Netherlands

In the Netherlands, higher education research expenditure has hardly grown since 1991. The share of internal funding has remained relatively high, although it has decreased considerably from the level of 1991. The system of direct funding was more output oriented than in most of

the other compared countries at the end of the 1980s, but at the beginning of the 1990s, more input criteria were introduced. At the end of the 1990s, the funding system was again altered towards a more output-oriented direction. All the performance indicators appear very positive for the Netherlands, though the share of publications and citations has started to grow only after the end of the 1990s.

Figure 5. Relative change in higher education sector R&D expenditure (million constant US dollars 2000 prices and PPPs) and in the share of direct government funding and universities' own funds of HERD in 1991-2003 in the Netherlands.
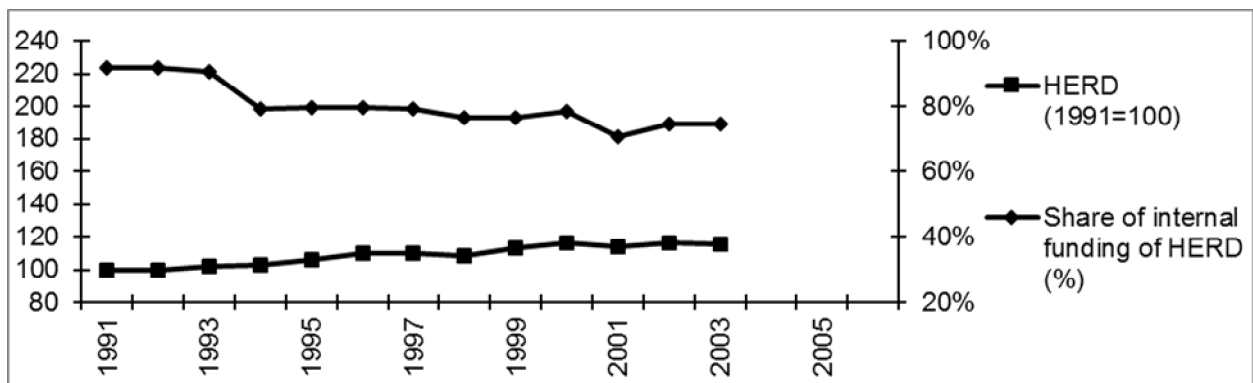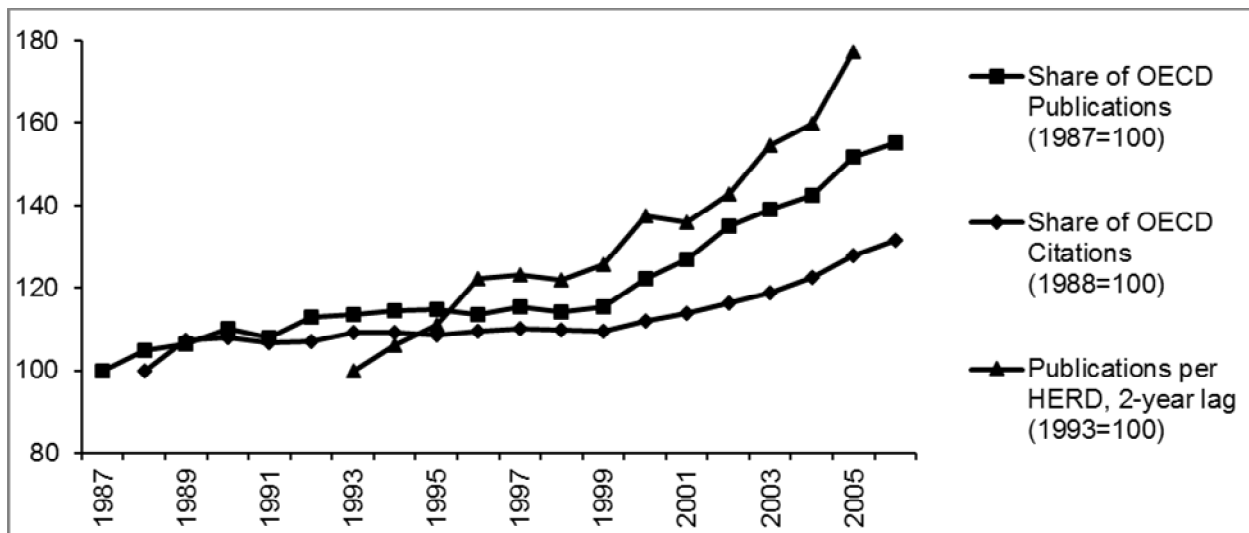
Figure 6. Relative change in Dutch universities' share of OECD14 publications in 1987-2006, share of OECD14 citations (to papers published in 1987-2006) in 1988-2006 and publications per higher education R&D expenditure (million constant US dollars 2000 prices and PPPs) in 1993-2005.

A policy paper in 1985 introduced a new strategy for higher education. It presented a new steering model based on the notion that the higher education sector would become more effective and efficient if universities had more autonomy and the government would step back accordingly. Until the late 1980s and early 1990s, the formal regulations for the university sector fit the sovereign state model. Also elements of the institutional model could be found. Universities had some latitude in organizing their basic research and teaching activities, but were regularly surprised by policy initiatives subscribing to the government's need to plan and control the higher education sector. (Gornitzka and Maassen, 2000)

After the new strategy, some critics still suggested that a number of characteristics of the old steering model were still present in the policies and instruments put forward. Nonetheless, universities were granted more autonomy, especially with respect to input matters. (Gornitzka and Maassen, 2000) In 1993, university autonomy was further strengthened in the Higher Education and Research Act. In many ways the governmental steering of higher education moved away from setting the conditions to focusing on the performance of institutions and

students. The change in the steering focus is visible in the quality assurance system, which instead of controlling beforehand, evaluates afterwards. Since 1993, university research programs have been assessed through a system of peer review. The assessment is conducted by the institutions themselves and the results are used for developing their internal policies, not as inputs in the ministry's funding decision. The government is indeed practically absent in this area, in terms of both funding and decision-making. As for the relationship between the method of assessment and performance, we suggest that when an assessment is conducted internally and when the main motivation for undertaking the assessment is to develop internal research policies, the institutions have better incentive to continuously improve their performance.

Norway

In Norway, research expenditure has increased constantly although there was a steady state at the turn of the millennium. The share of internal research funding has remained rather high. The system of direct funding was heavily input oriented until the turn of the millennium, after which some output criteria have been added to the system. Input orientation is still quite strong. Norway's share of OECD14 publications has gone hand in hand with the publications per expenditure ratio. The former increased considerably after 2003. The share of OECD14 citations has grown constantly.

Figure 7. Relative change in higher education sector R&D expenditure (million constant US dollars 2000 prices and PPPs) in 1991-2006 and in the share of direct government funding and universities' own funds of HERD in 1991-2005 in Norway.
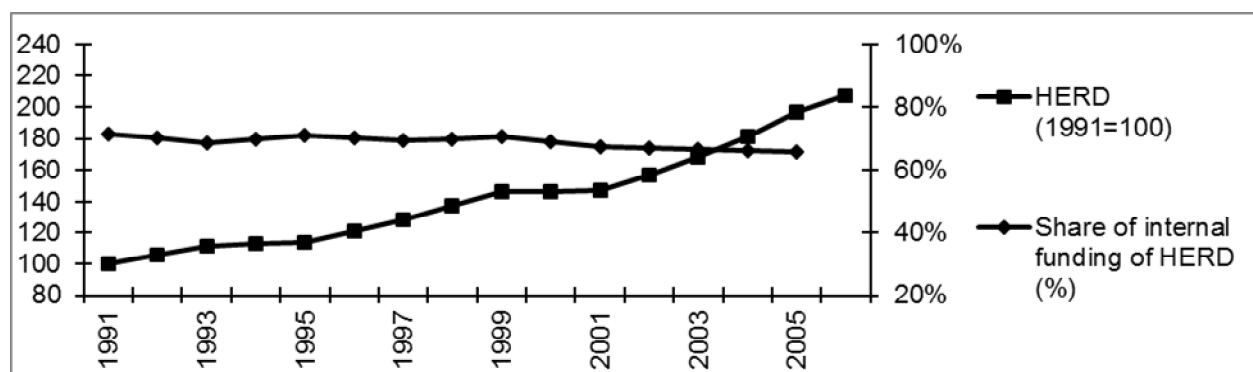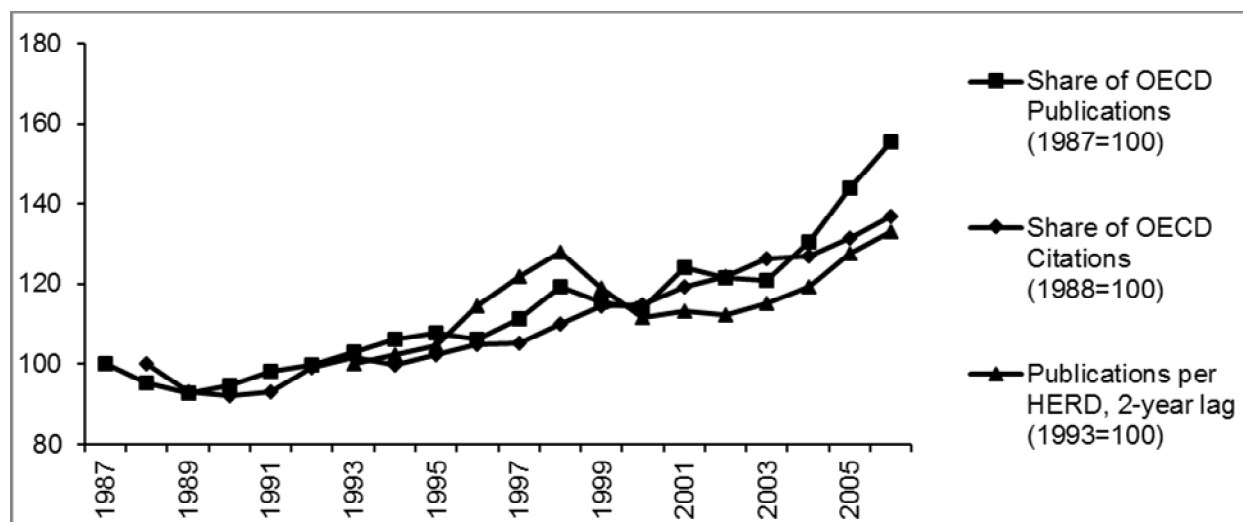
Figure 8. Relative change in the share of OECD14 publications in Norwegian universities in 1987-2006, share of OECD14 citations (to papers published in 1987-2006) in 1988-2006 and publications per higher education R&D expenditure (million constant US dollars 2000 prices and PPPs) in 1993-2006.

After the decline in the share of OECD14 publications in the early years of our data, it took a definite turn for the better. During the 1990s the government's role in controlling the higher education sector has changed significantly. The earlier system was more input-oriented and steering was relatively strongly centralized. Lately the system has become more output-oriented and the institutions have gained more autonomy and become more accountable. (UFD 2005) Between 1987 and 1994, university enrolment doubled; as a result resources were channeled into teaching and students received the most attention. Hence, the higher education sector felt the need to change the situation where university policy equals education policy. Universities started to develop their own research policies at the end of the 1980s. This development was also encouraged by the state but, according to Larsen (2000), governmental steering had little influence. Since the early 1990s, universities have prepared strategic research plans and established administrative units for research policy matters.

The state has a significant role in the Norwegian university sector, as it is responsible for most of the funding for research. Universities therefore cannot ignore its goals. A policy initiative for

strengthening Norwegian research was presented in a white paper in 1999 and in the same year, the Fund for Research and Innovation was established. The main purpose for setting up the fund was to provide a basis for long-term stable funding of research activities. And as part of the quality reform in 2001, which was the single most important reform to have taken place in recent years, universities now receive some of their research funding based on their performance. Even a rather moderate incentive can thus be enough to cause such a steep rise in the share of OECD14 publications.

None of the four steering models dominate, but the Norwegian steering approach consists of a mixture of elements of the sovereign model, the institutional model and the supermarket model. And, in the spirit of Norway's political tradition of consensus and dialogue, elements of the corporate-pluralist steering model can also be found. Besides the Ministry of Education, a number of other stakeholders are involved in decision-making and planning. (OECD, 2006) This continuous dialogue between the government, universities and other interest groups is seen as a considerable strength in the successful implementation of recent reforms (UFD, 2005).

United Kingdom

In the United Kingdom, research expenditure has grown, with the exception of two steady periods. The first occurred in the mid- to late 1990s, and the second at the beginning of the millennium. The share of internal funding has not declined very much, but it was rather low already in 1991. Output orientation has been high in the system of direct funding for the whole period of analysis. Shifts towards more selective core funding since the early 1990s have made the system even more output-oriented. There has been a moderate increase in the share of OECD14 publications. However, the proportion of OECD14 citations has not grown. Two peaks in the publications per HERD ratio are worthy of note. The first occurred in the mid-1990s, and the second in the late 1990s. Note also the remarkable fall in this ratio after 2000 and the rise since 2004.

Figure 9. Relative change in higher education sector R&D expenditure (million constant US dollars 2000 prices and PPPs) and in the share of direct government funding and universities' own funds of HERD in 1991-2005 in the United Kingdom.
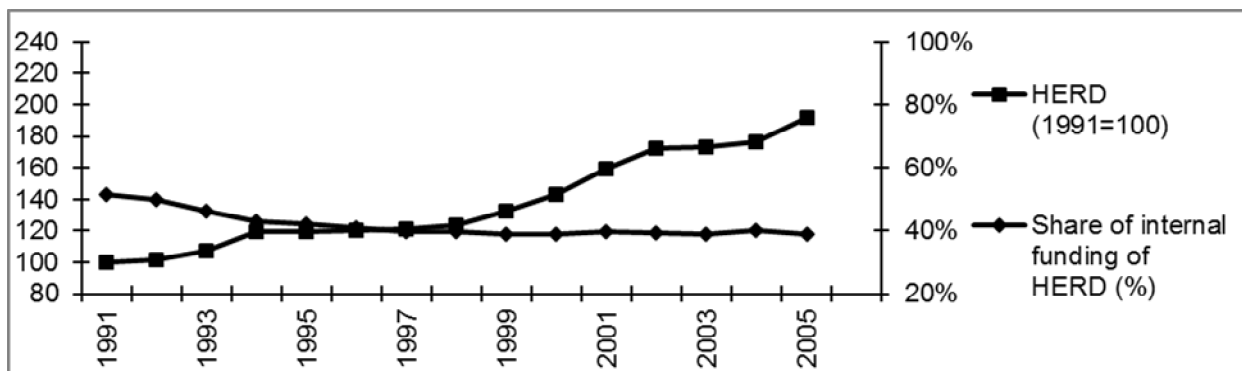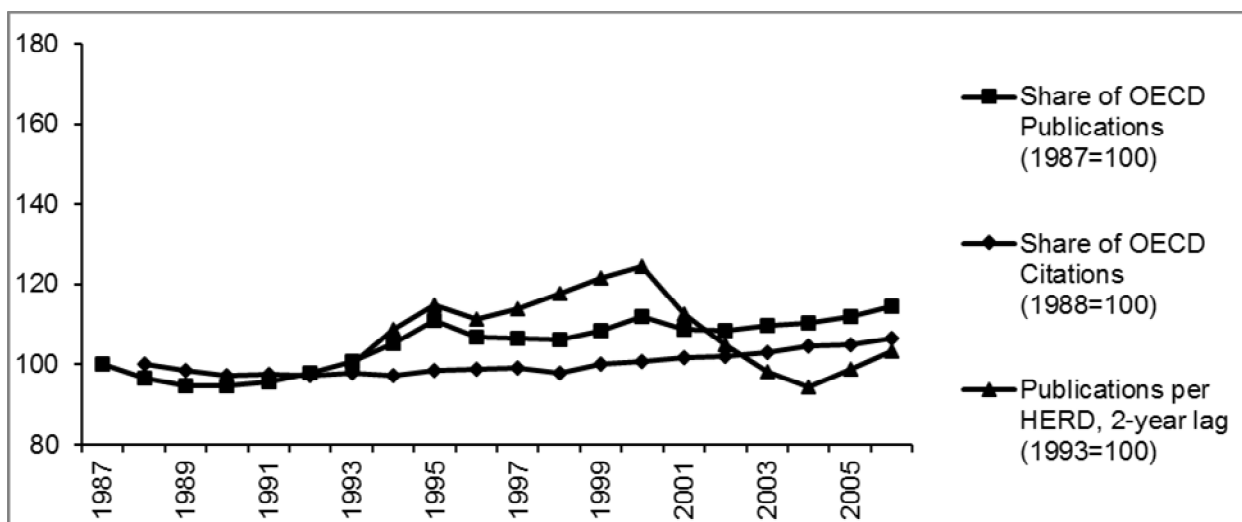

Figure 10. Relative change in the share of OECD14 publications in UK universities in 1987-2006, share of OECD14 citations (to papers published in 1987-2006) in 1988-2006 and publications per higher education R&D expenditure (million constant US dollars 2000 prices and PPPs) in 1993-2006.

In the UK, there was a notable reduction in public expenditure on higher education institutions in the early 1980s. Additionally, there was a movement away from the institutional steering model and towards the super market model. According to Gornitzka and Maassen (2000), the state managed by way of some substantial changes in the 1980s and 1990s to increase its

influence over the university sector. The effects of the cutbacks and the changes in the government approach sensitized the universities to money as a policy instrument of the central government. As one consequence of the cutbacks, the first evaluation of research quality was conducted in 1986. The evaluation, which was called the research selectivity exercise, had a significant effect on the basis of allocating research funding. The second research selectivity exercise was conducted in 1989.

In 1991, the UK abolished the dual system of higher education, which led to the creation of 30 new universities. The increase in the number of institutions with research activity can barely be seen in the data as a slight rise in the share of OECD14 publications, beginning around 1991. The most notable feature is clearly the research assessment exercise, which took place in 1992, 1996, and 2001. The results of the research assessment exercise are heavily connected to the core research funding of universities, more than 90 per cent of the funding councils' research funding is allocated based on the exercise. The effects of the exercise can be seen in our data as visible jumps in publishing performance in 1995 and 2001 – a year before the assessments. However, the effects of the assessments tend to remain transitory. Research performance in terms of both quantity and quality has grown steadily, but rather modestly in comparison with the other compared countries. In contrast to the Dutch case, we propose that when an assessment is conducted by a third party and when the main motivation for undertaking the assessment is to allocate funding, the institutions do not necessary have an incentive for constant improvement.

Universities as private sector institutions have a considerable amount of autonomy; they plan their own strategies, decide the profiles of their academic programs and define their own research priorities. As private sector institutions, they are also subject to the same constraints as other private bodies – if they have no customers, they fail. But even with a high level of autonomy, the government can use public funding in an effort to steer universities to act according to national science policies. (Clark, 2006)
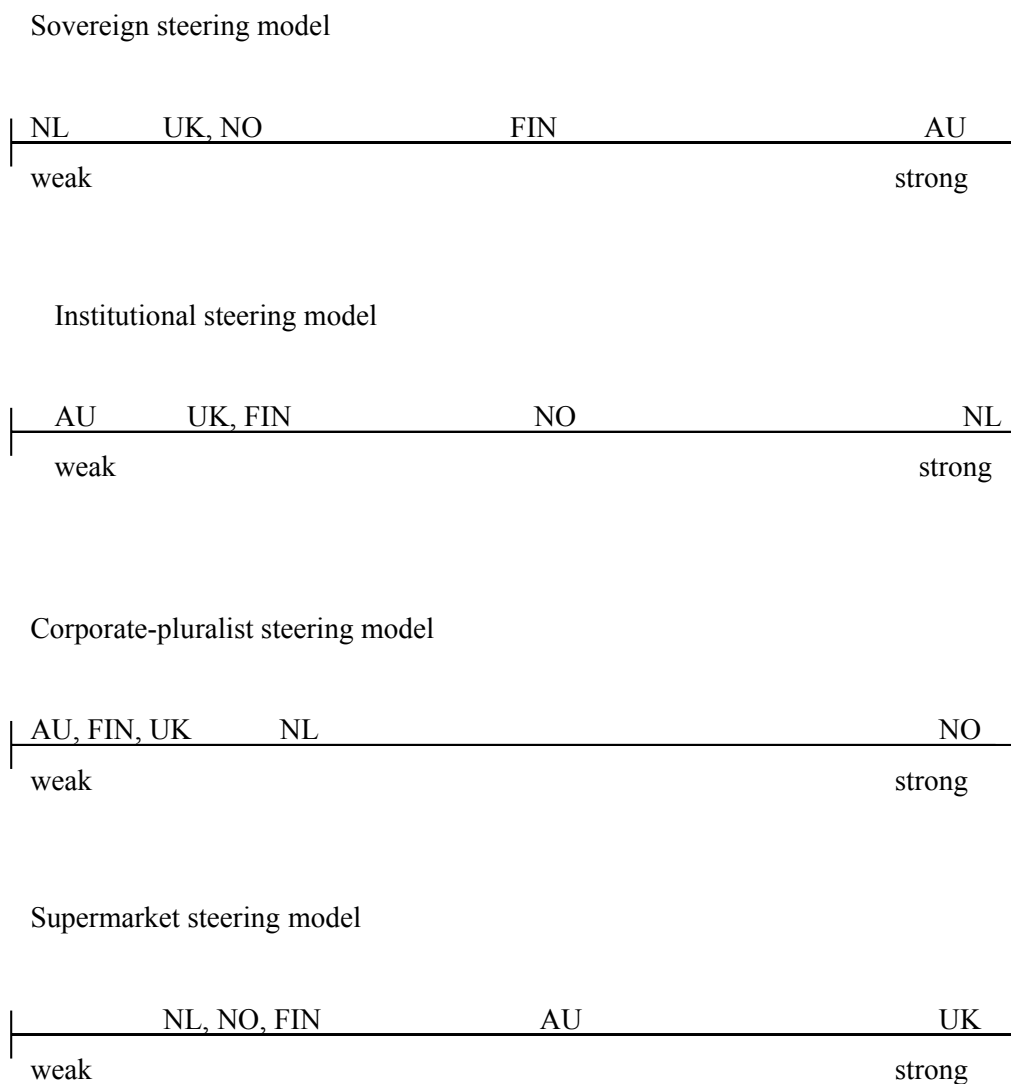
Conclusion

Between 1991 and 2006, R&D expenditure in the higher education sector has grown significantly in all the compared countries with the exception of the Netherlands. In the other countries, the expenditure has at least doubled. During the same period of time, the share of direct government funding and institutions' own funds has steadily decreased in all the countries. In this respect, universities in the UK and Finland have had the most competitive funding environments. Australia and Norway form the middle-group, while direct government funding and own funds have had a dominant position in Dutch university research. The UK and Australia have clearly employed the most output-oriented funding systems for direct research funding, but the funding systems of the other countries have also become more competitive. Taking into account both of these competitiveness indicators, the UK emerges as the most competitive environment. Australia and Finland form the second most competitive group, while the universities in Norway and the Netherlands still have relatively non-competitive funding environments.

In Australia and Norway the effects of increased output-orientation can be seen as an improvement in the share of OECD publications and citations. Similar effects can also be seen in Finland, but only until 2001. Dutch higher education institutions show a constant increase in both publication output and citation impact regardless of the stability in HERD during the study period. In the Netherlands, universities assess their own activities, and the results are used for developing the internal policies and strategies of universities, not for allocating research funding. Another example of the role of the assessments is the British academic research system, which has been characterised by the Research Assessment Exercise carried out by the funding councils. There is also growth in the UK share of OECD publications and citations, but it's very modest compared to the other countries.

Drawing on the science policy developments presented above, we have placed the compared countries in relation to each other, as they fit the descriptions of the four steering models (Figure 11). To sum up, it can be seen that all the countries studied have a mixture of elements from at

least two different models, with Norway having a mixture of elements of all the models. In all of the countries, besides Finland, one steering model clearly dominates - the dominant model being different in all four countries. Elements of the sovereign and institutional steering models cannot be found in all of the countries. The corporate-pluralist steering model is practically non-existent in most of the countries, whereas elements of the supermarket steering model can be found in all of the countries.

Figure 11. The compared countries in terms of their orientation towards the four state steering models.

Sovereign steering model

NL	UK, NO	FIN	AU
weak			strong

Institutional steering model

AU	UK, FIN	NO	NL
weak			strong

Corporate-pluralist steering model

AU, FIN, UK	NL		NO
weak			strong

Supermarket steering model

	NL, NO, FIN	AU	UK
weak			strong

As shown by our results on the publication per HERD ratio, the Dutch university system seems to be a 'success story'. It produces the most output for the least input among the compared countries. With respect to Olsen's four state steering models, the Dutch higher education system is a combination of all four but the institutional steering model dominates. This is the most traditional model of the four and emphasises university independence from the state. Norway's strong orientation towards the corporate-pluralist steering model has been seen as a considerable strength in the successful implementation of reforms that have improved Norway's scientific productivity in recent years. Relatively strong tendencies towards the institutional steering model, which has proven successful for the Netherlands, can also be found. A strong orientation towards the sovereign steering model, as can be found in Australia, does not have a positive influence on publication productivity. Australia's publication per HERD ratio has stagnated for the past 10 years. But in the case of the UK and Finland, the publication per HERD ratio has in fact been declining. This suggests that Britain's strong orientation towards the supermarket steering model and Finland's scattered orientation to all of the four models but to none in particular, have proven unsuccessful and even harmful to publication productivity.

As our research focuses on the research function of universities, some questions regarding the educational role and the effect of education on research performance remain unanswered. Both the Finnish and Norwegian cases show that these two roles cannot always be clearly divided in terms of funding or higher education policies. In Finland, much of the core funding aimed at research has in practice been used for doctoral training while in Norway the massification of higher education partly induced the creation of university research policies. Even though our Norwegian example shows that massification has a positive effect on publication productivity, it can result in 'crowding out' of research by teaching and in a situation where some of the research functions of universities spill over to other research institutions (Schimank and Winnes, 2000).

The analysis suggests that there is no straightforward relation between the competitive funding environment and research performance. There has been a steady growth in international

publications among the compared countries independent of developments in funding environments. The impact of incentives on research performance appears to be quite short-term and sometimes even negative. However, the model of state steering does have an effect. The institutional steering model, which emphasizes university independence from the state, seems to be the most beneficial to research performance.

The role of multiple micro-level (university departments, research groups) and meso-level (universities) factors should not be overlooked when studying the variations in research productivity. In further research, combining the analyses of all three levels could provide a more comprehensive picture of university research performance.

Acknowledgements

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[1] OECD14 refers to OECD15 countries (Austria, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Korea, Portugal, Spain, Sweden, United Kingdom and United States) excluding the United States. Publication and citation counts are unfractionalized. Citations to publications in 1987-2006 are included. Self-citations are included. Publication and citation data in the compared countries refer to the university sector only. As for OECD14, all the R&D sectors are included. As publication and citation data for the OECD14 were not readily available, we conducted a stratified search in the Web of Science databases for each member country as in the case of the compared countries.

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Connections between competition for funding and research performance in three Finnish universities

Abstract

In recent decades, policy makers in Finland have aimed at improving the research performance of the country's universities. Competition for money has been a central policy instrument to achieve this goal. In this article, we scrutinize the connection between funding competition and research performance in the context of three Finnish universities from the early 1990s to the mid-2000s. We address the following question: What is the relationship between the development of the funding environment and research performance of the three case universities? Our data include statistics on research expenditure, publication and PhD degree output, citation data, and documents on the funding models employed by the universities. The results indicate that the funding environment of research has become more competitive in all three universities and in the Finnish university system in general, but tightened competition has had varying effects on the research performance of universities. In all, positive influences of funding incentives appear to be short-term.

Keywords: research performance, research funding, universities, competition, efficiency

Introduction

Finnish policy makers have for the past few decades emphasized the improvement of universities' research performance as one of the key targets of science and higher education policies. In Finland, like in many other countries, interest in universities' research performance is connected to the policy framework influenced by New Public Management (Ferlie et al. 2009; Hakala 2009, 31–32). A main principle of NPM is the accountability and cost-effectiveness of the public sector (Hood 1991). On the other hand, the severe economic recession of the early 1990s forced the Finnish government to make budget cuts throughout the public sector, including universities. For its part, the necessity to make cuts promoted the idea that universities needed to become more effective in their activities. (Hölttä 2010; Nieminen 2005, 60–63; Pelkonen 2008, 63–65) Development towards more performance-oriented science policies marks the change in the social contract of science that has occurred in many of the developed countries since the 1980s (Martin 2003; Slaughter and Leslie 1997).

Competition for money has been a central policy instrument to achieve the goals of better research performance and cost-effectiveness. In Finland, major changes in funding of university research occurred in the 1990s. State funding to universities was soon increased after the budget cuts of the recession of the early 1990s. But unlike before, much of the increased funding was allocated through research councils' and other state financiers' project funding instead of recurrent basic funding. At the same time, state moved towards more performance-based allocation of basic funding. By moving to lump-sum budgeting instead of earlier line-item budgeting in allocations of basic funding, the government also gave universities more autonomy in using the funding. (Hölttä 2010; Nieminen 2005, 60–63, 67–70) Similar trends have been documented also from other countries since the 1990s (OECD 1998, 35–38; European Commission 2008, 96–97). Recent research has questioned whether or not this performance-oriented policy line has actually led to higher research performance in Finnish universities. In comparison with some other developed OECD countries, the research performance of the Finnish university sector – measured by scientific publication output per research expenditure – has weakened since the end of the 1990s. (Himanen et al. 2009; Auranen and Nieminen 2010)

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There are remarkable differences among universities in Finland with respect to size, structure of research funding and research fields, and research intensity (Kaukonen et al. 2011, 115–123; Nieminen 2005, 99-108; Tammi 2009), which makes the connection between competition and performance worth analysing at the university level. While the performance-oriented policies may not work very well on a national scale, their impact may be different in regard to individual universities.

In addition, our motivation for this study stems from lack of research addressing the connection between (competitive) funding instruments and research performance of universities. Studies on universities' research performance are often conducted without reference to explaining factors (e.g. Braun 1999; Gorraiz et al. 2008; Halffman and Leydesdorff 2010; Li et al. 2012; Sandström and Sandström 2007). Some studies explain the variation of research performance with internal factors of universities, such as the age of university, teaching vs. research orientation, volume of third stream activities, age of academic staff, share of women among academic staff, unit size, structure of funding, and disciplinary structure (Bonaccorsi et al. 2006, 2011; Kyvik and Bruen Olsen 2008; López-Illescas et al. 2011; Wolszczak-Derlacz and Parteka 2011). Previous research has also addressed the funding of universities together with their research performance, but typically funding is analysed as an input of research activity and not as a policy instrument (e.g. Abramo et al. 2008; Bonaccorsi et al. 2006; Luwel 2011; Kivinen and Hedman 2008; Worthington and Lee 2008).

A few studies exist that scrutinize universities' research performance in relation to their policy environment. For example, Jongbloed (2007) has analysed changes in Dutch universities' research performance in the conditions of monitoring and increasing competitive research funding but he does not make the connection between research inputs and outputs. Frølich et al. (2010) have done similar work on Norwegian higher education institutions. Tammi (2009) has conducted an analysis of Finnish universities' teaching and research performance in the environment of increasing competitive funding. He scrutinizes their performance at the aggregate level (the entire university system) and at the level of three clusters of Finnish universities. Liefner (2003) has studied the influence of research funding mechanisms on the activities and performance of universities in both Europe and the United States, basing his analysis of influence on estimates given by the interviewed research staff. In a study of a Turkish

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university, Baskurt (2011) refers to national and intra-university policies of recruitment and rewarding as potential explaining factors for the development of research performance.

In this article we analyse the development of research funding in three Finnish multi-disciplinary research universities from the early 1990s to the early 2000s, during the time of major changes in the funding environment of Finnish university research (Nieminen 2005, 67-70, 89-94). This analysis is then connected to the analysis of research performance of the aforementioned universities from the mid-1990s to the mid-2000s to see the potential (delayed) influences of changes in funding. The late 2000s has been another period of major changes in Finnish higher education policy with the new University Law of 2010 bringing reforms to management, employment and basic funding of universities. However, we have excluded this recent reform from our analysis, because more time and accumulated data are needed to analyse its effects.

Our main research question here is: What is the relationship between the funding environment and the research performance of universities?

The sub-questions that follow the above main research question are:

1. Have the case universities become more competitive as funding environments between the early 1990s and the early 2000s?

2. How has the research performance of the case universities developed during the afore-mentioned period?

Each university's research performance is analysed in relation to its own funding environment. By concentrating on this relationship we want to test the policy idea about the positive consequences of competition for funding. Also, we don't attempt to compare these different types of universities with each other; instead, we follow the development of their funding environments and research performance on a case-by-case basis.

This kind of analysis is of course not able to control all the possible factors that may affect positively or negatively on research performance. While the analysis of funding environments and research performance cannot positively confirm which factors are decisive for high research performance, it can illustrate the role of funding competition. If the influence of funding incentives proves to be weak or non-existent, the (policy) assumption about their positive consequences is doubtful. If the opposite is true, future research still has to confirm the result by

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investigating potential other factors.

Framework for the analysis of funding environments

Based on the idea by Jongbloed and Vossensteyn (2001), Auranen and Nieminen (2010) have developed a four-field framework for the analysis of funding environments of university research (Figure 1). Originally, the framework was developed for the analysis of national-level university systems; however, here we employ it in the analysis of single universities. This analytical framework is basically built on the idea that there are specific funding environments that vary by different funding sources, their shares of total funding, and involved incentives. The two dimensions of the framework are the input–output orientation of recurrent basic funding, and the shares of basic funding and other (external) research funding.

As to the dimension of the basic funding orientation, the more output criteria are used in the funding allocation, the more competitive a funding environment becomes. The logic behind this is that when the financier, in this case the university, focuses on the sufficiency of resources, it uses the input criteria, and when it focuses on the performance and results of the activity, it uses the output criteria. In regard to the internal–external funding ratio, when the share of external funding grows, the funding environment becomes more competitive. This is because the university units are able to rely less on the recurrent funding blocks to maintain their activities and to compete for various project-type research funding with other actors. In all, the more competitive the recurrent basic funding allocation and the smaller the share of basic funding of the entire research funding, the more competitive the funding environment is. Based on the analysis of allocation models for basic funding and the ratio of internal–external research funding, universities can be depicted having different positions in the framework during the time period in question. A shift in the position to the right (increasing share of external funding) and/or up (increasing output orientation in the allocation of basic funding) in the framework means that the funding environment becomes more competitive.

Fig. 1 Framework for analysis of funding environments of university research. Source: Auranen and Nieminen 2010, modified by authors

More output-oriented basic funding, smaller share of external funding	More output-oriented basic funding, larger share of external funding	
More input-oriented basic funding, smaller share of external funding	More input-oriented basic funding, larger share of external funding	

<- Decreases Increases ->

Share of external research funding

(right axis labels, bottom to top: <- More output criteria More input criteria ->; Orientation of basic funding)

According to the policy line emphasizing funding competition, those universities that make up the most competitive funding environments and that can be positioned in the upper right field of the framework should also be the ones with the highest research performance. This is because the funding incentives should make these universities dynamic research environments. Similarly, the universities in the lower left field of the framework should be the weakest performers in research. In general, a shift in the position to the right and/or up in the framework should become visible as improving research performance, if there is a positive connection between competition and performance.

Data and methods

Analysis of research funding

Our analysis of the funding environments of the case universities is based on orientations of basic funding allocations and share of external funding, as already mentioned in the previous section. In the case of basic funding, we differentiate between the funding components and their shares of total basic funding, and funding criteria. As the funding criteria form the dimension that determines the input–output orientation of basic funding in our model, they are described in more detail. Typical input criteria include, for example, the existing funding level of university units ("historical basis"), the numbers of staff and students, and the strategic considerations. Typical output criteria include, for example, the number of produced publications and degrees, the amount of (external) research income earned, and the results of quality assessments. Each mechanism for the allocation of basic funding in the case universities in the period 1991–2003 is presented in Appendix (Tables 1–3).

The second dimension of the funding environment, the ratio of recurrent (basic) research funding and external project funding, is presented as the percentage share of external funding of the entire research funding in the case universities in 1991–2003. In our definition, external research funding includes all funding sources other than basic funding from government and universities' own funding. Finally, the case universities are presented in different positions in the four-field analytical framework to illustrate their development as funding environments in 1991-2003.

Data on allocation mechanisms for basic funding mainly consist of various documents on universities. Statistical data on the so called academic research and development (R&D) expenditure (see the next section) and shares of basic and external funding were provided by Statistics Finland.

Analysis of research performance

We used four performance indicators for each of the case university:
- National publications per academic R&D expenditure,

- International publications per academic R&D expenditure,

- PhD degrees per academic R&D expenditure, and

- Citation impact relative to OECD14 countries.

Time span for these indicators is 1994-2006. As can be seen, our analysis aims to measure the performance of basic research activities in the case universities. National scientific publications include articles in refereed journals, articles in edited volumes, and articles in conference proceedings. International scientific publications include articles, review articles, and letters in refereed journals. We used separate indicators for national and international publications in order to see the development of the two sides of scientific publishing. In a small, non-English-speaking country, publishing for national audiences has traditionally been considered vital especially in the social sciences and humanities. On the other hand, in terms of publishing, internationality has also been strongly emphasized in Finnish science policy since the 1990s (Hakala 2002).

Academic R&D expenditure includes basic funding invested in research, funding from research councils (The Academy of Finland), and funding for doctoral schools[1]. R&D expenditure is indexed to 2000 prices in euros. We used only these funding streams because they better reflect the resources that are directed more to doing basic research and to basic types of research outputs. Previous research shows that although the funding for applied research has increased, research output typical of basic research has not decreased, and various types of funding and research output tend to accumulate among the high-performing researchers. (Gulbrandsen and Smeby 2005; Van Looy et al. 2004). This does not mean, however, that all sources of funding would be equally usable for doing academic basic research, given the financiers' objectives (Goldfarb 2008; Hessels and van Lente 2011; Nieminen 2005, 139–157).

For the first three indicators, we used 3-year moving averages and 3-year time lags between input (funding) and output (publications and degrees). For example, the average number of international publications in 1994-1996 was proportioned to the average volume of academic R&D expenditure in 1991-1993 to get the performance figure of 1994-1996. Time lag was used here because research resources are not immediately realized as research results. While

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[1] Since 1999, funding for doctoral schools has been a separate category in the statistics on R&D expenditure provided by the Statistics Finland. However, in the case of the University of Kuopio funding for doctoral schools was incorrectly classified as R&D funding coming from various ministries.

estimations on the optimal lag lengths have been argued to be as long as six years, a positive impact from investments in research has been shown to appear after two years (Crespi and Geuna 2008; Adams and Griliches 1996). We chose the three-year lag to be able to see more rapid changes in performance. Performance figures regarding publications and degrees are indexed to the 1994-1996 level.

Citation data includes citations to international publications that were published in 1994-2006, citations starting from 1994 and ending to 2008. We used 3-year citation windows, meaning that for each year's publications we took into account the citations of the publication year and the citations of the next two years. Each university's citation scores for publications in 1994-2006 were proportioned to the citation scores of the OECD14[2] countries of the respective years. The citation score of OECD14 countries was given a value of 1. Values over 1 are above the OECD14 average and values under are 1 below the OECD14 average. Using this kind of citation indicator corrects for the expansion of Web of Science database which would be visible as continuous rise of citation scores in all the case universities. Citation impact relative to OECD14 is presented as 3-year moving averages for each case university starting from 1994-1996.

Our data source for national publications and doctoral degrees is the Finnish higher education database (KOTA). Data on international publications and citations were retrieved from the Thomson Reuters Web of Science (WoS) databases (Science Citation Index Expanded, Social Sciences Citation Index, Arts & Humanities Citation Index).

A limitation of our performance indicators is that they don't reveal the social and economic influence of university research, such as patents, popular publications for lay audience, research reports for public administration, and spin-off companies. However, as we wanted to concentrate on basic research activities of universities, we have chosen the indicators accordingly. Also the lack of statistical data sources for the measurement of multi-dimensional phenomenon of third stream activities of universities makes it difficult to measure the social and economic influence of university research.

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[2] OECD14 refers to OECD15 countries (Austria, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Korea, Portugal, Spain, Sweden, United Kingdom and United States) excluding the United States. Citation counts are unfractionalized. Self-citations are included. All the R&D sectors of OECD14 countries are included. As citation data for the OECD14 were not readily available, a stratified search in the Web of Science databases for each member country was conducted.

Case universities

We selected the three case universities because they differed from each other in size, disciplinary structure, research intensity, and structure of research funding (Kaukonen et al. 2011, 118–123). The selection was also partially motivated by the availability of data. Our case universities are the University of Helsinki (UoH), the University of Jyväskylä (UoJ) and the University of Kuopio (UoK). The time span of the analysis is the period 1991–2006 when there were a total of 16 research universities and four art universities in Finland.

The University of Helsinki was the largest university in Finland in 1991–2003 with the largest academic (research and teaching) staff and student numbers in the country (KOTA database). Established in 1640, it is also the oldest university in Finland, covering virtually all fields of science. Most of the research in UoH was conducted in the natural and medical sciences in 1991–2003 (Kaukonen et al. 2011, 118, 121). On average, UoH produced 4045 scientific articles (on average 36% of all scientific articles published in Finnish universities) per year in 1994-2006. In 1994-2006, UoH produced an average of 333 PhD degrees per year (31% of yearly average of Finnish universities). Of the case universities, UoH is the most research-oriented university measured by publication output per MSc degree ratio (Kaukonen et al. 2011, 118).

Established in 1934, the University of Jyväskylä was the fifth largest university in Finland in 1991–2003 in terms of academic staff numbers and the sixth largest in terms of student population (KOTA database). Most of the research in UoJ was conducted in the natural and social sciences in 1991–2003. The university does not have a medical faculty, but the Faculty of Sport and Health Sciences conducts research that shows as person-years in medical and health research. (Kaukonen et al. 2011, 118, 123). On average, UoJ produced 777 scientific articles per year (7% of yearly national average) in 1994-2006. Yearly average number of PhD degrees from UoJ was 84 in 1994-2006 (8% of total average PhD production by Finnish universities). The University of Jyväskylä, in contrast to the University of Helsinki, is teaching-oriented when measured by publication output per MSc degree ratio (Kaukonen et al. 2011, 118).

The University of Kuopio was established in 1972 and merged with the University of Joensuu to become the University of Eastern Finland in 2010. Before that, in comparison with other Finnish universities, UoK was below average in size in 1991–2003 and the smallest of our three case

universities measured by academic staff and student numbers (KOTA database). During the period of the analysis, over half of the research in UoK was conducted in the medical and health sciences, and around one third in the natural sciences. This means that these fields of science covered nearly all the research conducted in UoK. (Kaukonen et al. 2011, 118, 122) On average, UoK produced 655 scientific articles (6% of yearly average of Finnish universities) per year in 1994-2006. The average number of PhD degrees from UoK was 67 per year in 1994-2006 (6% of yearly average of Finnish universities). The University of Kuopio can be described as being a research-oriented university like the University of Helsinki (Kaukonen et al. 2011, 118).

In general, the research resources devoted to basic academic activities increased steadily in Finnish universities from 1991 to 2003. At times, however, academic R&D expenditure declined, especially in the early 1990s and at the turn of the millennium. A notable phenomenon is the additional appropriation of state research funding for universities in 1997–1999. The expenditure of the University of Jyväskylä grew more modestly than the expenditure of the whole university system and other case universities, but UoJ has been catching up in the early 2000s. The research expenditure of the University of Kuopio grew more steadily than that of the University of Helsinki in 2001–2004. (Figure 7 in Appendix) Based on these figures, the resources for doing research in Finnish universities have clearly improved since the early 1990s recession of the Finnish national economy and the public sector.

According to the R&D statistics by the Statistics Finland, academic R&D expenditure covered most of the total R&D expenditure in the case universities in 1991-2003, but the share of other funding sources grew. The group of other funding sources included the Finnish Funding Agency for Technology and Innovation (Tekes), the European Union, other international public organizations, ministries, municipalities, other domestic public sources (e.g. foundations), and firms. Major single sources of funding in this group were the European Union and Tekes. In the University of Helsinki, the share of other funding sources of the total R&D expenditure was 14-28 per cent in 1991-2003, with an upward trend. In Jyväskylä the same share was between 15 to 30 per cent, also showing an upward trend. The share of other funding sources was largest in the University of Kuopio, varying from 23 to 48 per cent, with a growing trend.

Results

Development of funding environments

The early 1990s was mainly a time of the incremental mode of basic funding in the case universities. The universities allocated funding to their units (faculties or departments) according to same general principle as the state allocated basic funding to universities: based on the existing levels of funding (for a detailed description of mechanisms of basic funding in case universities in 1991–2003, see Appendix). This practice of funding allocations continued for a longer period of time in the Universities of Helsinki and Jyväskylä than in the University of Kuopio.

In the mid-1990s, UoK implemented formulas for basic funding. University allocated money to its faculties on the basis of the numbers of teaching staff and amount of teaching in curricula (input criteria) and the numbers of realized degrees and attained credits (output criteria). The weight of these criteria of the total basic funding was 60–40 in favour of the input criteria. This funding formula was used in the university's funding allocations until 2006, although there were plans to adopt a more output-oriented funding system at the turn of the millennium. This new system would have given more weight to the numbers of realized degrees and attained credits.

Both UoH and UoJ altered their basic funding systems at the turn of the millennium by implementing formulas for basic funding. UoJ implemented the new system gradually in 2001-2003, whereas UoH began using the formula at one go in 1998. In both universities, some of the recurrent basic funding was still allocated outside the formula, including funds for the rent of premises. Targeted and realized numbers of degrees were dominant criteria in both universities' funding systems. In UoH, these criteria determined around 65% of funding in 1998–2003 and, in UoJ, around 70% in 2001–2003. In Helsinki, the rest of the funding was allocated based on the data on research quality, which meant that the entire funding system largely relied on the output type of criteria. In Jyväskylä, the remaining 30% of funding was allocated based on input criteria, for example, the expenditure on staff salaries.

The share of external research funding grew in all case universities in 1991–2003 (Figure 2). This means that the situation had become more competitive in the case universities with respect

to this dimension of funding environment. The largest change occurred in the University of Jyväskylä; it needs to be noted, however, that the share of external funding in Jyväskylä was smaller than in Finnish universities in general at the beginning of the period. In the University of Kuopio, the share of external funding grew strongly after the drop in 1993–1995, and at the end of the period, Kuopio remained the most competitive funding environment in regard to external research funding.

Fig. 2 Share of external funding of the total R&D expenditure in Finnish universities and in the compared universities in 1991-2003 (%)
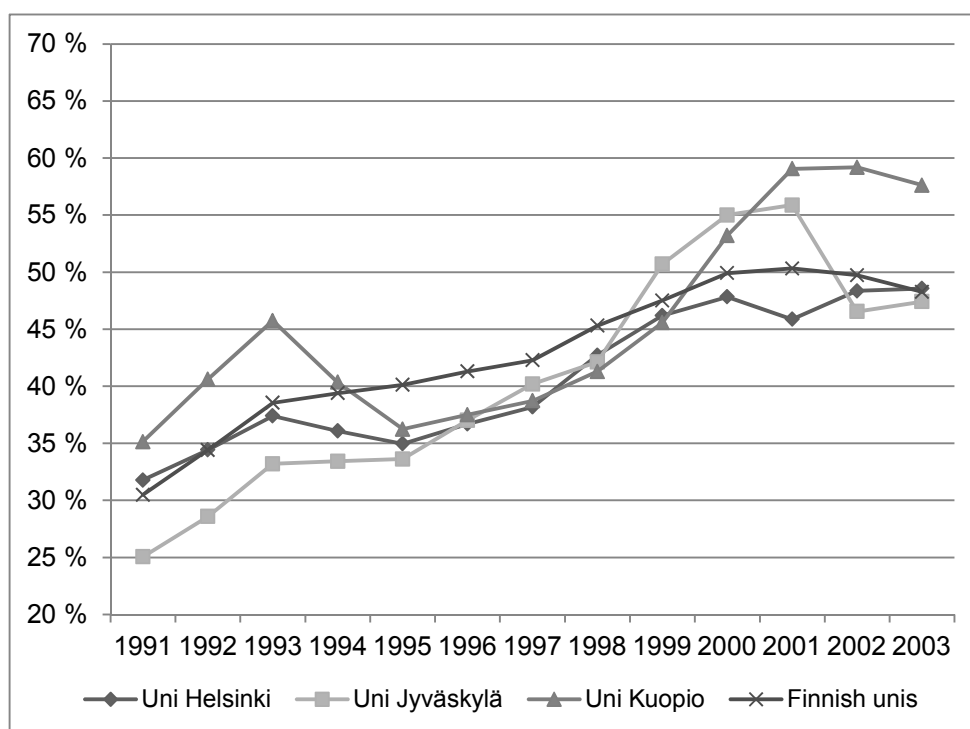
Because the state has been a very important financier of university research for the period of our analysis (Nieminen 2005, 94–97), we briefly describe here the changes occurred in the state funding system (see also Table 4 in Appendix). In 1991–2003, the state of Finland gradually placed more emphasis on competition for funds in regard to the allocation of basic funding to universities. The state also started to channel research funding increasingly through research funding agencies rather than distributing recurrent basic funding, which meant that the share of external funding increased throughout the university sector (Figure 2).

The early 1990s was still a period of status quo in regard to the state funding system. Universities received basic funding on an incremental basis: the funding granted to each

university was based on the previous years' levels. In 1997, the Ministry of Education introduced a new model for the allocation of basic funding. The model was strongly based on the targeted numbers of MSc and PhD degrees and implemented gradually in 1997–2003. It was also modified in 2001 to include the number of realized degree numbers. While the allocation model definitely included more incentives than the old system, it was not entirely based on the output criteria. Some of the basic funding was still allocated based on the input criteria, such as student numbers or facilities expenditures. (Table 4)

Figure 3 shows how the case universities evolved as funding environments from 1991 to 2003. We include the first (1991) and last (2003) year of the funding analysis for all case universities, as well as years when the universities have changed their basic funding models. This is because basic funding alone forms a major proportion of resources that are available for the units of these universities. We can see that the starting point in 1991 is rather non-competitive. Towards the turn of the millennium, all case universities had become clearly more competitive environments in respect to both dimensions. The University of Kuopio was ahead of other universities, implementing more output-oriented basic funding mechanisms already in the mid-1990s. The post-1995 growth of external funding has gradually tightened the competition for funding in UoK. The University of Jyväskylä was the least competitive funding environment in 1991, although it has moved closer to the other universities because of the rapid increase in external research funding as well as the implementation of the new funding model at the beginning of the 2000s.

All the case universities cluster in the middle of the framework at the end of the period of analysis after having been positioned in the lower left field in the early 1990s. The reason for this may lie in Finnish universities' general dependence on state funding in both research and teaching. Only a few universities in Finland have had alternate sources of income (e.g. tuition fees, donations or businesses) especially for their basic activities. The Finnish state also has a dominant role as a financier of university R&D that is not conducted with basic funding, because the state funds research through ministries, research councils, and the Finnish Funding Agency for Technology and Innovation (Tekes) (Nieminen 2005, 94–96).

At the end of the 1990s, as the state changed its university funding policy, it also created new incentives for universities. Because of slowly growing basic funding and increasing costs, it was

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possible for universities to increase their research activity mainly through rapidly growing external funding (Nieminen 2005, 92–94). At the same time, the new state funding model meant that some kind of performance-based funding allocation became a viable option for universities' own basic funding models. The impact of national funding policy is especially visible in the Universities of Helsinki and Jyväskylä, which began to emulate the state funding model in their internal funding. Similarly, the strong role of the state in external funding meant that the competition for external funding in the whole university sector also had an impact inside individual universities.

Fig. 3 Positions of the case universities and the Finnish university system (Finland) according to degree of competition of funding environments in 1991-2003
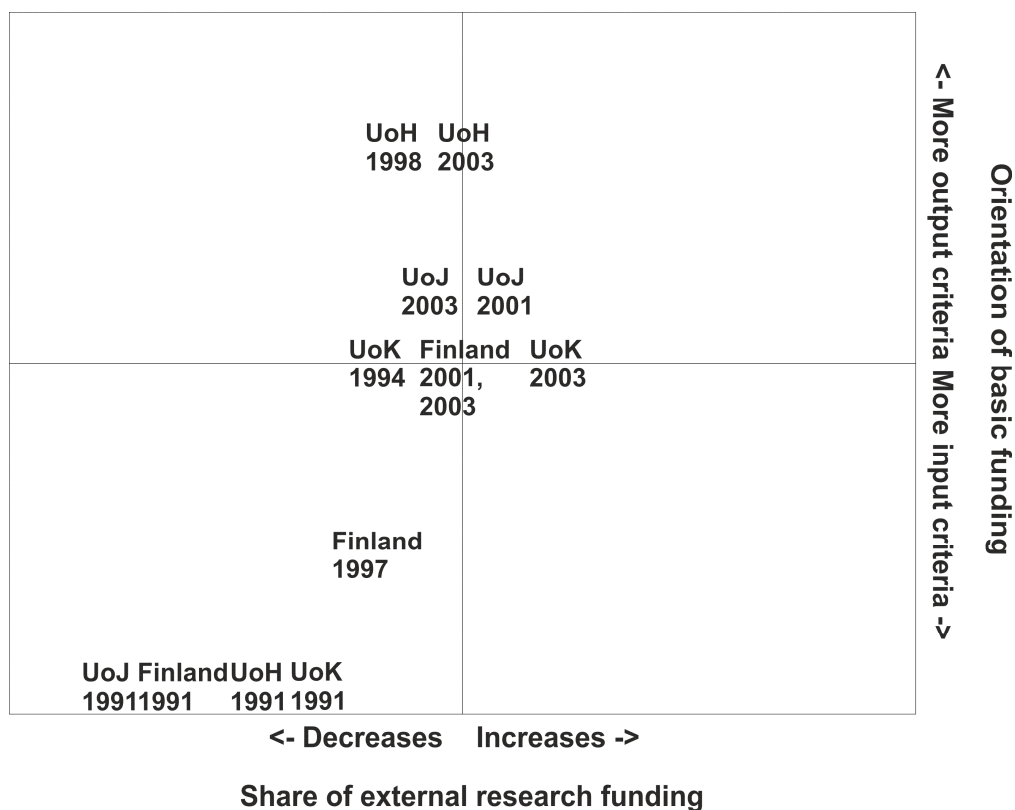
Development of research performance

Funding environment of research in all three universities became more competitive between 1991 and 2003. If competing for money does improve research performance, we should see improvement in every university. This did not happen according to the performance indicators

used. However, there is no reason to completely abandon the idea of performance oriented policy when looking at these universities.

Before the years 1996-1998 there was a modest increase in publication and PhD degree productivity in the University of Helsinki (Figure 4). However, all these figures show a decline in performance since the turn of the millennium to recover again modestly, starting from 2002–2004. Productivity of national publications started to decrease earlier and didn't recover as well as the productivity of international publications and PhD degrees. There was some improvement in citation impact of the University of Helsinki until the early 2000s, after which citation impact returned to the level of the mid-1990s. Sharp rise of impact after the period of 2003-2005 is remarkable.

Fig. 4 PhD degrees, international publications and national publications per academic R&D expenditure, and citation impact relative to OECD14 countries in the University of Helsinki in 1994–2006
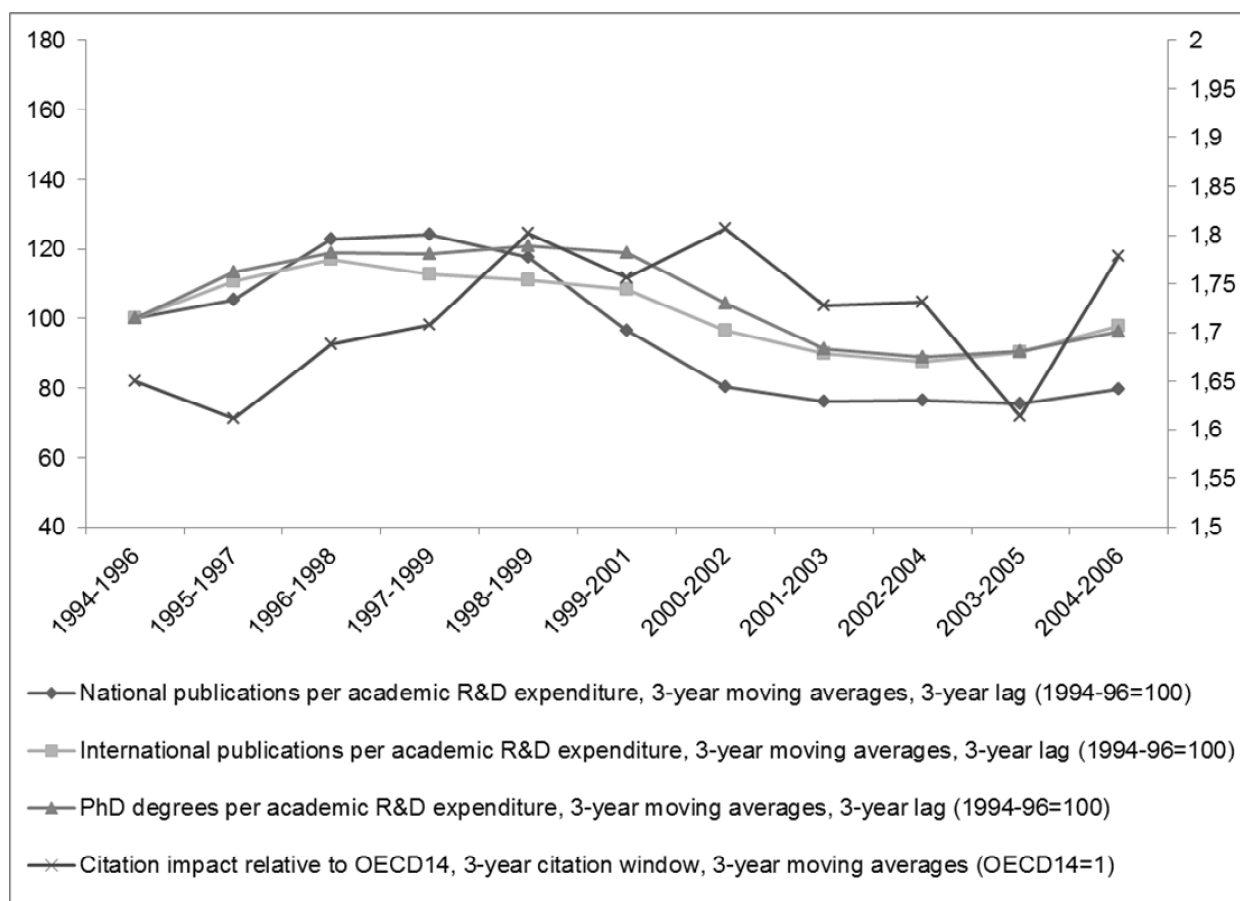
In Figure 5, we can see a general rising trend in PhD degree and international publication productivity in the University of Jyväskylä until the turn of the millennium, rise of the degree productivity lasting a couple of years longer. In contrast, the national publication productivity improved more modestly and actually declined after 1997-1999. Same decline can later be observed regarding international publication and degree productivity. However, we can also notice that the decline of productivity of national publications was much more remarkable. Jyväskylä was able to improve its citation impact to the average level of the OECD14 countries during the 1990s, but this achievement was lost during the first years of the 2000s.

Fig. 5 PhD degrees, international publications and national publications per academic R&D expenditure, and citation impact relative to OECD14 countries in the University of Jyväskylä in 1994–2006
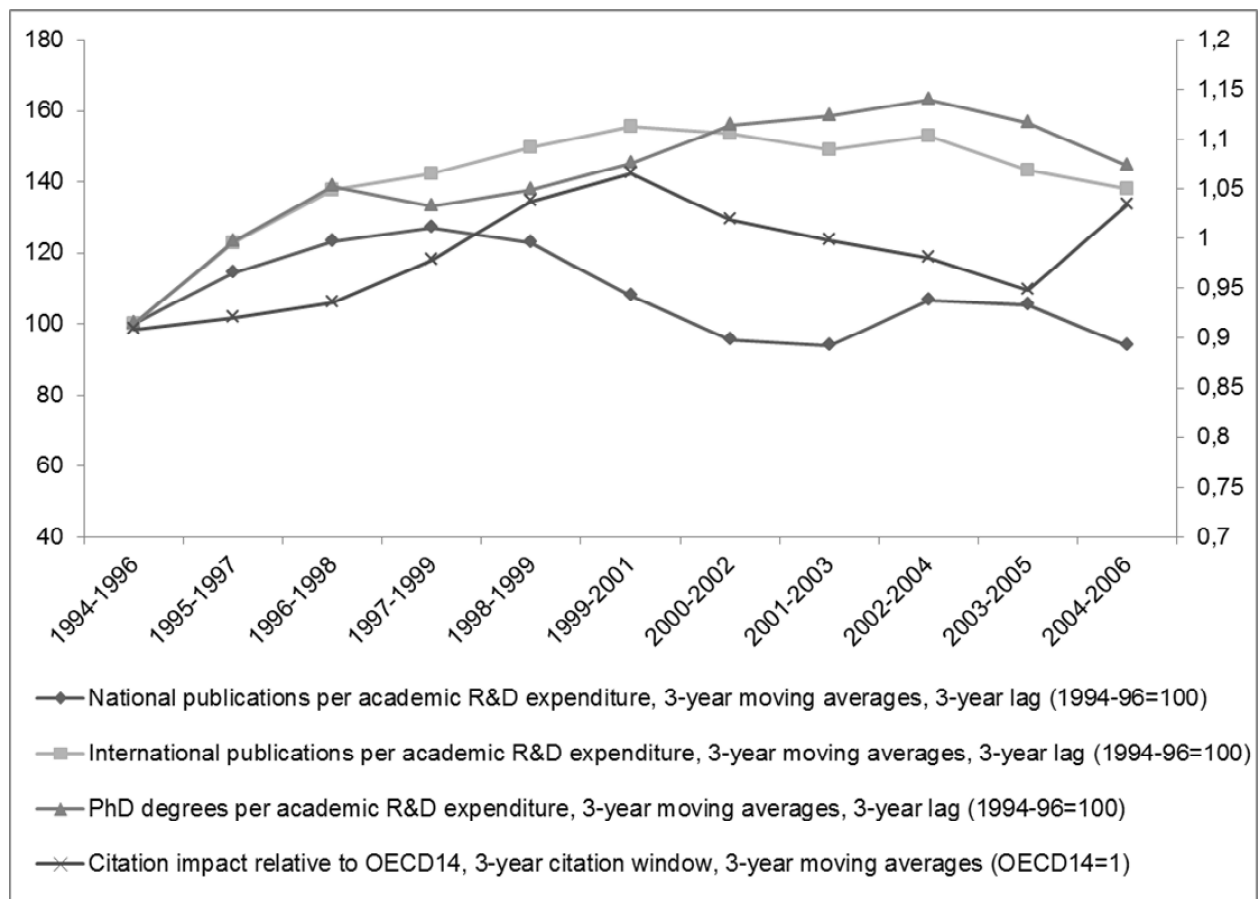
In the University of Kuopio, productivity development of PhD degrees and international publications was very steady for the whole period (Figure 6). Degree productivity showed some growth since 2000-2002. The university's national publication productivity followed a general

declining pattern particularly at the start of the period in 1994-1998, after which the figure remained rather steady. There was some improvement of citation impact in Kuopio, but also a rapid decline since 2001-2003, and a recovery couple of years later.

Fig. 6 PhD degrees, international publications and national publications per academic R&D expenditure, and citation impact relative to OECD14 countries in the University of Kuopio in 1994–2006
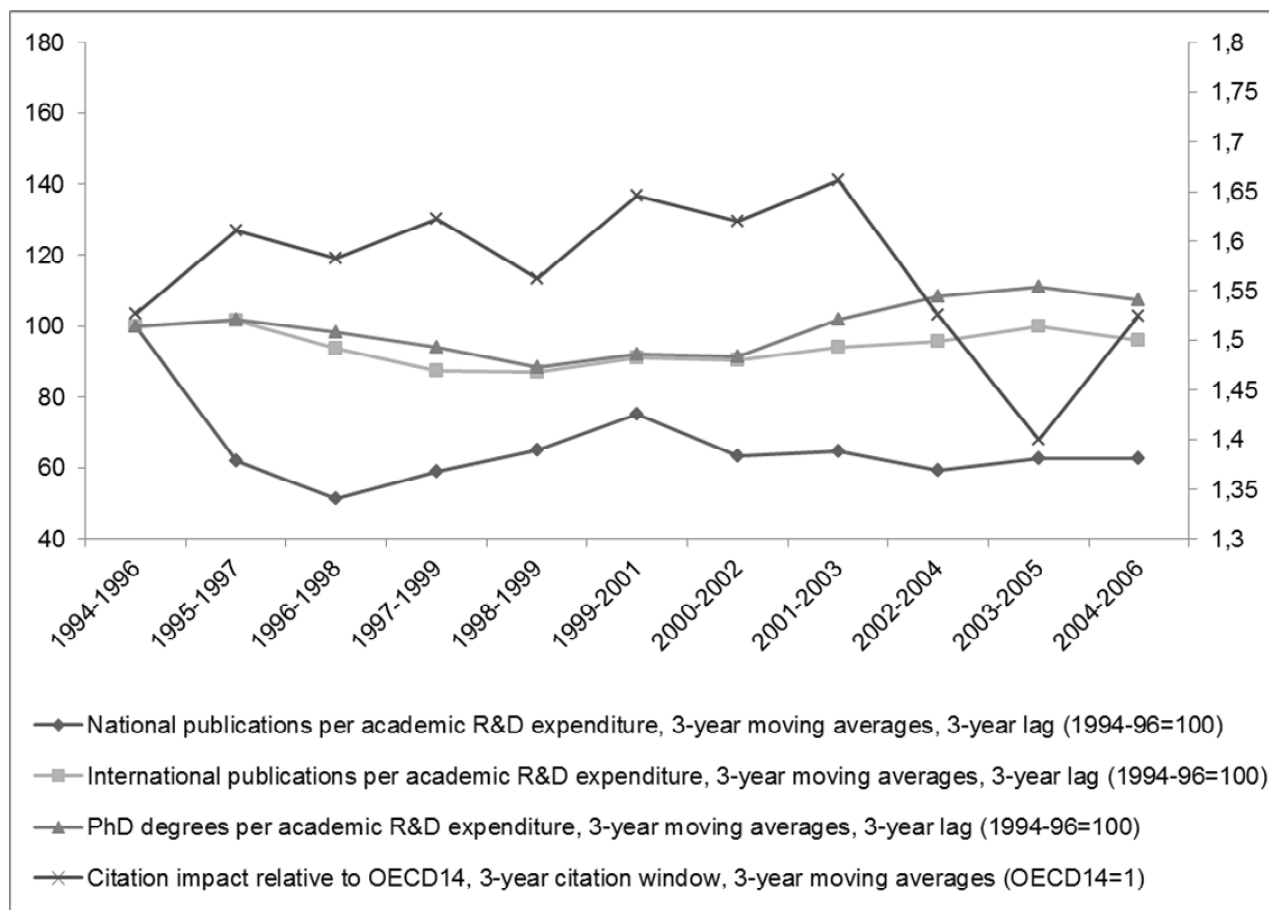
The increasing competition for funding both in terms of share of external research funding and allocation of basic funding in 1991-2003 appear to have had mixed consequences on research performance of the case universities in 1994-2006. It is worth noticing that improvement of performance in terms of publications and degrees in the universities of Helsinki and Kuopio was very modest. There was a visible improvement in citation impact that occurred in the conditions of increasing share of external research funding in the 1990s. However, this development was not sustainable.

In contrast to Helsinki and Kuopio, improvements in research performance are much more obvious in the University of Jyväskylä. Increase of the share of external funding in Jyväskylä occurred hand in hand with the rising productivity of international publications and degrees, and with a delay, with the rise of citation impact. More than in the cases of Helsinki and Kuopio, in the case of Jyväskylä we can find more support for the policy argument for funding incentives. But also for Jyväskylä, we need to observe the limitations of competitive funding environment. Improvements in research performance don't continue after the 1990s, although the university implements a new, more competitive model for allocating basic funding in 2001.

Discussion

Results of this study suggest that increasing external competitive funding can have a positive influence on research performance, more so than output-oriented models for allocating basic funding. This conclusion is based on the fact that citation impact improves in all case universities in the 1990s as the share of competitive external funding increases, and same happens to publication and degree productivity particularly in Jyväskylä but also in Helsinki. The implementation of more output-oriented models for allocating basic funding does not have the same influence. However, the positive influence of increasing competitive project funding on research performance appears also to be relatively short-lived.

Analysis on the influence of basic funding models is made difficult by the fact that more competitive funding models of Helsinki and especially in Jyväskylä were implemented quite late regarding the time window we have used for performance analysis (1994-2006). This is a limitation of our study.

While the funding environment of research of the case universities became more competitive in general, output-based criteria for basic funding mainly created incentive for producing more doctoral and Masters degrees. One could argue that this incentive obstructed the research activity in Finnish universities as too much attention and resources were given to educational function of universities. However, it's worth noticing that during the 1990s the growing share of external funding created an incentive for high publication productivity and citation visibility, as these are traditional means to be successful among scientific community when competing for resources. Furthermore, it's interesting to notice that improvements in productivity of PhD degrees in case

universities happened for the most part *before* the Finnish state or universities implemented funding models which included incentives for degree production. This finding also suggests a relatively weak connection between output criteria of basic funding and research performance.

An explanation for the improvement of research performance in the University of Jyväskylä may lie in the different levels of research culture of the case universities. In a Data Envelopment Analysis (DEA) on the efficiency of Australian universities, Worthington and Lee (2008) suggest that scientific research is a labour-intensive activity where the most efficient way of using the resources (the so called production frontier) among units of analysis is unlikely to change very much after best practices are implemented. In their study, the efficiency gains in research were visible in newer Australian universities, which were catching up with the established, older ones and moving up to the production frontier.

Applying this finding to the Finnish university system, we can assume that the University of Helsinki as an old and prominent university had already at the beginning of the 1990s established many of the best practices of organizing modern research, and was also able to recruit its staff from a larger pool of applicants than many other universities in Finland. Similarly, the University of Kuopio was a university with strong medical fields, where publishing has mainly taken place in international journals and research has been organized efficiently around collaborative team work. As a result, it is likely that Helsinki and Kuopio were closer than the University of Jyväskylä to the production frontier of research in the early 1990s. In these conditions, further improvements in efficiency are difficult to achieve.

In contrast to Helsinki and Kuopio, the University of Jyväskylä is a university which has oriented more to teaching (Kaukonen et al. 2011, 118). In Jyväskylä, there may have been potential for performance improvements in the conditions of increasing competition for funding. However, the levelling off of the performance improvements in Jyväskylä at the turn of the millennium suggests that it too had reached the limits of efficiency in the use of research funding. Our case-by-case analysis of universities' research performance cannot confirm whether the improvements in Jyväskylä are indeed a result of moving up to the production frontier, but this could be tested by conducting a DEA study on research efficiency of all Finnish universities.

It is important to acknowledge the impact of additional appropriations for research funding granted by the Finnish government in 1997–1999. A rapid increase in funding is best visible in the expenditure figures of the University of Helsinki and the University of Jyväskylä during that time (see Appendix, Figure 7), and appears to cause temporary inefficiency in the use of research resources. This is particularly clear when looking at all the performance indicators of Helsinki, but also publication productivity of the University of Jyväskylä is affected. The remarkable drop in research productivity at the turn of the millennium has been observed also in other studies on Finnish universities, and some authors have discussed the role of rapidly growing inputs ("congestion") causing diminishing marginal productivity. Congestion of inputs could relate to recruitment of inexperienced and less productive junior researchers in Finnish universities (Muhonen and Talola 2011; Poropudas et al. 2007) and increasing costs of administration and organization of activities (Tammi 2009; on British universities, see Flegg and Allen 2007).

Compared to other indicators, productivity of national publications is more modest or even declining in all the case universities, which gives rise to a conclusion that publishing internationally and nationally partially substitute each other. As Finnish policy makers have prompted international publishing, universities and academics have shifted more of their research resources for publishing internationally.

Increasing external, competitive research funding can have unintended negative consequences. It may a contributing factor in the steady state or decline of research performance that the case universities experienced since the turn of the millennium. While external research funding has provided incentives for the Finnish academic community and made it possible for financiers of research to select the best applicants, it has also made short fixed-term work contracts more common in Finnish universities since the 1990s (Hakala 2009, 48-50). This may have a negative impact on researchers' possibilities to do sustainable, long-term research. A by-product of increasing project funding, the strong increase in the numbers of PhD students in Finnish universities since the mid-1990s has increased the supervision workload of professors, who usually are the most productive researchers (Hakala 2009, 48-52; Puuska 2010). Pervasive evaluation culture has also gone hand in hand with the increase of competitive funding in Finnish universities (Treuthardt et al. 2006; Nieminen 2005, 70-72). Potentially burdening administrative work related to evaluations may affect negatively on research performance (see e.g. Bleiklie and Kogan 2007; Ziman 1994, 102-106).

Since the competitive funding environment doesn't seem to have a long-term and comprehensive positive effects on research performance, it is likely that in the long run, other factors such as various internal features of universities are actually more decisive for research performance than funding incentives. Furthermore, analysing universities' research performance at the institutional level also hides the variation of the performance of different university units. An interesting question is the extent of this variation and its impact on universities' performance. With regard to research funding, it's not only the share of project-based, external research funding, but also the structure and changes of it that are likely to have an impact on research outputs, since some of the funding is designated for other than basic research. Individual universities and units, depending on field of science, may experience a trade-off between basic and applied research. (Ylijoki et al. 2011; Tammi 2009) We suggest that in future studies the internal factors should be combined with external, policy-related factors (such as funding environment) to explain the research performance of universities.

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Appendix

Fig. 7 Academic R&D expenditure in the case universities and in all Finnish research universities 1991–2003 (in 2000 euro prices, 1991=100)
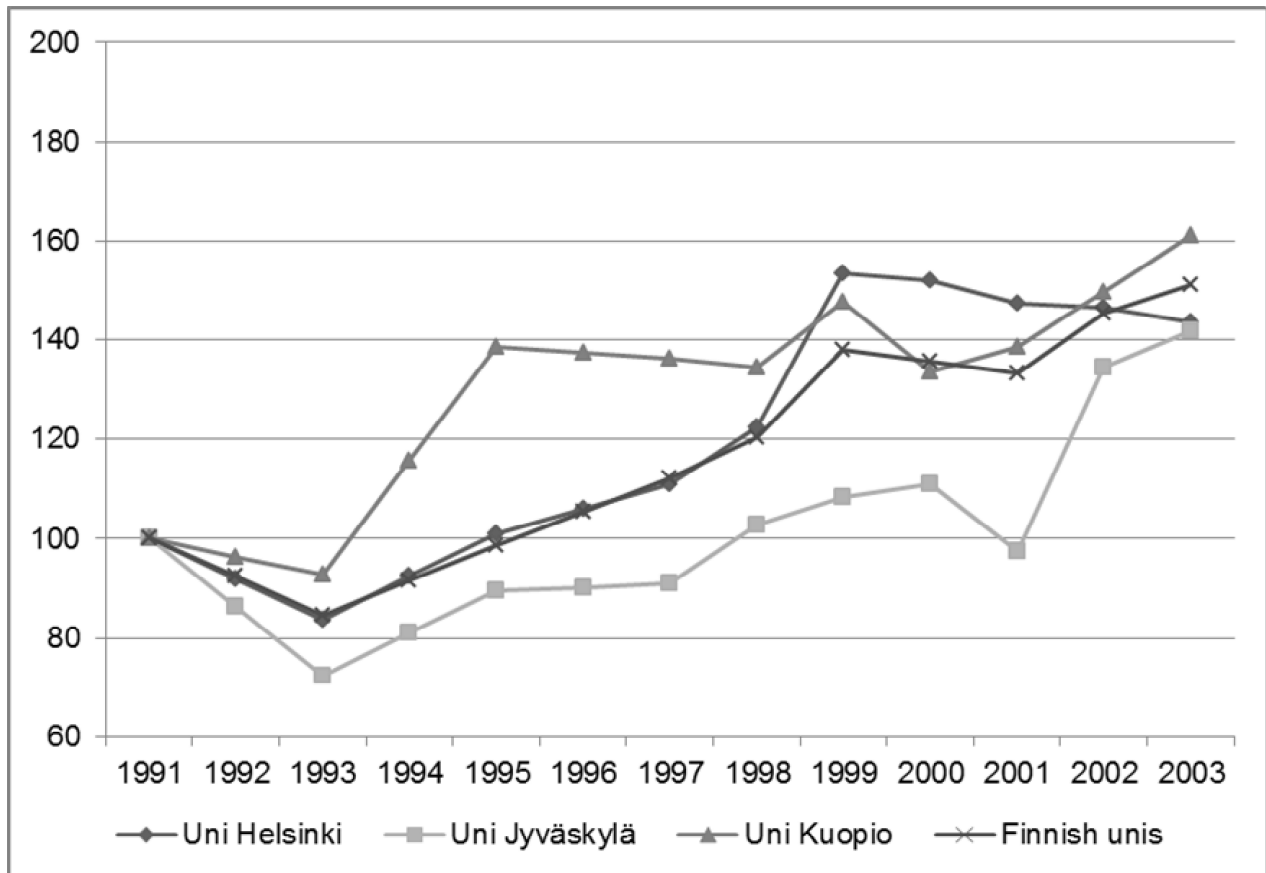
Table 1 Mechanisms for the allocation of basic funding in the University of Helsinki in 1991–2003

Components of basic funding **1991–1997:** Budget funding. **1998–2003:** - BSc and MSc degrees (50% of total basic funding). - Postgraduate degrees (15% of total basic funding). - Research (35% of total basic funding).
Criteria for basic funding **1991–1997:** Existing level of resources ("historical basis"). **1998–2003:** - BSc and MSc degrees: Number of targeted and realized MSc degrees, number of targeted and realized BSc degrees with the coefficient 0.6 against MSc degrees. - Postgraduate degrees: Number of targeted and realized PhD degrees, number of targeted and realized Licentiate degrees with the coefficient 0.5 against PhD degrees. - Research: In 1998–1999: The base level is multiplied by the index of research intensity and quality (scale 0.9–1.1). The base level is determined by the unit's share of basic funding and intermediary costs in 1997. The index of research intensity and quality is determined by qualitative and quantitative data. From 2000 onwards: The base level is multiplied with the coefficient of disciplinary research quality (scale 0.8–1.2). The base level is determined by the unit's share of 1998–1999 funding from the research component proportioned with the resource level at the time of funding allocation. The coefficient of research quality is determined by research assessment exercise conducted by 2000.

Table 2 Mechanisms for the allocation of basic funding in the University of Jyväskylä in 1991–2003

Components of basic funding **1991–2000:** Budget funding. **2001–2003:** - Education (36% of total basic funding). Component includes the following sub-components: targeted MSc degrees (50%) and realized MSc degrees (50%). - PhD education and research (35% of total basic funding). Component includes the following sub-components: targeted PhD degrees (50%) and realized PhD degrees (50%). - Minor studies teaching (4% of total basic funding). - Extent factor (18–20% of total basic funding) - Strategic funding (5–7% of total basic funding)
Criteria for basic funding **1991–2000:** Existing level of resources ("historical basis"), guidelines decided by the university board. **2001–2003:** - Education: Targeted MSc degrees: The number of targeted MSc degrees multiplied by the field-specific coefficient. Realized MSc degrees: Three-year average of the number of realized MSc degrees multiplied by the field-specific coefficient. - PhD education and research: Targeted PhD degrees: The number of targeted PhD degrees multiplied by the coefficient. Realized PhD degrees: Three-year average of the number of realized PhD degrees multiplied by the coefficient. - Minor studies teaching: The number of study points multiplied by the field-specific coefficient. - Extent factor: The framework for personnel expenditure. - Strategic funding: Strategic decisions by the university board.

Table 3 Mechanisms for the allocation of basic funding in the University of Kuopio in 1991–2003

Components of basic funding
1991–1993: Budget funding. **1994–2003:** - Teaching positions (40% of total basic funding). - Credits according to curricula (10% of total basic funding). - Realized credits (20% of total basic funding). - Realized MSc degrees (15% of total basic funding). - Realized postgraduate degrees (15% of total basic funding).
Criteria for basic funding **1991–1993:** Existing level of resources ("historical basis"). **1994–2003:** - Teaching positions: The number of teaching positions, number of professors and assistant professors is multiplied by the coefficient 2.0 against other positions. - Credits according to curricula: The number of credits. - Realized credits: The average number of credits from the previous three years. - Realized MSc degrees: The average number of degrees from the previous three years. - Realized postgraduate degrees: The average number of PhD, Licentiate and medical degrees from the previous three years (the coefficient for PhD degrees is 1.0, for Licentiate degrees 0.5, and for medical degrees 0.1). Each faculty has been given an allocation coefficient for all funding components.

Table 4 Allocation of state basic funding for Finnish universities in 1991–2003

1991–1996	Basic funding, incremental: Allocations are based on existing funding levels of universities.
1997–2000	Calculatory model for basic funding: Main funding criteria are targeted numbers of MSc and PhD degrees. A small share of basic funding is allocated for national tasks and artistic education and research in universities. The model is implemented gradually: in 1997, it determines 10% of basic funding; in 1998, 15%; in 1999, 25%; and, in 2000, 40%. The rest is allocated based on existing funding levels of universities.
2001–2003	Calculatory model for basic funding is renewed: Realized numbers of MSc and PhD degrees are included in the model; together they determine around 28% of the funding. Another significant change is to include the number of academic staff and doctoral schools in the funding criteria (together 16% of funding). Targeted degree numbers still determine 56% of funding. Implementation of the model is finished; in 2003, it determines 100% of basic funding.

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Scientific Productivity, Web Visibility and Citation Patterns in Sixteen Nordic Sociology Departments

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abstract: Science is being published increasingly on the web. In this article, we explore how Nordic sociology is represented on Google Scholar (GS), what its output and impact is, and what factors explain it. Our data consist of faculty in 16 Nordic sociology departments in March 2005. The distribution of their publications and citations is skewed. Thirteen per cent of scholars do not appear on GS, whereas only 15 per cent have more than 5 publications. Of scholars with at least 1 publication (*n* = 240), 75 per cent have at most 10 citations. Both the number of web hits (web visibility) and citations are influenced by the gender of the faculty member, type and age of publication. Web visibility, citations and position are mutually reinforcing. Departmental effect is greater in web visibility than citations. International publications have started to dominate the social sciences, international monographs being particularly frequently cited. The remaining salience of books shows that sociology is still a distinct form of knowledge. The exclusive use of refereed articles and direct comparisons with the natural sciences ignore important aspects of the social sciences. In all, while GS produces findings similar to those in citation databases such as the SSCI, some systematic differences exist. No individual method for measuring scientific output is objective.

keywords: citation ◆ Google Scholar ◆ Nordic sociology ◆ scientific output ◆ scientific productivity ◆ Thomson scientific ◆ web visibility

1. Introduction

The World Wide Web has become an important source of information in developed countries, and its importance is also growing in the developing world. Scientific communities are part of this development. Dissemination of scientific publications via the web is becoming more common, and scholars in information science have already been discussing the possibility of a web mention being comparable to a research citation for evaluating the impact of academic activity (Vaughan and Shaw, 2003: 1314–15; Kousha and Thelwall, 2007: 1056). During the history of the web, several search engines have been developed to help users find the information they need. In recent years, the Google search engine has held a leading position among web search engines because it covers more text documents on the web than other engines and is now the most popular among internet users (Notess, 2003; Sullivan, 2006). One of the latest applications introduced by Google Inc. is Google Scholar (GS) (http://scholar.google.com/),

which searches for 'scholarly literature' on the web (Google, 2005). GS also shows how many and which publications have cited the publications found in a search.

With GS, the web becomes an even more viable alternative for scientific publication and citation databases. Scientists and policy-makers in many countries regularly use the databases of Thomson Scientific (the Science Citation Index, the Social Sciences Citation Index, and the Arts & Humanities Citation Index) to determine the productivity and impact of research. Publications covered by these databases are sometimes regarded as equivalent to 'science' or 'scientific publications', although databases include mostly English language articles published in Anglo-American based journals (Paasi, 2005). The original use of the databases provided by the International Scientific Institute was more innocent, these being tools by which to analyse the use of knowledge and research networks. Thomson Scientific has since developed products that appear to be easy to use in distinguishing productive and frequently cited scholars from others (Weingart, 2005: 119–20; van Raan, 2005: 140–1).

Compared to Thomson Scientific, the web search based GS can provide a more extensive picture of scientific activity that covers a broader scale of scientific output than traditional databases. Despite this, web and developed search engines such as GS give a particular picture of scholarly activity: what is scientific literature? who is a productive researcher? and who does frequently cited research? Given the popularity, cost-free use and coverage of Google, it has the chance to develop a dominant position in determining scientific output and impact similar to what Thomson Scientific has now.

Different publishing cultures in science

Scientific disciplines and research fields differ from each other in their values and practices (Becher and Trowler, 2001), differences which have also traditionally affected publishing behaviour. Journal publishing has been more common in the natural sciences, medicine and technology than in the social sciences and humanities. Social scientists and humanities scholars tend to publish extensively in books and in their national languages. In the natural sciences, medicine and technology, international publishing, mainly in English, is dominant (Kyvik, 1991: 45–51). Differences in publishing behaviour are not necessarily linked to the number of international contacts researchers have. International contacts and publishing have been a necessity for small science systems such as in the Nordic countries, since they have had to import theories and methods from the centres of international academic communities. To create contacts with such centres, one needs to be attractive. Visibility, the precondition for attractiveness, can be created by publishing internationally. Social scientists in small countries have nevertheless used their international contacts largely for purposes other than international publishing (Kyvik and Larsen, 1997: 240–2, 248–50).

Recent studies suggest that publication behaviour in 'book-publishing disciplines' may be undergoing change. Publishing in books and in national languages has been decreasing over the past 10 or 20 years in Norway and Finland, both of which are small science systems (Kyvik, 2003: 39–41; Oksanen et al., 2003: 101–5). It has also been argued that academic researchers in the UK, a much larger science system, nowadays concentrate on publishing in journals across disciplines (Bence and Oppenheim, 2004). The origins of the demand for 'international publishing' can be found in the emerging academic capitalism and current science and technology policy priorities in developed countries. In the global economy, these countries cannot compete by offering inexpensive labour to firms. Instead, the developed countries aim to create knowledge-intensive economies in which highly skilled and highly educated labour does R&D work, develops technological and other innovations, sells processed services (e.g. knowledge-intensive business services), and so forth. In this effort, knowledge infrastructures such as universities have become important players for developed countries (Slaughter and Leslie, 1997).

Development of the knowledge-intensive economies has had two consequences that are relevant in regard to scientific publishing cultures. The first is the demand for a more effective higher education system. In many countries, state instruments directing and funding universities have become more performance oriented since the end of the 1980s (Nieminen, 2005: 39). The performance orientation of science and higher education policies is part of the persistent shift of public management from rules and regulations towards incentives and monitoring, i.e. from government (of science) to governance (of science) (Féron and Crowley, 2003: 371–5). Some have argued that governance of science contains a model of uniform science based on the practices and functions of the natural sciences and technology which policy-makers consider relevant and 'useful' for knowledge-intensive economies (Demeritt, 2000; Donovan, 2005). There are also indications that current science policies are steering human sciences, including sociology, towards a new mode of scientific publishing. At least Australia, Norway and indirectly the UK use the number of scientific publications as a measure of the research performance of the university system. These funding systems value international (journal) publishing typical for natural sciences and technology. The second consequence of the rise of the knowledge-intensive economy is the increasing need to internationalize the developed but peripheral science systems such as in the Nordic countries. International activity, for example research collaboration with foreign partners and publishing internationally, is thought to give smaller science systems access to knowledge and raise the quality and visibility of their research activity (Hakala, 2002: 12).

However, demands for effectiveness and internationalization are mediated by existing academic and disciplinary cultures (Hakala, 2002; Ylijoki, 2003). It is not self-evident that science publishing will become completely uniform across disciplines. Scholarly practices and uses of research findings may vary between disciplines and research, which means that social scientists will continue publishing and referring to extended prose, and targeting national audiences in their own languages. Furthermore, national science policies differ in respect of generality and depth of instruments of science governance. Development in one country does not necessarily repeat itself in another (Féron and Crowley, 2003: 383–4).

Research questions

We need answers to the following research questions:

1. Web visibility: How visible is Nordic sociology on the web?
2. Publication productivity and impact: What are the patterns of publication output and impact of Nordic sociology according to GS?
3. Explaining factors: Which factors explain web visibility and impact of Nordic sociologists?
4. Publication behaviour and possible policy impact: Do the findings support the 'single model' argument that science policies are changing publication behaviour in the human sciences, including sociology?
5. Coverage of GS and Social Sciences Citation Index: Is the analysis of web visibility and publication productivity with GS comparable with analyses based on the data from the publication and citation databases, especially the much used Social Sciences Citation Index?

We define a researcher's web visibility as the number of hits received in a GS search. Publication productivity is the number of scientific publications obtained in the search, and impact refers to the number of citations received by the author's most cited publication. This operationalization of impact is widely used, but also highly debatable (see Warner, 2000). In information science and webometrics, the term 'web visibility' usually means the number of external web links received by an individual web domain or site (Thomas and Willett, 2000; InternetLab, 2005). We use the term differently, since we are interested in sociologists and departments of sociology 'outside' the Internet, not sites or domains 'inside' it. There is some

research on academic web visibility as we use the term, and the term 'web citation' is also used (see, e.g., Vaughan and Shaw, 2003, 2005; Kretschmer and Aguillo, 2004). These studies concentrate on academic units or scientific publications. We analyse the web visibility of both individual researchers and academic departments.

2. Methods and data

GS is used in the same way as most of the other web search engines. A search word or phrase is typed in a search field, and the engine returns a set of 'hits', web pages or related documents. GS differs from other search engines in that it is designed to find scientific content. An individual search result (Figure 1) gives the bibliographical information on the publication or other scholarly document, the number of articles citing the document in question, a link to the document if it is online, links to documents that relate to the same topic, and links to a web search of the document. The 'group of' link lists other documents that are part of this search result (e.g. a preprint of the document searched for) (Google, 2006). GS follows the general principles of Google, which are presented elsewhere (Brin and Page, 1998). The data in GS are obtained from the databases of scientific publishers and their digital hosts, scholarly organizations, government agencies and preprint/reprint servers. However, it is not possible to evaluate the coverage of the data, since Google does not disclose the exact sources (Jacsó, 2005). The relevance ranking used by the engine 'takes into account the full text of each article as well as the article's author, the publication in which the article appeared and how often it has been cited in scholarly literature' (Google, 2005). The most relevant results are placed at the top of the results list.

Our data, consisting of faculty in the 16 Nordic sociology departments, and also studied by Bjarnason and Sigfusdottir (2002), was gathered in March 2005 when the GS was in the beta-testing phase, and it has been partially remodelled since. We used every individual faculty member's given and last name in quotation marks as a search phrase. Names and positions of the faculty were drawn from each department's web pages. If the individual's name contained Scandinavian letters, these were transformed to suit English alphabet standards; å and ä were transformed to a, ö and ø to o, æ to ae and ü to u. To achieve valid results, the researchers whose names contained Scandinavian alphabets were also searched for using phonetic forms. Furthermore, the search was done with and without the faculty member's middle name. In some cases, the various search results differed a little from each other. This inconsistency is a known technical problem in search engines and databases, which we resolved by using the best search result for the researcher.

The various academic positions were classified under three categories: 'Professor' referring to the highest faculty position in the department; 'Emeritus professor' to retired staff with

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ABSTRACT . The study of institutional interaction explicates the verbal

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Cited by 9 - Related Articles - Web Search - BL Direct

Figure 1 An individual search result in Google Scholar

continuing ties to the home department; 'other teaching position' to a large class containing researchers at PhD level, i.e. with a PhD, and other staff with teaching responsibility. For example, the 'adjunkt', '(universitets)lektor', 'førsteamanuensis', 'assistant professor', 'associate professor', 'professor II', and '1. amanuensis' positions were put in this category. A lack of data reliability prevented us from using the 'affiliated faculty'. The departments seemed to have different definitions of 'affiliated faculty', which does not enable us to compose a stable category.

In 31 cases the search result contained scholars from other disciplines with the same name as the sociologist searched for. If the number of hits was at most 30, all were examined and the wrong people were omitted. In the cases of more hits, the proportion of correct hits was calculated from the first 10. The right number of hits was then calculated using the proportion of correct hits on the first page. To ensure reliable data, one unclear search result was removed entirely.

Because of the sorting techniques of the GS search engine, this is enough to study the most relevant and influential publications, i.e. those that are the most visible on the web have been put in the highest places on the search results list. Working papers, abstracts of conference papers and master's theses were not considered as publications. The age of the most cited publication was limited to a range of 0–25 years; hence, the oldest publication in our data is 23 years old. The number of citations was drawn from the most cited publication of the researcher because of our research interest in the most visible work of these scholars. The first 10 hits from every scholar were subjected to closer study, thus limiting the maximum for an individual researcher to 10.

Because of GS's technical application, a hit does not necessarily represent a publication (see Table 1). Among the researchers with 10 hits at most, 37 per cent of hits were publications. We estimated that this proportion of publications also applied in the case of more than 10 hits. Furthermore, scientific references that come up as hits seem to be coding errors or malfunctions of the search engine because they are supposed to be represented in the list of citations hyperlinked to each publication in the search results list in GS. Table 1 gives the distribution of types of hit. We can see that 47 per cent of hits are some form of research output produced by the sociologists in question. However, our analysis concentrates on the published research output and its impact. When scientific references are excluded, acknowledgements and other references are clearly the largest category of 'other hits'.

Table 1 Estimated distribution of hits in Google Scholar, based on researchers with a maximum of 10 hits

	% of hits	% of hits (without publications)	% of hits (without publications and scientific references)
Publications	37	–	–
Conference papers, working papers, etc.	10	15	21
Scientific references to the person searched for	17	28	–
Other references to the person searched for (e.g. acknowledgements)	25	39	54
Others (e.g. person searched for mentioned on the web page or in a publication)	11	18	25
Total	100	100	100

3. Descriptive results

Judging by the figures in Bjarnason and Sigfusdottir's (2002) study, the number of sociologists in the Nordic countries has increased during the past few years. There were 271 faculty members in 2000, whereas in March 2005 the same departments' total faculty was 353 (Table 2). Thirteen per cent did not show up on GS. A third did not have publications in GS (excluding conference papers, working papers, etc.). By the same token, the proportion of faculty with no publication in SSCI or CSA's Sociological Abstracts (SA) in 2000 was 31 per cent (Bjarnason and Sigfusdottir, 2002). Because our research interest is to consider scholars with publications, the final multi-level analysis consists of faculty with at least one publication ($n = 240$).

Sociology departments in Sweden are the biggest on average, while Finland's and Iceland's departments are the smallest. Table 2 also shows that Iceland has the biggest proportion of faculty with publications and Norway the smallest. However, these publication numbers should be treated with caution, as they do not take into account the amount of resources; in terms of effective use of resources the figures do not necessarily represent 'good' and 'bad' departments, because the resources available and the composition of personnel differ from one university to the next. Only output is measured; input is omitted from the analysis, which is often the case in the so-called university quality rankings. The highest proportion of professors among the faculty can be found in Iceland, where 4 members out of 7 are professors. The figure is quite different in Sweden, where 33 members out of 163 have professorial status. Professor emeritus is also a position that varies in Nordic countries. In Denmark and Iceland it is not used at all, whereas in Sweden, Finland and Norway the emeritus professor proportion is almost the same (5–6 per cent of the total faculty).

Table 3, which portrays our data as a whole, indicates that Iceland has most publications per faculty (4.3). However, this success does not persist in terms of impact and web visibility, where Iceland's placing is below the average. Denmark is the most powerful country when impact (8.3 citations per faculty) and web visibility (15.4 hits per faculty) are considered. Sweden is also strong in terms of impact and web visibility.

Considered at the departmental level, Umeå University, the University of Helsinki and the University of Stockholm almost reach the publication level of the University of Iceland (4.3). Umeå University contrasts considerably with Bjarnason and Sigfusdottir's (2002) study, in which it was among the universities with the least publications. The universities with fewer than two publications per faculty are the University of Tromsø, the University of Bergen, Åbo Academy, the University of Turku and Lund University. Like Umeå, Åbo Academy's ranking differs between the SSCI or the SA and GS: in Bjarnason and Sigfusdottir's article (2002), Åbo Academy's publication number per faculty was above average. Differences in the order of rankings show that the criteria (or inclusion mechanisms) for measuring scientific output differ between GS and Thomson Scientific or CSA. Consequently, different research profiles amount to different outcomes.

As in Bjarnason and Sigfusdottir's data, the University of Stockholm shows its strength in impact (9.7 citations per faculty). The Copenhagen Business School, which had a low position in Bjarnason and Sigfusdottir's (2002) research, also has 9.7 citations per faculty member in our data. In addition, the University of Oslo and Umeå University are strong in citations. As with publications, small sociology departments have the lowest impact, the Universities of Turku, Jyväskylä and Bergen having fewer than three citations per faculty.

Umeå University is above other departments with 22.9 hits per faculty in web visibility, the Universities of Stockholm and Helsinki coming second and third. Below the average level for hits are the University of Tromsø and the University of Turku.

Table 4, which includes scholars with at least one publication and represents the data used in the multi-level analysis, demonstrates that women are a minority group in Nordic sociology

Table 2 *Faculty at 16 sociology departments in five Nordic countries*

	Professor	Other faculty	Professor emeritus	Total faculty	Faculty with publications in GS*	Faculty with publications out of total faculty (%)
Nordic countries						
Sweden	33	121	9	163	108	66
Finland	20	50	4	74	52	70
Norway	30	29	4	63	41	65
Denmark	14	32	0	46	34	74
Iceland	4	3	0	7	6	86
Nordic sociology departments						
Åbo Academy	1	4	0	5	3	60
Copenhagen Business School	11	20	0	31	22	71
Göteborg University	4	24	3	31	20	65
Lund University	9	28	0	37	21	57
Umeå University	6	24	0	30	24	80
University of Tromsø	4	5	0	9	5	56
University of Bergen	8	12	2	22	14	64
University of Copenhagen	3	12	0	15	12	80
University of Helsinki	8	18	2	28	19	68
University of Iceland	4	3	0	7	6	86
University of Jyväskylä	2	7	0	9	7	78
University of Oslo	18	12	2	32	22	69
University of Stockholm	7	24	1	32	23	72
University of Tampere	7	16	0	23	18	78
University of Turku	2	5	2	9	5	56
Uppsala University	7	21	5	33	20	61
Total	101	235	17	353	241	68

* Because of missing data, one case was removed from multilevel regression analysis.

Table 3 *Total and mean number of publications, citations and hits in Google Scholar at 16 sociology departments in five Nordic countries* (n = 353)

	Publications[1]		Citations[2]		Hits[3]	
	Total	Per faculty	Total	Per faculty	Total	Per faculty
Country						
Sweden	499	3.1	1105	6.8	2308	14.2
Finland	214	2.9	385	5.2	768	10.4
Norway	164	2.6	383	6.1	679	10.8
Denmark	131	2.9	380	8.3	707	15.4
Iceland	30	4.3	27	3.9	55	7.9
Department						
Åbo Academy	8	1.6	18	3.6	34	6.8
Copenhagen Business School	85	2.7	299	9.7	503	16.2
Göteborg University	79	2.6	141	4.6	362	11.7
Lund University	71	1.9	143	3.9	275	7.4
Umeå University	120	4.0	278	9.3	688	22.9
University of Tromsø	9	1.0	29	3.2	24	2.7
University of Bergen	35	1.6	61	2.8	162	7.4
University of Copenhagen	46	3.1	81	5.4	204	13.6
University of Helsinki	107	3.8	192	6.9	455	16.3
University of Iceland	30	4.3	27	3.9	55	7.9
University of Jyväskylä	27	3.0	24	2.7	65	7.2
University of Oslo	120	3.8	293	9.2	493	15.4
University of Stockholm	124	3.9	309	9.7	545	17.0
University of Tampere	58	2.5	131	5.7	178	7.7
University of Turku	14	1.6	20	2.2	36	4.0
Uppsala University	105	3.2	234	7.1	438	13.3
Total	1038	2.9	2280	6.5	4517	12.8

[1]Maximum number of publications is limited to 10.
[2]Maximum number of citations is limited to 100. Citation number has been drawn from the individual's most cited publication.
[3]Maximum number of hits is limited to 100.

departments, men being 63.5 per cent of the total. In fact, the same holds true for the whole faculty (353), in which 62.9 per cent are male.

Monographs, edited collections and articles in international refereed journals seem equally strong in attracting citations. International refereed articles are the most cited individual publication type with 40 per cent, while monographs and article collections, both in national languages and in English, comprise together over 40 per cent of the most cited publications. Other international and national articles are clearly less prominent among the most cited publications.

According to Table 4, the distribution of publications and citations among researchers is skewed, which is a typical finding in bibliometric measurements, deriving from the cumulative nature of science. The more one has published, the easier it is to publish one more, and the more visible one is – measured by citations – the easier it is to be cited (see, e.g., Cole and Cole, 1973: 119–20; Price, 1986: 38–45). The skew pattern of publishing productivity was first noticed by Lotka (1926) and has been repeated in a number of studies in all disciplines, also in social sciences (e.g. Cole and Cole, 1973; Kyvik, 1991; Phelan, 1995). Of those scholars with publications, 67 per cent have at most 5; only 10 per cent have at least 10. The average is 4.3

Table 4 *Descriptive statistics. Faculties without publications are excluded (*n = 240*) in March 2005*

	%	Mean	SD	Range
Position				
Professor	37.3			
Other faculty	58.5			
Emeritus professor	4.1			
Sex				
Female	36.5			
Male	63.5			
Type of most cited publication				
International monograph/ed. collection	18.6			
National monograph/ed. collection	23.7			
Article in international refereed journal	40.3			
Other international article	13.1			
National article	4.2			
No. of publications[1]		4.2	3.2	1–10
1–5 publications	67.6			
6–9 publications	22.0			
10 or more publications	10.4			
Age of most cited publication		7.9	4.5	0–23
0–10 years old	75.9			
11–23 years old	24.1			
Citations[2]		9.0	14.5	0–100
No citations	9.8			
1–5 citations	49.3			
6–9 citations	18.3			
10–49 citations	20.0			
At least 50 citations	2.6			
Hits[3]		17.4	20.6	1–100
1–5 hits	29.5			
6–9 hits	18.4			
10–49 hits	44.4			
At least 50 hits	7.7			

[1]Maximum number of publications is limited to 10.
[2]Maximum number of citations is limited to 100.
[3]Maximum number of hits is limited to 100.

when the maximum is limited to 10 publications. Twenty-three per cent of scholars have at least 10 citations, 10 per cent of scholars with at least one publication being left without citations. An average value for citations is 9 where the maximum is limited to 100 citations. In terms of web hits, the average visibility is 17 hits per scholar, with the maximum limited to 100 hits.[1] The mean age of the most cited publication is 8 years.

4. Multi-level explanations of web visibility and citation patterns

Through the multi-level analysis, we trace the relations of various potentially influential factors of web visibility of Nordic sociologists; the position and sex of the author, productivity, the age and type of the most influential publication and the effect of the departmental level. The data

have been subjected to multi-level analysis, which takes into account the nested structure of the data and allows variation to be examined at two levels: 1) author and 2) departmental. The multi-level linear regression model is fitted separately for the web hits and the citations on GS.

The separate models of citations and web hits allow us to determine whether similar factors influence citations and web visibility. The relationship between web visibility and impact is also examined. Furthermore, we consider the degree to which citation patterns in publications available on the web are similar to those in international refereed articles in the databases. Analysis of the impact of publication type is difficult, however, as we have no standard impact factors on other types of publication. We compare the citation frequency of the most cited publication types to estimate its impact on citations and web hits. Since the Nordic countries' science systems have their own characteristics as small, rather peripheral, systems on the global scale, we cannot determine the validity of our findings beyond Nordic countries.

The descriptive statistics for the data in these analyses are given in Table 4. The analysis concerns 240 faculty members for whom GS found 4295 hits in March 2005. The multi-level Poisson regression model was fitted because of the skew distribution of the explanatory variables, but since the findings did not differ markedly from the multi-level linear regression model, only the normal linear models are reported in Tables 5 and 6. The distortion of dependent variables was corrected by limiting the high end of hits and citations to 100. This affected the two most cited publications with 198 and 1328 citations and the four authors with most hits, ranging from 121 to 378.

Patterns of web hits

At the author level, a number of factors are statistically related to the number of hits on GS. Female scholars have far fewer hits than men. Position is closely linked with hits, such that emeritus professors have the most and professors almost as many. The type and, in particular, the place of publication are predictors of the number of hits, i.e. authors whose most influential publication is international gain more hits than those whose top publication is a national one. The age of the most cited publication is also positively associated with the number of hits. The multivariate model shows that controlling the effects of the others slightly weakens the effects of all these factors.

The variation in the number of GS hits is not only between individual researchers but to some extent between departments as well. Since the departmental level explains 4.1 per cent of the variance in web hits, some activities seem to be departmentally bound such that particular departments are slightly preferred in activities visible as GS hits**.** Variation between these departments is partly explained by the department's number of faculty, bigger departments producing significantly more hits than smaller ones, even when the effects of the author-level factors are taken into account. The countries do not differ significantly from each other.

According to the random coefficient model (see Table 5), the differences between females and males are similar in all departments, but the effect of position varies significantly across departments. A more detailed examination shows that individual top scholars tend to increase the difference in the visibility between professors and other faculty. The top performers' achievements do not impact equally with other researchers' performance at the department. This suggests that individual top performers do not necessarily enhance the level of the entire department (Smeby and Try, 2005).

Citation patterns on the web

The bivariate relations between author level factors and the number of citations follow a similar pattern to web hits. First, women are cited significantly less often than men are. Professors and emeritus professors are cited significantly more than other staff. The type of the most cited publication predicts the number of citations, such that international monographs

Table 5 *Multi-level linear regression analysis of hits on Google Scholar. Faculties without publications are excluded (*n = 240*)*

	Bivariate model		Multivariate model*	
	Coefficient estimate	*p*-value	Coefficient estimate	*p*-value
Fixed effects				
Author level (level 1)				
Sex[a]		<0.001		0.060
Female	−9.4		−6.6	
Position[b]		<0.001		0.025
Professor	13.3	<0.001	9.1	0.014
Emeritus professor	16.1	0.016	12.0	0.143
Type of most cited publication[c]		0.002		<0.001
International monograph/ed. collection	19.0	0.003	12.2	0.000
National monograph/ed. collection	3.9	0.534	1.9	0.395
Article in international refereed journal	12.5	0.036	11.2	0.006
Other international article	12.1	0.071	4.4	0.336
Age of most cited publication	1.4	<0.001	0.9	0.004
Department level (level 2)				
Country[d]		0.270		–
Sweden	11.7	0.192	–	
Finland	5.4	0.458	–	
Norway	6.9	0.554	–	
Denmark	11.7	0.215	–	
No. of faculties	0.5	0.005	0.5	0.010
Random effects				
Variance at level 2				
Intercept		0.064		0.124
Sex		0.393		
Position		0.039		

[a]Males are contrast.
[b]Entered as a block, other faculties are contrast.
[c]Entered as a block, national articles are contrast.
[d]Entered as a block, Iceland is contrast.
*Only significant fixed effects (*p* < 0.05) in the bivariate model are included in the multivariate model.

draw far more citations than any other kind of publication. International refereed journals, only the second most cited type of publication, are to some degree more cited than other international articles or national publications. Not surprisingly, the age of the publication correlates strongly with the number of citations, each year adding one citation on average.

However, the effects of sex, position and age of publication largely vanish when the effect of individual visibility on the web is added to the model. Although female scholars seem to attract far fewer citations, this difference turns out to be mostly an outcome of the individual differences in visibility indicated in Table 5. Both individual web visibility and productivity are strongly associated with web impact. Each new publication adds more than two new citations to the most cited publication. Similarly, web visibility and citations go almost hand in hand. According to the model, the greater the GS visibility, the more citations the author draws. An active publishing history increases the probability of citations. In the multivariate model, only individual visibility and type of the most cited publication remain significant predictors of the probability of citations. The fact that monographs are cited on average more

Table 6 Multi-level linear regression analysis of citations on Google Scholar. Faculties without publications are excluded (n = 240)

	Bivariate model		Multivariate model*	
	Coefficient estimate	*p*-value	Coefficient estimate	*p*-value
Fixed effects				
Author level (level 1)				
Sex[a]		0.001		0.155
Female	−6.3		−1.3	
Position[b]		<0.001		0.878
Professor	8.3	<0.001	0.5	0.625
Emeritus professor	9.0	0.051	−0.7	0.861
Type of most cited publication[c]		0.002		0.002
International monograph/other book	13.3	0.003	3.5	0.137
National monograph/other book	3.5	0.412	1.5	0.102
Article in international refereed journal	8.8	0.032	2.9	0.006
Other international article	5.5	0.231	−0.5	0.753
Age of most cited publication	1.0	0.001	0.3	0.146
No. of hits	0.5	<0.001	0.5	<0.001
No. of publications	2.7	<0.001	**	
Department level (level 2)				
Country[d]		0.739		–
Sweden	5.0	0.417	–	
Finland	3.0	0.636	–	
Norway	4.9	0.447	–	
Denmark	6.7	0.306	–	
No. of faculties	0.2	0.254	–	–
Hits per faculty member	0.5	0.004	−0.07	0.519
Publications per faculty	2.5	0.021	**	
Random effects				
Variance at level 2				
Intercept		0.608		0.891
Sex		0.972		
Position		0.102		
No. of hits		<0.001		

[a]Males are contrast.
[b]Entered as a block, other faculties are contrast.
[c]Entered as a block, national articles are contrast.
[d]Entered as a block, Iceland is contrast.
*Only significant fixed effects (*p* < 0.05) in the bivariate model are included in the multivariate model.
**Because of the dependence of number of publications and number of hits, only the number of hits is included in the multivariate model.

than articles in both international and national journals suggests the salience of the monograph format as references in the social sciences. Controlling for the effect of web visibility diminishes the impact of international publication types compared to national ones, which might reflect the fact that productive authors also tend to write the types of publication that produce the most citations.

Unlike the case of web hits, departmental level explains only a small proportion of variation (0.3 per cent) in the number of citations in our data. In other words, compared to the variation across individual authors, the variation between departments in terms of citations is almost non-existent. The differences between countries do not appear to be statistically significant.

Since the average number of hits is the only departmental factor that is significantly related to the number of citations, the productive departments also attract significantly more citations. However, this is only due to the author-level relation between web hits and citations, since the departmental-level effect disappears when the author-level effect is taken into account.

The correlation between hits and citations varies significantly across departments. In some departments (Göteborg, Lund, Turku and Åbo), the most cited authors are among the least visible authors within the department measured by GS hits.

5. Discussion

Citations appear to be more closely tied to individuals, while hits are more related to positions and departments. Academic recognition turns out to be individual and science an individualistic institution. The author's position correlates heavily with web hits. Position, along with age, seems to bring web visibility. The connection between position and web visibility is probably explained by the fact that professorships are gained through an academic evaluation process in which productivity in publishing is a central criterion. Furthermore, some activities and some forms of acknowledgement are position bound. Higher-ranked scholars gain more encouragement to publish, and better publication opportunities, despite anonymous refereeing practices. They may also improve the chances of cooperation and co-authoring of publications that may enhance visibility and impact. Furthermore, students tend to acknowledge professors in their publications. Female authors are less visible on the web, which also explains most of the gender differences in the number of citations. Gender differences in productivity have been found in various studies in several countries, the lower publication frequencies of women being attributed to marital status, child care, structural location and lack of scientific collaboration, and so on (Kyvik, 1991; Kyvik and Teigen, 1996; Xie and Shauman, 1998; Prpic, 2002). Our data do not allow us to trace where the gender difference comes from, but the smaller number of women in the faculties supports the view that they are still marginal in academia, which perhaps keeps them underrepresented among gatekeepers in publication, web and GS activities. It seems likely that structural historical reasons still explain the poorer visibility and impact of women in the current academic world. Grey male professor panthers still dominate the faculties and web visibility.

Since the relationship between web visibility and citations is probably mutually reinforcing, active publishing increases the likelihood of citations which, as a form of recognition, improve the chance of further publications. However, the causality of the relationship between citations and hits cannot be examined through the cross-sectional data and regression model techniques used in this article. Thus, only hypothetical arguments about mutual dependence can be advanced. It is obvious that without publications there cannot be citations. On the other hand, recognition brings publication opportunities that add further recognition. This self-reinforcing and cumulative nature of scientific recognition, sometimes called the Matthew effect, has been found early on in science studies (Merton, 1973: 443–7). Individual recognition translates into visible activities like those of GS hits. A strong correlation between position and web visibility suggests that a similar kind of circle may exist between web visibility and position. In all, a mutually reinforcing configuration between web visibility, citations and position seems to prevail, so that web visibility, citations and position mutually influence each other. Networking and co-authorships may be the intertwining factors that tie the visibility, impact and position together. Both networking and co-authorship would merit closer study.

Nordic departments of sociology also vary in terms of average web visibility. The size of the department correlates strongly with web visibility. Bigger departments are more visible because of their better resources or more powerful networks. However, departments do not seem to support individual impact; although they increase web visibility, they do not boost

the citations of their members. The departments themselves may differ critically in terms of their average productivity and recognition of their faculty members, as shown in the descriptive results, but the departmental level does not have explanatory potential for citations for individuals on GS. The best departments may be able to recruit the most productive researchers, but the departments as such do not attract more citations of their staff. In other words, there are no centres of excellence among Nordic sociology departments. Interestingly, contrary conclusions can be drawn from this fact. First, the science policy which attempts to develop stronger units, or even centres of excellence, does not seem to have succeeded in sociology in Nordic countries. We may note either that policy supporting the facilitation of stronger units has not been sufficient, or that direct support to individual researchers may turn out to be the more efficient way to influence the increase of scientific productivity as a whole.

Monographs and article collections seem to have maintained their standing as references in the social sciences. Sixty per cent of the most influential publications of the Nordic sociology departments' staff on GS are other than international refereed articles. International monographs and edited collections attract more citations on average than other types of publication. As far as the number of citations per publication goes, international refereed articles have not become the dominant type of publication in sociology. However, they have become the most cited publication type in Nordic sociology, attracting the majority of the citations in our data. Nevertheless, the number of references to international books in particular shows that publication types other than refereed articles have not lost their significance. Consequently, studies concerning citation patterns of refereed articles do not cover the full range of recognition given in citations. This is particularly salient given that the publication types are not distributed evenly between scholars, i.e. the individual research profiles may vary such that some researchers are more prone to produce other types of publications than refereed articles, such as monographs that social scientists seem to value more than refereed articles.

The remaining salience of books and extended prose in sociology suggests that practices and functions of sociology have remained different from the natural sciences. It also shows that current science policies arguably favouring certain fields of science over others have not standardized publishing behaviour in the case of Nordic sociology – at least not yet. Lack of uniform mode of scientific publishing does not necessarily mean that policy pressures for publishing in journals do not exist. Still, perhaps the strongest incentive for doing so seems to be lacking, namely funding. Most of the systems for university core funding in Nordic countries lack the element of rewarding universities for journal publications (Auranen et al., 2005: 34–8). The system in Norway contains such an element, but it was implemented only after our data were collected.

There are also other reasons for the persistence of books as publication format in sociology. Sociology is still and perhaps permanently a distinct form of knowledge, a hybrid of the scientific and literary traditions (Lepenies, 1988). It may have functions other than technical interest, such as (hermeneutical) understanding of social phenomena and criticism of undesired forms of social development, which are served best by forms of prose other than scientific articles (Habermas, 1971; von Wright, 1971). Following Kyvik's (1991: 71–2) line of argument, we can point out three explanations for the persistent differences between the publication patterns in the social and natural sciences. The social sciences do not provide mechanical explanations of facts; they account for historical, context-bound phenomena that cannot be purified from a certain degree of hermeneutic understanding. Sociological accounts cannot become value-free, which makes rhetorical persuasion of the audience an inescapable part of the sociological trade. Second, sociology is not a science of discovery where competition for priority in publishing makes shorter formats a necessity. Third, sociological publications are often intended for policy processes requiring extensive argument. The communal values and norms of sociology may also have supported longer prose as its jewel (Becher and Trowler, 2001: 75–6). If writing

books is valued among sociologists and they are rewarded for it (e.g. in recruitment), they will keep on writing books, despite possible external pressures for article publishing. For these reasons, the exclusive use of refereed articles or direct comparisons with the natural sciences may ignore important and constitutive aspects of the social sciences. Furthermore, individual authors are likely to vary in terms of their scholarly output styles. Even the most productive and recognized scholars of social sciences may be neglected if article productivity is the only measurement technique used.

On an aggregate level, GS seems to amount to findings largely similar to those in citation databases, although the beta version of GS covered an estimated half of the articles available in citation databases. For instance, both SSCI or SA and GS showed no publications for about one-third of the teaching staff in Nordic sociology departments, although we may expect that they do have some. There are also some systematic differences. The success of individual departments or authors may vary significantly between GS and citation databases. Kousha and Thelwall (2007) found that fields of science are unequally represented in GS and citation databases. Likewise, individual publications or publishers may be completely absent, amounting to systematic differences between GS and citation databases (Jacsó, 2005). Inclusion criteria of what is considered reportable scientific product vary between citation databases and GS. Consequently, different media produce different outcomes depending on how well the activities by an individual author or department fit within the set of parameters applied. It seems likely that new, less conventional fields of research are better represented in GS, because the providers of citation databases tend to be slow and 'cautious' in accepting new journals. Within Nordic sociology departments for instance, Umeå seems to be publishing widely in new areas that are well covered in GS, but considerably less in SSCI or SA. Åbo, in contrast, tends to publish in areas represented well in SSCI or SA, but not in GS (at least in the beta-testing phase in 2005). At the level of individual researchers, differences in outcomes can be even greater. Some research profiles simply fit better within the set of parameters applied in the media in question. In all, citation indexes give a more stable picture of academic work. Without further analysis, no individual method for measuring scientific output should be accepted as neutral and objective. A combination of measures or an adapted measurement whose criteria have been purposefully selected would yield a more balanced outcome. A form of capture–recapture method might be used to estimate the overall productivity that would not be dependent on any single set of inclusion criteria (cf. Fienberg, 1992).

This study supports the view that internationalization of the social sciences is growing. Although international refereed articles have not yet become dominant, international publications dominate the scene on GS. International monographs are particularly frequently cited; refereed and other international articles being cited almost as often. National publications produce considerably fewer citations. National monographs may also gain some recognition in terms of citations, but articles published nationally do not seem to draw significant numbers of citations; obviously so, considering the fact that the international audience is usually much larger than the national one. These findings do not seem to differ between citation indexes and GS.

6. Conclusions

Research findings are increasingly available on the web, which offers enhanced opportunities for web-based measurement of academic productivity. Individual systems of measurement differ in their inclusion criteria, amounting to significantly different representations of individual researchers and departments. GS may be more open to new research fields than established citation indexes, which are slow and cautious in accepting publishing outlets into their databases. Differences in the inclusion criteria mean that the serious measurement of scientific

productivity should be based on several sets of criteria, and that the consequences of the selection of criteria should be discussed. GS does not differ from citation indexes in its emphasis on international publishing. On the contrary, the growing importance of the web emphasizes international publishing and wider international networks that have sufficient mass to make them visible. Nordic sociology has met the challenge of internationalization. Seventy per cent of the most cited Nordic sociology publications in GS are international. The remaining salience of monographs and other books shows that sociology has not become solely an article production industry, but has retained a style distinct from the natural sciences. In many other respects, Nordic sociology seems to follow the patterns of general scholarly development. The distribution of academic productivity is skewed in Nordic sociology, as elsewhere. Bigger departments produce significantly higher web visibility that may become increasingly salient in the future. However, departmental affiliations do not explain the differences in citations between individuals. There do not seem to be any Nordic sociology centres of excellence that attract recognition to their faculty.

Note

1. Note that figures refer to the results in March 2005. Subsequent development of the Google Scholar database has generally led to some degree of increase in hits and citations.

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